



File: 38050-03/ Nicola Valley Aggregates

March 31, 2021

To: Vanessa Dunae, Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
Via email to Vanessa.Dunae@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.
David.Thomson@gov.bc.ca

Re: Review of Active Earth Engineering Ltd (Active Earth) Reports: “Revised Hydrogeological Study” and “Preliminary Hydrogeological Study Response”

This memo is in response to a request by yourself to review the aforementioned reports as they relate to a Ministry of Energy, Mines and Petroleum Resources (EMPR) permit application for the Nicola Valley Aggregates near Merritt, BC. The following summarizes my review of these reports, with reference to my previous review and other reports.

BACKGROUND

Nicola Valley Aggregates (NVA) has submitted a permit application to EMPR for a sand and gravel quarry at 701 Highway 8 near Merritt, BC. NVA retained Active Earth Engineering Ltd. (AE) to undertake a *Preliminary Hydrogeological Study* (Active Earth, 2019). The Active Earth report was subsequently peer reviewed by Hemmera Envirochem Inc (Hemmera, 2020). In their peer review, Hemmera references the *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, as a reference point for their review.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) reviewed and commented on the aforementioned documents as it pertains to groundwater and provided those comments to EMPR. FLNRORD's review was dated September 23, 2020 and professionally authenticated October 9, 2020. Active Earth Engineering Ltd. generated two

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reports "*Revised Hydrogeological Study*" (September 28, 2020) and "*Preliminary Hydrogeological Study Response*" (December 3, 2020).

Active Earth's September, 2020 revised study (AE, 2020a) and the December 2020 response (AE, 2020b) are referenced throughout.

Summary of the Revised Hydrogeological Study (September 2020)

The purpose of the September *Revised Hydrogeological Study* is stated in the report as "... to complete a hydrogeological review and provide an opinion on potential impacts of the proposed gravel mining on the groundwater and surface water resources and provide mitigation measures if necessary."

This response does not offer much new information. A field-verified survey to identify other potentially affected downgradient water users has not been done although the BC Water Resources Atlas shows several users to exist immediately downgradient of the proposed pit area. This is a significant deficiency in their study.

Summary of Preliminary Hydrogeological Study Response (December 2020)

The December response is a review of Hemmera's July 2020 evaluation and FLNRORD's September 2020 review of the same. The response does provide some additional background information such as recharge values and clarifies that no water will be pumped as a result of mining operations. Statements like "...it is not necessary to install 3 monitoring wells to determine the general groundwater flow direction at the Site" without investigating known downgradient users (Figure 1) suggest a reluctance to move toward the most basic standards of a hydrogeological study supported by the Guide, FLNRORD and Hemerra. Installing a monitoring well after a resource extraction project has commenced operation, as suggested, generally has little-to-no value.

REVIEW OF THE GUIDE REQUIREMENTS

Note that staff with EMPR may have a general understanding or established best practices relative to applicants' following of the Guide, which can be brought to bear on my general observations. They also will be able to confirm whether some items such as knowledge of depth to groundwater is required in the Notice of Work as suggested by the Guide, or whether such information needs can be deferred until after mining begins, as suggested by the applicant (AE, 2020b).

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The Guide does indicate that the following information about groundwater should be provided in Mine Permit Applications:

- *Describe potential impacts of the proposed operation on groundwater quantity and quality;*
- ***If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required;***
- *Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required;*
- *minimize sediment and pollutants reaching natural and man-made surface water, groundwater and aquatic environments;*
- *Information will be required to demonstrate the proximity of the proposed excavation to the water table;*
- *The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers;*
- *The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level; and,*
- *Excavations below the water table will require special approval.*

The bolding above indicates the key missing information in the Reports. The apparent down slope users have not been field-verified, as recommended above, so the degree of hydrogeological study required is not apparent. Figure 1 from FLNRORD's earlier 2020 response, and reproduced below, indicates existing water wells of interest that are available to review from a desktop analysis as well as a field visit. In the absence of this knowledge it is difficult to design appropriate site-specific mitigative measures. More specifically, it is best practice for aggregate operators to design site-specific measures in regards to groundwater protection, then additional site-specific information about groundwater is required relative to these downslope users.

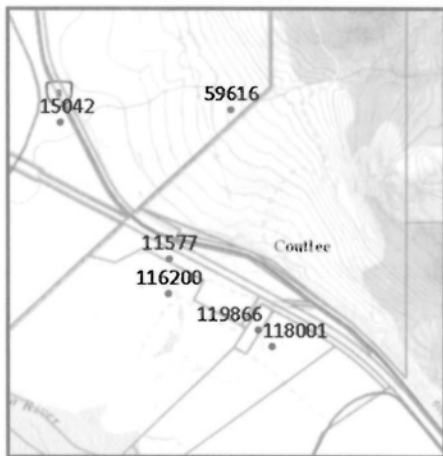


Figure 1: Water wells in the vicinity of the site, accessed from GWELLS on September 14, 2020

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Hemerra also notes that potential impacts to groundwater from gravel pit development are indicated in the *Aggregate Operators Best Management Practices Handbook for British Columbia* (Province of BC, 2002).

AQUIFERS and GROUNDWATER WELLS

FLNRORD's previous review noted the lack of aquifer mapping across the pit area doesn't preclude its potential presence. This is acknowledged in AE (2020a) Section 4.3 where it is stated that an unmapped overburden aquifer is present beneath the Site. However, in Section 4.3.1, it is stated that the "Upper Merritt Unconfined Watertable Aquifer" is "...not located within the boundaries of the subject site and is hydraulically connected to the Nicola River." AE (2020b) confirm there is no mapped aquifer beneath the site footprint. However, it can be inferred from these two statements that the shallow aquifer at the quarry is likely hydraulically connected to a mapped aquifer.

In their review of groundwater records, Active Earth (2019) stated "In addition, several private wells are present south of the Site, but are not included in the provincial WELLS database." The same statement, verbatim (including "no" instead of "not") was made in AE 2020(a).

With respect to the downgradient private wells (shown in Figure 1 but not necessarily limited to those), FLNRORD restate their previous comment:

"This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application."

A field-verified survey of the unmapped groundwater wells south of the site (ie, confirming whether groundwater flows toward the wells from the gravel pit) does not appear to have been done. FLNRORD's opinion regarding this item remains unchanged. AE (2020b) state "If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required (Section 6)." This wording is taken verbatim from the Guide, except for the "Section 6" reference. A "Section 6" could not be found in AE's 2020b report and Section 6 of AE's 2020a report does not address this. Regardless, since online mapping and statements by AE make it clear there are down slope users, the apparent reluctance to install three wells to determine groundwater travel time and inform the ability to design site-specific mitigation measures or react to unplanned releases of contaminants is not understood.

Section 5 of AE (2020a) states that "Groundwater flow within the unconfined aquifer is bedrock controlled on Site. The shallow groundwater is perched over bedrock within the overburden

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soils. Groundwater flow is assumed to be south.” This statement is confusing as “perched” groundwater by definition cannot flow. The statement seems to originate from the Hemmera report, although it is not referenced within AE 2020a. AE 2020b does state “The well logs do not indicate any perched water tables.”, adding to the confusion surrounding this.

The conclusions (AE, 2020b) state AE have assumed groundwater flow is to the south and “...the receiving environment includes groundwater underlying the site, as well as Parry’s Spring and the Upper Merritt Unconfined Water Table Aquifer. These water resources require consideration for protection via mitigation measures described below.”

The first two sentences of recommendations 10 and 13 regarding installation of a single monitoring well appear to be identical. As noted above, three monitoring wells is a minimum standard in the profession of hydrogeology to obtain a basic understanding of groundwater movement, elevation changes and baseline/operational quality. Those three wells could also inform an improved cross-section, as well as providing the applicant with a better idea of the grading and depth of the resource.

SUMMARY AND RECOMMENDATIONS

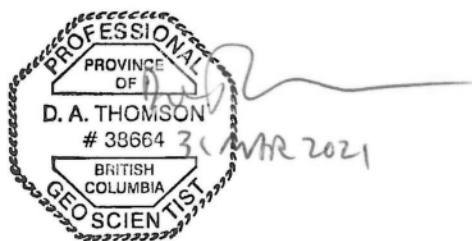
Hemmera and FLNRORD recommended a revised hydrogeological study. The two documents provided (AE 2020a and 2020b) add some clarity but fail to address key questions as noted and sometimes add further confusion.

If the applicant surveys downslope water users then a groundwater monitoring response plan can be utilized should complaints arise if the mine becomes operational.

Hemmera also note that assessment of potential impacts to downgradient users require consideration of pit closure. The applicant states the pit will not be filled in, but do not seem to address this question. Monitoring and regular reporting and interpretation of groundwater data could inform adaptive management of daily operations and final reclamation planning.

Please contact me with any questions.

Signed,



David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science,
Vernon, British Columbia.

To: Vanessa Dunae

References

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study*, April 10, 2019. Project 1887.

Active Earth Engineering Ltd, 2020a. *Revised Hydrogeological Study*. September 28, 2020. Project 1887.

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study Response*. December 3, 2020. Project 1887.

Hemmera Envirochem Inc., 2020. *Evaluation of Nicola Valley Aggregates Permit Application Final Report*. Prepared for Lower Nicola Indian Band, Merritt, BC. Project 104684-01, July 24, 2020.

Province of British Columbia, Ministry of Energy and Mines, 2002. *Aggregate Operators Best Management Practices Handbook for British Columbia, Volume 2: Best Management Practices*. April 2002.

Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division, 2010. *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia*. February 2010.

Province of British Columbia, 2016. *Determining the Likelihood of Hydraulic Connection – Guidance for the Purpose of Apportioning Demand from Diversion of Groundwater on Streams*. Version 1.0. Water Science Series, WSS2016-01. Province of British Columbia, Victoria BC.

From: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)

To: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)

Subject: NVA review

Sent: 03/30/2021 20:29:00

Attachments: image001.jpg

Message Body:

Apologies for being so late with this. I told Vanessa end of the month so that was good. FYI I also was planning to go to Nicola Dam Thursday to help Sarah install loggers. We coordinated last week, but I'm not sure if you have seen any direction to put a hold on field work/travel?

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Aggregates\2021\NVA Review RH March 2021 DRAFT.docx

David Thomson, M.Sc., P.Geo.

Regional Hydrogeologist, Groundwater Science, South Area

Ministry of Forests, Lands and Natural Resource Operations and Rural Development

2501-14th Ave, Vernon, BC V1T 8Z1

VOIP 778 943-6924

From: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Cc: Epp, Michael ENV:EX (Michael.Epp@gov.bc.ca)
Subject: RE: FN question re: water use regulations
Sent: 04/15/2021 18:45:10
Message Body:

Hi David ? this is super helpful. Thank you so much!

I will include these links in our response and hope to hear back from the FN on April 28. If they express an interest in learning more about water use policies, I may follow up with Michael.

I appreciate you taking the time to gather these resources and explain the division of responsibility across provincial agencies. Hope you both have a good day and great weekend.

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines & Low Carbon Innovation
vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: April 14, 2021 4:47 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Epp, Michael ENV:EX <Michael.Epp@gov.bc.ca>
Subject: RE: FN question re: water use regulations

Hi Vanessa ? those are fairly high-level questions and I think that page is one of the better places to start for a high-level response. As discussed water quality is generally the domain of ENV and water quantity/use is something that generally falls within FLNRORD.

The link below summarizes a variety of water-related Provincial Acts and Regulations

<https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/laws-rules>

More specific to your questions there's a couple useful PDFs on the right hand side of the public facing page you sent that address the mineral exploration question.

There's a number of avenues to address non-compliance with these and other regulations. FLNRORD had a Compliance and Enforcement branch <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/natural-resource-law-enforcement/natural-resource-officers>

This page has links related to water quality, including the RAPP line for reporting water pollution issues.
<https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality>

It occurs to me that our water policy folks might be best situated to provide a more detailed response if required. While they don't always work directly with the legislation they are aware of interlinkages and roles and responsibilities. I have cc'd Mike Epp if he has anything to add at this point, and as he may be a useful resource in the event that more focussed questions need answering.

I hope this helps
Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: April 14, 2021 3:05 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: FN question re: water use regulations

Hi David,

Thanks for your time today! As discussed, an Indigenous group is seeking to understand:

?□□□□□□□□ BC's surface and groundwater regulations as they relate to mineral exploration, and
?□□□□□□□□ the penalties for non-compliance of water use regulations.

I want to provide a high level response to each question and as well as links to relevant sections of our public-facing website (e.g. [Water - Province of British Columbia \(gov.bc.ca\)](https://www2.gov.bc.ca/gov/content/water)).

I understand that FLNRORD and ENV may be best positioned to address those topics. Could you recommend somewhere for me to start?

Vanessa Dunae

Senior Negotiations Lead, Regional Operations
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cell (250) 320-8250

From: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Subject: RE: Hydrogeologist request
Sent: 02/17/2021 22:02:13
Attachments: LNIB NVA Issues Tracking Table 2021-02-16.xlsx, image001.jpg
Message Body:

Hi David,

Thanks again for reviewing the reports associated with the Nicola Valley Aggregates permit application. Two questions:

I've transcribed your report into the attached issues tracking table. Could you please review and confirm that I lined everything up correctly?

Since you completed your review, we've received another two hydrological studies from Active Earth/the proponent. Could you review those, or should I check in with Skye and start the review process fresh?

Thanks,

Vanessa

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: October 9, 2020 10:18 AM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Subject: RE: Hydrogeologist request

Good morning ? please find attached my response. Also attached is an authenticated version of Hemmera?s evaluation, as explained toward the end of my response.

Please contact me with any questions
Dave

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: September 10, 2020 4:55 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa,

Our Regional Hydrogeologist, David Thomson, will be able to assist with this review. I have cc'd David on this note. I understand that the review comments are due by October 9th, but preferably sooner. If you have any further information related to this review, please send to David directly.

Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 3:05 PM

To: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Thanks, Trevor. How about a month from now ? Friday, October 9?

Earlier is welcomed but I imagine your team is as busy as we are. Please let me know if you need more context. Right now, all we have from Lower Nicola Indian Band is the Hemmera report but we may be receiving additional information regarding springs in the area later this month.

From: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Sent: September 10, 2020 2:51 PM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi All,
We can accommodate this request, when do you need the review completed by?

Trevor

Trevor Bohay M.Sc., P.Geo. (he/him)
A/Director, Authorizations
Thompson-Okanagan Region
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
1259 Dalhousie Street
Kamloops, BC

New Phone no: **250.312.7421**

From: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Sent: September 10, 2020 1:14 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: FW: Hydrogeologist request

Hi Vanessa,
I don't have one on staff but Trevor Bohay does (a. Director of Authorizations).

By way of this email, Trevor, can you consider Vanessa's request below?

Thx,
E

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 11:49 AM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: Hydrogeologist request

Hi Eric,

I'm looking for a hydrogeologist to review a report from Lower Nicola Indian Band evaluating the Nicola

Valley Aggregates permit application near Merritt, BC. It's a twelve-page report developed by Hemmera and it references groundwater impacts, which is outside my field of expertise.

Could you please point me in the right direction? I don't know any of our provincial hydrogeologists and was encouraged to reach out to you for advice.

Thanks,

Vanessa Dunae

Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
vanessa.dunae@gov.bc.ca
cell (250) 320-8250

1	Issue Raised by LNB s.16, s.18.1	Source LNB's February Letter; LNB's Cultural Heritage Policy	EMJ Response I understand the situation and I respect the history, the traditions, and the beliefs expressed here. I also understand that LNB has very legitimate high concerns about the archaeological potential of the proposed mine site and fear for their ancestors remains to be disturbed. In addition, I accept the declared rights of LNB to protect LNB's historical and archaeological sites, and recognize LNB's asserted right to use, develop and control the lands, territory and resources of the bench land north of Nicola River. Our ministry standard policy and work procedure for any Notice of Work applications on sites with known medium and high archaeological potential is to ask for an archaeological assessment or study to be carried out by a professional archaeologist. The level of the assessment/study is solely established by the professional without our interference. We only require that the study report, when ready, be sent to us and to the First Nations affected and with interests for the site. The archaeologist, exclusively, establishes if additional in depth studies need to be carried out after the initial study. We also require that a Chance Find Procedure (CFP) is written and submitted to this ministry together with the application and is implemented during operations. This CFP states the actions taken in the event when unknown archaeological sites, relics or human remains would be found. Work is stopped at the location immediately, the government is notified, and so are the FN affected.	FLNR Response This issue is beyond NVA's knowledge as NVA is not aware of any archeology site "approximately 250 meters northwest of NVA's proposed pit." We have spoken to the previous owners (the Poolrys), whose family has owned the Property since the 1950's, and there have never been concerns raised by the LNB indicating any burial sites with crosses or cemeteries on the Subject Property. I am attaching a July 9, 2015 email from Dana Cooper of FLNR stating that the "Provincial records indicate that there are no known archaeological sites recorded on either of the subject properties." However, NVA is still willing to consider the Province's reasonable requests of NVA to conduct an archaeological investigation on its Subject Property to alleviate the concerns of the LNB.	
2	s.16, s.18.1	LNB's February Letter	We respect the right of the members of LNB to use their land in their traditional way including for berry picking or any other traditional use. If a permit would be issued for the proponent, the access to the sites traditionally use by the people of LNB will be required to be open to the members of LNB.		This issue is beyond NVA's knowledge and the onus would be on the LNB to establish (i) where the Adjacent Land is and if it is within or outside the boundary lines of NVA's Property, (ii) the evidence of "intensive land use" and perhaps most importantly whether or not NVA's use and operation of a gravel pit on the subject property would interfere with this particular land use on a go forward basis.
3	s.16, s.18.1	LNB's February Letter	Any known sacred site will be protected. Based on information provided by LNB specifically for the proposed mine site, the areas where people gather water, and where beaver, mink, muskrat, rabbit and coyote trapping areas are known and used by LNB will be assessed and required to be excluded from the mine development if practical. The same for the potlatch sites and story areas. It is essential for LNB to identify any and all of these sites existent on the proposed mine development location and share the information with the ministry so we can evaluate them and require their exclusion from the mine development if practical.		This issue is beyond NVA's knowledge and the same comments in response to issue #2 apply
4	Presence of aquifer beneath the Site: the Preliminary Groundwater Investigation by Active Earth Engineering (2019) at Section 4.3 indicates "no mapped aquifer underlying the site but then in Section 5, describes a "bedrock-contact aquifer with groundwater flow within the unconfined aquifer perched over bedrock within overburden soils. Although there is no mapped aquifer in iMapBC, it does not necessarily mean that one is not present as the aquifer's boundaries shown in the report are based on limited information which may not have been updated with recent information. Unconfined aquifers have been mapped about 600 m south (Upper Merritt Unconfined Aquifer) and around 400 m west (Stumbles Creek Unconfined Aquifer) of the proposed Site. There is no evidence to assume that there is no aquifer beneath and downgradient of the Site given the presence of several wells and a spring (Perry's) in proximity of the southern property boundary.	Hemmera Report at 3	See FLNR Response	It is important to note first that while Figure 2 (Active Earth, 2019) has correctly identified Aquifer 74 as unconfined, the shading does not match the legend. This could lead the reader to believe there is not an unconfined aquifer on the other side of the proposed development. This is important because, as indicated by Hemmera (2020), the lack of aquifer mapping doesn't preclude its potential presence. In the current situation it is reasonable to suspect the proposed quarry footprint may overlie an extension of either of the unconfined aquifers that border the property. [FLNR Review, pp 2-3]	See Report #2, pages 7 to 10 and Appendix A and also see Report #3, page 3
5	Depth of groundwater in the proposed quarry site: s.16	Hemmera Report at 4; LNB's February Letter	See FLNR Response	Delineation of aquifers is often done through review of private well records that were voluntarily submitted to the Province in the past. Active Earth (2019) did this, stating "In addition, several private wells are present south of the Site, but are no [sic] included in the provincial WELLS database." This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application. When accessed September 14, 2020, the GWELLS database showed 4 registered wells south of the site as shown in the screenshot below (Figure 1). Figure 2 (Active Earth, 2019) shows only three wells to be considered as part of the review. WTN 58616 is shown to exist south of the property, but the GWELLS database (accessed September 14, 2020) shows it to be present immediately west of the property. This well record is assigned to Aquifer 725, which is present approximately 10 km west of the site. WTN 15042 is shown in Active Earth's Figure 2 to be immediately south of the southwest property boundary, in contrast to on line mapping that places it to the north west. WTN 11577 is not present in Active Earth's report, but if located correctly in on line mapping indicates groundwater at eight feet below the ground surface. This and other well information noted above needs to be reconciled and incorporated into a more detailed hydrogeological report, and should better inform a revised subsurface cross-section. [FLNR Review, pp.3]	See Report #2, page and also see Report #3, pages 3 to 6
6	s.16	Hemmera Report at 4; LNB's February Letter	See FLNR Response	[...] I agree with Hemmera that Active Earth's report is preliminary and additional work is required to assess potential risks and determine existing information about groundwater presence. Successful implementation of Hemmera's recommendation 3, to monitor groundwater for one year prior to permitting, would be a primary objective in this regard. Doing so may address the following concerns raised by Hemmera: <ul style="list-style-type: none">• Presence of aquifer, water level and bedrock contact (verify conceptual model and depth to groundwater in overburden)(Recommendation 2 and 4);• Groundwater flow direction, hydraulic conductivity and velocity (Perry Spring concern)(Recommendation 4);• Seasonal variance in groundwater levels; and,• Assess potential impacts to downgradient users. Note that a minimum, three wells roughly equidistant from one another are required to determine groundwater flow direction. Therefore implementation of groundwater monitoring to address these concerns should include a network of at least one upgradient well and at least two downgradient wells. They should be monitored for water quality through sampling several times a year (e.g., major ions/potability). Daily monitoring of groundwater levels, best accomplished with dedicated continuous recording dataloggers, will provide seasonal groundwater elevation data across the site area. Baseline (pre-permitting) values can then be compared to data collected during operation. Baseline data will also assist any potential future investigations into reports of changes in groundwater quality or quantity by downgradient domestic users. Assuming the downgradient wells are being used - and this should be investigated - it may be advisable to prepare a groundwater monitoring response plan that can be utilized should complaints arise if the mine becomes operational.	See Report #2, pages 11 and 12 and also see Report #3, pages 5 to 10
7	s.16	Hemmera Report at 4; LNB's February Letter	See FLNR Response	See response to comment 8 above	See Report #3, page 6
8	s.16	LNB's February Letter	Please explain the cultural significance of these springs so we can understand it. If LNB considers that the proposed mine development would destroy the cultural value of these springs and affect their significance, this needs to be declared.		This issue is beyond NVA's knowledge and without knowing precisely the location of the "Adjacent Land" we are not able to comment further.
9	s.16	Hemmera Report at 4; LNB's February Letter	A water license will be required and must be acquired by the proponent for any use of water on the proposed mine site. Obtaining a water license is an obligation of the proponent aside from holding a mine permit. The issuing of a water license will be assessed by other government agency not by EMJ.	I agree with Hemmera's comment that clarification should be sought as to whether NVA plan to use groundwater for dust suppression. That has the potential to impact groundwater, and should be considered. This also implies non-domestic use of groundwater in BC, which requires authorization via a license to use groundwater. It is probable that groundwater in the pit area would be considered hydraulically connected to the Coldwater River (Province of BC, 2016) in that context and would need to be taken into account in the application for authorization. [FLNR Review, pp.5]	
10	Given the potential for adverse effects, a baseline air monitoring program is needed to establish air quality prior to operation so there are data against which to compare future air quality impacts associated with quarry operation. Unless there is a suitable meteorological station for the area, the baseline monitoring should include a meteorological station so that air quality on LNB lands can be correlated with wind direction.	Hemmera Report at 5	Micro meteorological stations have been required for operating mines, mainly major mines, and the ministry could require one be installed on the site if a mines permit would be issued. This normally only takes place in the mine construction phase, after obtaining a permit, for monitoring natural phenomena, including wind direction and speed, precipitation quantities, and air pressure changes which may affect propagation of noise and the normal planned mine operations. Noise is also monitored during operations to establish any negative effect on neighbourhood population, employees and animals, and to propose mitigation actions if needed. Collection of logs will be assumed by the mine operator and must be made available to any inspector of mines when required. The mine operator will be asked to come with adequate measures to eliminate or to reduce to minimum any negative effect produced by the mine operations. However, this ministry will not come with any technical suggestions, but will only review the submitted proposed prevention and mitigation plans and accept them if their rationale is correct and would produce expected results. The responsibility for the results lays with the professional who submitted the technical report and the actions recommended together with the mine manager who will implement the proposed plans.	See letter from Gary Breaks to Bob Zryd and John Rus dated October 7, 2020 (the "Response Letter"). The Access Road in and out of the proposed Pit will be graded and paved and all interior roads will be treated with an environmentally safe dust suppressant. If dust is created beyond reasonable levels, then all required remediation will be undertaken including the installation of a dust monitoring system. This issue (if it comes up) can be resolved via regular inspections which would we assume would be a part of the ongoing operations of the gravel pit by NVA.	

11	<p>The permit application indicates that dust-suppression measures including water spray suppression on the screen plant and use of a paved access road will minimize dust impacts. However, there is no information on what monitoring will be done to verify that the measures are effective and what steps will be taken to address complaints. A dust management plan which describes how dust will be managed, including details on monitoring, complaint resolution and the steps to be taken if further mitigation is needed to assess whether the proposed mitigations will be sufficient to minimize off-site impacts.</p>	Hemmera Report at 5	<p>If a permit will be approved, dust suppression actions will be required by this ministry with the approval.</p> <p>These actions must be proposed directly by the applicant by submitting a detailed plan with prevention/mitigation measures written and signed by a qualified person within the first 30 days after receiving the permit.</p> <p>This ministry will assess the proposed prevention/mitigation actions for effectiveness and will require monitoring and reporting.</p> <p>Monitoring would mean hourly and daily observations by the mine operator and adjustment of the actions needed to suppress the dust. If the adopted actions to control dust would prove not to be effective, they must be changed.</p> <p>If during production the adopted dust suppression actions would fail to prevent dust creation and spreading, the ministry may consider actions to remediate the situation, including temporary suspension of work at the location where the dust is produced and along the mine access road on the mine site.</p> <p>The ministry will also collect all complaints and investigate them. Responses would then be provided to the complainants and actions will be required to be taken by the mine operator to address the complaints.</p> <p>It will be the duty of the community to enforce the bylaws outside of the mine site.</p>	See response to comment 9 above	<p>NVA is willing to draft and submit a dust management plan if that is required as a condition of the issuance of the Permit.</p> <p>Dust from the proposed NVA's project will be negligible. The Access Road to the Project will be paved from Highway #15's entrance to the mine's entrance. An environmentally friendly dust suppressant will be used to treat the interior roads. NVA will take mitigation actions to address dust created from the operations or transportation that materially impairs air quality. If required, NVA will install a dust monitoring station. [Responsive Letter, page 1]</p>
12	<p>As with air quality, a baseline noise monitoring program should be conducted to determine baseline noise levels prior to operation so there are data against which to compare future noise impacts associated with facility operation and increased truck traffic along haul routes through LNB lands. The baseline monitoring should be done for a sufficiently long period of time to establish a reliable baseline.</p>	Hemmera at 6	<p>This is not standard practice of this ministry and we cannot require noise monitoring before a mine operation would be established.</p>		<p>See the Responsive Letter and the comments of Gary Breaks under the heading "Noise."</p> <p>The nearest residences are approximately 300 meters from the nearest point of the project. The main mining activities are proposed to take place an additional 100 meters or more further away from this point. Along with other measures, the installation of the landscaped berm will provide additional sound suppression along with the activities taking place lower than the surrounding landscape, which will deflect noise upward.</p> <p>The 2020 Hemmera Report states backup alarms as being the most annoying type of noise from projects such as ours. Based upon past experiences of operating similar operations in densely populated areas in the Lower Mainland where back up alarms were a concern, the Inspector of Mines was able to authorize the use of the visual back up signals thus eliminating the need for audible alarms. NVA will pursue this.</p> <p>Prior to commencement of operations NVA intends to engage a professional to take decibel readings at property lines and mine boundaries to establish a baseline. [Responsive Letter, page 2]</p>
13	<p>The permit application states that restricted hours of operation and design of the pit to deflect sound upwards will minimize noise impacts. However, there is no information to show that ambient noise levels on LNB will be acceptable or what monitoring will be done to verify that the proposed noise mitigation measures are effective. It is best practice to develop a noise management plan which describes how noise will be managed, including details on monitoring, complaint resolution and the steps to be taken if further mitigation is needed.</p>	Hemmera at 6	<p>See NVA Response</p>		<p>See the Responsive Letter and the comments of Gary Breaks under the heading "Noise."</p> <p>The nearest residences are approximately 300 meters from the nearest point of the project. The main mining activities are proposed to take place an additional 100 meters or more further away from this point. Along with other measures, the installation of the landscaped berm will provide additional sound suppression along with the activities taking place lower than the surrounding landscape, which will deflect noise upward.</p> <p>The 2020 Hemmera Report states backup alarms as being the most annoying type of noise from projects such as ours. Based upon past experiences of operating similar operations in densely populated areas in the Lower Mainland where back up alarms were a concern, the Inspector of Mines was able to authorize the use of the visual back up signals thus eliminating the need for audible alarms. NVA will pursue this.</p> <p>Prior to commencement of operations NVA intends to engage a professional to take decibel readings at property lines and mine boundaries to establish a baseline. [Responsive Letter, page 2]</p>
14	S 16	LNB's February Letter	<p>If a permit would be approved, this operation will be restricted to the day shift hours between 7am to 5pm. This is an adopted standard timeframe for this type and size of operations provincially.</p>		<p>This is too vague a concern in NVA's submission to constitute an issue. Further clarification will be required before we are able to provide further comment.</p>
15	S 16	Hemmera at 6; LNB's February Letter	<p>See NVA Response</p>		<p>See the Responsive Letter and Mr. Break's comments under the heading "Visual Effects." Furthermore, NVA proposes to have its environmental consultant, Mathew Davidson, of Sage Environmental Consulting, design the landscaped berm and also provide a written plan on the types and quantity of trees and perhaps other vegetation which would be planted to create the visual and noise barriers if required either as a condition of the Permit or down the road during the regular maintenance of the NVA's operations.</p> <p>A landscaped berm is planned to minimize any visual effects. In addition, progressive reclamation with seeding is planned. [Responsive Letter, page 2]</p>
16	<p>Visual changes to a landscape can degrade the aesthetic value of a place. While there is no accepted methodology for assessing such impacts on indigenous communities, it is possible that the quarry may degrade how the aesthetic and spiritual value of the area for traditional use is perceived by LNB residents. Furthermore, there are studies which indicate that some individuals may experience increased levels of annoyance due to noise when the source of the noise is visible from their homes.</p>				
17	<p>The permit application indicates that the estimated cost of reclamation is \$17,000. This, presumably, will be for grading and seeding of grasses on disturbed areas. However, there is no information on what measures such as berms or tree plantings will be done to minimize visual impacts during operation. This information is needed in order to assess potential future impacts.</p>	Hemmera at 6	<p>See NVA Response</p>		<p>Same comments as Issue #15 above.</p>
18	S 16	LNB's February Letter	<p>During the entire operation, monitoring of the water quality in existing water wells from the neighbourhood will be required to ensure the quality of the water is not affected.</p> <p>As a standard adopted policy, EMLI does not accept any mine closure before a complete reclamation of the mine site takes place to bring the land to the approved final use. For this reason, the ministry ensures that adequate bonding is in place.</p> <p>If a proponent defects and does not or is not capable of reclaiming the mine site before mine closure, the ministry confiscate the bond and hires contractors to produce the reclamation and bring the site to the required reclamation state.</p> <p>Mine closure date is not required and not submitted with NwO applications. Mine closure depends on numerous factors, and an operator may decide at any time in the future to keep a mine open, or to complete reclamation and close the mine.</p> <p>Unlike for major mines where a decision to open a mine is based on feasibility studies, for regional mines these studies are not a practice in the industry, and a decision is made based on very limited and preliminary economic studies and assessments of the demand and supply on the market, in some cases just empiric assumption that a mine would turn profitable.</p> <p>Similarly, a mine is only closed by the operator when no profit is made, or when the market conditions change, or when unpredicted events happen, etc.</p>		<p>NVA submits that once it concludes its gravel mining operations, it will reclaim the Lands it has mined and so we are unclear as to why the LNB state that there is "no plan for closure." Furthermore, Report #2 and Report #3 already address the groundwater contamination issues thoroughly in our view.</p>
19	S 16	LNB's February Letter	<p>I acknowledge this very close proximity and all the asserted consequences for the neighbours.</p> <p>It is up to LNB to state openly their opposition for this mine development if they wish to do so.</p> <p>The decision-maker, during the final review of the NwO application, acting in good faith, will read and ponder on all the information attached to this file and will make a fair and independent decision to issue a permit or reject the application.</p> <p>This decision will be based on all information available on file and on the decision-maker's assessment of the merits of the application and all the files attached, either supporting the application or opposing it.</p> <p>The decision-maker will consider the potential benefits of a permit approval for the community on one hand, and the negative effects of such approval on the community members, neighbourhood, landscape and the animal habitat, on the other hand.</p>		<p>This issue is addressed in the engineered drawings which indicate that the gravel pit will have adequate fencing around it.</p>
20	S 16	Hemmera at 6; LNB's February Letter	<p>See NVA Response</p>		<p>See the Responsive Letter and Mr. Break's comments under the heading "Truck Traffic."</p> <p>The 2020 Hemmera report estimates 70-80 truck movements per day; this is a very unrealistic. The permit application seeks to extract a maximum of 200,000 tonnes annually. NVA does not anticipate realising 50% of that volume.</p> <p>As the main market will be in the City of Merritt area the bulk of the truck traffic will be eastbound. We anticipate the maximum average number of truck movements from the project to be 40 per day. Given the distance of the next closest source of aggregates is at least three times further to the City of Merritt, we anticipate a lot fewer trucks will be required to transport the same volume of material.</p> <p>This project will not have control over truck traffic originating from other sources. [Responsive Letter, page 2]</p>
21	<p>Dump truck operation will result in increased emissions of diesel exhaust which comprise contaminants such as volatile organic compounds (VOCs), PM25 nitrogen oxides (NOx) and diesel particulate matter (DPM) along haul routes. Inhalation of these substances can cause adverse health effects if present at concentrations above accepted ambient air guideline values.</p>	Hemmera at 6-7	<p>See NVA Response</p>		<p>NVA has no specific comments on this issue except to state that all traffic causes some level of emissions and there is no hard evidence being presented by LNB to indicate that increased gravel trucks in the area will cause adverse health effects to its members. Highway No 8 is already a very busy provincial highway and the amount of additional truck traffic originating from the Subject Property in this area will be marginal.</p>
22	<p>Increased truck traffic will result in higher ambient noise levels along haul routes. Studies show that increased noise levels can result in increased levels of stress and annoyance, especially if the noise is unwanted by the community.</p>	Hemmera at 7	<p>See NVA Response</p>		<p>Similar comments to Issue No. 21. No direct evidence by LNB about the issues identified.</p>

23	<p>The proponent should consider, or at least acknowledge, that there may be potential impacts to First Nation communities associated with the increased truck traffic along the highway. It would be prudent to consult potentially affected First Nations along the highway.</p> <p>Statistically, the increased truck traffic will lead to increased accidents and increased probability of personal injury or death because studies show that there is a higher probability of injury and death when accidents involve trucks.</p> <p>The net contribution of increased emissions of greenhouse gases (GHG) from truck traffic along the highway will be small relative to overall emissions, but nevertheless the proponent should at least acknowledge this fact.</p>	Hemmera at 7	See NIVA Response	<p>See comments to Issue No. 20 and Issue No. 21. Also, please see the Responsive Letter and MR Breaks comments under the heading "Regional Impacts."</p> <p>The 2020 Hemmera report estimates 70-80 truck movements per day; this is very unrealistic. The permit application seeks to extract a maximum of 200,000 tonnes annually. NIVA does not anticipate realizing 50% of that volume.</p> <p>As the main market will be in the City of Merritt area the bulk of the truck traffic will be eastbound. We anticipate the maximum average number of truck movements from the project to be 40 per day. Given the distance of the next closest source of aggregates is at least three times further to the City of Merritt, we anticipate a lot fewer trucks will be required to transport the same volume of material.</p> <p>This project will not have control over truck traffic originating from other sources. [Responsive Letter, page 2]</p>
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24	s.16	LNIB's February Letter	<p>I am not aware of such suggestions by any ministry employees.</p> <p>What I know is that British Columbia lawmakers unanimously adopted the Declaration on the Rights of Indigenous Peoples Act on November 26, 2019 and the bill received Royal Assent.</p> <p>On Thursday, December 3, 2020, the Liberal government has introduced legislation that will begin the process of bringing Canadian law into alignment with the United Nations Declaration on the Rights of Indigenous People (UNDRIP).</p> <p>As per the above, we will act in good faith and in the spirit of the UNDRIP.</p> <p>LNIB may submit to this ministry their expectations with regards to the implementation of UNDRIP and to clearly and openly state their desired outcome for the this NoW application.</p> <p>I need to state here that the opinions expressed here only belong to this decision-maker.</p> <p>Although the ministry has the same policies and work procedures in all the offices provincially, there are differences in decisions made by various inspectors. This is because although all inspectors of mines are acting in the name of the chief inspector and the chief permitting officer, each individual decision is made solely by the decision-maker after consulting with peers and senior inspectors.</p> <p>Accordingly, one decision-maker acting independently and in good faith could come to a different conclusion and outcome for a NoW application than another inspector.</p>	No comment.
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Issue Tracking Table for Consultation on Nicola Valley Aggregates ("NVA") proposed gravel excavation per Notice of Work 1621718201801 ("NVA's Proposed Pit")

Date	From	Document	Shorthand
04/10/2019	NVA	Active Earth - Preliminary Hydrogeological Study	Active Earth Report, 2019 Report #1
02/27/2020	LNIB	Letter from Lower Nicola Indian Band (LNIB) to BC	LNIB's February Letter
07/24/2020	LNIB	Hemmera - Evaluation of Nicola Valley Aggregates Permit Application	Hemmera Report
09/23/2020	BC	Ministry of Forests, Lands, Natural Resource Operations and Rural Development - Hemmera Rep	FLNR Review
09/28/2020	NVA	Active Earth - Revised Hydrogeological Study	Active Earth Report, 2020 Report #2
10/09/2020	NVA	Letter from NVA to BC RE: Hemmera Report	Responsive Letter
12/03/2020	NVA	Active Earth - Preliminary Hydrogeological Study Response	Active Earth Response Report #3

From: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
To: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
Cc: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: Hydrogeologist request
Sent: 03/31/2021 17:21:45
Attachments: 38050-03_Nicola_Valley_Aggregates_DT_SEALED_Mar31_2021.pdf, image002.jpg, image003.jpg
Message Body:

Good morning Vanessa ? please find attached a review as requested. Let me know if you have any questions.

Dave

David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist, Groundwater Science, South Area
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
2501-14th Ave, Vernon, BC V1T 8Z1
VOIP 778 943-6924

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 24, 2021 1:17 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Earlier is better, but I appreciate that you have other things on the go right now! I'll advise the First Nation that we're aiming to provide an update for the end of March.

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: February 24, 2021 12:54 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa, and apologies for delay in response to your original email. My schedule is opening up in March and there's certainly efficiencies in me continuing with this. I'll target one month TAT but is end of March possible?

Thanks

Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 24, 2021 11:45 AM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Dave and Skye,

Just wanted to confirm that someone from your team can review the two Active Earth responses to the Hemmera/LNIB report. I've suggested internally that we're looking at a one-month turnaround, but need to advise the First Nation of our plan in the next few days.

Thanks,

Vanessa

From: Dunae, Vanessa EMLI:EX
Sent: February 18, 2021 11:01 AM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Dave and Skye,

EMLI would greatly appreciate a review the two Active Earth/proponent responses to the Hemmera/LNIB report (attached). Is a month reasonable? Please let me know if you need more information or wish to further discuss.

Thanks,

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines & Low Carbon Innovation
vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: February 17, 2021 3:56 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa. I reviewed my previous response and the tracking table makes sense. By way of response to your second question I've cc'd Skye. January and now February are quite busy. What timelines are you looking at?

Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 17, 2021 2:02 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi David,

Thanks again for reviewing the reports associated with the Nicola Valley Aggregates permit application. Two questions:

I've transcribed your report into the attached issues tracking table. Could you please review and confirm that I lined everything up correctly?

Since you completed your review, we've received another two hydrological studies from Active Earth/the proponent. Could you review those, or should I check in with Skye and start the review process fresh?

Thanks,

Vanessa

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: October 9, 2020 10:18 AM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX

<Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Subject: RE: Hydrogeologist request

Good morning ? please find attached my response. Also attached is an authenticated version of Hemmera's evaluation, as explained toward the end of my response.

Please contact me with any questions
Dave

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: September 10, 2020 4:55 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa,

Our Regional Hydrogeologist, David Thomson, will be able to assist with this review. I have cc'd David on this note. I understand that the review comments are due by October 9th, but preferably sooner. If you have any further information related to this review, please send to David directly.

Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 3:05 PM
To: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Thanks, Trevor. How about a month from now ? Friday, October 9?

Earlier is welcomed but I imagine your team is as busy as we are. Please let me know if you need more context. Right now, all we have from Lower Nicola Indian Band is the Hemmera report but we may be receiving additional information regarding springs in the area later this month.

From: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Sent: September 10, 2020 2:51 PM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi All,
We can accommodate this request, when do you need the review completed by?

Trevor

Trevor Bohay M.Sc., P.Geo. (he/him)
A/Director, Authorizations
Thompson-Okanagan Region
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
1259 Dalhousie Street
Kamloops, BC

New Phone no: **250.312.7421**

From: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Sent: September 10, 2020 1:14 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: FW: Hydrogeologist request

Hi Vanessa,
I don't have one on staff but Trevor Bohay does (a. Director of Authorizations).

By way of this email, Trevor, can you consider Vanessa's request below?

Thx,
E

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 11:49 AM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: Hydrogeologist request

Hi Eric,

I'm looking for a hydrogeologist to review a report from Lower Nicola Indian Band evaluating the Nicola Valley Aggregates permit application near Merritt, BC. It's a twelve-page report developed by Hemmera and it references groundwater impacts, which is outside my field of expertise.

Could you please point me in the right direction? I don't know any of our provincial hydrogeologists and was encouraged to reach out to you for advice.

Thanks,

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
vanessa.dunae@gov.bc.ca
cell (250) 320-8250



File: 38050-03/ Nicola Valley Aggregates

March 31, 2021

To: Vanessa Dunae, Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
Via email to Vanessa.Dunae@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.
David.Thomson@gov.bc.ca

Re: Review of Active Earth Engineering Ltd (Active Earth) Reports: “Revised Hydrogeological Study” and “Preliminary Hydrogeological Study Response”

This memo is in response to a request by yourself to review the aforementioned reports as they relate to a Ministry of Energy, Mines and Petroleum Resources (EMPR) permit application for the Nicola Valley Aggregates near Merritt, BC. The following summarizes my review of these reports, with reference to my previous review and other reports.

BACKGROUND

Nicola Valley Aggregates (NVA) has submitted a permit application to EMPR for a sand and gravel quarry at 701 Highway 8 near Merritt, BC. NVA retained Active Earth Engineering Ltd. (AE) to undertake a *Preliminary Hydrogeological Study* (Active Earth, 2019). The Active Earth report was subsequently peer reviewed by Hemmera Envirochem Inc (Hemmera, 2020). In their peer review, Hemmera references the *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, as a reference point for their review.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) reviewed and commented on the aforementioned documents as it pertains to groundwater and provided those comments to EMPR. FLNRORD’s review was dated September 23, 2020 and professionally authenticated October 9, 2020. Active Earth Engineering Ltd. generated two

To: Vanessa Dunae

reports "*Revised Hydrogeological Study*" (September 28, 2020) and "*Preliminary Hydrogeological Study Response*" (December 3, 2020).

Active Earth's September, 2020 revised study (AE, 2020a) and the December 2020 response (AE, 2020b) are referenced throughout.

Summary of the Revised Hydrogeological Study (September 2020)

The purpose of the September *Revised Hydrogeological Study* is stated in the report as "... to complete a hydrogeological review and provide an opinion on potential impacts of the proposed gravel mining on the groundwater and surface water resources and provide mitigation measures if necessary."

This response does not offer much new information. A field-verified survey to identify other potentially affected downgradient water users has not been done although the BC Water Resources Atlas shows several users to exist immediately downgradient of the proposed pit area. This is a significant deficiency in their study.

Summary of Preliminary Hydrogeological Study Response (December 2020)

The December response is a review of Hemmera's July 2020 evaluation and FLNRORD's September 2020 review of the same. The response does provide some additional background information such as recharge values and clarifies that no water will be pumped as a result of mining operations. Statements like "...it is not necessary to install 3 monitoring wells to determine the general groundwater flow direction at the Site" without investigating known downgradient users (Figure 1) suggest a reluctance to move toward the most basic standards of a hydrogeological study supported by the Guide, FLNRORD and Hemerra. Installing a monitoring well after a resource extraction project has commenced operation, as suggested, generally has little-to-no value.

REVIEW OF THE GUIDE REQUIREMENTS

Note that staff with EMPR may have a general understanding or established best practices relative to applicants' following of the Guide, which can be brought to bear on my general observations. They also will be able to confirm whether some items such as knowledge of depth to groundwater is required in the Notice of Work as suggested by the Guide, or whether such information needs can be deferred until after mining begins, as suggested by the applicant (AE, 2020b).

To: Vanessa Dunae

The Guide does indicate that the following information about groundwater should be provided in Mine Permit Applications:

- *Describe potential impacts of the proposed operation on groundwater quantity and quality;*
- ***If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required;***
- *Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required;*
- *minimize sediment and pollutants reaching natural and man-made surface water, groundwater and aquatic environments;*
- *Information will be required to demonstrate the proximity of the proposed excavation to the water table;*
- *The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers;*
- *The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level; and,*
- *Excavations below the water table will require special approval.*

The bolding above indicates the key missing information in the Reports. The apparent down slope users have not been field-verified, as recommended above, so the degree of hydrogeological study required is not apparent. Figure 1 from FLNRORD's earlier 2020 response, and reproduced below, indicates existing water wells of interest that are available to review from a desktop analysis as well as a field visit. In the absence of this knowledge it is difficult to design appropriate site-specific mitigative measures. More specifically, it is best practice for aggregate operators to design site-specific measures in regards to groundwater protection, then additional site-specific information about groundwater is required relative to these downslope users.

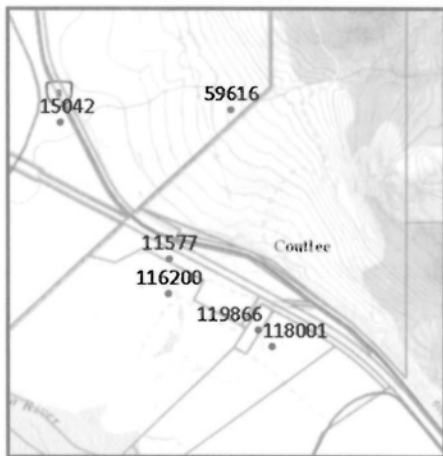


Figure 1: Water wells in the vicinity of the site, accessed from GWELLS on September 14, 2020

To: Vanessa Dunae

Hemerra also notes that potential impacts to groundwater from gravel pit development are indicated in the *Aggregate Operators Best Management Practices Handbook for British Columbia* (Province of BC, 2002).

AQUIFERS and GROUNDWATER WELLS

FLNRORD's previous review noted the lack of aquifer mapping across the pit area doesn't preclude its potential presence. This is acknowledged in AE (2020a) Section 4.3 where it is stated that an unmapped overburden aquifer is present beneath the Site. However, in Section 4.3.1, it is stated that the "Upper Merritt Unconfined Watertable Aquifer" is "...not located within the boundaries of the subject site and is hydraulically connected to the Nicola River." AE (2020b) confirm there is no mapped aquifer beneath the site footprint. However, it can be inferred from these two statements that the shallow aquifer at the quarry is likely hydraulically connected to a mapped aquifer.

In their review of groundwater records, Active Earth (2019) stated "In addition, several private wells are present south of the Site, but are not included in the provincial WELLS database." The same statement, verbatim (including "no" instead of "not") was made in AE 2020(a).

With respect to the downgradient private wells (shown in Figure 1 but not necessarily limited to those), FLNRORD restate their previous comment:

"This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application."

A field-verified survey of the unmapped groundwater wells south of the site (ie, confirming whether groundwater flows toward the wells from the gravel pit) does not appear to have been done. FLNRORD's opinion regarding this item remains unchanged. AE (2020b) state "If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required (Section 6)." This wording is taken verbatim from the Guide, except for the "Section 6" reference. A "Section 6" could not be found in AE's 2020b report and Section 6 of AE's 2020a report does not address this. Regardless, since online mapping and statements by AE make it clear there are down slope users, the apparent reluctance to install three wells to determine groundwater travel time and inform the ability to design site-specific mitigation measures or react to unplanned releases of contaminants is not understood.

Section 5 of AE (2020a) states that "Groundwater flow within the unconfined aquifer is bedrock controlled on Site. The shallow groundwater is perched over bedrock within the overburden

To: Vanessa Dunae

soils. Groundwater flow is assumed to be south.” This statement is confusing as “perched” groundwater by definition cannot flow. The statement seems to originate from the Hemmera report, although it is not referenced within AE 2020a. AE 2020b does state “The well logs do not indicate any perched water tables.”, adding to the confusion surrounding this.

The conclusions (AE, 2020b) state AE have assumed groundwater flow is to the south and “...the receiving environment includes groundwater underlying the site, as well as Parry’s Spring and the Upper Merritt Unconfined Water Table Aquifer. These water resources require consideration for protection via mitigation measures described below.”

The first two sentences of recommendations 10 and 13 regarding installation of a single monitoring well appear to be identical. As noted above, three monitoring wells is a minimum standard in the profession of hydrogeology to obtain a basic understanding of groundwater movement, elevation changes and baseline/operational quality. Those three wells could also inform an improved cross-section, as well as providing the applicant with a better idea of the grading and depth of the resource.

SUMMARY AND RECOMMENDATIONS

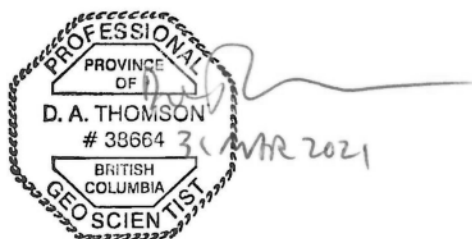
Hemmera and FLNRORD recommended a revised hydrogeological study. The two documents provided (AE 2020a and 2020b) add some clarity but fail to address key questions as noted and sometimes add further confusion.

If the applicant surveys downslope water users then a groundwater monitoring response plan can be utilized should complaints arise if the mine becomes operational.

Hemmera also note that assessment of potential impacts to downgradient users require consideration of pit closure. The applicant states the pit will not be filled in, but do not seem to address this question. Monitoring and regular reporting and interpretation of groundwater data could inform adaptive management of daily operations and final reclamation planning.

Please contact me with any questions.

Signed,



David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science,
Vernon, British Columbia.

To: Vanessa Dunae

References

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study*, April 10, 2019. Project 1887.

Active Earth Engineering Ltd, 2020a. *Revised Hydrogeological Study*. September 28, 2020. Project 1887.

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study Response*. December 3, 2020. Project 1887.

Hemmera Envirochem Inc., 2020. *Evaluation of Nicola Valley Aggregates Permit Application Final Report*. Prepared for Lower Nicola Indian Band, Merritt, BC. Project 104684-01, July 24, 2020.

Province of British Columbia, Ministry of Energy and Mines, 2002. *Aggregate Operators Best Management Practices Handbook for British Columbia, Volume 2: Best Management Practices*. April 2002.

Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division, 2010. *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia*. February 2010.

Province of British Columbia, 2016. *Determining the Likelihood of Hydraulic Connection – Guidance for the Purpose of Apportioning Demand from Diversion of Groundwater on Streams*. Version 1.0. Water Science Series, WSS2016-01. Province of British Columbia, Victoria BC.

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Subject: RE: Hydrogeologist request
Sent: 02/24/2021 21:16:47
Attachments: image001.jpg
Message Body:

Earlier is better, but I appreciate that you have other things on the go right now! I'll advise the First Nation that we're aiming to provide an update for the end of March.

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Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

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A/Director, Authorizations
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Ministry of Forests, Lands, Natural Resource Operations and Rural Development
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New Phone no: **250.312.7421**

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Sent: September 10, 2020 4:55 PM

To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX

<Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>

Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>

Subject: RE: Hydrogeologist request

Hi Vanessa,

Our Regional Hydrogeologist, David Thomson, will be able to assist with this review. I have cc'd David on this note. I understand that the review comments are due by October 9th, but preferably sooner. If you have any further information related to this review, please send to David directly.

Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>

Sent: September 10, 2020 3:05 PM

To: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>

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From: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>

Sent: September 10, 2020 2:51 PM

To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>

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Subject: RE: Hydrogeologist request

Hi All,

We can accommodate this request, when do you need the review completed by?

Trevor

Trevor Bohay M.Sc., P.Geo. (he/him)

A/Director, Authorizations

Thompson-Okanagan Region

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

1259 Dalhousie Street

Kamloops, BC

New Phone no: **250.312.7421**

From: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>

Sent: September 10, 2020 1:14 PM

To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>

Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>

Subject: FW: Hydrogeologist request

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By way of this email, Trevor, can you consider Vanessa's request below?

Thx,

E

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>

Sent: September 10, 2020 11:49 AM

To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>

Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>

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Could you please point me in the right direction? I don't know any of our provincial hydrogeologists and was encouraged to reach out to you for advice.

Thanks,

Vanessa Dunae

Senior Negotiations Lead, Regional Operations

Ministry of Energy, Mines and Petroleum Resources

vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Cc: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: Hydrogeologist request
Sent: 02/18/2021 19:01:13
Attachments: image001.jpg, 2020-09-28 Active Earth Revised Hydrogeology Study - 701 Hwy 8 - FINA.pdf, 2020-12-03 Preliminary Hydrogeology Study_Hemmera_FLNRORD Review - 701 Hwy 8 _FINAL.pdf
Message Body:

Hi Dave and Skye,

EMLI would greatly appreciate a review the two Active Earth/proponent responses to the Hemmera/LNIB report (attached). Is a month reasonable? Please let me know if you need more information or wish to further discuss.

Thanks,

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines & Low Carbon Innovation
vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: February 17, 2021 3:56 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa. I reviewed my previous response and the tracking table makes sense. By way of response to your second question I've cc'd Skye. January and now February are quite busy. What timelines are you looking at?

Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 17, 2021 2:02 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi David,

Thanks again for reviewing the reports associated with the Nicola Valley Aggregates permit application. Two questions:

I've transcribed your report into the attached issues tracking table. Could you please review and confirm that I lined everything up correctly?

Since you completed your review, we've received another two hydrological studies from Active Earth/the proponent. Could you review those, or should I check in with Skye and start the review process fresh?

Thanks,

Vanessa

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: October 9, 2020 10:18 AM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson,

Skye FLNR:EX <Skye.Thomson@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>

Subject: RE: Hydrogeologist request

Good morning ? please find attached my response. Also attached is an authenticated version of Hemmera?s evaluation, as explained toward the end of my response.

Please contact me with any questions
Dave

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Thanks,

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Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
vanessa.dunae@gov.bc.ca
cell (250) 320-8250



REVISED HYDROGEOLOGICAL STUDY

September 28, 2020

Project No. 1887

Nicola Valley Aggregates
PO Box 796
Merritt, BC
V1K 1B8

ATTENTION: Gary Breaks

REFERENCE: Preliminary Hydrogeological Assessment
701 Hwy 8, Merritt, BC

1 INTRODUCTION

Active Earth Engineering Ltd. (Active Earth) provides this Revised Hydrogeological Study for the property at 701 Hwy 8, Merritt, BC (the Site) to reply to a review completed by Hemmera dated July 24, 2020. The purpose of the study is to complete a hydrogeological review and provide an opinion on potential impacts of the proposed gravel mining on the groundwater and surface water resources and provide mitigation measures if necessary.

2 SCOPE OF WORK

Active Earth has undertaken the following scope of work and reviews for the study:

- Site visit on April 2, 2019 and August 31, 2020;
- Mine plans and sections developed by L.A. Morgenthaler, P.Eng.;
- IMapBC database to identify aquifers in the area;
- Lower Nicola Valley Groundwater Budget, MOE Groundwater Science Study, prepared by Golder Associates, March 7, 2016;
- Available topographic mapping and survey information;
- WELLS database for existing wells in the surrounding area;
- Provincial Observation Well Network;
- Climate Data;
- Preparation of a preliminary hydrogeological study report, and

BURNABY

160 – 2250 Boundary Road
Burnaby, BC V5M 3Z3
Tel. 778-737-3488

ABBOTSFORD

304 – 2600 Gladys Avenue
Abbotsford, BC V2S 0E9
Tel. 778-752-2222

VICTORIA

105 – 4343 Tyndall Avenue
Victoria, BC V8N 3R9
Tel. 778-430-5475

- Review of Response to Hemmera review of the preliminary report: *Evaluation of Nicola Valley Aggregates Permit Application, Final Report, Hemmera Envirochem Inc., July 24, 2020.*
- Preparation of this revised report.

3 SITE DESCRIPTION

3.1 Location

The Site is located approximately 2.5 km west of Merritt, BC on Hwy 8. as shown on Figure 1. The following table summarizes the location and physical description for the Site.

LOCATION AND PHYSICAL DESCRIPTION

Address	Current Civic Address	701 Hwy 8, Merritt, BC
Location and Dimensions	Location	2.5 kms west of Merritt
	Cartographic Coordinates	50° 7 44.51" North 120° 49 21.8" West
	Legal Description	District Lot 1923, KDYD Land District
	Approximate Area	45.3 ha

The ground surface slopes at approximately 24% downward to the southwest with a steeper scarp located at Hwy 8. The upper reaches of the property are moderately treed with conifers. Bedrock exposures are located in the east. Approximately 10 ha of the property is hay field. A residential building and other out-buildings are located in the southeast corner of the property. A photo of the site showing the hay field and rock outcrop looking east is shown below:



3.2 Climate

The following table summarizes the climate data for the Site.

Climate Normals	Local Weather Station	<i>Merritt, approximately 3km southeast Data collected from 1981 to 2010.</i>
	Annual Rainfall	<i>254.5mm (average).</i>
	Annual Snowfall	<i>66.7mm (average).</i>

3.3 Topography

The following table summarizes the topography of the Site and surrounding area.

Topography	Geodetic Elevation	<i>Approximately 590 - 800m.</i>
	Site Topography	<i>Sloping Southwest</i>
	Regional Topography	<i>Regional topography slopes downwards to the southwest</i>

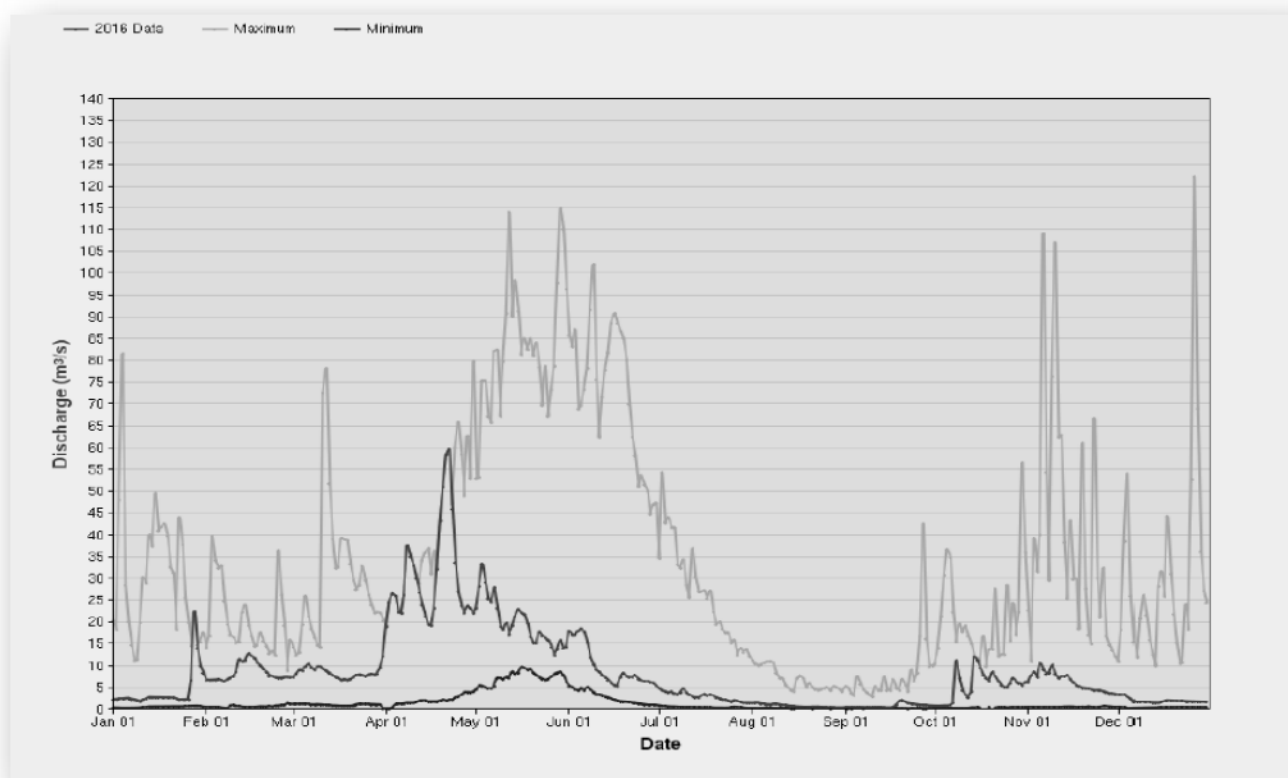
3.4 Nearby Surface Water Bodies

Nearby surface water bodies are described in the following table.

Area Water Uses	Surface Water	<i>The Nicola River is approximately 700 m south of the Site. Drainages are present to the south of Hwy 8. No streams are located on the property.</i>
-----------------	---------------	--

The Nicola River discharges to the Coldwater River as it enters Merritt to the east of the Site. The Coldwater River is generally a gaining stream and becomes a losing stream in Merritt, which recharges the aquifer. Further west, the Nicola River levels reflect groundwater levels and is therefore inferred to be a gaining stream in these areas.

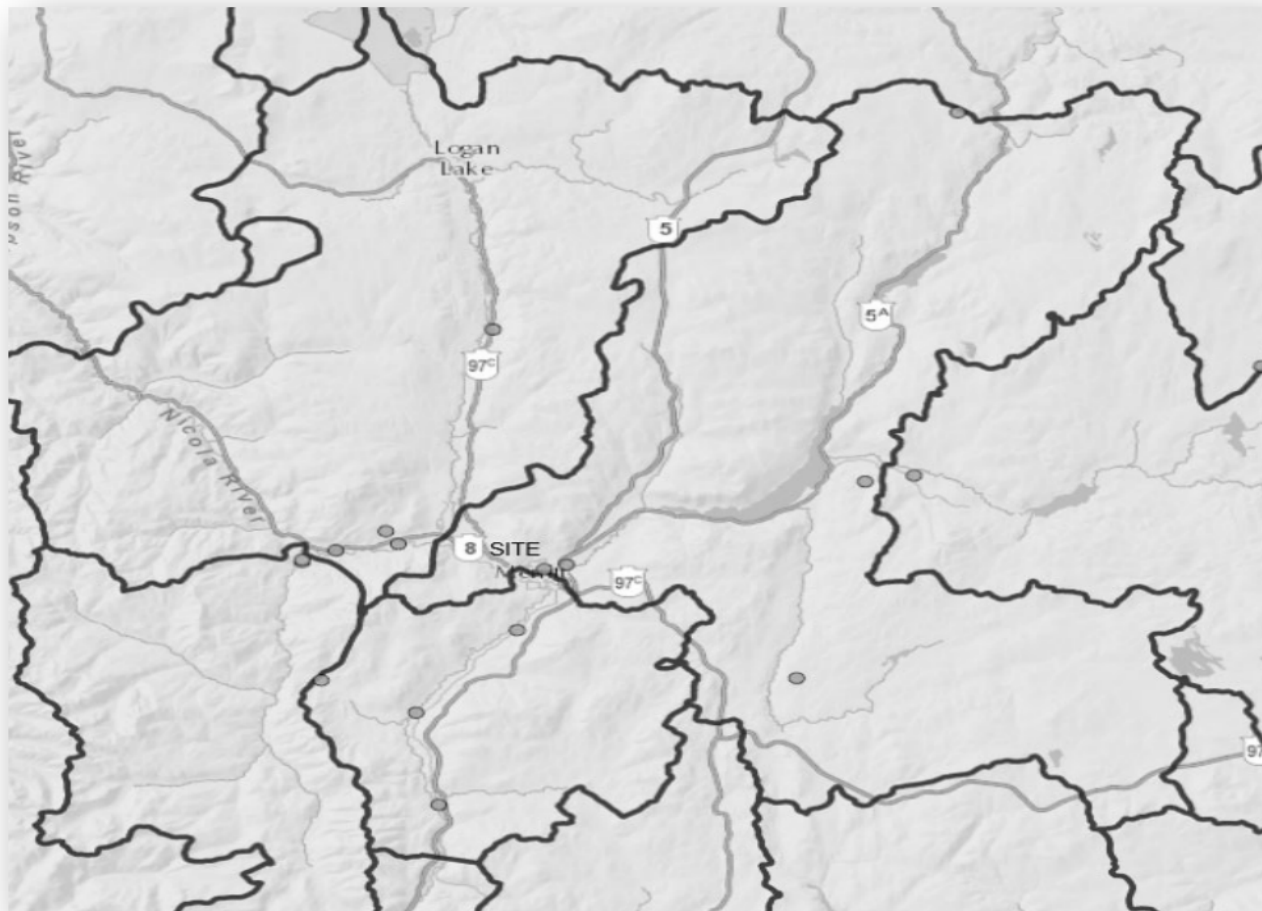
Hydrometric Station 08LGO is located on the Coldwater River in Merritt. The following plot shows the average river discharge for 55 years of record compared to 2016 data.



It is noted that high flows take place in May/June as a result of snowmelt and low flows occur between August and October annually.

Several surface water points of diversion licenses are located on the Nicola River and tributaries, largely used for irrigation purposes.

The Site is located in the Nicola River Watershed as shown below:



3.5 Surficial Geology

The surficial geology mapping of the Site is described in the following table.

<p>Geology</p>	<p><i>Surficial Geology Map of Merritt (Geoscience Map 1393a)</i></p>	<p><i>Three assemblages are present on the site as follows:</i></p> <p><i>Bedrock of the Nicola Group, noted as outcroppings in the northeast corner of the property.</i></p> <p><i>Kettle terrace sand and gravel deposits.</i></p> <p><i>Alluvial fan sand and gravel deposits.</i></p>
-----------------------	---	---

The proposed gravel extraction will take place in the Kettle terrace and alluvial fan deposits.

4 GROUNDWATER RESOURCES

The BC Water Resource Atlas (BCWRA) was reviewed for available aquifer mapping and existing water well information as described in the following.

4.1 Existing Water Wells

A search of the WELLS database indicates there are three water wells in close proximity of the Site. The locations of the wells are shown on Figure 2 attached and a summary is presented below.

Address	Well Tag Number	Yield* (USgpm)	Well Depth (ft)	Depth to Water (ft)	Estimated Ground Surface Elevation (m)	Estimated Groundwater Elevation (m)
701 Hwy 8	1241	11	100	80	605	580.6
1600 Billwiller Road	Unknown	Unknown	50	6	589	587.2
Unknown	15042	Unknown	10	8	585	582.3

*Driller's Estimate

GREY SHADING – Site Well

Golder Associates *note the following groundwater uses in the area:*

- The Lower Nicola Indian Band operates two water systems on the Nicola-Mameet Indian Reserve. One of these water systems services the Shullus subdivision from water wells completed in the east side of the Stumbles Creek Aquifer and the second water system services the Rocky Pines subdivision from water wells completed in the north end of the Stumbles Creek Aquifer.
- The Lower Nicola community is serviced by the Lower Nicola Waterworks District (LNWD). The LNWD utilizes three water wells completed in the Lower Nicola Aquifer that range from 57 m to 110 m in depth. All three of the Lower Nicola community wells are flowing artesian wells.
- The Lower Nicola Trailer Park is located on the south side of Highway 8 adjacent to the Shullus subdivision and obtains its water supply from two flowing wells completed in the Lower Nicola Aquifer.
- The community water system sources supplying the Shullus and Rocky Pines subdivisions have their sources upgradient to the west in the unconfined Stumbles Creek Aquifer.
- In addition, several private wells are present south of the Site, but are not included in the provincial WELLS database.

4.2 Springs

A water point of diversion license is present for Perry's Spring located in the valley near the site, as shown on Figure 2.

4.3 Aquifer Mapping

A search of the IMapBC interface indicates there is no mapped aquifer underlying the Site. However, the presence of a water well drilled on Site and nearby indicates that an unmapped, overburden aquifer is present beneath the Site.

The water well drilled on the Site identified the following stratigraphy:

0.0 – 27.4m: Clay and rocks; overlying

27.4 – 30.5m: Broken bedrock

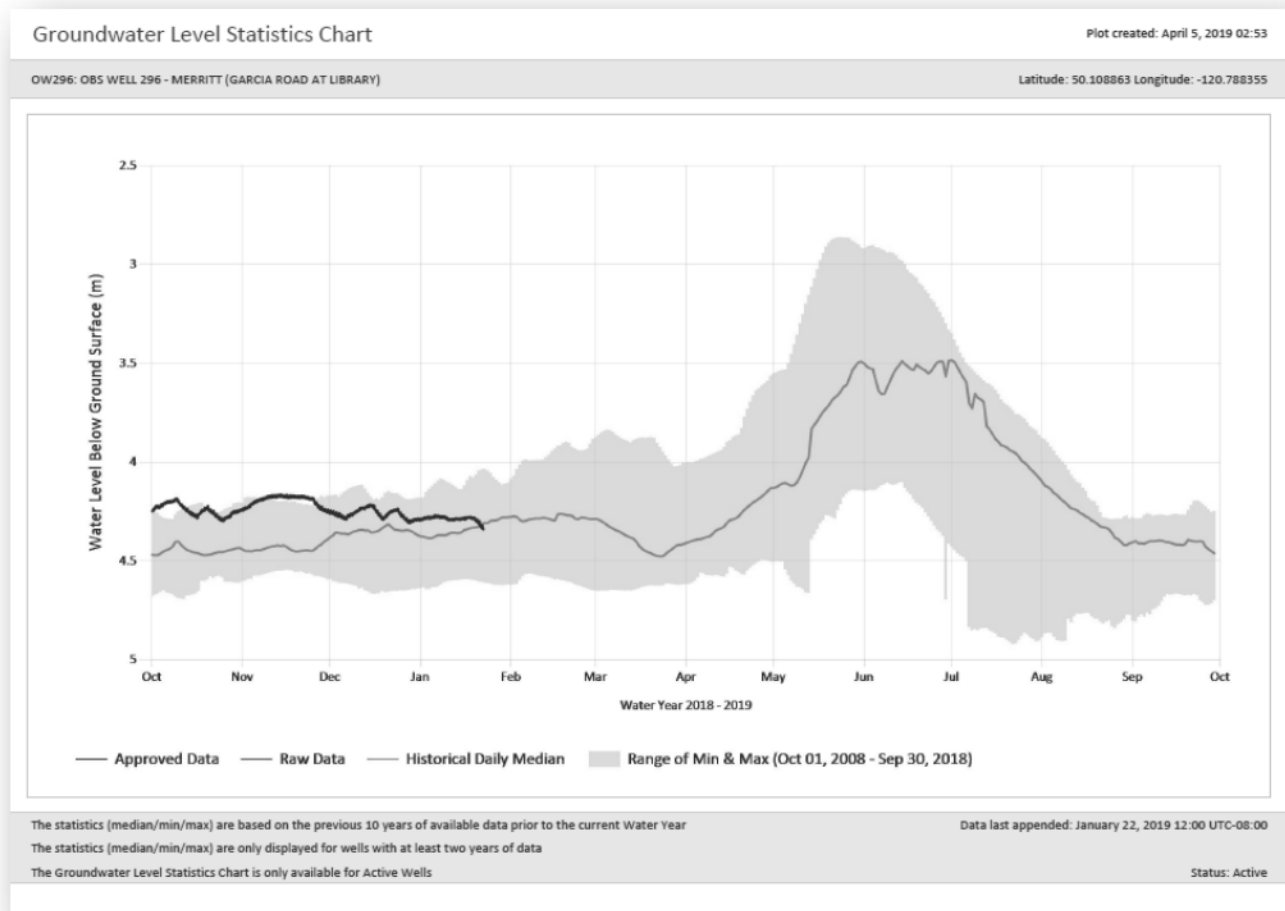
The depth to water in the well is 24.3 m (elevation 580.7 m) according to the well log.

There are three aquifers identified in iMapBC in the general vicinity of the Site. Two of these aquifers are located in the valley southeast of the Site in Merritt as shown on Figure 2. The third mapped aquifer (Stumbles Creek Unconfined Aquifer) is located west of the Site. Available aquifer reports are included in Appendix A.

4.3.1 Upper Merritt Unconfined Watertable Aquifer

This aquifer is approximately 7 km² in area. The aquifer is located southeast of the Site in the valley bottom and its western extent is approximately equal to the eastern property line of the Site (see Figure 2). This aquifer is not located within the boundaries of the subject Site and is hydraulically connected to the Nicola River.

A BC Groundwater Section Observation Well (OW 296) is completed within this aquifer. The depth to water when the well was constructed was 4.4m. Seasonal water levels vary up to 2m. The following graph presents the historical water level data for this well.



High water levels generally occur in June each year in response to recharge from snowmelt which corresponds to high discharges in the Nicola River.

4.3.2 Middle Merritt Confined Aquifer

This aquifer is approximately 12.9 km² in area. It is located southeast of the Site with its western extremity extending to the eastern property line of the Site as shown on Figure 2 (similar to the Upper Merritt Unconfined aquifer).

The aquifer is intersected between 45 - 65 m below the local ground surface and is overlain fine-grained lacustrine deposits.

4.3.3 Stumbles Creek Aquifer

This aquifer is approximately 13 km² in area. It is located west of the Site with its eastern extremity being mapped approximately 300m west of the western property line of 701 Hwy 8 as shown on Figure 2.

The aquifer is an unconfined alluvial fan deposit and groundwater is present approximately between 5 and 15 m in depth.

Note that the extremities of the Upper Merritt Unconfined Aquifer and the Stumbles Creek Aquifer may extend to south of the subject site. The extremities of the aquifers are not accurately mapped due to limited available information.

5 CONCEPTUAL HYDROGEOLOGICAL MODEL

A conceptual hydrogeological model (Figure 3) has been developed for the Site based on the above-described background and site investigation information.

The groundwater flow direction is inferred to be south towards the Nicola River.

Recharge to groundwater flow beneath the Site occurs primarily within the surrounding upgradient catchment versus the footprint of the Site. The amount of precipitation is low in the region, with an average of 321 mm annually.

The proposed gravel extraction occurs within the alluvial fan and kettle terrace deposits which overlie bedrock as shown on Figure 3. Precipitation falling within the property infiltrates the fan and kettle deposits where it encounters the bedrock and flows down into the valley to the south. Golder Associates¹ has estimated that 5% of the precipitation falling within the catchment recharges the shallow unconfined aquifer.

Groundwater flow within the unconfined aquifer is bedrock controlled on Site. The shallow groundwater is perched over bedrock within the overburden soils. Groundwater flow is assumed to be south.

6 CONCLUSIONS AND RECOMMENDATIONS

The extraction plan includes a working area of approximately 5.2 ha and a proposed gravel extraction area is approximately 3.2 ha. Gravel extraction is proposed to elevation 600 masl. Backfilling of the pit with soil is not contemplated.

There is no mapped aquifer underlying the Site, however recharge to the aquifers in the Nicola River Valley occurs from precipitation, groundwater flow and runoff from the valley sides and bottom. Although the aquifer is not mapped in the provincial database, we have assumed that an aquifer is present beneath the Site. The fact that no aquifer is mapped beneath the Site does not alter the conclusions in our report. We have assumed that the groundwater flow direction is south and the receiving environment includes groundwater underlying the site, as well as Parry's Spring

¹ Lower Nicola Valley Groundwater Budget, MOE Groundwater Science Study, Golder Associates, March 7, 2016

and the Upper Merritt Unconfined Water Table Aquifer. These water resources require consideration for protection via mitigation measures described below.

Groundwater on the Site occurs at approximately elevation 589 masl., and the proposed minimum gravel extraction elevation is 600 masl. At the southern end of the proposed extraction area the base of the pit is approximately 11 m above the watertable, therefore no dewatering will be required. This level of separation distance above the watertable is protective of the aquifer.

Gravel extraction generally does not limit infiltration of precipitation except where haul roads and stockpiles are present. These areas should direct runoff towards the undisturbed sand and gravel deposits.

The most significant risks to groundwater resources and mitigation measures from gravel extraction are listed below:

a. Over-pumping groundwater such that groundwater depletion occurs.

There is no groundwater pumping for gravel pit processing, only domestic use for staff operating in the pit. We estimate that 3 to 4 workers will be on site during the daytime when the pit is operating. This is a very small flow, which is sustainable with the existing well.

b. Pollution from equipment.

Groundwater pollution can occur from lubricants, fuel and coolants. The greatest risk of a spill occurs during equipment repair and maintenance. Proper handling of fluids is required during these processes. A dedicated area with secondary containment for fuelling and maintenance purposes should be established if significant maintenance is required. There is no fuel storage on site, which represents the largest potential source of groundwater pollution should a spill occur.

We have recommended a spill response plan and spill kits be available on site should a leak or spill occur. Quick response times are necessary, and personnel should be trained in spill control.

Equipment should be parked in the same location and daily inspection for leaks should be carried out each morning, prior to moving equipment.

Spills over 100 L in size must be reported to the province.

Equipment on site is capable of immediately excavating any impacted soil which should a spill occur. In addition, the operator should contact Active Earth to direct any remediation measures that may be required.

Infiltration of precipitation will increase slightly following pit development. Contributing factors to infiltration of precipitation are climate (including amount of rainfall/snowfall), surface cover, soil type and slope of the ground surface. It is significant to note that the total infiltration (16 mm) over the area of the pit is very low. There will be no backfilling of the pit, therefore precipitation will accumulate onto native granular soils. Infiltration is largely due to snowmelt and spring rains

accumulating at the site, prior to increased temperature as noted by the highest groundwater levels which occur in May and June. Changes to infiltration factors from the pit operations will include flattening the slope which would allow for increased infiltration which is not significant due to the amount of rainfall.

The depth of the proposed pit varies from 25 to 40 m from the south to north end respectively. The water table at the on-site well is noted to be 580.7 masl and the lowest elevation of the pit is proposed to be 600 masl allowing an approximate vertical separation of 19.3 m at the southern end of the pit. The on-site well is located near the southern boundary of the proposed extraction area at a slightly lower elevation than the lowest point of extraction and is suitable to determine the groundwater levels at the southern end of the pit, at the commencement of pit development where extraction will begin.

Potential impacts to groundwater and surface water resources from the proposed gravel mining at the Site are considered to be negligible based on the following conditions and recommendations:

1. Community water systems are located up-gradient of the Site or in a confined aquifer.
2. Total annual precipitation is low (321 mm) and approximately 5% of precipitation recharges the shallow unconfined aquifers. Recharge to the aquifer at the Site is limited largely due to climactic conditions of low precipitation and high evapotranspiration during the summer months.
3. The area proposed for gravel extraction (3.2 ha) is very small compared to the overall watershed of the Nicola River (2,190 kms).
4. Infiltration of precipitation will not be impeded provided haul roads are designed to shed runoff towards permeable areas.
5. Spill kits should be present on Site and a spill response plan with appropriate staff training should be developed.
6. No fuel storage should occur on Site.
7. Maintenance of equipment should be carried out on a paved pad with secondary containment in case of fluid leaks.
8. Any leaks or drips from equipment should be cleaned up immediately.
9. The unsaturated thickness above the water table at the south end is 19.3m which is significant. This provides protection to groundwater resources by attenuation of potential pollution from the surface.
10. After year one, a monitoring well should be constructed to monitor water levels within the pit to ensure there is a minimum of 2m separation to the watertable. The monitoring well should be located within the upper (northern) reaches of the pit where the separation

distance will be lesser as a result of the water table elevation being higher upslope. Groundwater levels should be measured quarterly. Groundwater samples should be collected from Parry's Spring and the on-site wells in the spring and fall. A baseline water sample should be obtained from the on-site well prior to pit development. Analyses should include dissolved metals, Light and Heavy Extractable Hydrocarbons (LEPH/HEPH) Polycyclic Aromatic Hydrocarbons (PAH), Benzene, Toluene, Ethylbenzene and Xylenes (BTEX).

11. No site filling is being contemplated following gravel extraction; as a result, placement of potentially contaminated soil is not considered an environmental concern.
12. No groundwater pumping for soil processing will take place on Site.
13. After year one, a monitoring well should be constructed to monitor water levels within the pit to ensure there is a minimum of 2m separation to the watertable. The monitoring well should be located within the upper (northern) reaches of the pit where the separation distance will be lesser as a result of the water table elevation being higher upslope.

7 LIMITATIONS

This report has been prepared by Active Earth Engineering Ltd. exclusively for Nicola Valley Aggregates. This report is intended to provide a preliminary assessment of the hydrogeology of the Site to assess potential impacts and mitigation measures of gravel mining on water resources.

Should Nicola Valley Aggregates submit this report to the TNRD Regional District and the Ministry of Mines, they are authorized to rely on the results within the limitations of the following paragraphs.

The findings and conclusions documented in this report have been prepared for specific application to this project and have been developed in a manner consistent with that level of care normally exercised by hydrogeological professionals currently practicing under similar conditions in the area. The conclusions made in this report reflect Active Earth's best judgement in light of the information available at the time of writing. No warranty is expressed or implied. Should additional information become available or site conditions change, the conclusions and recommendations of this report may be subject to change.

Information included in this report has been obtained from several sources. Active Earth makes no representation as to the accuracy of information obtained from outside sources other than direct observations made by Active Earth.

Any use which the client or a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such parties. Active Earth accepts no responsibility for damages, if any, suffered by third parties as a result of business decisions made or actions based on this letter.


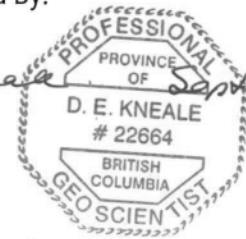
8 CLOSURE

We trust that this provides the information you currently require. If you have any questions, please contact the undersigned.

Yours truly,

ACTIVE EARTH ENGINEERING LTD.

Prepared By:

  Sept 30, 2020

David Kneale, P.Geo.
Senior Hydrogeologist

Reviewed by:



Matt Pye, P.Eng.,
Senior Hydrogeologist

ATTACHMENTS

- Figure 1 Location Plan
- Figure 2 Site Plan
- Figure 3 Conceptual Hydrogeological Section
- Appendix A Aquifer Classification Worksheets
- Appendix B Mining Plans – L.A. Morgenthaler, P.Eng.



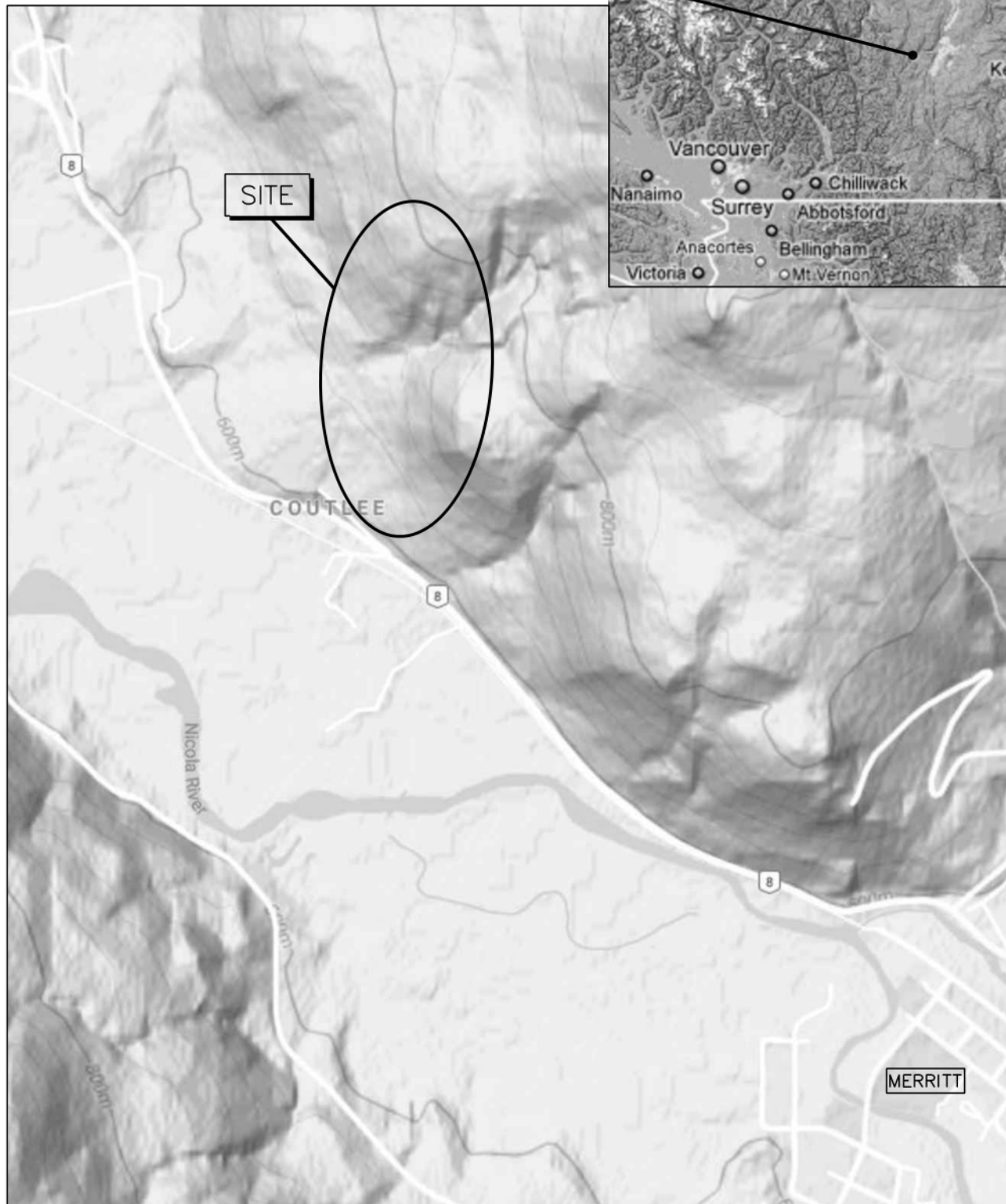
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FIGURES



MAP LOCATION



LOCATION PLAN

REFERENCE: GOOGLE MAPS

SCALE: N.T.S.

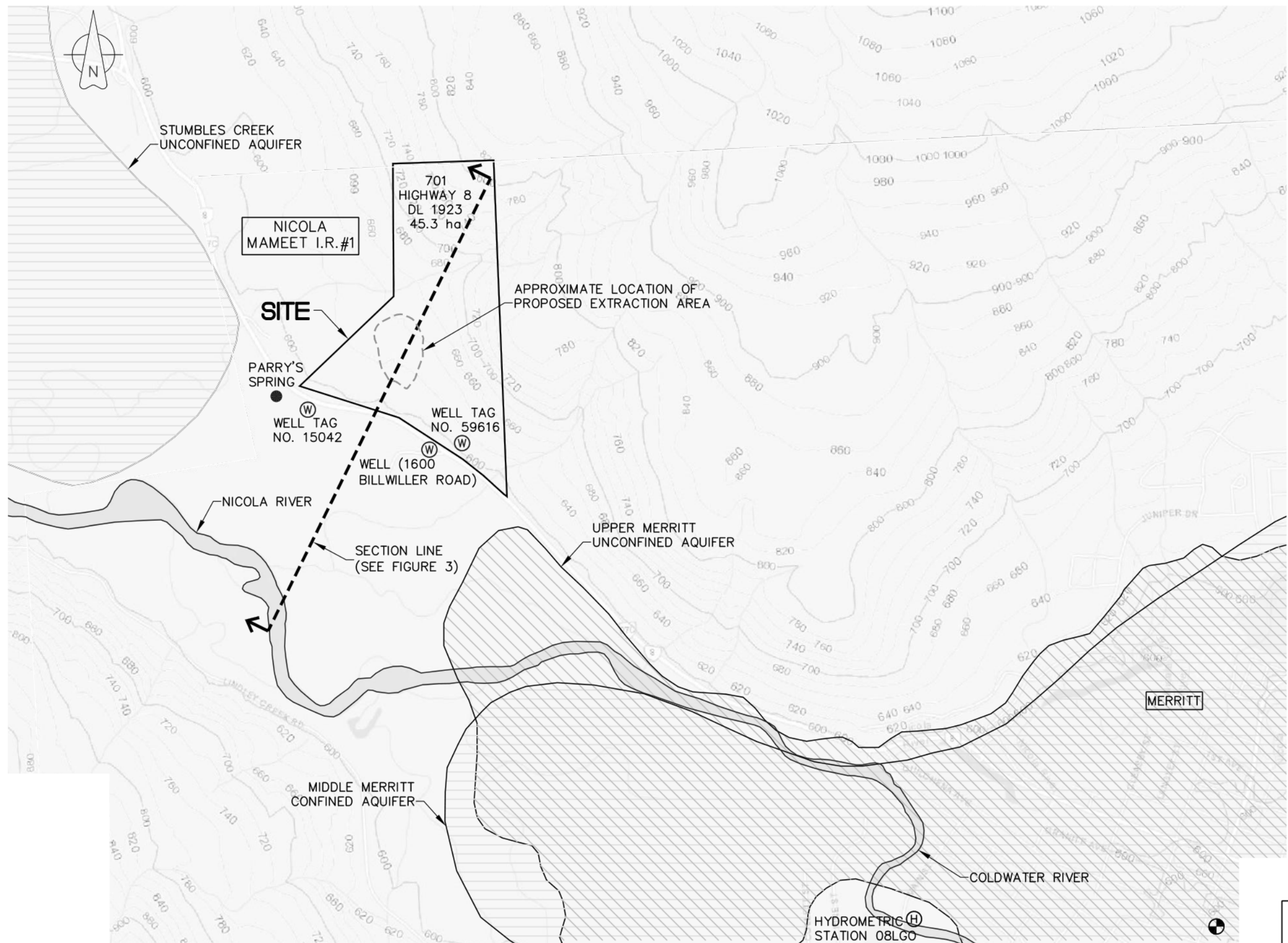
NICOLA VALLEY AGGREGATES



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LOCATION PLAN
701 HIGHWAY 8
MERRITT, BC

date:	APR 18	scale:	N.T.S.
drawn:	GM	checked:	DK
file:	1887-1	drawing no:	FIGURE 1
issue:	A		



- LEGEND**
- APPROXIMATE LEGAL LOT LINE
 - ⊙ OBSERVATION WELL
 - ⊕ HYDROMETRIC STATION
 - ⊙ WATER WELL
 - ▨ AQUIFER 4b
 - ▨ AQUIFER 1c

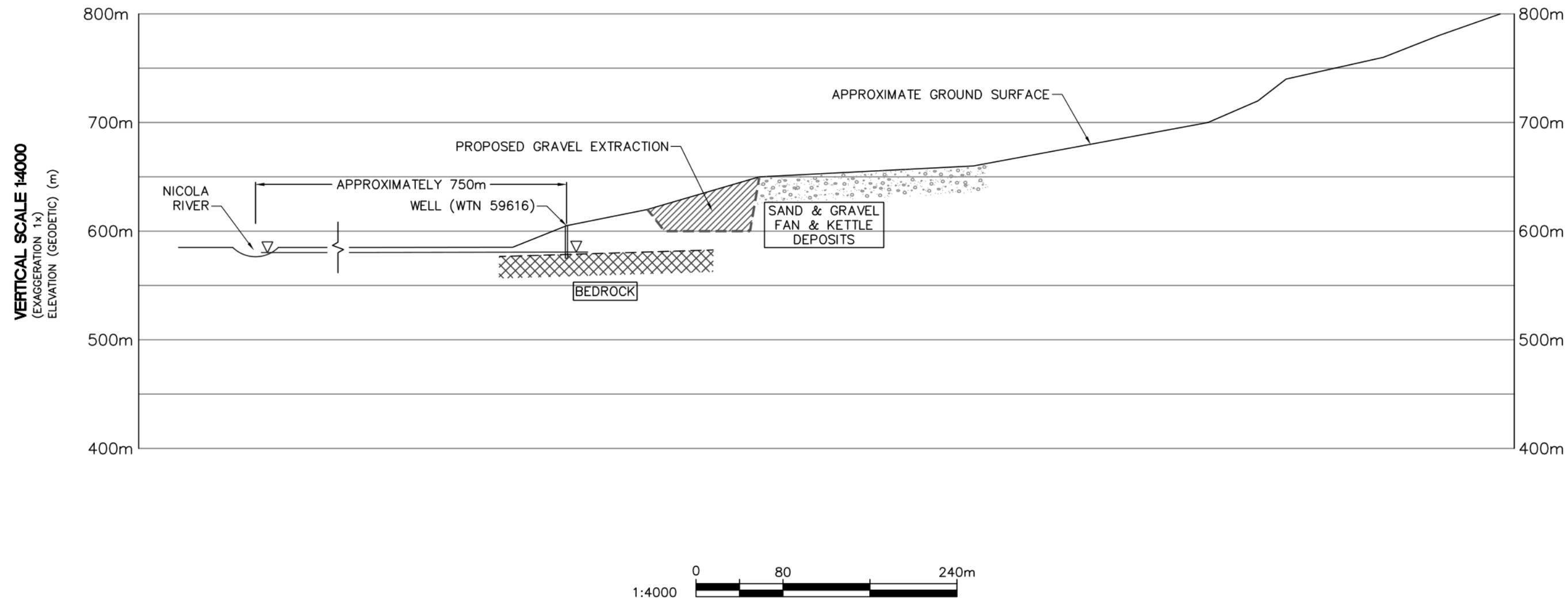


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CLIENT NAME: NICOLA VALLEY AGGREGATES		PROJECT LOCATION: MERRITT, BC	
SITE PLAN (CONTOUR & AQUIFER MAP) 701 HIGHWAY 8			
DWN BY: EB/GM	DWG NAME: -2	DATE: 2019-04-05	FIGURE 2
CHK'D: DK	PLOT:	CADFILE: 1887	

LEGEND

▽ GROUNDWATER ELEVATION



CLIENT NAME:
NICOLA VALLEY AGGREGATES

PROJECT LOCATION:
MERRITT, BC

**CONCEPTUAL HYDROGEOLOGICAL SECTION
701 HIGHWAY 8**

DWN BY: EB/GM

DWG NAME: -3

DATE: 2019-04-08

CHK'D: DK

PLOT:

CADFILE: 1887

FIGURE 3



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APPENDIX A

Aquifer Classification Worksheets

AQUIFER CLASSIFICATION WORKSHEET

DATE: March 2018

AQUIFER REFERENCE NUMBER: 0074

DESCRIPTIVE LOCATION OF AQUIFER: Upper Merritt Aquifer

NTS MAP SHEET: 092I017

BCGS MAP SHEET: 092I016.2.2.4, 092I.016.2.2.2, 092I.017.1.1.3, 092.017.1.1.1, 092.007.3.3.3, 092.007.3.3.4, 092I.017.1.1.2, 092I.017.1.1.4

AUTHOR: Golder Associates Ltd. - Nick Gorski, MSc / Kevin Bennett, PEng

CLASSIFICATION: IA

RANKING: 15

Aquifer Size: 7.0 km²

Aquifer Boundaries: The Upper Merritt Aquifer is an unconfined aquifer comprised of modern alluvial sand and gravel deposits associated with the Nicola and Coldwater Rivers near their confluence in the Merritt area. The aquifer boundary is predominantly based on morphology, whereby the aquifer boundary is coincident with the floodplain limits of the Nicola and Coldwater Rivers and the associated topographic change, as the shallow sand and gravel deposits are generally not observed in the limited wells outside of this boundary. Changes in topography and morphology also mark the assumed limits of the Lower Merritt Aquifer in the valleys to the northwest and south. In the valley to the east, at the outflow of the Nicola River from Merritt, the aquifer boundary is assumed to be where the floodplain deposits become more constrained by the valley walls. Subsurface data in this location is sparse but there is an assumed degree of interconnectivity with permeable deposits as the valley widens to the east.

Aquifer Sub-type: 1c - Predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifers found along lower order (< 3-4) streams in confined valleys with relatively undeveloped floodplains, where aquifer thickness and lateral extent are more limited.

Observation Wells: Observation Well #296 – Merritt (Garcia Road at Library)

Geologic Formation (overlying materials): None.

Geologic Formation (aquifer): Modern alluvial sand and gravel deposits.

Confined / Partially Confined / Unconfined: Unconfined

Vulnerability: High. Largely unconfined, high permeability sand and gravel deposits and depth to static water level is generally shallow (0-15m). Based on this, the vulnerability of the aquifer is considered high.

Productivity: High (Geomean – 5.4 L/s). Wells completed in the Upper Merritt Aquifer generally have high yields. Estimated hydraulic conductivity is on the order of 0.001 m/sec to 0.002 m/sec (Bennett K. and Caverly, 2009). Four municipal supply wells with rated capacities between 60 to 125 L/s are completed in the unconfined aquifer (Merritt, 2015). Pumping tests completed in 2012 at the Colletville and Vought Park #2 wells indicated specific capacities of 27.1 L/s/m and 9.22 L/s/m, respectively (Western Water, 2012).

Depth to Water: Shallow (Average – 4.0 m bgs). Depth to water ranges from 2.1 to 5.6 m below ground surface. Water levels were reported to be approximately 4.5 m below ground surface at OBS Well # 296 in 2016.

Direction of Groundwater Flow: Groundwater flow direction is assumed to be from nearby topographic highs towards the topographic lows and surface water features in the valley, namely the Nicola River and Coldwater River. The Coldwater River is a losing reach as it flows through Merritt (Bennett and Caverly, 2009). The Nicola River is inferred to be gaining reach between Nicola Lake and the confluence with the Coldwater River (Golder, 2015). Natural river losses from the Nicola River to underlying aquifers is inferred to be zero in Merritt (Golder 2015).

Recharge: The major source of recharge to the aquifer is infiltration from river loss from the Coldwater River as it flows through Merritt (Bennett and Caverly, 2009). Other sources of recharge likely include infiltration of precipitation and inflows from upstream aquifers in the alluvial sediments.

Domestic Well Density: Light – < 4 wells/km².

Type of Known Water Use: Drinking water (municipal water supply/domestic), irrigation.

Reliance on Source: Primary. The Vought Park #1 and #2, Fairley Park and Colletville municipal wells are completed in the Upper Merritt Aquifer.

Conflicts between Users: No documented conflicts.

Quantity Concerns: No documented concerns.

Quality Concerns: Isolated. The municipal water supply wells are rated as Groundwater Under Direct Influence from Surface Water (GWUDI). Isolated occurrences of detectable total coliforms were reported between 2006-2012 (Western Water, 2012). In general, quality of water is high with no documented water quality concerns in recent years.

Comments: None.

Water Budget: None. Groundwater budgets are currently planned (as of 2018).

Groundwater Model(s): None. Numerical or analytical groundwater modelling is currently planned for 2018.

References:

- Bennett K. and Caverly, A. 2009. Review of Ground Water/Surface Water Interaction within the City of Merritt. Province of B.C, Ministry of the Environment, Water Stewardship and Bio. Environmental Stewardship.
- Berardinucci J. and K. Ronneseth, 2002. *Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater*. BC Ministry of Water, Land and Air Protection, Water Air and Climate Change Branch, Water Protection Section.
- Bobrowsky P., Cathro, M. and Paulen, R. 2001. Quaternary Geology Reconnaissance Studies 92I/2 and 7. British Columbia Geological Survey, Geological Fieldwork 2001. Paper 2002-1.
- CDN Water Management Consultants Inc. 2008. *Surface and Groundwater Supply and Interaction Study – Phase 1 and Phase 2 WUMP-2006-S02*. Prepared for the Nicola Watershed Community Round Table.
- City of Merritt. 2015. City of Merritt Community Water System Annual Report. Contained within the City of Merritt 2015 Annual Report.
- EBA Engineering Consultants Ltd. 2002. Aquifer Protection Plan City of Merritt, Merritt, BC. Produced for the City of Merritt. EBA file No. 0805-5875017.
- Fulton, R.J. 1975. Quaternary Geology and Geomorphology, Nicola-Vernon Area, British Columbia. Geological Survey of Canada, Memoir 380.
- Hender Environmental Consulting Ltd. 1999. Hydrologic Assessments of the Merritt District Sub-basins. Prepared for Weyerhaeuser Canada Ltd.
- Hy-Geo Consulting, Hodge Hydrogeology Consulting, and Azar & Associates. 2009. Provincial Observation Well Network Review British Columbia. Prepared for the BC Ministry of Environment Water Stewardship Division.
- Kalyn, D. 1988. Construction and Testing of Observation Well No. 296 Merritt, British Columbia. B.C. MoE Water Management Branch. Contract No. 84.
- Kosakiski G.T. and Hamilton, R.E. 1982. Water Requirements for the Fisheries Resource of the Nicola River, B.C. Department of Fisheries and Oceans. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1680.
- Nicola WUMP Multi-Stakeholder Committee. 2010. Nicola Water Use Management Plan (A water use management plan for the Nicola watershed). Prepared on the behalf of the Citizens of the Nicola watershed.
- Opus DaytonKnight. 2012. Merritt Water Utility Master Plan. Prepared for the City of Merritt.
- Pacific Hydrology Consultants Ltd. 1984. Construction and Testing Production Well No. 2. Prepared for Lower Nicola Waterworks District.
- Rathfelder, K.M. 2016. *Modelling Tools for Estimating Effects of Groundwater Pumping on Surface Waters*. Province of B.C., Ministry of Environment, Water Science Series WSS2016-09.

Summit Environmental Consultant Ltd. 2007. Nicola River Watershed, Present and Future Water Demand Study. Presented for the Nicola Watershed Community Round Table.

Van der Gulik, T., Neilsen, D., Fretwell, R., Petersen, A. and Tam, S. 2013. Agriculture Water Demand Model - Report for the Nicola Watershed. Prepared for the B.C. Ministry of Agriculture and B.C. Agricultural Council.

Wei, M., D. M. Allen, A. P. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin, FORREX Forum for Research and Extension in Natural Resources.

Western Water Associates Ltd. 2012. Well Assessment and Asset Evaluation: City of Merritt, B.C. Prepared for the City of Merritt.

AQUIFER CLASSIFICATION AND RANKING

<u>Ranking Component:</u>	<u>Ranking Value</u>
----------------------------------	-----------------------------

Productivity:	3
---------------	---

Vulnerability:	3
----------------	---

Size:	2
-------	---

Demand:	3
---------	---

Type of Use:	3
--------------	---

Quality Concerns:	1
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Quantity Concerns:	0
--------------------	---

Total:	15
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Statistical Summary of Well Data for Aquifer

Total number of wells available for statistical analysis: 10

	Depth to Bedrock (m bgs)	Well Depth (m bgs)	Depth to Water (m bgs)	Reported Est. Well Yield (L/s)	Est. Thickness of Confining Materials (m)
Number of Wells	NA	10	7	4	NA
Minimum	NA	11.6	2.1	2.2	NA
Maximum	NA	30.5	5.8	25.2	NA
Median	NA	18.3	4.0	4.0	NA
Average	NA	20.1	4.0	8.9	NA
Geometric Mean	NA	19.2	3.8	5.4	NA

AQUIFER CLASSIFICATION WORKSHEET

DATE: March 2018

AQUIFER REFERENCE NUMBER: 0076

DESCRIPTIVE LOCATION OF AQUIFER: Stumbles Creek Aquifer

NTS MAP SHEET: 092I016

BCGS MAP SHEET: 092I.016.4.3.1, 092I.016.4.1.3, 092I.016.4.1.2, 092I.016.4.1.1, 092I.016.4.1.4, 092I.016.4.1.2, 092I.016.2.3.3, 092I.016.2.3.4, 092I.016.2.4.3, 092I.016.2.3.2, 092I.016.2.4.1

AUTHOR: Golder Associates Ltd. - Nick Gorski, MSc / Kevin Bennett, PEng

CLASSIFICATION: II A

RANKING: 12

Aquifer Size: 12.9 km²

Aquifer Boundaries: The Stumbles Creek Aquifer is a shallow, predominantly unconfined, alluvial fan-type sand and gravel aquifer located near the confluence of Guichon Creek and the Nicola River. The fan spreads distally from north to south and is incised to some degree by modern-day Stumbles Creek. The lateral and distal boundaries of the aquifer are the valley sides and the Nicola River, respectively, though the aquifer is less understood at its margins due to limited subsurface information in these areas.

Aquifer Sub-type: 3 – Post-glacial alluvial fan-type aquifer

Observation Wells: None.

Geologic Formation (overlying materials): None.

Geologic Formation (aquifer): Post-glacial alluvial sands and gravels, poorly sorted

Confined / Partially Confined / Unconfined: Unconfined

Vulnerability: High. The Stumbles Creek Aquifer is unconfined, with high permeability sand and gravel deposits extending from surface to below reported static water levels. Groundwater is generally shallow with several locations of reported groundwater levels less than 5 m below ground surface.

Productivity: Moderate (Geomean – 0.9 L/s). Estimated hydraulic conductivity of 0.001 m/s for the fan deposits (Golder, 2016).

Depth to Water: Shallow (Average – 4.6 m bgs). Groundwater is generally shallow (0-15m) with several locations of reported groundwater levels less than 5 m below ground surface near the northern extend of the aquifer.

Direction of Groundwater Flow: The general direction of groundwater flow is interpreted to be from local topographic highs in the aquifer area to topographic lows. Groundwater flow is inferred to be in the southwards direction towards the Nicola River (Golder, 2016). The Nicola River is a gaining reach in

the Lower Nicola. The Stumbles Creek Aquifer is inferred to be the primary source of recharge to the Nicola River in the area.

Recharge: The primary source of recharge is precipitation and inflows from adjacent formations (Golder, 2016).

Domestic Well Density: Low – < 4 wells/km².

Type of Known Water Use: Drinking water (water supply, community wells, domestic), irrigation. The Shullus subdivision and the Rocky Pines subdivisions are supplied by two water systems operated by the Lower Nicola Indian Band on the Nicola-Mameet Indian Reserve (Golder, 2016).

Reliance on Source: Primary.

Conflicts between Users: No documented conflicts.

Quantity Concerns: No documented concerns.

Quality Concerns: No documented concerns.

Comments: None.

Water Budget: A water budget was developed for Lower Nicola between Merritt and Spius Creek by Golder (2016) as part of the Lower Nicola Valley Groundwater Budget.

Groundwater Model(s): None.

References:

- Berardinucci J. and K. Ronneseth, 2002. *Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater*. BC Ministry of Water, Land and Air Protection, Water Air and Climate Change Branch, Water Protection Section.
- Bobrowsky P., Cathro, M. and Paulen, R. 2001. Quaternary Geology Reconnaissance Studies 92I/2 and 7. British Columbia Geological Survey, Geological Fieldwork 2001. Paper 2002-1.
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- Golder Associates Ltd. 2005. Hydrogeology Assessment of the Lower Nicola Valley, Lower Nicola, British Columbia. Prepared for Associate Engineering (BC) Ltd.
- Golder Associates Ltd. 2016. Lower Nicola Valley Groundwater Budget. Ministry of Environment, Groundwater Science Study.
- Henderson Environmental Consulting Ltd., 1999. Hydrologic Assessment of the Spius Creek Watershed. Prepared for Aspen Planers Ltd. Merritt Division.
- Hender Environmental Consulting Ltd. 1999. Hydrologic Assessments of the Merritt District Sub-basins. Prepared for Weyerhaeuser Canada Ltd.

Hy-Geo Consulting, Hodge Hydrogeology Consulting, and Azar & Associates. 2009. Provincial Observation Well Network Review British Columbia. Prepared for the BC Ministry of Environment Water Stewardship Division.

Pacific Hydrology Consultants Ltd. 1984. Construction and Testing Production Well No. 2. Prepared for Lower Nicola Waterworks District.

Wei, M., D. M. Allen, A. P. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin, FORREX Forum for Research and Extension in Natural Resources.

AQUIFER CLASSIFICATION AND RANKING

<u>Ranking Component:</u>	<u>Ranking Value</u>
----------------------------------	-----------------------------

Productivity:	2
---------------	---

Vulnerability:	3
----------------	---

Size:	2
-------	---

Demand:	2
---------	---

Type of Use:	3
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Quality Concerns:	0
-------------------	---

Quantity Concerns:	0
--------------------	---

Total:	12
---------------	-----------

Statistical Summary of Well Data for Aquifer

Total number of wells available for statistical analysis: 24

	Depth to Bedrock (m bgs)	Well Depth (m bgs)	Depth to Water (m bgs)	Reported Est. Well Yield (L/s)	Est. Thickness of Confining Materials (m)
Number of Wells	NA	24	13	10	NA
Minimum	NA	1.8	0.6	0.2	NA
Maximum	NA	54.9	9.1	1.9	NA
Median	NA	12.2	3.7	1.3	NA
Average	NA	14.5	4.6	1.1	NA
Geometric Mean	NA	10.3	3.8	0.9	NA

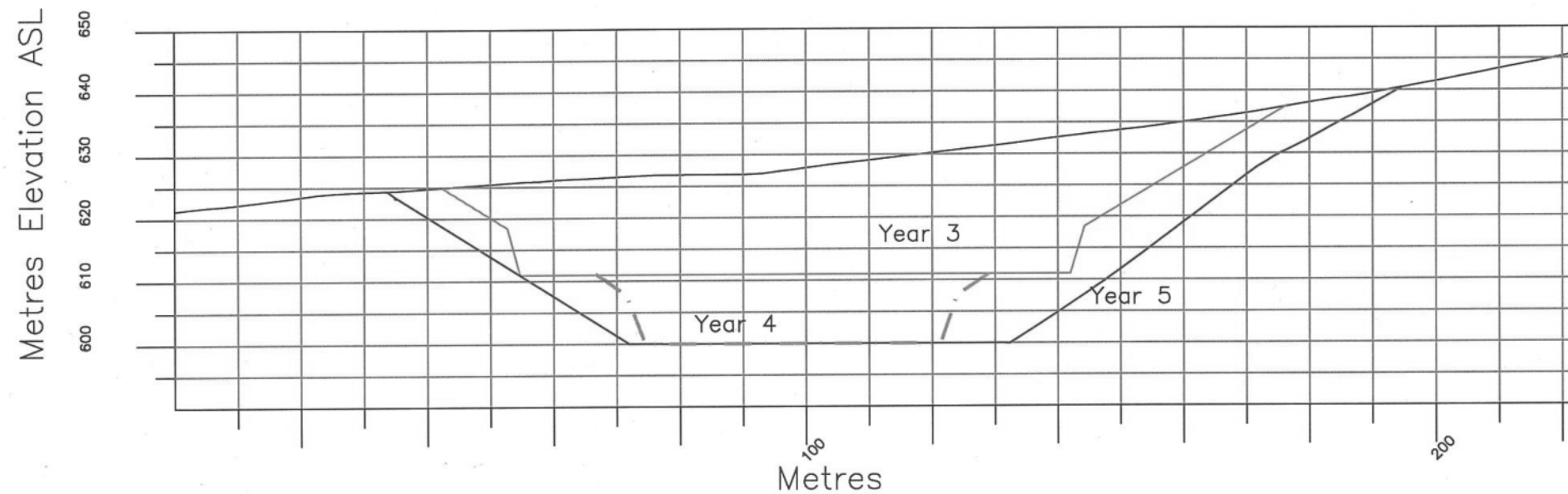


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APPENDIX B

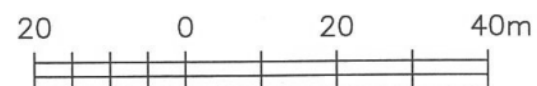
Mining Plans – L.A. Morgenthaler, P.Eng.



Section 1+00N Looking North

- Year 1
- Year 2
- Year 3
- Year 4
- Year 5

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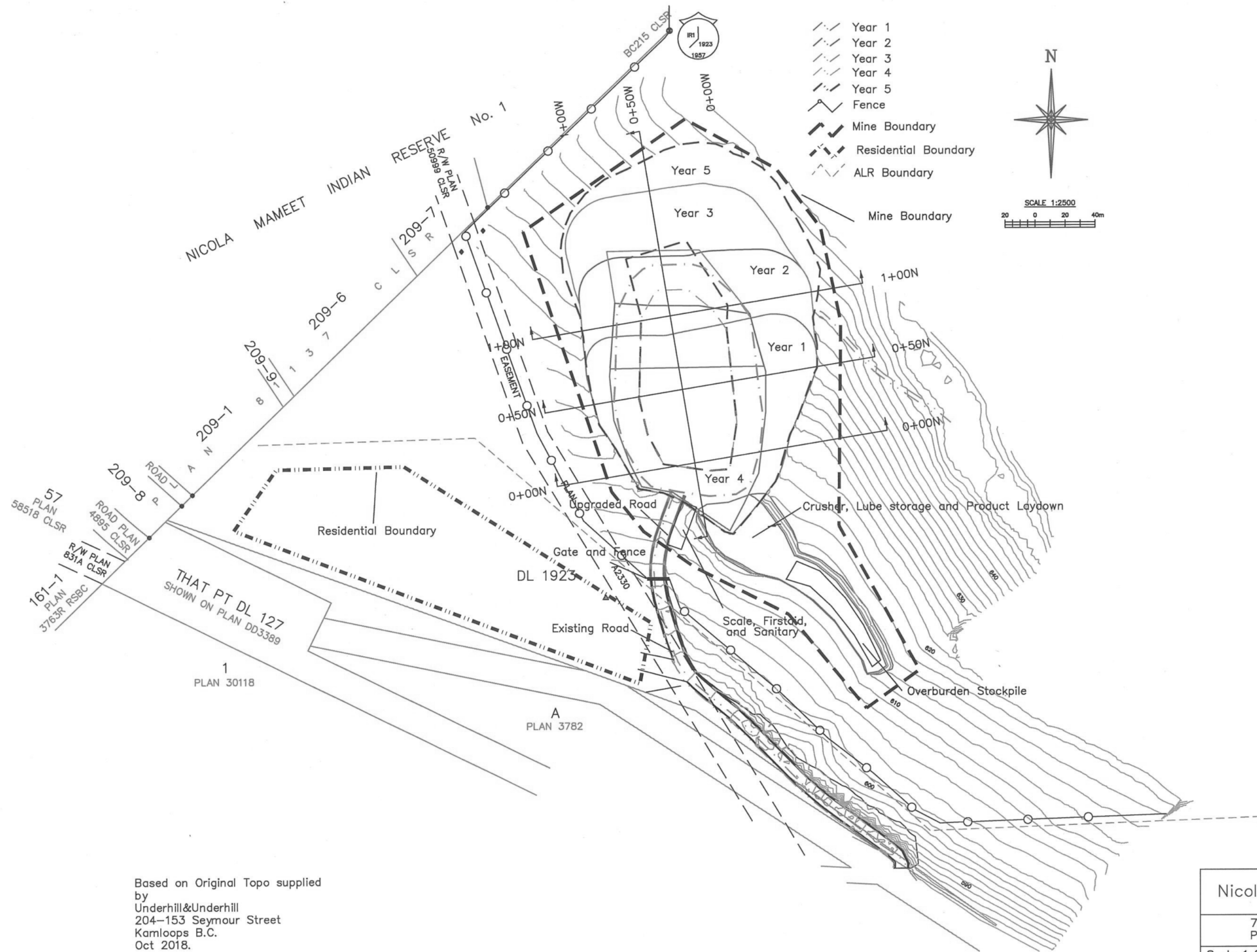


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ENGINEER
JAN 3 2019

Nicola Valley Aggregates Ltd

701 Highway #8
Section 1+00N

Scale 1:1000 Date Jan 3 2019
Dwg by : LAM Drawing 582-1801 R4
Page 71 of 118 FOR-2023-31814



Based on Original Topo supplied
by
Underhill&Underhill
204-153 Seymour Street
Kamloops B.C.
Oct 2018.

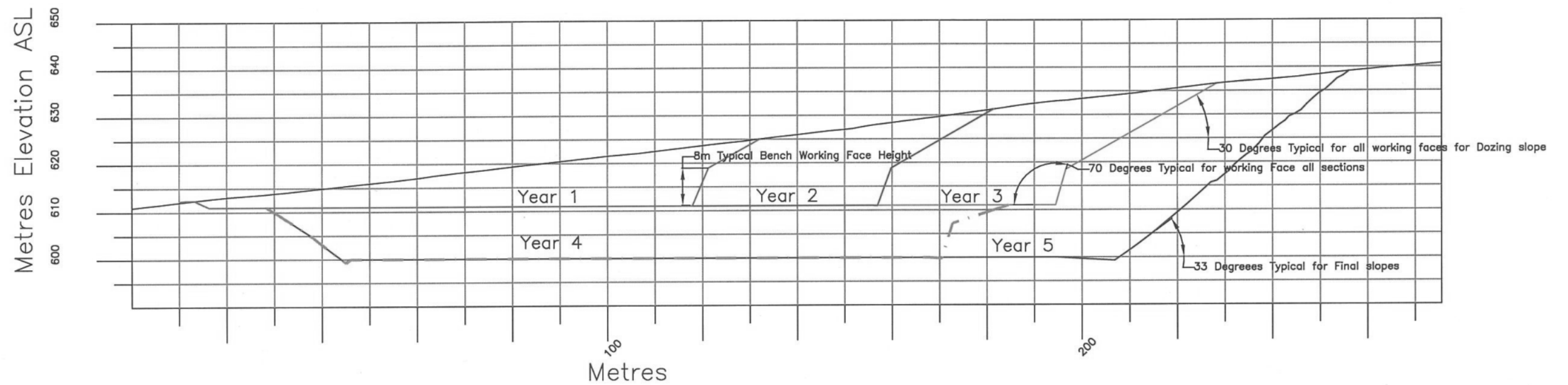
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701 Highway #8
Plan View - Yrs 1 to 5

Scale 1:2500 Date Jan 3 2019
Dwg by : LAM Drawing 582-1801 R4
Page 72 of 118 FOR-2023-31814

L. A. Morgenthaler
L. A. Morgenthaler
BRITISH COLUMBIA
ENGINEER
JAN 3 2019

- Year 1
- Year 2
- Year 3
- Year 4
- Year 5



Section 0+50W Looking West

SCALE 1:1000

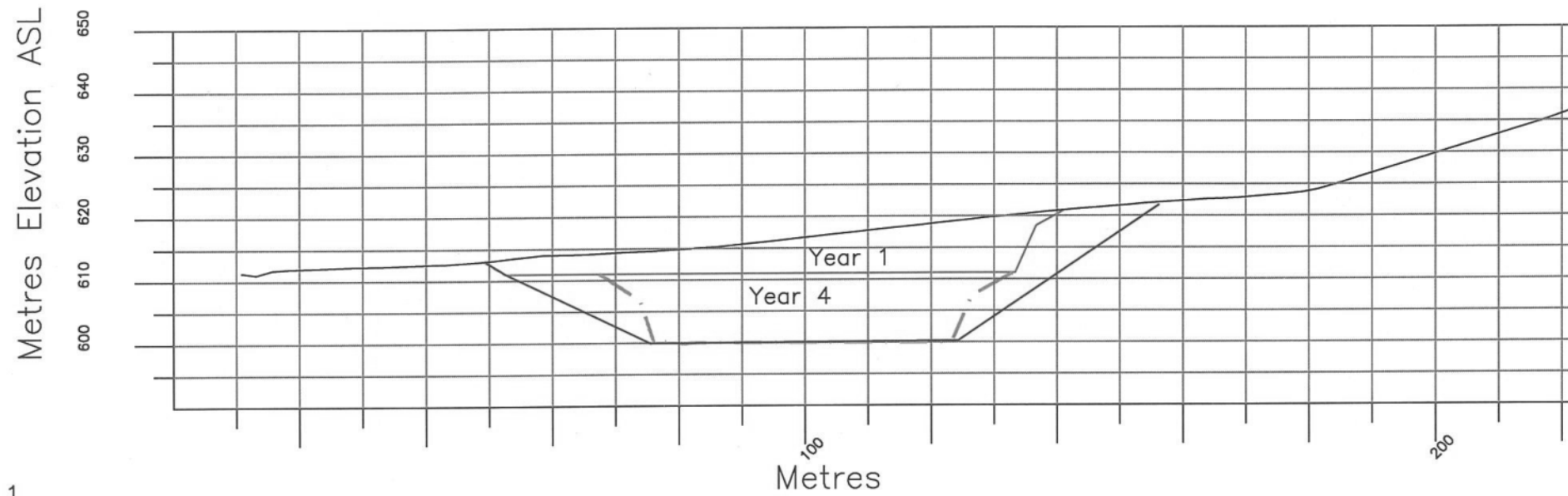


PROFESSIONAL
OF
L. A. Morgenthaler
BRITISH
COLUMBIA
ENGINEER
L. A. Morgenthaler
JAN 3 2019

Nicola Valley Aggregates Ltd

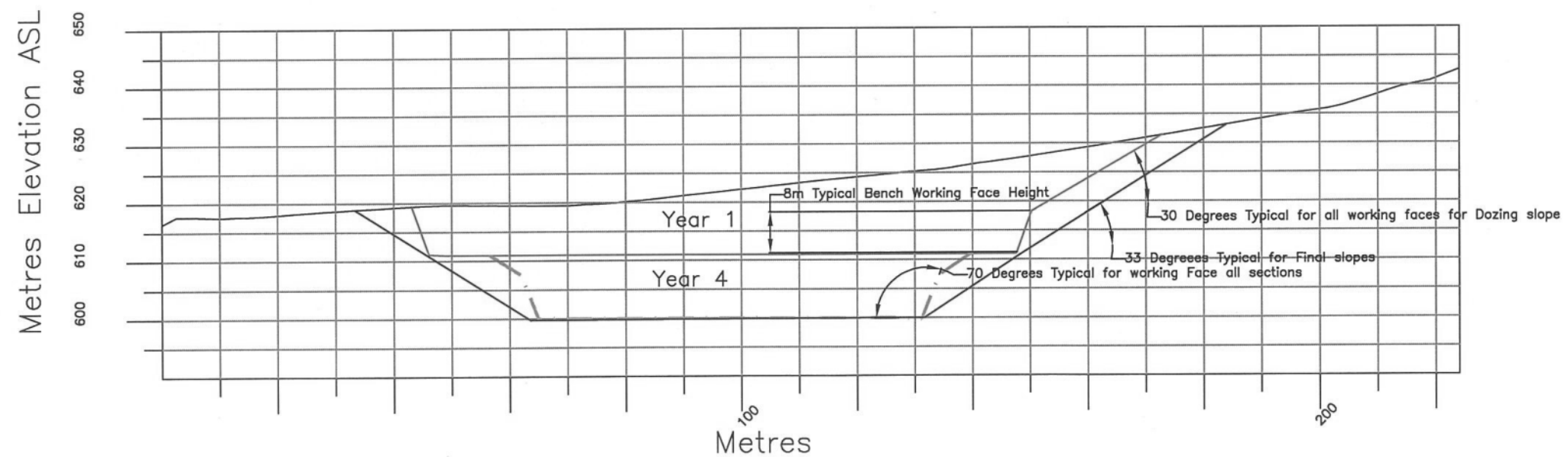
701 Highway #8
Section 0+50W

Scale 1:1000 Date Jan 3 2019
Dwg by : LAM Drawing 582-1801 R4
Page 73 of 118 FOR-2023-31814



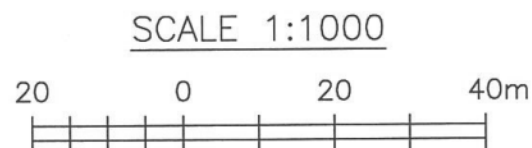
Section 0+00N Looking North

- Year 1
- Year 2
- Year 3
- Year 4
- Year 5



Section 0+50N Looking North

L. A. Morgenthaler
 BRITISH COLUMBIA
 ENGINEER
 JAN 3 2019



Nicola Valley Aggregates Ltd

701 Highway #8
 Sections 0+00N and 0+50N

Scale 1:1000 Date Jan 3 2019
 Dwg by : LAM Drawing 582-1801 R4
 Page 74 of 118 FOR-2023-31814



PRELIMINARY HYDROGEOLOGICAL STUDY RESPONSE

December 3, 2020

Project No. 1887

NICOLA VALLEY AGGREGATES
PO Box 796
Merritt, BC
V1K 1B8

ATTENTION: Gary Breaks

REFERENCE: Response to Hemmera and FLNRORD Comments
701 Hwy 8, Merritt, BC

1 INTRODUCTION

In accordance with your request, Active Earth Engineering Ltd. (Active Earth) has undertaken a review of the following documents:

- Evaluation of Nicola Valley Aggregates Permit Application, Final Report, Hemmera Envirochem Inc., July 24, 2020.
- Review of Hemmera Envirochem Inc. Report: "Evaluation of Nicola Valley Aggregates Permit Application", Ministry of Forest Lands, Natural resources Operations and Rural Development., September 23, 2020

The following section provides comments on both reports.

2 REVIEW

Response to Section 2.1 of Hemmera's Report

- 1. **Decreased Safety Margin for Pollution Prevention:** By reducing the thickness of unsaturated sediments above the groundwater table, an aggregate operation may affect the ability of those sediments to ameliorate contaminants. The use of operational practices such as regular maintenance, proper fuel handling, spill avoidance, use of spill kits and emergency planning will keep contamination as low as possible. These measures can be planned using the "Stormwater, Emergency and Spill Response" section of the Risk Management Module and the Traffic Module from Aggregate Operators Best Management Practices Handbook for British Columbia. These provisions should be*

BURNABY

160 – 2250 Boundary Road
Burnaby, BC V5M 3Z3
Tel. 778-737-3488

LANGLEY

4510 Saddlehorn Crescent
Langley, BC V2Z 1J6
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ABBOTSFORD

304 – 2600 Gladys Avenue
Abbotsford, BC V2S 0E9
Tel. 778-752-2222

VICTORIA

105 – 4343 Tyndall Avenue
Victoria, BC V8N 3R9
Tel. 778-430-5475

described in the Notice of Work and Reclamation application for sand and gravel pit and rock quarry permits.

- The unsaturated thickness above the water table is approximately 19.3m (see Section C2) at the south end of the pit which is significant. Note that spill mitigation measures including a spill response plan are presented in the report (Section 6b).
2. **Altered Groundwater Recharge Rates:** *Vegetation, together with soil, may act as both a filter and a sponge and has the potential to return almost all rainfall to the atmosphere, allowing as little as 10% to become groundwater. When that filter and sponge capacity is removed due to a disturbance, there may be an increase in both the volume and rate of recharge into a groundwater system from the disturbed area. Recharge rates are also affected by the clay and silt content of the gravel deposit and the direction of the surface drainage with respect to the site.*
- Golder Associates¹ noted that recharge to groundwater recharge is in the order of 5% of the total annual precipitation which is estimated to be 321 mm. It is significant to note that the total precipitation is very low for the region based on recharge rate provided by Golder. The total annual infiltration is estimated at 16 mm over the area of the pit, which is very low. Most of the infiltration will occur during snowmelt as indicated by Golder plots which show the highest discharge in May and June (Section 5).
 - Contributing factors to infiltration of precipitation (Section 6b) are climate (including amount and distribution of rainfall/snowfall and temperature), surface cover, soil type and slope of the ground surface. There will be no backfilling of the pit, therefore precipitation will accumulate onto native soils. Infiltration is largely due to snowmelt and spring rains accumulating at the site, prior to increased temperature as noted by the highest groundwater levels which occur in May and June. Changes to infiltration factors from the pit operations will include flattening the slope which would allow for increased infiltration which is not significant due to the limited amount of rainfall.
3. **Lowering of Groundwater Table:** *An aggregate operation can lower the ground water table if excavation occurs at a depth below the average high table. In BC, this situation rarely occurs because most aggregate operating permits prohibit excavation within one meter of the high groundwater table.*
- Contrary to this remark and based on Active Earth's experience in monitoring

¹ MOE Groundwater Science Study, Lower Nicola Groundwater Budget, Report No. 153225-001-R-Rev1, Golder Associates, 7 March 2016.

gravel pits, most jurisdictions require a minimum of 2m unsaturated vertical separation with the high water table.

- There is no groundwater use proposed for the pit operations (Section 6a).

Surface watercourses and groundwater have a complex yet balanced relationship. During low flow periods, that relationship can be crucial in ensuring adequate water is supplied to rivers to support aquatic ecosystems. The average depth to the groundwater table is required information in the Notice of Work and Reclamation application for sand and gravel pit and rock quarry permit.

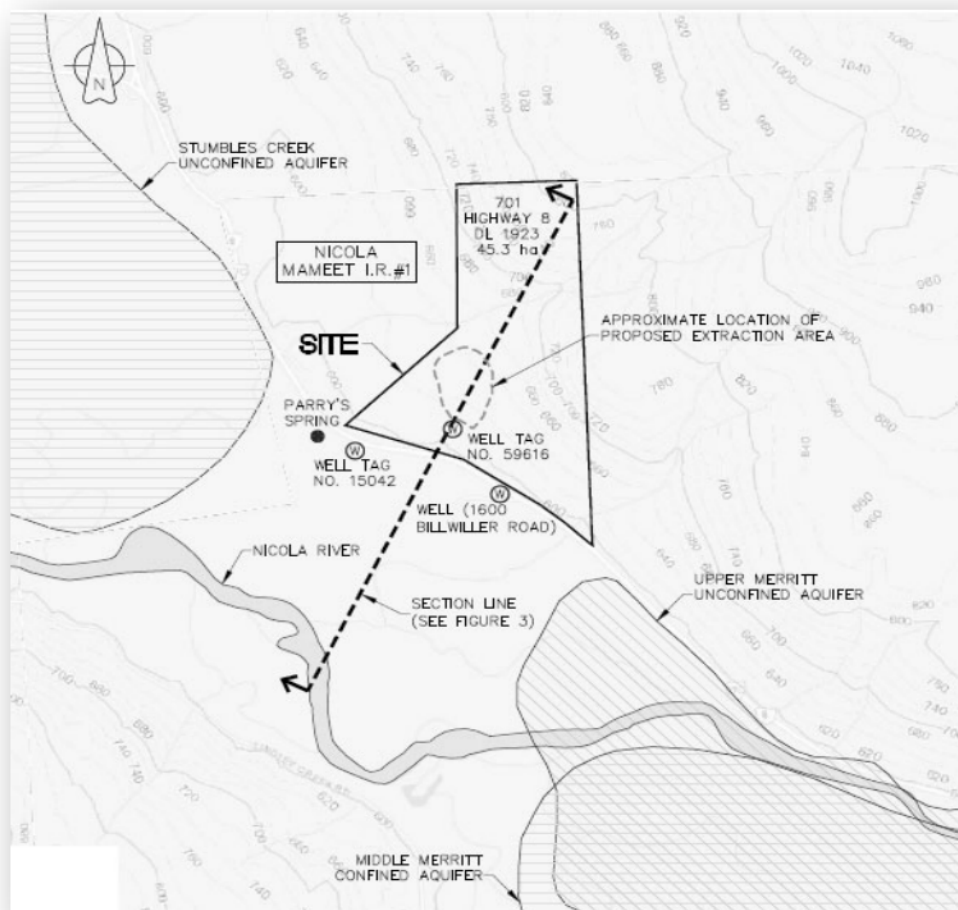
- Given the significant unsaturated thickness at the south end of the pit, the depth to groundwater can be established as mining progresses during year 1.
- There is no groundwater use proposed for the pit operations (Section 6a).

Response to Section 2.2 of Hemmera's Report

1. **Presence of aquifer beneath the Site:** *Section 4.3 indicates "no mapped aquifer underlying the site" but then in Section 5, describes a "bedrock-contact aquifer with groundwater flow within the unconfined aquifer perched over bedrock within overburden soils." Although there is no mapped aquifer in iMapBC, it does not necessarily mean that one is not present as the aquifer's boundaries shown in the report are based on limited information which may not have been updated with recent information. Unconfined aquifers have been mapped about 600 m south (Upper Merritt Unconfined Aquifer) and around 400 m west (Stumbles Creek Unconfined Aquifer) of the proposed Site. There is no evidence to assume that there is no aquifer beneath and downgradient of the Site given the presence of several wells and a spring (Parry's) in proximity of the southern property boundary.*
 - Active Earth did not state there was no aquifer below the site, only that there was no mapped aquifer (Section 4.3).
 - The Ministry of Forest Lands, Natural Resource Operations and Rural Development (MFLNRORD) noted that the aquifer map (Figure 2) did not show the presence of an unconfined aquifer as noted in Section 4.3 of our report. Please note this map was taken from the British Columbia provincial data base and is accurate for its intended purpose showing the mapped aquifers. Our report noted (Section 4.3) there is an unconfined aquifer underlying the proposed pit area.
2. **Depth to groundwater in the proposed quarry area:**
 - a. *The Active Earth study mentions 24.3 m (80 feet) depth to water for a well drilled on Site (Well Tag No. 59616). However, this well is not drilled at the proposed quarry*

location but in the southeast corner of 701 Hwy 8 (see the Site Plan), which is about 300 m from the proposed quarry. A monitoring well should be installed at the quarry location to determine the presence/ absence of groundwater in overburden.

- The on-site well is located near the southern boundary of the proposed extraction area at a slightly lower elevation than the lowest point of proposed pit and is suitable to determine the groundwater levels at the southern end of the pit, where extraction will begin.
- This existing well (WTN 50616) is located approximately 50m from the southern extent of the proposed gravel extraction area. The well location (WTN 59616) was originally plotted based on the provincial database; ground truthing shows the well is immediately downgradient of the proposed pit and approximately 50 m from the south end of the pit. This well is suitably located for monitoring as shown below: The revised site plan is shown below:



- b. The Conceptual Hydrogeological Section (Figure 3) shows shallow dipping bedrock and an assumed depth to bedrock beneath the proposed gravel pit. This has not been proven at this location and should be established by drilling and installing a monitoring well at the quarry.*
- A monitoring well has been recommended for this purpose in the northern area of the proposed pit after one year of operation (Section 6). The pit level may or may not have to be adjusted based on water level measurements taken in May/June to establish the high groundwater levels.
- c. The Active Earth Study indicates that the maximum pit depth will be 40 m (Appendix B) indicating that the quarry could extend below the water table if it is shallower than this depth at the proposed quarry location. This will require special permission.*
- The proposed pit will not extend into the water table. The depth of the proposed pit varies from 25 to 40 m from the south to north end respectively. The water table at the on-site well is noted to be 589 masl and the lowest elevation of the pit is proposed to be 600 masl allowing an approximate vertical separation of 11.0 m to the water table.
 - It is noted that the year 1, 2 and 3 year extraction plan is to develop the pit to elevation 611 masl which is approximately 22 m above the water table at the south end of the property.
 - Golder Associates noted that recharge to groundwater is in the order of 5% of the total annual precipitation estimated to be 321 mm. Most of the infiltration will occur during snowmelt as indicated by Golder plots which show the highest discharge in May and June. It is significant to note that the total annual infiltration estimated at 16 mm over the area of the pit is very low and will not result in significant seasonal water table (see Response to Section 5.0 of Hemmera's Report below).

Lowering of Groundwater Table: *An aggregate operation can lower the ground water table if excavation occurs at a depth below the average high table. In BC, this situation rarely occurs because most aggregate operating permits prohibit excavation within one metre of the high groundwater table.*

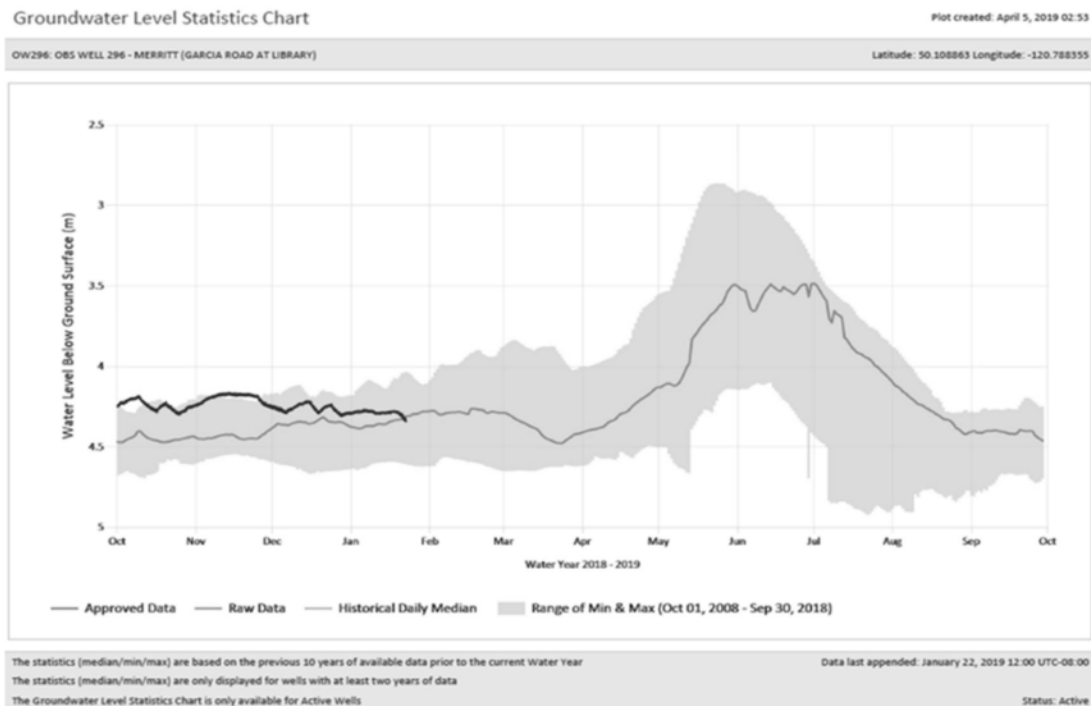
- There is no groundwater use for gravel processing purposes or dust control.
3. **Groundwater monitoring:** *Groundwater monitoring should be completed for one year before the project is permitted; monitoring well(s) should be installed and monitored as part of the planning phase, not just for operational monitoring.*
- This can be established during the first three years of operation since mining will commence at the south end to elevation 611 masl, approximately 22m above the estimated water table at the south end of the site. There is sufficient time to adjust the pit depth at the north end if necessary, but in our opinion, this will not likely be required.
 - FLNRORD noted that WTN 11577 is not present in the report. Please note that Figure 2 shows the most relevant wells as a result of ground truthing. It is common knowledge that old wells are not plotted correctly simply because they were located by legal description. We are aware that groundwater levels are shallower in the valley below Highway 8
4. **Artesian groundwater:** *There is mention of flowing wells in the area and Parry's Spring is downgradient of the proposed extraction area. Springs are vulnerable to contamination and can dry up with small changes to groundwater levels. The groundwater flow direction and velocity should be determined to establish the flow path downgradient of the proposed quarry to assess whether there is a connection between the Site and Parry's Spring.*
- There are no flowing wells in the area of the proposed pit since the aquifer is unconfined. Parry's (correct spelling Pare) Spring is an expression of the water table and no more vulnerable to contamination than the groundwater underlying the pit area. Contamination mitigation measures have been recommended.
5. **Water use:** *Should groundwater be used for dust suppression or other purposes, the use will need to be licensed (which will require detailed characterization of the system and other users and sensitivities). The proponent should state whether groundwater will be used and estimate the quantity and assess the potential impact to downstream users.*
- There will be no groundwater use for gravel processing purposes or dust control.

Response to Section 5.0 of Hemmera's Report

Based on our review of the Preliminary Groundwater Investigation by Active Earth Engineering (2019), we maintain that the requirements of 'The Guide' are fully implemented so that groundwater characterization is carried out at the proposed quarry site to confirm the stated depth to groundwater. This will require installation of a dedicated monitoring well to include careful logging of the geological materials and whether perched groundwater is present. In addition, determination of the following should be carried out:

- *Seasonal variance in the water table at the quarry monitoring well:*
 - Annual precipitation is less than 400 mm with approximately 5% infiltration estimated by Golder². Given the low amount of precipitation, seasonal variations will be minimal on the mountainside as compared to the valley bottom. We know that 50% of the precipitation falls between October and March each year and the majority of infiltration will occur in the spring.
 - Seasonal groundwater fluctuations in shallow aquifers generally range up to 5 m in British Columbia. The higher ranges are in areas that have significant rainfall and or snowmelt. Mountainous areas near the coast tend to have two groundwater peaks, one from winter rainfall and one from snowmelt.
- Section 4.3.1 of our report shows the groundwater statistics chart for Provincial Observation Well 296 in Merritt. This well is completed in the Upper Merritt Unconfined Aquifer. The chart shows (below) that seasonal water levels vary 1.9 m between winter lows and May/June high groundwater levels. This is indicative of the lower part of the valley south of Hwy 8 opposite the Site.

2



This Interior site has a total annual infiltration to ground estimated at 16 mm over the area of the pit. Seasonal fluctuations at the north end of the site would be slightly greater than noted here, however, this is an extremely low value and given the seasonal groundwater fluctuations noted, a significant seasonal rise in the water table would not occur where it would reach within 2m of the pit floor particularly during the first three years of operation.

A monitoring well is proposed to be installed during the first year of operation (Section 6) to ensure that the high groundwater levels are greater than 2 m above the high water table during the 4th year of operation when the pit level is at its lowest.

- *Flow direction:*
 - We have assumed the groundwater flow direction is towards the Nicola River. Based on observed groundwater levels, topography and bedrock exposures, it is not necessary to install 3 monitoring wells to determine the general groundwater flow direction at the Site. This site is located on a mountainside and we have concluded that the downstream water resources identified need to be protected and monitored. The groundwater flow velocity can be used to identify the rate of groundwater flow and determine the groundwater monitoring schedule. Active

Earth's experience in groundwater monitoring for gravel pits has shown that quarterly monitoring of groundwater levels and quality during the first two years of operation is adequate to identify potential groundwater impact. The monitoring schedule can usually be decreased to twice annually if no impacts are observed in the first two years; generally at high and low groundwater conditions (April/May and October for this project).

- *Hydraulic conductivity and velocity;*
 - Knowing the groundwater travel time does not change the conclusions of our report or the monitoring schedule. Please note, there are no requirements or mention of determining groundwater flow direction and velocity noted in the *Guide*.
- *Baseline groundwater quality for this well and other wells and springs downgradient of the proposed quarry;*
 - Agree, the on-site well and the spring and down-gradient wells should be monitored prior to and during mining for background water quality results.
- *Stating whether groundwater will be used in the project; and,*
 - Groundwater will not be used for gravel processing or dust control.
- *Assessing the potential impacts to downgradient groundwater users. This assessment should also consider closure of the pit and how it will be carried out in a safe and sustainable manner that prevents risk to the public and protects the groundwater resource;*
 - The pollution prevention procedures presented are for the protection of groundwater and down-gradient groundwater users.

Hemmera references the following document:

- *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia (Province of BC 2010).*

The following is the recommended groundwater issues and our response which shows these issues have been addressed:

GROUNDWATER IMPACTS

Information will be required to demonstrate the proximity of the proposed excavation to the water table.

- The estimated depth to the water table at the south end of the proposed pit elevation is 589 m and approximately 22 m below the ground surface for the year 1, 2, and 3 production levels. This is a significant factor of safety and the pit elevation at the north end can be established during the first year of operation with drilling a monitoring well.

The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers.

- The well logs do not indicate any perched water tables. If present, seepage would be identified in the slope adjacent to Highway 8; none was observed.

The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level.

- Referencing the first point above, the base of the pit has significant unsaturated zone and seasonal high water table conditions will not intersect the pit.

Excavations below the water table will require special approval.

- There will be no excavation below the water table (Section 6).

GROUNDWATER MITIGATION AND CONTROL

Describe potential impacts of the proposed operation on groundwater quantity and quality.

- Groundwater impacts include slightly increased infiltration of snowmelt and rainfall (Section 6). Infiltration is estimated at 16mm over the full area of the pit. This is not a significant amount.

Spill mitigation measures have been presented in the report.

- If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required (Section 6).

Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required.

- All excavation will be above the water table (Section 6). Geotechnical impacts are beyond our scope of work for this project.

The initial study has been completed. Recommendation for monitoring have been included.

4 LIMITATIONS

This report has been prepared by Active Earth Engineering Ltd. exclusively for Nicola Valley Aggregates. This report is intended to provide a preliminary assessment of the hydrogeology of the Site to assess potential impacts and mitigation measures of gravel mining on water resources.

Should Nicola Valley Aggregates submit this report to the TNRD Regional District and the Ministry of Mines, they are authorized to rely on the results within the limitations of the following paragraphs.

The findings and conclusions documented in this report have been prepared for specific application to this project and have been developed in a manner consistent with that level of care normally exercised by hydrogeological professionals currently practicing under similar conditions in the area. The conclusions made in this report reflect Active Earth's best judgement in light of the information available at the time of writing. No warranty is expressed or implied. Should additional information become available or site conditions change, the conclusions and recommendations of this report may be subject to change.

Information included in this report has been obtained from several sources. Active Earth makes no representation as to the accuracy of information obtained from outside sources other than direct observations made by Active Earth.

Any use which the client or a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such parties. Active Earth accepts no responsibility for damages, if any, suffered by third parties as a result of business decisions made or actions based on this letter.

5 CLOSURE

We trust that this provides the information you currently require. If you have any questions, please contact the undersigned.

Yours truly,

ACTIVE EARTH ENGINEERING LTD.

Prepared By:



David Kneale, P. Geo.
Senior Hydrogeologist

Reviewed by:

Matt Pye, P. Eng.,
Senior Hydrogeologist

ATTACHMENTS

Hemmera Report (attached as separate document)
FLNRORD Report



ACTIVE EARTH
ENGINEERING LTD

www.activeearth.ca

ATTACHMENTS



File: 38050-03/ Nicola Valley Aggregates

September 23, 2020

To: Vanessa Dunae, Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
Via email to Vanessa.Dunae@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.

Re: Review of Hemmera Envirochem Inc. Report: *"Evaluation of Nicola Valley Aggregates Permit Application"*

This memo is in response to a request by yourself to review the aforementioned report as it relates to the Nicola Valley Aggregates permit application near Merritt, BC. The Hemmera report is a review of another consultant's report and references groundwater impacts, which you indicate are outside of your field of expertise. The following summarizes my review of the Hemmera Report.

BACKGROUND

Nicola Valley Aggregates (NVA) has submitted a permit application to the Ministry of Energy, Mines and Petroleum Resources for a sand and gravel quarry at 701 Highway 8 near Merritt, BC. NVA retained Active Earth Engineering Ltd. (AE) to undertake a *Preliminary Hydrogeological Study* (Active Earth, 2019). The Active Earth report was subsequently peer reviewed by Hemmera Envirochem Inc (Hemmera, 2020). In their peer review, Hemmera references the *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, as a reference point for their review. AE did not reference the Guide in their report. This fact may explain the perception of deficiencies by Hemerra. I need to note that while I do not have experience with the Guide, general hydrogeologic principles still apply.

REVIEW OF THE GUIDE REQUIREMENTS

Section 2.1 of Hemerra's report refer to the Guide's requirements as "Statutory Requirements". I note the Guide itself does not indicate these items to be legislative requirements. Staff with the Ministry of Energy, Mines and Petroleum Resources (EMPR) may have a general understanding or established best practices relative to applicants' following of the Guide, which can be brought to bear on my general observations.

The Guide does indicate that the following information about groundwater should be provided in Mine Permit Applications:

- *Describe potential impacts of the proposed operation on groundwater quantity and quality;*
- *If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required;*
- *Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required;*
- *minimize sediment and pollutants reaching natural and man-made surface water, groundwater and aquatic environments;*
- *Information will be required to demonstrate the proximity of the proposed excavation to the water table;*
- *The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers;*
- *The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level; and,*
- *Excavations below the water table will require special approval.*

Hemerra also note that potential impacts to groundwater from gravel pit development are indicated in the *Aggregate Operators Best Management Practices Handbook for British Columbia* (Province of BC, 2002).

SCOPE OF REVIEW

Hemerra's review indicate deficiencies relative to potential effects of the proposed development on groundwater, and also on human health. The scope of my comments are focused on groundwater.

AQUIFERS and GROUNDWATER WELLS

It is important to note first that while Figure 2 (Active Earth, 2019) has correctly identified Aquifer 74 as unconfined, the shading does not match the legend. This could lead the reader to believe there is not an unconfined aquifer on the other side of the proposed development. This

To: Vanessa Dunae

is important because, as indicated by Hemmera (2020), the lack of aquifer mapping doesn't preclude its potential presence. In the current situation it is reasonable to suspect the proposed quarry footprint may overlies an extension of either of the unconfined aquifers that border the property.

Delineation of aquifers is often done through review of private well records that were voluntarily submitted to the Province in the past. Active Earth (2019) did this, stating "In addition, several private wells are present south of the Site, but are not [sic] included in the provincial WELLS database." This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application.

When accessed September 14, 2020, the GWELLS database showed 4 registered wells south of the site as shown in the screenshot below (Figure 1). Figure 2 (Active Earth, 2019) shows only three wells to be considered as part of the review; WTN 59616 is shown to exist south of the property, but the GWELLS database (accessed September 14, 2020) shows it to be present immediately west of the property. This well record is assigned to Aquifer 725, which is present approximately 10 km west of the site. WTN 15042 is shown in Active Earth's Figure 2 to be immediately south of the southwest property boundary, in contrast to online mapping that places it to the north west.

WTN 11577 is not present in Active Earth's report, but if located correctly in online mapping indicates groundwater at eight feet below the ground surface. This and other well information noted above needs to be reconciled and incorporated into a more detailed hydrogeological report, and should better inform a revised subsurface cross-section.

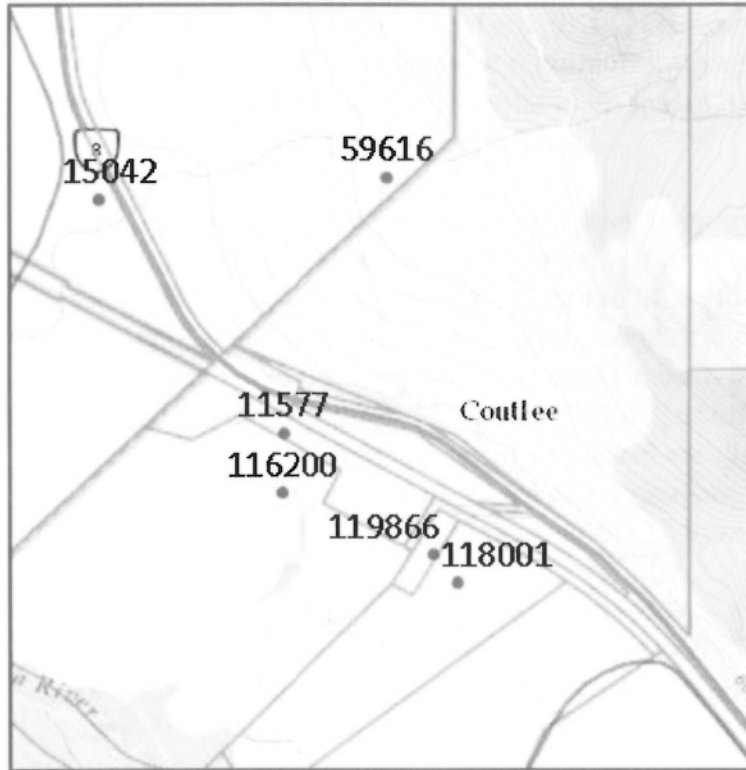


Figure 1: Water wells in the vicinity of the site, accessed from GWELLS on September 14, 2020

ENVIRONMENTAL ASSESSMENT

Hemmera commented that the proposed extraction is close to the threshold for EAO notification. Just prior to their July 24, 2020 report, EAO's Project Notification Policy (V.1.1) was updated (July 14, 2020). It clarifies that "a project that would meet the project design or effects thresholds if those thresholds were reduced by 15%" would be required to notify the EAO". The application was initiated prior to the revised policy guidance, but appears to be applicable to this type of application. EMPR staff may want to contact EAO for guidance and/or consider whether this policy may be now applicable to this application.

SUMMARY AND RECOMMENDATIONS

In summary, I agree with Hemmera that Active Earth's report is preliminary and additional work is required to assess potential risks and determine existing information about groundwater presence. Successful implementation of Hemmera's recommendation 3, to monitor groundwater for one year prior to permitting, would be a primary objective in this regard.

Doing so may address the following concerns raised by Hemmera:

- Presence of aquifer, water level and bedrock contact (verify conceptual model and depth to groundwater in overburden)(Recommendation 2 and 4);
- Groundwater flow direction, hydraulic conductivity and velocity (Perry Spring concern)(Recommendation 4);

To: Vanessa Dunae

- Seasonal variance in groundwater levels; and,
- Assess potential impacts to downgradient users.

Note that a minimum, three wells roughly equidistant from one another are required to determine groundwater flow direction. Therefore implementation of groundwater monitoring to address these concerns should include a network of least one upgradient well and at least two downgradient wells. They should be monitored for water quality through sampling several times a year (e.g., major ions/potability). Daily monitoring of groundwater levels, best accomplished with dedicated continuous recording dataloggers, will provide seasonal groundwater elevation data across the site area. Baseline (pre-permitting) values can then be compared to data collected during operation.

Baseline data will also assist any potential future investigations into reports of changes in groundwater quality or quantity by downgradient domestic users. Assuming the downgradient wells are being used – and this should be investigated - it may be advisable to prepare a groundwater monitoring response plan that can be utilized should complaints arise if the mine becomes operational.

Hemmera also note that assessment of potential impacts to downgradient users require consideration of pit closure. The Nicola River is immediately downgradient of domestic groundwater users and the ultimate receiving body for groundwater, and similarly require consideration of potential groundwater impacts to surface water, through mine life and post-closure reclamation. Conceptually, removal of excavation of up to 50 m of overburden may accelerate local groundwater recharge. If the groundwater-bearing zone below the mine is also gravelly, groundwater flow will be rapid and any foreign dissolved constituents or increased turbidity may be transported to the river. Monitoring and regular reporting and interpretation of groundwater data could inform adaptive management of daily operations and final reclamation planning.

I agree with Hemerra's comment that clarification should be sought as to whether NVA plan to use groundwater for dust suppression. That has the potential to impact groundwater, and should be considered. This also implies non-domestic use of groundwater in BC, which requires authorization via a license to use groundwater. It is probable that groundwater in the pit area would be considered hydraulically connected to the Coldwater River (Province of BC, 2016) in that context and would need to be taken into account in the application for authorization.

In any reports supplemental to the preliminary investigation submitted, the water well records now online for locations downgradient of the proposed development can be incorporated into cross-sections and estimation of water table elevation. Any substantial change in estimated groundwater elevation has the potential to alter the total planned extraction volumes and/or the proposed mine footprint.

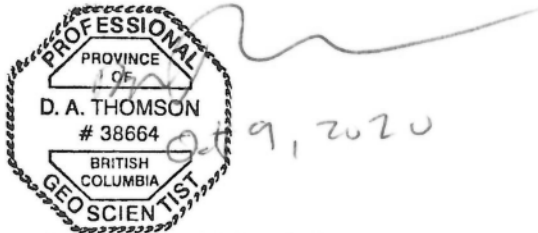
Please note that Hemerra's report, and any future reports from members of the Engineering and Geoscientists of BC (EGBC) that involve the practice of geoscience, should be authenticated

To: Vanessa Dunae

(signed and stamped) in a similar manner to Active Earth's. I communicated with Hemerra and obtained an authenticated version, attached.

Please contact me with any questions.

Signed,



David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science,
Vernon, British Columbia.

References

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study*, April 10, 2019. Project 1887.

Hemerra Envirochem Inc., 2020. *Evaluation of Nicola Valley Aggregates Permit Application Final Report*. Prepared for Lower Nicola Indian Band, Merritt, BC. Project 104684-01, July 24, 2020.

Province of British Columbia, Ministry of Energy and Mines, 2002. *Aggregate Operators Best Management Practices Handbook for British Columbia, Volume 2: Best Management Practices*. April 2002.

Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division, 2010. *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia*. February 2010.

Province of British Columbia, 2016. *Determining the Likelihood of Hydraulic Connection – Guidance for the Purpose of Apportioning Demand from Diversion of Groundwater on Streams*. Version 1.0. Water Science Series, WSS2016-01. Province of British Columbia, Victoria BC.

From: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
To: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
Cc: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: Hydrogeologist request
Sent: 02/17/2021 23:56:11
Attachments: image001.jpg
Message Body:

Hi Vanessa. I reviewed my previous response and the tracking table makes sense. By way of response to your second question I've cc'd Skye. January and now February are quite busy. What timelines are you looking at?

Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 17, 2021 2:02 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi David,

Thanks again for reviewing the reports associated with the Nicola Valley Aggregates permit application. Two questions:

I've transcribed your report into the attached issues tracking table. Could you please review and confirm that I lined everything up correctly?

Since you completed your review, we've received another two hydrological studies from Active Earth/the proponent. Could you review those, or should I check in with Skye and start the review process fresh?

Thanks,

Vanessa

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: October 9, 2020 10:18 AM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Subject: RE: Hydrogeologist request

Good morning ? please find attached my response. Also attached is an authenticated version of Hemmera's evaluation, as explained toward the end of my response.

Please contact me with any questions
Dave

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: September 10, 2020 4:55 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa,

Our Regional Hydrogeologist, David Thomson, will be able to assist with this review. I have cc'd David on this note. I understand that the review comments are due by October 9th, but preferably sooner. If you have any further information related to this review, please send to David directly.

Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 3:05 PM
To: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Thanks, Trevor. How about a month from now ? Friday, October 9?

Earlier is welcomed but I imagine your team is as busy as we are. Please let me know if you need more context. Right now, all we have from Lower Nicola Indian Band is the Hemmera report but we may be receiving additional information regarding springs in the area later this month.

From: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Sent: September 10, 2020 2:51 PM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi All,
We can accommodate this request, when do you need the review completed by?

Trevor

Trevor Bohay M.Sc., P.Geo. (he/him)
A/Director, Authorizations
Thompson-Okanagan Region
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
1259 Dalhousie Street
Kamloops, BC

New Phone no: **250.312.7421**

From: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Sent: September 10, 2020 1:14 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: FW: Hydrogeologist request

Hi Vanessa,
I don't have one on staff but Trevor Bohay does (a. Director of Authorizations).

By way of this email, Trevor, can you consider Vanessa's request below?

Thx,
E

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>

Sent: September 10, 2020 11:49 AM

To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>

Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>

Subject: Hydrogeologist request

Hi Eric,

I'm looking for a hydrogeologist to review a report from Lower Nicola Indian Band evaluating the Nicola Valley Aggregates permit application near Merritt, BC. It's a twelve-page report developed by Hemmera and it references groundwater impacts, which is outside my field of expertise.

Could you please point me in the right direction? I don't know any of our provincial hydrogeologists and was encouraged to reach out to you for advice.

Thanks,

Vanessa Dunae

Senior Negotiations Lead, Regional Operations

Ministry of Energy, Mines and Petroleum Resources

vanessa.dunae@gov.bc.ca

cell (250) 320-8250

From: Dunae, Vanessa EMLI:EX (Vanessa.Dunae@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Cc: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: Hydrogeologist request
Sent: 03/31/2021 17:39:21
Attachments: image001.jpg, image002.jpg
Message Body:

Thank you so much, David!

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 31, 2021 10:22 AM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Good morning Vanessa ? please find attached a review as requested. Let me know if you have any questions.

Dave

David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist, Groundwater Science, South Area
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
2501-14th Ave, Vernon, BC V1T 8Z1
VOIP 778 943-6924

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 24, 2021 1:17 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Earlier is better, but I appreciate that you have other things on the go right now! I'll advise the First Nation that we're aiming to provide an update for the end of March.

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: February 24, 2021 12:54 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa, and apologies for delay in response to your original email. My schedule is opening up in March and there's certainly efficiencies in me continuing with this. I'll target one month TAT but is end of March possible?

Thanks
Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 24, 2021 11:45 AM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Dave and Skye,

Just wanted to confirm that someone from your team can review the two Active Earth responses to the Hemmera/LNIB report. I've suggested internally that we're looking at a one-month turnaround, but need to advise the First Nation of our plan in the next few days.

Thanks,

Vanessa

From: Dunae, Vanessa EMLI:EX
Sent: February 18, 2021 11:01 AM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Dave and Skye,

EMLI would greatly appreciate a review the two Active Earth/proponent responses to the Hemmera/LNIB report (attached). Is a month reasonable? Please let me know if you need more information or wish to further discuss.

Thanks,

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines & Low Carbon Innovation
vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: February 17, 2021 3:56 PM
To: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa. I reviewed my previous response and the tracking table makes sense. By way of response to your second question I've cc'd Skye. January and now February are quite busy. What timelines are you looking at?

Dave

From: Dunae, Vanessa EMLI:EX <Vanessa.Dunae@gov.bc.ca>
Sent: February 17, 2021 2:02 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi David,

Thanks again for reviewing the reports associated with the Nicola Valley Aggregates permit application. Two questions:

I've transcribed your report into the attached issues tracking table. Could you please review and confirm that I lined everything up correctly?

Since you completed your review, we've received another two hydrological studies from Active Earth/the proponent. Could you review those, or should I check in with Skye and start the review process fresh?

Thanks,

Vanessa

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: October 9, 2020 10:18 AM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Subject: RE: Hydrogeologist request

Good morning ? please find attached my response. Also attached is an authenticated version of Hemmera's evaluation, as explained toward the end of my response.

Please contact me with any questions
Dave

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: September 10, 2020 4:55 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi Vanessa,

Our Regional Hydrogeologist, David Thomson, will be able to assist with this review. I have cc'd David on this note. I understand that the review comments are due by October 9th, but preferably sooner. If you have any further information related to this review, please send to David directly.

Kind Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 3:05 PM
To: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>; Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Thanks, Trevor. How about a month from now ? Friday, October 9?

Earlier is welcomed but I imagine your team is as busy as we are. Please let me know if you need more context. Right now, all we have from Lower Nicola Indian Band is the Hemmera report but we may be receiving additional information regarding springs in the area later this month.

From: Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Sent: September 10, 2020 2:51 PM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>; Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>

Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>; Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: Hydrogeologist request

Hi All,

We can accommodate this request, when do you need the review completed by?

Trevor

Trevor Bohay M.Sc., P.Geo. (he/him)
A/Director, Authorizations
Thompson-Okanagan Region
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
1259 Dalhousie Street
Kamloops, BC

New Phone no: **250.312.7421**

From: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Sent: September 10, 2020 1:14 PM
To: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>; Bohay, Trevor FLNR:EX <Trevor.Bohay@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: FW: Hydrogeologist request

Hi Vanessa,

I don't have one on staff but Trevor Bohay does (a. Director of Authorizations).

By way of this email, Trevor, can you consider Vanessa's request below?

Thx,
E

From: Dunae, Vanessa EMPR:EX <Vanessa.Dunae@gov.bc.ca>
Sent: September 10, 2020 11:49 AM
To: Valdal, Eric FLNR:EX <Eric.Valdal@gov.bc.ca>
Cc: Cloet, Mike A EMPR:EX <Mike.Cloet@gov.bc.ca>; Zryd, Bob FLNR:EX <Bob.Zryd@gov.bc.ca>
Subject: Hydrogeologist request

Hi Eric,

I'm looking for a hydrogeologist to review a report from Lower Nicola Indian Band evaluating the Nicola Valley Aggregates permit application near Merritt, BC. It's a twelve-page report developed by Hemmera and it references groundwater impacts, which is outside my field of expertise.

Could you please point me in the right direction? I don't know any of our provincial hydrogeologists and was encouraged to reach out to you for advice.

Thanks,

Vanessa Dunae
Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources

vanessa.dunae@gov.bc.ca
cell (250) 320-8250

From: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Subject: RE: NVA review
Sent: 03/30/2021 22:14:23
Attachments: NVA_Review_RH_March_2021_DRAFT.docx, image001.jpg
Message Body:

Hi Dave,

Here are my comments.

Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:31 PM
To: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: NVA review

Sure thing, here you go

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:30 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: NVA review

I cant access VPN , can you please email? Thanks

Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:29 PM
To: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: NVA review

Apologies for being so late with this. I told Vanessa end of the month so that was good. FYI I also was planning to go to Nicola Dam Thursday to help Sarah install loggers. We coordinated last week, but I'm not sure if you have seen any direction to put a hold on field work/travel?

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David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist, Groundwater Science, South Area
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
2501-14th Ave, Vernon, BC V1T 8Z1
VOIP 778 943-6924



File: 38050-03/ Nicola Valley Aggregates

March 30, 2021

To: Vanessa Dunae, Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
Via email to Vanessa.Dunae@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.

Commented [TSF1]: Add your email?

Re: Review of Active Earth Engineering Ltd (Active Earth) Reports: "*Revised Hydrogeological Study*" and "*Preliminary Hydrogeological Study Response*"

This memo is in response to a request by yourself to review the aforementioned reports as they relate to a Ministry of Energy, Mines and Petroleum Resources (EMPR) permit application for the Nicola Valley Aggregates near Merritt, BC. The following summarizes my review of these reports, with reference to my previous review and other reports.

BACKGROUND

Nicola Valley Aggregates (NVA) has submitted a permit application to EMPR for a sand and gravel quarry at 701 Highway 8 near Merritt, BC. NVA retained Active Earth Engineering Ltd. (AE) to undertake a *Preliminary Hydrogeological Study* (Active Earth, 2019). The Active Earth report was subsequently peer reviewed by Hemmera Envirochem Inc (Hemmera, 2020). In their peer review, Hemmera references the *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, as a reference point for their review.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) reviewed and commented on the aforementioned documents as it pertains to groundwater and provided those comments to EMPR. FLNRORD's review was dated September 23, 2020 and professionally authenticated October 9, 2020. Active Earth Engineering Ltd. generated two reports "*Revised Hydrogeological Study*" (September 28, 2020) and "*Preliminary Hydrogeological Study Response*" (December 3, 2020).

**Ministry of Forests, Lands,
Natural Resource Operations
and Rural Development**

Regional Water Management
Thompson Okanagan Region

Mailing/Location Address:
2501 14th Avenue
Vernon BC V1T 8Z1

Telephone: 250-558-1700
Website: www.gov.bc.ca/env

To: Vanessa Dunae

Active Earth's September, 2020 revised study (AE, 2020a) and the December 2020 response (AE, 2020b) are referenced throughout. The *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, continues to be used as a reference point for reviewing these additional reports.

Commented [TSF2]: Is this needed? Its referenced above – delete?

Summary of the Revised Hydrogeological Study (September 2020)

The purpose of the September *Revised Hydrogeological Study* is stated in the report as "... to complete a hydrogeological review and provide an opinion on potential impacts of the proposed gravel mining on the groundwater and surface water resources and provide mitigation measures if necessary."

This response does not offer much new information. A field-verified survey to identify other potentially affected downgradient water users has not been done although the BC Water Resources Atlas shows several users to exist immediately downgradient of the proposed pit area. This is a significant deficiency in their study.

Summary of Preliminary Hydrogeological Study Response (December 2020)

The December response is a review of Hemmera's July 2020 evaluation and FLNRORD's September 2020 review of the same. The response does provide some additional background information such as recharge values and clarifies that no water will be pumped as a result of mining operations. Statements like "...it is not necessary to install 3 monitoring wells to determine the general groundwater flow direction at the Site" without investigating known downgradient users (Figure 1) suggest the applicant lacks willingness to move toward the most basic standards of a hydrogeological study supported by the Guide, FLNRORD and Hemerra. Installing a monitoring well after a resource extraction project has commenced operation, as suggested, generally has little-to-no value.

Commented [TSF3]: ? Is this supposed to be here?

REVIEW OF THE GUIDE REQUIREMENTS

Note that staff with EMPR may have a general understanding or established best practices relative to applicants' following of the Guide, which can be brought to bear on my general observations. They also will be able to confirm whether some items such as knowledge of depth to groundwater is required in the Notice of Work as suggested by the Guide, or whether such information needs can be deferred until after mining begins, as suggested by the applicant (AE, 2020b).

The Guide does indicate that the following information about groundwater should be provided in Mine Permit Applications:

- Describe potential impacts of the proposed operation on groundwater quantity and quality;

To: Vanessa Dunae

- ***If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required;***
- *Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required;*
- *minimize sediment and pollutants reaching natural and man-made surface water, groundwater and aquatic environments;*
- *Information will be required to demonstrate the proximity of the proposed excavation to the water table;*
- *The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers;*
- *The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level; and,*
- *Excavations below the water table will require special approval.*

The bolding above indicates the key missing information in the Reports. The apparent down slope users have not been field-verified, as recommended above, so the degree of hydrogeological study required is not apparent. Figure 1 from FLNRORD's earlier 2020 response, and reproduced below, indicates existing water wells of interest that are available to review from a desktop analysis as well as a field visit. In the absence of this knowledge it is difficult to design appropriate site-specific mitigative measures. More specifically, it is best practice for aggregate operators to design site-specific measures in regards to groundwater protection, then additional site-specific information about groundwater is required relative to these downslope users.

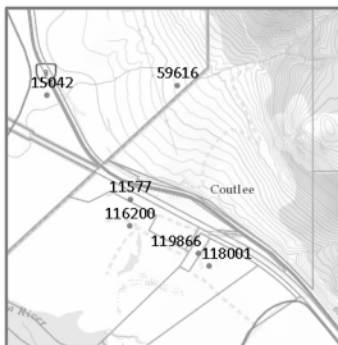


Figure 1: Water wells in the vicinity of the site, accessed from GWELLS on September 14, 2020

Hemerra also notes that potential impacts to groundwater from gravel pit development are indicated in the *Aggregate Operators Best Management Practices Handbook for British Columbia* (Province of BC, 2002).

AQUIFERS and GROUNDWATER WELLS

To: Vanessa Dunae

FLNRORD's previous review noted the lack of aquifer mapping across the pit area doesn't preclude its potential presence. This is acknowledged in AE (2020a) Section 4.3 where it is stated that an unmapped overburden aquifer is present beneath the Site. However, in Section 4.3.1, it is stated that the "Upper Merritt Unconfined Watertable Aquifer" is "...not located within the boundaries of the subject site and is hydraulically connected to the Nicola River." AE (2020b) confirm there is no mapped aquifer beneath the site footprint. However, it can be inferred from these two statements that the shallow aquifer at the quarry is likely hydraulically connected to a mapped aquifer.

In their review of groundwater records, Active Earth (2019) stated "In addition, several private wells are present south of the Site, but are not included in the provincial WELLS database." The same statement, verbatim (including "no" instead of "not") was made in AE 2020(a).

With respect to the downgradient private wells (shown in Figure 1 but not necessarily limited to those), FLNRORD restate their previous comment:

"This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application."

A field-verified survey of the unmapped groundwater wells south of the site (ie, confirming whether groundwater flows toward the wells from the gravel pit) does not appear to have been done. FLNRORD's opinion regarding this item remains unchanged. AE (2020b) state "If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required (Section 6)." This wording is taken verbatim from the Guide, except for the "Section 6" reference. A "Section 6" could not be found in AE's 2020b report and Section 6 of AE's 2020a report does not address this. Regardless, since online mapping and statements by AE make it clear there are down slope users, the apparent reluctance to install three wells to determine groundwater travel time and inform the ability to design site-specific mitigation measures or react to unplanned releases of contaminants is not understood.

Section 5 of AE (2020a) states that "Groundwater flow within the unconfined aquifer is bedrock controlled on Site. The shallow groundwater is perched over bedrock within the overburden soils. Groundwater flow is assumed to be south." This statement is confusing as "perched" groundwater by definition cannot flow. The statement seems to originate from the Hemmera report, although it is not referenced within AE 2020a. AE 2020b does state "The well logs do not indicate any perched water tables.", adding to the confusion surrounding this.

To: Vanessa Dunae

The conclusions (AE, 2020b) state AE have assumed groundwater flow is to the south and "...the receiving environment includes groundwater underlying the site, as well as Parry's Spring and the Upper Merritt Unconfined Water Table Aquifer. These water resources require consideration for protection via mitigation measures described below."

The first two sentences of recommendations 10 and 13 regarding installation of a single monitoring well appear to be identical. As noted above, three monitoring wells is a minimum standard in the profession of hydrogeology to obtain a basic understanding of groundwater movement, elevation changes and baseline/operational quality. Those three wells could also inform an improved cross-section, as well as providing the applicant with a better idea of the grading and depth of the resource.

SUMMARY AND RECOMMENDATIONS

Hemmera and FLNRORD recommended a revised hydrogeological study. The two documents provided (AE 2020a and 2020b) add some clarity but fail to address key questions as noted and sometimes add further confusion.

If the applicant surveys downslope water users then a groundwater monitoring response plan can be utilized should complaints arise if the mine becomes operational.

Hemmera also note that assessment of potential impacts to downgradient users require consideration of pit closure. The applicant states the pit will not be filled in, but do not seem to address this question. Monitoring and regular reporting and interpretation of groundwater data could inform adaptive management of daily operations and final reclamation planning.

Please contact me with any questions.

Signed,

David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science,
Vernon, British Columbia.

References

To: Vanessa Dunae

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study*, April 10, 2019. Project 1887.

Active Earth Engineering Ltd, 2020a. *Revised Hydrogeological Study*. September 28, 2020. Project 1887.

Active Earth Engineering Ltd, 2019. *Preliminary Hydrogeological Study Response*. December 3, 2020. Project 1887.

Hemmera Envirochem Inc., 2020. *Evaluation of Nicola Valley Aggregates Permit Application Final Report*. Prepared for Lower Nicola Indian Band, Merritt, BC. Project 104684-01, July 24, 2020.

Province of British Columbia, Ministry of Energy and Mines, 2002. *Aggregate Operators Best Management Practices Handbook for British Columbia, Volume 2: Best Management Practices*. April 2002.

Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division, 2010. *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia*. February 2010.

Province of British Columbia, 2016. *Determining the Likelihood of Hydraulic Connection – Guidance for the Purpose of Apportioning Demand from Diversion of Groundwater on Streams*. Version 1.0. Water Science Series, WSS2016-01. Province of British Columbia, Victoria BC.

From: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
To: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: NVA review
Sent: 03/30/2021 20:31:15
Attachments: NVA_Review_RH_March_2021_DRAFT.docx, image001.jpg
Message Body:

Sure thing, here you go

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:30 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: NVA review

I cant access VPN , can you please email? Thanks

Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:29 PM
To: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: NVA review

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Aggregates\2021\NVA Review RH March 2021 DRAFT.docx

David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist, Groundwater Science, South Area
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
2501-14th Ave, Vernon, BC V1T 8Z1
VOIP 778 943-6924



File: 38050-03/ Nicola Valley Aggregates

March 30, 2021

To: Vanessa Dunae, Senior Negotiations Lead, Regional Operations
Ministry of Energy, Mines and Petroleum Resources
Via email to Vanessa.Dunae@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.

Re: Review of Active Earth Engineering Ltd (Active Earth) Reports “Revised Hydrogeological Study” and “Preliminary Hydrogeological Study Response”

This memo is in response to a request by yourself to review the aforementioned reports as they relates to the Nicola Valley Aggregates permit application near Merritt, BC. The following summarizes my review of these reports, with reference to the previous review and other reports.

BACKGROUND

Nicola Valley Aggregates (NVA) has submitted a permit application to the Ministry of Energy, Mines and Petroleum Resources for a sand and gravel quarry at 701 Highway 8 near Merritt, BC. NVA retained Active Earth Engineering Ltd. (AE) to undertake a *Preliminary Hydrogeological Study* (Active Earth, 2019). The Active Earth report was subsequently peer reviewed by Hemmera Envirochem Inc (Hemmera, 2020). In their peer review, Hemmera references the *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, as a reference point for their review.

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To: Vanessa Dunae

Active Earth's revised study (AE, 2020a) and the December 2020 response (AE, 2020b) are referenced throughout. The *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia* (Province of BC, 2010), hereafter referred to as the *Guide*, continues to be used as a reference point for reviewing these additional reports.

Summary of the Revised Hydrogeological Study (September 2020)

The purpose of the September *Revised Hydrogeological Study* is stated as "... to complete a hydrogeological review and provide an opinion on potential impacts of the proposed gravel mining on the groundwater and surface water resources and provide mitigation measures if necessary."

This response does not offer much new information. A field-verified survey to identify other potentially affected downgradient users has not been done although the BC Water Resources Atlas shows several users to exist immediately downgradient of the proposed pit area. This is a significant deficiency in a study of this nature.

Summary of Preliminary Hydrogeological Study Response (December 2020)

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REVIEW OF THE GUIDE REQUIREMENTS

Note that staff with the Ministry of Energy, Mines and Petroleum Resources (EMPR) may have a general understanding or established best practices relative to applicants' following of the Guide, which can be brought to bear on my general observations. They also will be able to confirm whether some items such as knowledge of depth to groundwater is required in the Notice of Work as suggested by the Guide, or whether such information needs can be deferred until after mining begins, as suggested by the applicant (AE, 2020b).

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- *Describe potential impacts of the proposed operation on groundwater quantity and quality;*
- ***If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required;***

To: Vanessa Dunae

- Depending on known soil types and/or terrain, a slope stability analysis, which will be used in the mine plan to mitigate groundwater and surface water effects on slope stability, may be required;
- minimize sediment and pollutants reaching natural and man-made surface water, groundwater and aquatic environments;
- Information will be required to demonstrate the proximity of the proposed excavation to the water table;
- The operator must be aware of the possibility of perched water tables bounded by hard till or clay/silt layers;
- The inspector may require a professional estimate of the winter high water table if the excavation is likely to approach that level; and,
- Excavations below the water table will require special approval.

The bolding indicates the key missing information. The apparent down slope users have not been field-verified, so the degree of hydrogeological study required is not apparent. Figure 1 from FLNRORD's response earlier, and reproduced below, indicates existing water wells of interest that are available to review from a desktop analysis as well as a field visit. In the absence of this knowledge it is difficult to design appropriate site-specific mitigative measures. More specifically, it is best practice for aggregate operators to design site-specific measures in regards to groundwater protection, then additional site-specific information about groundwater is required relative to these downslope users.

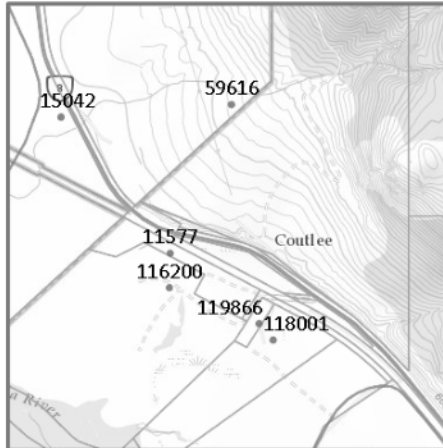


Figure 1: Water wells in the vicinity of the site, accessed from GWELLS on September 14, 2020

Hemerra also note that potential impacts to groundwater from gravel pit development are indicated in the *Aggregate Operators Best Management Practices Handbook for British Columbia* (Province of BC, 2002).

AQUIFERS and GROUNDWATER WELLS

FLNRORD's previous review noted the lack of aquifer mapping across the pit area doesn't preclude its potential presence. This is acknowledged in AE (2020a) Section 4.3 where it is

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stated that an unmapped overburden aquifer is present beneath the Site. However in Section 4.3.1 it is stated that the “Upper Merritt Unconfined Watertable Aquifer” is “...not located within the boundaries of the subject site and is hydraulically connected to the Nicola River.” AE (2020b) confirm there is no mapped aquifer beneath the site footprint. However, it can be inferred from these two statements that the shallow aquifer at the quarry is likely hydraulically connected to a mapped aquifer.

In their review of groundwater records, Active Earth (2019) stated “In addition, several private wells are present south of the Site, but are no included in the provincial WELLS database.” The same statement, verbatim (including “no” instead of “not”) was made in AE 2020(a).

With respect to the downgradient private wells (shown in Figure 1 but not necessarily limited to those), FLNRORD restate their previous comment:

“This is typical that many water wells are not in the GWELLS database due to a lack of submission. To maximize the available data, this type of discrepancy is typically resolved by hydrogeologists through a field-verified survey of groundwater wells, since not all records of domestic use wells are in the provincial database (GWELLS), or may be mis-located. This type of field investigation is common for larger projects related to groundwater, and certainly would be part of an EA-level application.”

A field-verified survey of the unmapped groundwater wells south of the site (ie, groundwater flows toward the wells from the gravel pit) does not appear to have been done. FLNRORD’s opinion regarding this item remains unchanged. AE (2020b) state “If there are nearby wells or down slope water users, a hydrogeological study to assess potential impacts and recommend mitigative measures will be required (Section 6).” This wording is taken verbatim from the Guide, except for the “Section 6” reference. A “Section 6” could not be found in AE’s 2020b report and Section 6 of AE’s 2020a report does not address this. Regardless, since online mapping and statements by AE make it clear there are down slope users, the apparent reluctance to install three wells to determine groundwater travel time and inform the ability to design site-specific mitigation measures or react to unplanned releases of contaminants is not understood.

Section 5 of AE (2020a) states that “Groundwater flow within the unconfined aquifer is bedrock controlled on Site. The shallow groundwater is perched over bedrock within the overburden soils. Groundwater flow is assumed to be south.” This statement is confusing as “perched” groundwater by definition can not flow. The statement seems to originate from the Hemmera report, although it is not referenced within AE 2020a. AE 2020b does state “The well logs do not indicate any perched water tables.”, adding to the confusion surrounding this.

The conclusions (AE, 2020b) state AE have assumed groundwater flow is to the south and “...the receiving environment includes groundwater underlying the site, as well as Parry’s Spring and

To: Vanessa Dunae

the Upper Merritt Unconfined Water Table Aquifer. These water resources require consideration for protection via mitigation measures described below.”

The first two sentences of recommendations 10 and 13 regarding installation of a single monitoring well appear to be identical. As noted above, three monitoring wells is a minimum standard in the profession of hydrogeology to obtain a basic understanding of groundwater movement, elevation changes and baseline/operational quality. Those three wells could also inform an improved cross-section, as well as providing the applicant with a better idea of the grading and depth of the resource.

SUMMARY AND RECOMMENDATIONS

Hemmera and FLNRORD recommended a revised hydrogeological study. The two documents provided (AE 2020a and 2020b) add some clarity but fail to address key questions as noted and sometimes add confusion.

If the applicant surveys down slope users then a groundwater monitoring response plan can be utilized should complaints arise if the mine becomes operational.

Hemmera also note that assessment of potential impacts to downgradient users require consideration of pit closure. The applicant states the pit will not be filled in, but do not seem to address this question. Monitoring and regular reporting and interpretation of groundwater data could inform adaptive management of daily operations and final reclamation planning.

Please contact me with any questions.

Signed,

David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science,
Vernon, British Columbia.

References

To: Vanessa Dunae

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From: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
To: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
Subject: RE: NVA review
Sent: 03/30/2021 20:30:05
Attachments: image001.jpg
Message Body:

I cant access VPN , can you please email? Thanks

Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:29 PM
To: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: NVA review

Apologies for being so late with this. I told Vanessa end of the month so that was good. FYI I also was planning to go to Nicola Dam Thursday to help Sarah install loggers. We coordinated last week, but I'm not sure if you have seen any direction to put a hold on field work/travel?

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David Thomson, M.Sc., P.Geo.
Regional Hydrogeologist, Groundwater Science, South Area
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
2501-14th Ave, Vernon, BC V1T 8Z1
VOIP 778 943-6924

From: Thomson, David A FLNR:EX (David.Thomson@gov.bc.ca)
To: Thomson, Skye FLNR:EX (Skye.Thomson@gov.bc.ca)
Subject: RE: NVA review
Sent: 03/31/2021 14:34:51
Attachments: image001.jpg
Message Body:

Thanks ? heading in to office this morning to print/stamp/scan. No COVID symptoms.

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: March 30, 2021 3:14 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: NVA review

Hi Dave,

Here are my comments.

Regards,

Skye Thomson, M.Sc., P.Geo.
Section Head, Groundwater Science

From: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:31 PM
To: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Subject: RE: NVA review

Sure thing, here you go

From: Thomson, Skye FLNR:EX <Skye.Thomson@gov.bc.ca>
Sent: March 30, 2021 1:30 PM
To: Thomson, David A FLNR:EX <David.Thomson@gov.bc.ca>
Subject: RE: NVA review

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