Proposed Burlington Quarry Expansion
JART COMMENT SUMMARY TABLE – Natural Heritage

Please accept the following as feedback from the Burlington Quarry Joint Agency Review Team (JART). Fully addressing each comment below will help expedite the potential for resolutions of the consolidated JART objections and individual agency objections. **Additional, new comments may be provided once a response has been prepared to the comments raised below and additional information provided**.

	JART Comments (February 2021)	Reference	Source of Comment	Applicant Response (July 2021)	JART Response
Report/Date: Level 1 and Level 2 Natural Environment Technical Report, April 2020		**Author: Savanta**			
1.	Confirmation of the existence and extent of critical fish habitat within 240.0 metres of any identified key hydrologic feature should be provided though DFO (NEP, Part 2.7.5 & 2.7.6 (d))	General	Niagara Escarpment Commission	DFO has confirmed in the Letter of Advice dated June 23, 2021, and their accompanying email that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
2.	Further clarification should be provided related to assessed significant woodlands on the western expansion site (golf course). The technical report identifies woodlands 'D' & 'M' on the golf course lands as significant; with woodlands 'A' on the opposite side of Colling Road also being significant. • If the technical report identifies these areas as significant woodlands, Part 2.7.3 of the NEP (2017) must be considered in the context of the future health of the feature. Currently the extraction plan proposes to isolate significant woodlands 'D' from surrounding features; NEC Staff are of the opinion this would not maintain or enhance the feature, or associated features through extraction. • The impact of this isolation should be discussed in the report and should take into consideration the wording of Part 2.7.6 (d) & 2.9.3 (e). • Hedgerows are identified in the ELC mapping; typically, hedgerows will be included in the connectivity/wildlife corridor considerations. Please include assessment of hedgerows within the scope of maintenance and enhancement of key natural heritage features and wildlife habitat. • Amphibian movement corridors are considered an important function of significant wildlife habitat, they have been identified as being present impacts/mitigation should be considered in relation to SWH.	General	Niagara Escarpment Commission	As summarized in section 6.2.1, woodland D is relatively isolated and located on the golf course, adjacent to the existing quarry. While a portion of this woodland is native, the cultural woodland area is non-native, with an abundance of Black Locust, an undesirable tree species, and the FOD5/DIST area contains only a canopy layer, along with turf grass and paved golf cart paths in the ground layer (sub-canopy and understory vegetation are absent). There is high potential to enhance this woodland both in species diversity and composition. The proposed rehabilitation plans will create a system that is better connected and functional than what currently exists in the golf course and adjacent quarry. Further details are provided in response #9 below. Hedgerows are not a component of woodlands or SWH and are not a KNHF; therefore, survey effort is not recommended. The amphibian movement corridor will remain untouched. No direct impacts are anticipated due to its location outside of the Study Area at the far edge of the 120 m adjacent lands. Potential hydrological impacts and associated mitigation measures are provided in detail in the Wetland Characterization Summaries – wetland 13203 – appended to this response submission.	
3.	In some areas buffers to significant woodlands have been proposed <30.0 metres in width despite lands being available to achieve 30.0 metres. 30.0 metres is a generally accepted standard for protection from an extraction use, please provide further justification for these reductions (relevance to significant woodlands and wetlands) (Part 2.7.6 (c) & 2.7.7)	General	Niagara Escarpment Commission	With the exception of the buffer area adjacent to the pine plantation along the east side of the south extension, the buffers in areas that are less than 30 m will be revised on the site plans. In the West Extension, there will be a 30 m setback from the edge	

	• Reduced setbacks to the FOD7-4 community is of specific concern.			of the Weir Pond to the edge of the berm and a 30 m buffer from the edge of the FOD7-4 to the proposed limit of extraction and/or the edge of the berm. In the South Extension, there will be a 30 m setback from the FOD7-4 to the edge of the berm.	
4.	Fulsome assessment of potential endangered species habitat on the golf course lands has not been completed. Golf course ponds were not surveyed for presence of Jefferson salamander. Connectivity between these ponds, and potential salamander corridors are in scope for the study. The presence of predatory fish in the northernmost pond does not justify excluding the more southern ponds from assessment (Part 2.7.6 (d)).	General	Niagara Escarpment Commission	We respectfully disagree with the comment that a fulsome assessment of potential endangered species habitat on the golf course lands has not been completed. All potential salamander breeding habitat was assessed and trapped as required. Discussions with the MECP confirm that the golf course irrigation ponds are not habitat for Jefferson Salamander and did not need to be surveyed. We are continuing to work with MECP for all SAR related matters and are adhering to their survey recommendations and protocols. As a point of clarification to the presence of predatory fish, Largemouth Bass was visually observed in all golf course irrigation ponds in September 2019, not just the northernmost one.	
5.	Only one Turtle basking station was implemented on the southern expansion lands. Clarification sought as to why wet areas farther south were not included in the turtle assessment.	General	Niagara Escarpment Commission	Turtle basking surveys are used to help determine the presence of turtle overwintering habitat. The extent of the Study Area was surveyed for presence of deeper, pooling water wetland characteristics, and where these features were identified, they were further assessed by completing turtle basking surveys. Such features were limited to just the one on the Adjacent Lands of the South Extension.	
6.	Amphibian assessment is noted in close proximity to wetland 13200; clarification is sought as to why no amphibian call station was implemented in the feature.	General	Niagara Escarpment Commission	Wetland 13200 did not contain water and therefore was not considered a suitable feature to survey for amphibian breeding.	
7.	Overall impacts on the hydroperiod for the assessed wetlands should be further assessed taking into account various phases of quarry operation and rehabilitation.	General	Niagara Escarpment Commission	More details are provided in the attached Wetland Characterization Summaries.	
8.	It is identified that wetlands 13200 & 13201 will likely be impacted due to a change in catchment area resulting from extraction. • A broader review of impacts should be provided that considers the connectivity of these wetlands (and 13202) as well as the cumulative impact on key natural and hydrologic features demonstrating connectivity within 240.0 metres. (Part 2.2.1, 2.7.3, 2.7.6 (d), 2.9.3(d&e)). • Outlets for these areas should be confirmed. • Maintenance and enhancement of key hydrologic features considered through this report, including wetlands, should be incorporated into the proposed rehabilitation and after-use plans (Part 2.9.3 & 2.9.11 (b)).	General	Niagara Escarpment Commission	More details are provided in the attached Wetland Characterization Summaries.	

9.	Broadly, the report needs to discuss the impacts of fragmentation on the significant woodlands and wetlands in more depth, and should discuss how this fragmentation may, or may not be addressed through mitigation or rehabilitation. • Scope of consideration for impacts to key natural heritage and hydrologic features extends to connected features within 240.0 metres of the individual feature being assessed. A landscape approach within the site as well as broader capture and discussion of connected features off-site should be incorporated into the report. (Part 2.7.6 (d)).	General	Niagara Escarpment Commission	The proposed Extension Areas are sited within an active golf course and agricultural area. There is a Regional and Provincial NHS that runs north south; however, the area of the proposed expansion does not appear to negatively affect the redundancy of these smaller branches of the RNHS. The major areas of the NHS run along the Medad Valley, which is west of the proposed West Extension, as well as along the Mount Nemo Plateau and Grindstone Creek Complex, located east of the proposed South Extension. The proposed Extension areas are located between these two RNHS branches and are not impeding or removing any of the features that make up these two branches; the Extension areas are well outside of these two large systems. Based on the Region's NHS mapping, there are some smaller systems that lie parallel to, and between, these two major systems; however, these smaller systems do not connect to the larger NHS, north of the Study Area. These smaller branches of the overall NHS do not provide connectivity to begin with, and therefore, the removal or disturbance of golf course features and their potential for enhancement and future connectivity opportunities can only add to the limited contribution being made to the smaller NHS.	
10.	An acknowledgement/assessment of Section 2.2 of the PPS (2020) – Water, does not appear in Section 2.1.1 of the Report. NEC Staff are of the opinion that Section 2.2 of the PPS contains a number of policies linked to natural heritage that should be assessed and incorporate findings from the Hydrologic and Surface Water reports.	General	Niagara Escarpment Commission	Section 2.2 of the PPS identifies the following water-related policies: "Planning authorities shall protect, improve or restore the *quality and quantity of water* by: a) using the *watershed* as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development; b) minimizing potential *negative impacts*, including cross-jurisdictional and cross-*watershed* impacts; c) evaluating and preparing for the *impacts of a changing climate* to water resource systems at the watershed level; d) identifying water resource systems consisting of *ground water features*, *hydrologic functions*, *natural heritage features and areas*, and *surface water features* including shoreline areas, which are necessary for the ecological and hydrological integrity of the *watershed*; e) maintaining linkages and related functions among *ground water features*, *hydrologic functions*, *natural*	

				heritage features and areas, and *surface water features* including shoreline areas; f) implementing necessary restrictions on *development* and *site alteration* to: 1. protect all municipal drinking water supplies and *designated vulnerable areas*; and 2. protect, improve or restore *vulnerable* surface and ground water, *sensitive surface water features* and *sensitive ground water features*, and their *hydrologic functions*; g) planning for efficient and sustainable use of water resources, through practices for water conservation and sustaining water quality; h) ensuring consideration of environmental lake capacity, where applicable; and i) ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces. *Development* and *site alteration* shall be restricted in or near *sensitive surface water features* and *sensitive ground water features* such that these features and their related *hydrologic functions* will be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required in order to protect, improve or restore *sensitive surface water features*, *sensitive ground water features*, and their *hydrologic functions*." The water policies that are relevant to natural heritage are indirectly addressed throughout the NETR, specifically in the sections regarding fish and fish habitat, given the importance of water quality and quantity to maintaining fish and fish habitat. Relevant water policies are also indirectly addressed in other technical reports (i.e., Surface Water Assessment and Hydrogeological and Hydrological Impact Assessment Report)." The overall policy analysis is found in the Planning Report, which includes a review of Section 2.2 of the PPS.	
11.	Additional assessment of downstream impacts to Brook Trout populations related to Willoughby creek is being requested due to the proposed change in water levels and the proposal to utilize perpetual pumping as a mitigation measure to maintain water levels in key hydrologic features.	General	Niagara Escarpment Commission	DFO has reviewed the documentation and issued a Letter of Advice, dated June 23, 2021. One of the requirements is to "maintain an appropriate depth and flow (i.e., base flow and seasonal flow of water)	

				for the protection of fish and fish habitat. This will be addressed though the provisions of the AMP to ensure the pumping regime maintains base flow and seasonal flow of water. More details are provided in the attached Watercourse Characterization Summaries. DFO's guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations.	
12.	The Level 1 and Level 2 NETR describes the current fisheries inventories conducted within the existing quarry (Burlington Quarry) and proposed expansion lands and provides an assessment based on the proposed changes associated with extraction and future operations on those lands. Discussion is limited to within 120.0 metres of the proposed quarry expansion lands. Supporting studies, such as the Surface Water Assessment, as well as hydrogeology submitted as part of the application discuss potential fisheries impacts to surrounding areas beyond 120.0 metres. The aquatic impacts provided in the 2020 NETR do not appear to be integrated with surface and groundwater reports and impacts to fisheries from these studies are not well understood.	General	Matrix Solutions Inc.	The application includes protection of surface water features beyond 120 m which also protects any associated fish habitat. DFO is the regulatory authority and is satisfied that application will not result in HADD subject to its Letter of Advice, dated June 23, 2021. More details are provided in the attached Watercourse Characterization Summaries. DFO's guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations.	
13.	The inventories presented in the NETR describe the existing fisheries as consisting primarily of warm water species such as Largemouth Bass, which are commonly stocked in warm water ponds, as well as tolerant warm water fish communities typically found in intermittent tributaries. Given that the existing land uses consisted of a golf course and quarry operations, these results are not surprising for the most part, as the golf course has been in operation since the early 1960s and the lands have undergone ongoing disturbances. Since the existing quarry has been in operation, fisheries impacts have existed due to changes in drainage patterns from extraction activities. As the initial placement of the quarry has irreversibly changed the fish habitat conditions within the headwaters, it is more relevant to focus on the effect of the proposed new quarry expansions on the surrounding fish habitat. The 2020 NETR does not include discussion of the cumulative impacts to the surrounding water bodies that have been described in historical studies as being important. The cumulative effect on the surrounding aquatic habitats from the incremental quarry footprint expansion should be included in the discussion.	General	Matrix Solutions Inc.	We agree that the existing land uses in the study area (e.g., quarry, golf course, residential, transportation) have irreversibly changed the natural pre-existing fish and fish habitat conditions. We also agree that the NETR should focus on the effects of the proposed new quarry on surrounding fish habitat. We interpret the second paragraph of this comment to be similar to other comments regarding the request to expand the discussion regarding potential impacts to Willoughby Creek, which has been done in other rows in this table. Additional information on flows in Willoughby Creek will be provided in the AMP. The water resources report does, in fact, clearly delineate the "cumulative effects" of all existing and proposed excavations in the water level maps and	

				hydrographs presented for each development scenario phase. The results were presented in terms of absolute water levels and streamflows, not just in terms of change, so the cumulative impacts were fully taken into consideration. The water resources report presents incremental drawdowns from a fully transient 10-year baseline, and both average and minimum remaining available drawdown in the aquifers. As part of the report, extensive use of observations of change in groundwater levels due to excavation within the quarry footprint was utilized (See Section 6.11.3). This work resulted in a recommendation to revise the rehabilitation plan for the existing quarry to mitigate impacts from the existing approved quarry. As JART is aware the existing approved rehabilitation plan for the Burlington Quarry requires dewatering to stop and the site to naturally flood to a lake with no off-site discharge. As part of the Burlington Quarry Extension application, Nelson has agreed to modify the existing quarry rehabilitation plan to maintain off-site pumping to maintain existing conditions for off-site fish habitat and other water based key natural heritage features which rely on water being discharged from the existing quarry.	
14.	The Level 1 and 2 NETR also states that although that ponds and drainage features within the existing quarry and proposed expansion lands contain fish, these systems are not really fish habitat due to their anthropogenic origin and their isolation from other features, and as a result support no recreational fishery. Given the extent of quarrying, the fish community within the quarry footprint is expected to consist of species that can persist within the changing aquatic habitat conditions that are artificially maintained. The NETR describes the ponds and drainage features as having a hydrologic connection to fish bearing waters in the surrounding watercourses immediately outside of the proposed quarry extension lands. As there are linkages to fish habitat downstream of these areas, it is not clear where does fish habitat begin and end, and if alterations within the quarry in terms of flow, thermal regime, water quality or quantity will affect the downstream fish bearing waters. A table describing the rationale for fish habitat designations, supported by *Fisheries Act* definitions for these habitats should be included. Consistency with the application of fish habitat designations should be demonstrated in this table.	General	Matrix Solutions Inc.	Contrary to this comment, the NETR does not indicate that ponds and drainage features within the existing quarry contain fish habitat. Our interpretation of the limit of what does and does not constitute fish habitat is as follows, as discussed in Section 6.6 of the NETR: • The portion of the Unnamed Tributary of Willoughby Creek between the existing quarry discharge from Sump 0100 and the Colling Road culvert is indirect fish habitat, given that no fish were captured during sampling in this reach in 2019, with exception of Largemouth Bass that were captured in the Weir Pond. It is our opinion that Largemouth Bass are only present in this area as a result of the construction of the golf course drainage feature and therefore, the presence of bass in the Weir Pond, which is part of the commercially constructed golf course water feature, does not constitute direct fish habitat. This reach along Colling Road does	

				• provide important functions that contribute to downstream fish bearing waters, including flow conveyance (from the quarry discharge) and organic material inputs. • The constructed golf course drainage features (ponds and interconnecting channels) are not considered to be fish habitat for the reasons outlined in section 6.6.1 of the NETR, as confirmed by DFO in their June 23, 2021, letter. • The reach of the Unnamed Tributary of Willoughby Creek downstream from Colling Road has assumed to be direct fish habitat (i.e., could support direct use by fish), given that no studies have been completed on private property to confirm the presence of fish. • The West Arm of the West Branch of the Mount Nemo Tributary is direct fish habitat downstream from Sideroad 2. • The East Arm of the West Branch of the Mount Nemo Tributary is indirect fish habitat upstream from the buried karst reach and direct habitat downstream from that point. • H2 is indirect fish habitat. DFO has confirmed in letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
15.	Drainage and surface outflows of the existing quarry operations extend beyond the quarry footprints and are maintained through pumping operations, which are recommended to continue in perpetuity, long after the license for extraction has been surrendered. As long-term plans for the quarry contemplates changes to drainage conditions, along with the changes associated with climate change, understanding the effects on the surrounding fisheries habitat within the Niagara Escarpment is a key consideration in the proposed quarry expansion. The rationale for continued pumping operations should be supported by more detailed information on how fish habitats and linkages are to be maintained. Discussion on the existing flow regime and the form and function of watercourses and linkages should be included to determine how future changes with pumping and drainage will impact these watercourses. Hydrograph information and hydroperiods in relation to the surrounding fish habitat should also be included in the discussion.	General	Matrix Solutions Inc.	Continued pumping after the operational period has ceased has been identified in the NETR as a key mitigation measure to prevent long term impacts on fish and fish habitat in Willoughby Creek and the West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek (as well as further downstream reaches). Pumping from the existing quarry sumps 0100 and 0200 has been occurring since construction of the original quarry and fish communities in these watercourses, as well as the habitat within the watercourses (i.e., stream form and associated function, such as channel size and biophysical processes such as erosion and sedimentation) are expected to be accustomed to, and reliant upon, the pumped discharge. Elimination of pumped discharge would be expected to have negative impacts on the form and function of these watercourses as they revert back to pre-quarry	

				pumping hydrological regime (recognizing that the rehabilitated quarry will be remaining), which, in the case of the West Arm of the West Branch, would be intermittent and in the case of Willoughby Creek, would involve substantially less flow downstream from the current discharge outlet at the mouth of the Unnamed Tributary. The comment has requested more detailed information on "how fish habitats and linkages are to be maintained". Essentially, the proposed pumping regime will continue the current flow rates supplied by pumping indefinitely to avoid the substantial change in hydrology that would occur if pumping were to cease after operations are done (as permitted by the current approvals for the existing quarry). Pumping will continue indefinitely to the current outlet locations and at the same general discharge rate regime as currently occurring and will be occurring through the operational scenario. This has been modelled in Rehabilitation Scenario 1 in the integrated stream flow model in the Hydrogeological and Hydrologic Impact Assessment Report. Hydrological changes in Willoughby Creek and the West Arm of the West Branch are predicted to be minimal relative to existing conditions. Further, the predicted impacts on stream flows outlined in Rehabilitation Scenario 2 depict much more substantial changes in flow relative to current conditions and would be expected to have substantial impacts on fish and fish habitat in these watercourses.	
16.	With respect to the quarry expansion application, the applicant has assessed the fisheries habitat within 120.0 metres of the proposed expansion area. Other studies that relate to fish habitat that are submitted as part of the quarry application discuss impacts beyond 120.0 metres of the proposed quarry expansion area. To have a better understanding of the impacts to fisheries resources, the applicant needs to integrate the 2020 NETR with surface and groundwater studies which extend beyond 120.0 metres. Impacts to fisheries resources needs to be described in relation to future drainage scenarios associated with the changing nature of the quarrying activities over time, as well as the ultimate rehabilitation scenarios involving the creation of landforms, lakes, and changes associated with climate. The following provides a summary of the issues and concerns as they relate to fisheries.	General	Matrix Solutions Inc.	Comment noted. Responses are provided to subsequent comments in the rows below.	
17.	The fish information available in the downstream reaches such as in Willoughby Creek are based on older baseline data (2006) and no further recent information regarding the fish communities in these areas have been made available. The paucity of recent fish data is reflected by the limited study area, no sampling or surveys in private property, and of active sampling gear such as seining, electrofishing methods and visual observations.	General	Matrix Solutions Inc.	Comment noted. The assessment of impacts on fish and fish habitat is based on the predictions of stream flow and groundwater discharge from the integrated model (as documented in detail in the supporting surface water and groundwater technical reports) with knowledge of the fish species that have been	

				confirmed in Willoughby Creek in past studies. Although changes in relative abundance and biomass of fish within watercourses are expected to change over time in natural scenarios, it is reasonable to assume that generally the same species are present, as have been confirmed during previous studies, given the lack of available access to complete current fish community studies on Willoughby Creek which is predominantly held in private property. Habitat life history requirements of the species known to be present are well documented in the literature and from those requirements, an assessment of potential impacts on fish and fish habitat can be completed based on the predicted changes in habitat (e.g., stream flow and groundwater discharge). It is not necessary to have recent fish community data to complete an impact assessment based on the minor changes in streamflow that are predicted to occur, particularly when the assessment is primarily based on the presence of Brook Trout and associated habitat, as this species is predicted to be the most sensitive to environmental change of those species known to be present in Willoughby Creek. Section 2.2.9 of the NETR included a summary of Conservation Halton's fish sampling data from stations on Willoughby Creek in 2012. In addition, data collected in support of the original quarry expansion application, as documented in the 2004 Level II Natural Environment Technical Report remains a relevant component of the background knowledge that has supported the impact assessment.	
18.	Predicted impacts to downstream watercourses are discerned from the surface water report which can only be based on older baseline data by collected by others, such as records from 2006. As the data has been collected over 14 years ago, changes that have occurred over time regarding the fish community and habitat changes are not accounted for in predictions related to surface water impacts.	General	Matrix Solutions Inc.	Predicted impacts can be assessed based on the fish species that have previously been confirmed in the watercourse (i.e., through previous studies conducted for the original quarry application or by Conservation Halton as part of their Long-term Environmental Monitoring Program) and the known habitat preferences of those species. Also, of key importance is the minimal actual predicted change in habitat (as documented through the surface and groundwater assessment reports and further analysis of changes in water depth, wetted cross-sectional area, wetted width). Based on the minimal habitat change predicted, Savanta is of the opinion that more recent fish community data for Willoughby Creek would not change the assessment of potential impacts. In our opinion, the general composition of	

				the fish community (in terms of species present) is unlikely to have undergone any substantial change over time that would change how the impact assessment is completed.	
19.	The 2020 NETR discusses what is impacted within the existing quarry and extension footprints, it does not provide a more fulsome picture of what happens to the downstream watercourses and particularly the Willoughby Creek system. The applicant should provide more discussion on specific effects to fish habitat as it relates to the receiving waters affected by future drainage and alterations to hydrology and hydrogeology from future expansion. The surface water assessment report provides statements which affirms the sensitivity of Willoughby Creek to changes in baseflow, and the primary concern is that this feature, as well as the other watercourse will be maintained through pumping. Should pumping be subjected to unexpected shutdowns or malfunctions, it is unclear what these effects would manifest to fish habitat. For example, if fish populations are reliant on this flow to successfully spawn and rear their young, what happens during the coldest winters and summer drought conditions is of concern as a sudden withdrawal of flow in the upper reaches may result in fish mortality.	General	Matrix Solutions Inc.	See response to Comments 15, 17 and 18. If the agencies are concerned that any potential impacts of continued pumping outweigh the impacts of ceasing pumping once quarry operations are completed (which is permitted by the current quarry approvals) then the proponent is willing to consider this approach.	
20.	As extraction proceeds to its later stages and progressive rehabilitation takes place, it is unclear how this impacts fish habitat. It is not fully explained how the quality and quantity of discharge water will be maintained. It is anticipated that there will be a lowering of local groundwater and surface water levels from quarry operations and quarry dewatering. It would be good to understand how water quantities will be balanced and water quality will be maintained at various stages during blasting and quarry operations. Furthermore, it is uncertain if ground water conduit flow paths will be interrupted during quarrying operations.	General	Matrix Solutions Inc.	Changes in water quantity through the P3456 and Rehabilitation scenarios have been assessed in the integrated flow model. This has accounted for the predicted lowering of localized groundwater table in vicinity of the quarry as well as predicted increases in some phases as a result of shifting the groundwater volume to the surface water level (i.e., through discharge of intercepted groundwater through sump 0100 into the Unnamed Tributary of Willoughby Creek). Discharge of water will be consistent with current operations and potential impacts to water quantity and quality will be addressed through the provisions of the AMP and MECP approvals. More details are provided in the attached Watercourse Characterization Summaries.	
21.	There may be contaminants introduced into water bodies from blasting and quarry operations that can affect fish habitat. As blasting will be used for extraction, what is the potential for contaminants to be released or the event of a pipeline rupture from blasting (from the Enbridge Pipeline in Colling Road)?	General	Matrix Solutions Inc.	There will be no difference in the potential for changes in water quality as a result of blasting the quarry extension than there has been for the life of the existing quarry. Appropriate mitigation to prevent impacts on the pipeline will be in place during all quarry blasting activities as per the Blast Impact Analysis (Explotech 2020). This report also recommends monitoring when blasting is occurring in proximity to the pipeline.	
22.	Effects from pumping and lake creation, including shutdown of the pumps, malfunctions or spills at the quarry should be included in the discussion. Furthermore, temperature impacts from the creation of the lake, and other potential effects such as exotic species invasion/blue green algae should also be included in the discussion.	General	Matrix Solutions Inc.	The AMP includes appropriate mitigation and monitoring measures to ensure the effects from pumping and lake creation will not negatively impact the surrounding environment. The AMP includes monitoring, mitigation and reporting requirements	

				during operations and lakefilling. If there are additional requirements that the agencies would like included in the AMP please provide these for Nelson's consideration.	
23.	Future Gaps to be Addressed: The setting for the quarry extension takes place within the Niagara Escarpment Protection Area where the management focus is directed to maintaining the key natural heritage features and key hydrologic features for the movement of native plants and animals across the landscape. The natural feature of concern is in Willoughby Creek, where a remnant Brook Trout population exists. This remnant population presumably still occurs within a short distance within the Willoughby Creek Tributary kept separated from Bronte Creek through a dam from more aggressive migratory salmonid species. This current population is dependent on the existence of baseflows and groundwater discharges that occur in Willoughby Creek. During the previous quarry submission, the Joint Agency Review Team (JART) had requested that discussion of each watercourse should include a detailed description of each of the following: (a) locations of groundwater upwellings (and their significance to fisheries), species composition, distribution, relative abundance, and life history of the fish inhabiting the creek. (b) JART also requested identification of critical or sensitive habitat with reference to species distributions. (c) Considering the pumping which will be used to maintain the current baseflows to the Willoughby Creek and other tributaries, this strategy needs to be further understood with respect to future risks to the fish habitat downstream. For example, if a passive means of supplying water to these downstream systems is possible, this may be a safer alternative rather than relying on pumps that may be susceptible to mechanical failure and regular monitoring to ensure proper function. (d) Some of the information requirements that are relevant to the understanding of the potential impacts of the proposed extension raised by JART include: • predicted flow rates for groundwater discharge for the tributaries • effects of groundwater and surface water changes on the fisheries in each tributary • groundwater disruptions may have a very large effect on fisheries and the effects should be further quantified • threshold flows and predicted effects on fisheries habitat • impact of shortened periods of groundwater contribution on fish productive capacity in intermittent streams • the relative contributions/effects to groundwater should be summarized in a table for each watercourse • potential thermal impacts on the watercourse and whether the quality of groundwater is affected (including thermal pollution) • effect of increased flows on channel stability, fisheries, and productive capacity in Willoughby Creek	General	Matrix Solutions Inc.	DFO has issued a Letter of Advice, dated June 23, 2021, identifying those measures required to prevent the harmful alteration, disruption or destruction of fish habitat. One of the requirements is to "maintain an appropriate depth and flow (i.e., base flow and seasonal flow of water) for the protection of fish and fish habitat. This will be addressed though the provisions of the AMP to ensure the pumping regime maintains base flow and seasonal flow of water. DFO's guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations. More details are provided in the attached Watercourse Characterization Summaries.	

	• effect of mitigation/pumping of water into the ground and the impact on watercourses In addition to these, the applicant should discuss how the progression of quarrying (in various stages) impacts the water quality that is discharged to downstream systems.				
24.	Discussion of the site's ecoregion, ecodistrict and physiographic context is missing, as is a discussion about the relationship with significant Regional features such as the Mount Nemo Plateau. The previous hearing raised concerns about the variable local groundwater setting within discrete areas of the Mount Nemo Plateau, with concerns that groundwater flows were currently affected by the existing quarry and these impacts could extend further because of the cumulative impacts of the existing quarry plus the extension. There is the potential for significant harm to the off-site Jefferson's Salamander breeding habitat pools (the "wetland vernal pool" and "woodland vernal pool" shown on Figure 4.0), through impacts on their hydroperiod, if the groundwater inputs to the ponds are significantly affected by the extraction. The 2012 decision by the Joint Board noted that monitoring of water levels in the salamander breeding ponds (which are off-property) is critical because of the uncertainty regarding the impacts of lowering the groundwater table. The concern associated with the accuracy of assessment of groundwater inputs to the Jefferson's Salamander breeding habitat ponds was an important issue to the 2011 Joint Board and it is not clear what additional work has been done to address these concerns. Concerns that the connection between groundwater and surface features has been underestimated in the current application have again been noted by many technical experts in their review of this application.	General	North-South Environmental Inc.	This application is significantly different than the previous application. The extraction area is smaller which results in less groundwater drawdown and there is greater separation distance between the extraction area and off-site salamander breeding ponds. These ponds and the lack of potential impact have been extensively studied in the integrated groundwater and surface water model. More details regarding these features are provided in the attached Wetland Characterization Summaries.	
25.	Golf course ponds were omitted from salamander trapping. The report states this is because they have predatory fish in them but the only pond that was electrofished was the northernmost pond. Other ponds were surveyed visually. Largemouth Bass were observed only in the main irrigation pond, the uppermost irrigation pond and the golf course irrigation channel. No fish were observed in the three smaller ponds. The author of this review has personal experience with Jefferson's Salamanders breeding in human-made ponds (and salamanders would be more likely to breed in smaller ponds that might be without fish). Salamander trapping should be conducted in the smaller golf course ponds, particularly smaller ponds that do not contain predatory fish.	General	North-South Environmental Inc.	As a point of clarification to the presence of predatory fish, Largemouth Bass was visually observed in all golf course irrigation ponds in September 2019, including the three smaller ones. All potential salamander breeding habitat was assessed and trapped as required. Discussions with the MECP confirm that the golf course irrigation ponds are not habitat for Jefferson Salamander and did not need to be surveyed. We are continuing to work with MECP for all SAR related matters and are adhering to their survey recommendations and protocols.	
26.	Additional surveys should also be conducted for: a. Blanding's Turtle, according to Provincial Blanding's Turtle protocols, b. turtle nesting areas, and c. snakes, according to the protocols for Milksnake.	General	North-South Environmental Inc.	Blanding's Turtle survey effort was discussed with MECP and addressed in the MECP response letter after completing Blanding's Turtle surveys, as per MECP direction, in 2021. Neither Blanding's Turtle nor its habitat were observed and are considered absent from the Study Area. As stated in section 4.2.6, turtle nesting surveys were not completed in 2019 due to the lack of suitable microhabitat conditions. Further mitigation measures have been included in updated site plans. Exclusionary fencing adjacent to	

				the extraction areas will be installed, as per discussions with MECP, to prevent negative impacts. It is unclear which Milksnake protocols are being referred to. However, available occurrence data (as determined in the desktop review of the NETR 2020, sections 2.2.3 and 2.2.5) did not identify SAR snakes in the Study Area or surrounding area. It is understood that snakes are a cryptic species and occurrence data is limited; however, as described in the NETR, habitat assessment surveys and visual encounter surveys during suitable weather conditions did not identify SAR snakes or individual or groupings of snakes large enough to indicate significant wildlife habitat in the 14 areas that were searched specifically for snake presence.	
27.	Weather conditions were omitted from the table summarizing field investigations. Though there are general notes about weather conditions in the text describing the field methods, the weather conditions should be shown for each date for amphibian, reptile and bird surveys.	General	North-South Environmental Inc.	In addition to the general notes about weather conditions in the methodology section, full weather details are recorded for each survey and provided on the data sheets in Appendix C of the NETR.	
28.	The significant Woodlands analysis resulted in several woodlands (E, F and G) identified as Key Natural Heritage Features in the Regional Natural Heritage System being evaluated as non-significant. More discussion should be provided to explain the difference between the Region's and Nelson's analysis of these features. The discussion should include the rationale behind removing from the NHS both the features and the intervening restoration areas that provided a connected north-south linkage between these woodlands.	General	North-South Environmental Inc.	Section 6.2.2 of the NETR (2020) contains complete details on the analysis of wooded and woodland features through application of the Regional OP (2018). Wooded features E, F and G (among others) did not meet the minimum size threshold (0.5 ha), and therefore, did not meet the Regional definition of Woodland. Only Woodlands can be assessed for significance, and therefore, due to these areas not meeting the Regional definition of Woodland, they were not assessed for significance. In addition, section 9 of the NETR (2020) speaks to the Regional NHS; more specifically, it includes language from section 116.1 of the OP, which states that the boundaries of the NHS may be refined, with additions, deletions and/or boundary adjustments through several processes, including completion of an EIA. The technical requirements of an EIA have been met through this process, and therefore this data should be considered when reviewing the Regional NHS. Finally, the RNHS was created through a very high-level desktop exercise with little ability to zoom in and observe a closer look of features. These are highly disturbed patches on a highly active and regularly used golf course. These areas should not have been included in the RNHS.	

				There is a large NHS south of the golf course that consists of the Lake Medad Valley, and there is a large NHS east and north of the existing quarry operation that consists of the Mount Nemo Plateau. Creating an arm of the NHS to/through a golf course and active quarry operation does not add to the resiliency of the NHS. Improving the resiliency should be identified in those larger, contiguous features that provide greater connection opportunities.	
29.	The function of woodlands E and F, particularly as stepping stones that link Woodland D to adjacent features, should be discussed. This is particularly important for Woodland E, which appears to be less than 20.0 metres from Woodland D on the basis of on-line aerial photography, and would therefore meet the criterion for inclusion as a continuous part of woodland D, as stated in Section 6.2.1 (last paragraph on page 50). Since Woodland E meets the criteria for Significant Wildlife Habitat, its contributing function to Woodland D should be assessed.	General	North-South Environmental Inc.	Section 6.2.1 of the NETR (2020) includes the information that wooded features were considered a contiguous unit if they were <20 m apart. On-site surveys determined that wooded feature E is >20 m from Woodland D and, therefore, is not included as a contiguous part of Woodland D. Not only is wooded feature E <0.5 ha and >20 m from another wooded feature, it is a highly disturbed area that has no understory development due to golf course maintenance, and the ground cover consists of turf grass or sparse cover of Garlic Mustard, Herb Robert and exposed soil. It also includes paved golf cart paths throughout. Full details have been provided in Table 2 of the NETR (2020).	
30.	There is almost no discussion of impacts other than surface water on Woodland D: the area of woodlands that will be retained between the existing quarry and the western extension. This area will become fragmented as it will be surrounded by existing and proposed quarry land. There is a strong north-south emphasis in the Regional Natural Heritage System through the extension lands, and this linkage will be eliminated throughout the extraction. The phasing of the extraction and the placement of the infiltration pond do not mitigate fragmentation. In addition, a note on the Operational Plan regarding the western edge of the existing quarry states that this edge is "subject to separate Site Plan Amendment to reduce setback to 0 m", which would isolate the woodland completely. Clarity is required to describe exactly what changes are proposed to the existing plan, when they will occur, and to assess the cumulative impacts of the increased setback and the extension.	General	North-South Environmental Inc.	Please see attached Wetland Characterization Summaries for details on Wetland 13200. The proposed Extension Areas are sited within an active golf course and agricultural area. There is a Regional and Provincial NHS that does run north-south; however, the area of the proposed expansion does not appear to negatively affect the redundancy of these smaller branches of the RNHS. The major areas of the NHS run along the Medad Valley, which is west of the proposed West Extension, as well as along the Mount Nemo Plateau and Grindstone Creek Complex, located east of the proposed South Extension. The proposed Extension areas are located between these two RNHS branches and are not impeding or removing any of the features that make up these two branches; the Extension areas are well outside of these two large systems. Based on the Region's NHS mapping, there are some smaller systems that lie parallel to, and between, these two major systems; however, these smaller systems do not connect to the larger NHS, north of the Study Area. These smaller branches of the overall NHS do not provide connectivity to begin with, and	

				therefore, the removal or disturbance of golf course features and their potential for enhancement and future connectivity opportunities can only add to the limited contribution being made to the smaller NHS.	
31.	Fragmentation will in effect create a literal island with no physical connection. Impacts of fragmentation should be described, and appropriate mitigation proposed so sufficient corridors are provided to allow movement of wildlife. Provincial and Regional policies require that the test of no negative impact be met. These two policies will not be met if there is no physical linkage/connection with the woodland to the south. According to the Niagara Escarpment Plan, diversity and connectivity between key natural heritage features must be maintained and/or enhanced. The Regional Official Plan Guidelines' Aggregate Resources Reference Manual also notes that it should be demonstrated that the long-term ecological function and biodiversity of the natural heritage system can be maintained, restored or where possible improved. While the rehabilitation plan shows that the southern linkage will be restored in the final rehabilitation plan, the time frame to restoring this linkage is unclear. Section 4 of the Final Rehabilitation and Monitoring Study (page 14) appears to indicate that it could be more than 30 years before this linkage is restored.	General	North-South Environmental Inc.	The proposed Extension Areas are sited within an active golf course and agricultural area. There is a Regional and Provincial NHS that does run north-south; however, the area of the proposed expansion does not appear to negatively affect the redundancy of these smaller branches of the RNHS. The major areas of the NHS run along the Medad Valley, which is outside and west of the proposed West Extension, as well as along the Mount Nemo Plateau and Grindstone Creek Complex, located outside and east of the proposed South Extension. The proposed Extension areas are located between these two RNHS branches and are not impeding or removing any of the features that make up these two branches; the Extension areas are well outside of these two large systems. Based on the Region's NHS mapping, there are some smaller systems that lie parallel to, and between, these two major systems; however, these smaller systems do not connect to the larger NHS, north of the Study Area. These smaller branches of the overall NHS do not provide connectivity to begin with, and therefore, the removal or disturbance of golf course features and their potential for enhancement and future connectivity opportunities can only add to the limited contribution being made to the smaller NHS. In addition, the Rehabilitation Plan has been revised (and provided to JART) to include additional area and create a connection between the two features.	
32.	Exposure to wind and high light levels in Woodland D will likely increase. The population of Large Toothwort (Cardamine maxima), a Provincially rare plant species with a status of S3, is particularly adapted to cool, moist, sheltered forests and would likely be affected by the increase in exposure as it is on the eastern side of Woodland D. The two wetlands within Woodland D that are collectively numbered 13200 (the wetlands between the existing quarry and western extension, which will become physically isolated) are discussed only to say that since the catchment will be removed, mitigation such as discharge of quarry water will have to be used to maintain these wetlands. There should be further discussion of impacts, including isolation, fragmentation of surrounding habitat, noise, drying winds and light, etc., in addition to impacts of pumping quarry water.	General	North-South Environmental Inc.	As summarized in section 6.2.1, woodland D is relatively isolated and located on the golf course, adjacent to the existing quarry. While a portion of this woodland is native, the cultural woodland area is non-native, with an abundance of Black Locust, an undesirable tree species, and the FOD5/DIST area contains only a canopy layer, along with turf grass and paved golf cart paths in the ground layer (sub-canopy and understory vegetation are absent). This feature is highly disturbed. Both the catchment area and corridor will be re-established as part of the Rehabilitation Plan. There is high potential to	

				enhance this woodland both in species diversity and composition. The proposed rehabilitation plans will create a system that is better connected and functional than what currently exists in the golf course and adjacent quarry. If there are additional specific mitigation measures, please provide them for Nelson's consideration for inclusion in the AMP.	
33.	The discussion of wetlands should include Wetland 13203, which is the only wetland identified that provides Significant Wildlife Habitat for breeding amphibians, as well as habitat for painted turtle.	General	North-South Environmental Inc.	Wetland 13203 was evaluated by MNRF and determined to be non-significant and is also reliant on pumping from the existing quarry. Full details are provided in the Wetland Characterization Summaries.	
34.	There is no discussion of potential cumulative impacts of the existing quarry and the extensions (only a very brief mention of cumulative impacts).	General	North-South Environmental Inc.	See response to Comment 13.	
35.	Discussion of mitigation is incomplete: there should be a discussion about the mitigation of impacts in the short term (in addition to impacts related to erosion and sediment control) as extraction progresses (as required by the Aggregate Resources References Manual) – impacts of the quarry will not be addressed by the rehabilitation for many years.	General	North-South Environmental Inc.	Additional mitigation discussion is provided in the Wetland Characterization Summaries and AMP.	
36.	Mitigation should include a discussion of Wetland 13203.	General	North-South Environmental Inc.	Full details are provided in the Wetland Characterization Summaries.	
37.	All studies should be coordinated and integrated. In particular, the findings of the Hydrogeologic and Hydrologic Impact Assessment, Surface Water Assessment and Level 1 and 2 Natural Environment Technical Report should inform each other and should be reviewed for consistency	General	Conservation Halton	The water resources and natural environment team worked very closely on the assessment of the application. To assist the agencies the attached wetland and watercourse characterization summary tables have been prepared to integrate all of the findings from the various technical reports. DFO's guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations.	
38.	Not all of the natural heritage features that have the potential to be impacted are identified in the report. For example: • PSWs that are within the zone of influence of the proposed quarry but outside of the 120.0 metres adjacent lands are discussed only at a high level, though potential exists for impact as noted in the Hydrogeological and Hydrological Impact Assessment Report and the Surface Water Assessment. • Significant Wildlife Habitat (SWH) discussions did not include all of the identified SWH in the study area (e.g., FOD7-4, seeps and springs, amphibian movement corridors, etc.).	General	Conservation Halton	Wetland Characterization Summaries provide further details. The FOD7-4 and seeps and springs are discussed in more detail in this submission. The amphibian movement corridor will remain untouched. No direct impacts are anticipated due to its location outside of the Study Area at the far edge of the 120 m adjacent lands. Potential hydrological impacts and associated mitigation measures are provided in detail in the	

	• The extent of fish habitat on the site and within the zone of influence should be confirmed by DFO. • Connectivity across the landscape should be considered in more broader terms. Recommend revising the report to discuss all of the natural features that have the potential to be impacted by the proposed quarry and mitigation measures developed as appropriate.			Wetland Characterization Summaries – wetland 13203 – appended to this response submission. DFO has confirmed in its letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat. Connectivity across the landscape and the natural heritage system has been previously addressed in this submission.	
39.	Please include a more detailed discussion on net gain as per Halton Region's Aggregate Resources Reference Manual. Currently direction is to refer to the Site Plan and AMP, which does not give enough detail to ensure that net gain is achieved.	General	Conservation Halton	Limited natural heritage features are proposed for removal and substantial natural heritage features are proposed for creation and enhancement. For example, woodland cover will have a net gain of 28 ha. Wetland cover will have a net gain of 3.6 ha. The native diversity and composition of habitat will increase greatly from that which is golf course and agriculture. We disagree that the site plans do not provide sufficient detail for the creation of these habitats. In addition, MNRF has to be satisfied that these habitats are created prior to the surrender of the license.	
40.	Savanta states: "An assessment of the quality and extent of natural heritage features found on, and adjacent to, the Subject Lands and the potential impacts to these features from the proposed aggregate application will be undertaken in association with the following legislation and policies." It should be clear that the significance of each feature will be evaluated according to the criteria provided by the Province and Region. Two pieces of legislation should be added to the list of policy and legislation in this section: • the *Migratory Birds Convention Act* and • *Fish and Wildlife Conservation Act*.	Section 2.1. Natural Heritage Policy Overview	North-South Environmental Inc.	Comment noted.	
41.	Recommend expanding the applicable PPS policies to include those in the Policy 2.2 Water, given that some of these speak to natural heritage features and areas, and the connection to the water system.	Page 9 Section 2.1.1. Provincial Policy Statement	Conservation Halton	See response to Comment 10.	
42.	Policy 110 (7.2) should be specifically discussed in this section, as it addresses the requirement for a systems-based approach to the assessment of impacts as follows: "In accordance with Section 118(3)d), apply the following systems based approach in the assessment of the impact of a new or expanded mineral aggregate operation on the Region's Natural Heritage System…"	Section 2.1.3. Halton Regional Official Plan	North-South Environmental Inc.	Policy 110 (7.2) has been considered in the preparation of the rehabilitation plan which outlines the short-, medium- and long- term natural heritage features that will be created to enhance the Regional Natural Heritage System compared to existing conditions. The NETR report addresses how the Regional Natural Heritage System will be enhanced both in terms of size, diversity and function. The detailed policy analysis is included in the Planning Report.	

43.	The paragraph in Savanta's report in Section 2.1.6 indicates the following: "Some projects may be eligible for exemption from the DFO review process, as specified under Step 3 of the DFO Fish and Fish Habitat Protection Program review process (DFO 2019b; e.g., artificial waterbodies with no hydrological connection to occupied fish habitat)." In the Fish Habitat Discussion section in 7.2.4, it is mentioned that "There is no direct or indirect fish habitat within the proposed Limit of Extraction within either the South or West Extension areas. Therefore, no direct encroachment into any watercourse providing fish habitat will occur and no direct impacts on fish habitat are anticipated within the Limit of Extraction, during any phase of the Project." Since there is a hydrological connection by way of the outflows to direct and indirect habitat, it would seem that the irrigation ponds within the golf course have been ruled out as not fish habitat. This would suggest that the *Fisheries Act* does not apply to harmful alterations to these ponds. Unless the ponds are self-contained, pollutants could potentially be released into the discharges flowing out of these ponds to direct and indirect fish habitat. It is unclear how the irrigation ponds would not be considered fish habitat if they are hydrologically connected to fisheries habitat and impacts from alterations to these ponds could have a downstream impact.	Section 2.1.6. Federal *Fisheries Act*	Matrix Solutions Inc.	DFO has confirmed in letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
44.	The background data collection should have included Citizen Science databases such as eBird and iNaturalist. The report notes that in the NHIC background search, four 1.0 square kilometre "squares" were examined. In fact, six squares are needed to encompass the site: 17NJ 8805, 8905, 9005, 9105, 9104 and 9004. If the search is broadened to include the immediately surrounding habitat (as is the usual approach), approximately 12 squares should have been selected. This larger study area is justified because the locations of significant species are often not known exactly, and many wildlife species are mobile enough to roam more widely within the landscape than where they were reported. This section should be summarized by a more inclusive table listing all the SAR that have been noted by an extensive review of background sources in the general area, with their habitat requirements. This should have directed Savanta's survey methodology and focus. In addition, several Species at Risk were left out of the analysis. The following additional species, noted in the two Ontario Reptile and Amphibian Atlas squares that encompass the site, were omitted from the sources mentioned: Ontario Herpetofaunal Atlas: • Western Chorus Frog (latest record 2019) – Threatened Federally, Not at Risk Provincially. • Blanding's Turtle (latest record 2017) – Threatened Provincially and Federally • Midland Painted Turtle (latest record 2018) – Special Concern Federally • Map Turtle (latest record 2018) – Special Concern Provincially and Federally • Milksnake (latest record 2019) – Special Concern Federally, Not At Risk Provincially.	Section 2.2. Background Data Collection	North-South Environmental Inc.	Both e-Bird and iNaturalist sources are considered citizen science databases that collect, archive and share species observations. As the observations and identifications can be submitted by anyone, and the records are not officially vetted, the data obtained from these tools should not be used as a clear indicator of species presence. Species may be filtered out based on habitat and targeted survey efforts. The following SAR were identified in the citizen science databases: - Bald Eagle (special concern – eBird observation near the cliffs of the escarpment near Mount Nemo; preferred habitat absent within Study Area) - Barn Swallow (threatened – eBird observation, as well as a confirmed observation within the Study Area and discussed in the NETR 2020) - Golden Eagle (endangered – eBird observation near the cliffs of the escarpment near Mount Nemo; preferred habitat absent within Study Area) - Blanding's Turtle (threatened – iNaturalist observation 3.5 km from Study Area; preferred habitat absent within Study Area) - Northern Map Turtle (special concern – iNaturalist observation within 1 km of Study	

				Area; preferred habitat and food source absent within Study Area) - American White Pelican (threatened – iNaturalist observation within 1 km of Study Area; preferred habitat absent within Study Area. Species range limited to Northern Ontario; observation likely a migrant) - Lilliput mussel (threatened – iNaturalist observation within 1 km of Study Area; preferred habitat and host fish species absent within Study Area) Based on the habitat assessments and field survey program discussed in the 2020 NETR, the conclusions remain unchanged.	
45.	This section provides a listing of the natural features within the defined Study Area and the Broader Landscape. The first paragraph in this section states that Savanta has relied, in part, on supporting background information from government agencies and previous site surveys/investigations to provide additional insight into the overall character of these Subject Lands. The second paragraph describes how Savanta was involved in the previous application and states that "given the period of time that has passed, changes in policies and the changes in both the footprint and field conditions, we have not relied on it but have considered the field data and information obtained during that process to enhance the background data collection review and establishment of the field program." The lack of reference to previous historical work from 2004 and 2006 limits the understanding of the fisheries context regarding quarry operations and surrounding fish habitat. The next sections describing the fish habitat in the 2020 NETR are therefore very limited, whereas the fisheries information from the previous work by Stantec is extensive.	Section 2.2. Background Data Collection	Matrix Solutions Inc.	Comments on fish habitat have been discussed extensively above. DFO is the regulatory agency responsible for fish habitat and issued a letter of advice dated June 23, 2021. Nelson will implement the recommendations of DFO to protect fish habitat. More details are provided in the attached Watercourse Characterization Summaries. DFO's guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations.	
46.	Features on or within the Study Area (bottom of Page 15 and top of page 16) should have included a discussion of the Mount Nemo Plateau. This is a landscape feature that is not mapped per se as an ecological feature – however, it has been identified as an important area for wildlife connectivity and it was identified as a significant recharge zone by the previous study team. Previous findings of groundwater connection with the wetlands in the previous hearing should be addressed.	Section 2.2.1. Natural Features Desktop Summary	North-South Environmental Inc.	The function of the Mount Nemo Plateau as a recharge function is addressed in the water resources report and discussion regarding the important areas for wildlife connectivity on the Mount Nemo Plateau are discussed above.	
47.	Discussion of the fisheries context is found in Section 2.2.9 Conservation Halton Long-Term Environmental Monitoring Program Data, where characterization of the Grindstone Creek Watershed and Bronte Creek Watershed from Conservation Halton in 2002 was used to describe fish habitat. The fish habitat character from 2002 and fish species data in 2012 provided in this section from Conservation Halton provides a very limited background information despite the wealth of more detailed fisheries information contained in historical reports, which provide an indication of baseline conditions.	Section 2.2.9. Conservation Halton Long-Term Environmental Monitoring Program Data	Matrix Solutions Inc.	See previous responses regarding fish habitat. Contrary to this comment, as described in NETR Section 5.3.2, starting on Page 43, fish community sampling was completed on the West Arm of the West Branch of the Mount Nemo Tributary. The NETR also references the results of previous fish community surveys completed in the West Arm of	

	This section confirms no fish community sampling is known to have been conducted in the unnamed tributary of Willoughby Creek downstream from the Subject Lands. Furthermore, no fish sampling has been completed on the West Branch of the Mount Nemo Tributary of Grindstone Creek. The Mount Nemo Tributary has been characterized as intermittent.			the West Branch by Stantec as well as surveys by MNRF in the East Arm of the West Branch.	
48.	This section should have included a description of the Ecoregion and Ecodistrict context of the site.	Section 3. Physiographic Conditions	North-South Environmental Inc.	Comment noted.	
49.	In addition to considering individual Coefficients of Conservatism, Floristic Quality Analysis (FQA) should be included to provide an assessment of vegetation quality in each community as a whole.	Section 4. Field Investigations and Methods - Section 4.1.2	North-South Environmental Inc.	The NETR discusses plant species that have a high CC value and their associated communities. At this point, regarding FQA, it is our understanding that baseline values have not been established formally in Ontario (i.e., none that have been peer reviewed and published). Without formal baseline values, relative comparisons of communities are not reliable and would not add value to the current assessment and results. The NETR assesses floristic quality for the Study Area as a whole by using the CC values, and therefore, the vegetation data has been sufficiently assessed and applies appropriate mitigation measures.	
50.	A sampling plot radius of 5.0 metres is smaller than that generally accepted for sampling of woodlands (e.g. the sampling method for determining whether there are enough trees with cavities to meet the threshold for bat maternity colony habitat is 12.0 metres). This small sampling radius could have influenced the assessment of Significant Woodlands, if the small radius was used in the smaller woodlands as noted. A description of how the location of sampling plots were selected should be provided. It would be easy to unconsciously select areas with fewer trees for sampling if plots were selected in the field.	Section 4. Field Investigations and Methods - Section 4.1.4	North-South Environmental Inc.	Woodland stem density surveys and bat maternity colony surveys have differing objectives and should not be compared with respect to plot size. The latter is targeting larger trees capable of supporting bat maternity roosts and therefore requires larger plots. Woodland stem density surveys target all trees measurable at DBH – since many of the trees observed in the 5m plot communities were small diameter, a smaller plot size was deemed appropriate. 5m radius plots were only used in two of the five vegetation communities assessed; the remaining three consisted of 10m radius (two communities) and 15m radius (one community). In these instances, rationale for using the 5m radius plots was based on size of the overall feature and visibility within the plot (i.e., polygon CUT1-1), and observed variability within the community (e.g., varying density of stems in the overall community, varying species, and/or varying maturity; i.e., polygon CUT1b). The issue of visibility, in this case, relates to density of shrub species, where an abundance of Staghorn Sumac, Common Buckthorn, and Multiflora Rose made it difficult to count stems reliably in larger plots. Since 10% community coverage was generally the target, it meant that smaller communities would require fewer large-diameter plots to achieve this target. For these two communities, only one 10m plot would be	

				necessary to exceed that target. For polygon CUT1b, it was determined on site that a single plot appeared unlikely to sufficiently address the variability within the overall community. Determination of plot location consisted first of desktop imagery interpretation – selecting locations that appeared to capture community variability, which was then adjusted on site (if necessary) to ensure the pre-planned plots could be safely accessed and that any variability within the community was proportionately represented.	
51.	The golf course ponds should have been included in salamander surveys (Figure 4a, Appendix A) and aquatic turtle surveys. Though these are human-made, there is the potential that one or more of them may provide habitat for SAR, including Jefferson's Salamanders (The retained consultant has personally observed this and other Ambystoma species in human-made ponds). There is no detail on time or weather during amphibian, bird, turtle and snake surveys, to permit a full assessment of whether wildlife survey methods were appropriate. Appropriate weather conditions (generally relatively warm, with no precipitation and low winds) are essential for reptile, amphibian and bird surveys. Inappropriate weather conditions can lead to the false conclusion that the species is not present. Surveys did not conform to the MNRF protocols for Blanding's Turtle, for which five visits are required prior to June, in highly specific weather conditions.	Section 4.2. Wildlife Surveys	North-South Environmental Inc.	All potential salamander breeding habitat was assessed and trapped as required. Discussions with the MECP confirm that the golf course irrigation ponds are not habitat for Jefferson Salamander and did not need to be surveyed. We are continuing to work with MECP for all SAR related matters and are adhering to their survey recommendations and protocols. In addition to the general notes about weather conditions in the methodology section, full weather details are recorded for each survey and provided on the data sheets in Appendix C of the NETR. Blanding's Turtle survey effort was discussed with MECP and addressed in the MECP response letter after completing Blanding's Turtle surveys, as per MECP direction, in 2021. No Blanding's Turtle or its habitat were observed and are considered absent from the Study Area.	
52.	It is not clear that MNRF/MECP were involved in selection of sampling sites; only that they were consulted regarding survey protocols. This should be clarified. Conservation Halton should also have been consulted regarding survey locations and methods. As noted above, the retained consultant has had experience with Jefferson's Salamanders and other Ambystoma species use of human-made ponds, so golf course ponds should have been included in trapping.	Section 4.2.2. Salamander Habitat Assessment and Hydro-period Monitoring Methodology	North-South Environmental Inc.	All potential salamander breeding habitat was assessed and trapped as required. Discussions with the MECP confirm that the golf course irrigation ponds are not habitat for Jefferson Salamander and did not need to be surveyed. We are continuing to work with MECP for all SAR related matters and are adhering to their survey recommendations and protocols.	
53.	It is not clear whether tail-tip samples were obtained for genetic testing.	Section 4.2.3. Salamander Minnow Trapping Survey Methodology	North-South Environmental Inc.	Table 6 includes full details of the 2019 trapping results. No salamanders were caught during the trapping surveys; therefore, no tail-tip samples were obtained.	

54.	This section states: "Survey protocols were created in consideration of MNRF (2012) and Toronto Zoo (Caverhill et al. 2011) turtle survey methods." This is imprecise language as it is unclear what "consideration" means: whether MNRF protocols were followed, or whether they were just given "consideration". If a variation in the protocols was followed this must be fully described. Clear times and weather conditions for each visit have not been provided. The final paragraph in this section notes that turtle nesting surveys were not completed due to absence of suitable habitat. However, turtles are frequently observed to nest on lawns (personal experience of the author), and turtles frequently nest at long distances from their basking habitat. Turtle nesting surveys should have been conducted at the appropriate time of year. There is no indication that methods for surveying non-basking turtles were used. As noted above, Blanding's Turtle (Threatened) have been noted within the Ontario Amphibian and Reptile Atlas "squares" in the vicinity of the site in addition to Midland Painted Turtle (Recently evaluated as Special Concern) and Snapping Turtle (Special Concern). Blanding's Turtles bask less often than other turtle species, and must be surveyed particularly early in the year, in ideal weather conditions, as detailed by Blanding's Turtle survey protocols (MNRF 2013).	Section 4.2.6. Turtle Basking Habitat and Nesting Surveys	North-South Environmental Inc.	In addition to the general notes about weather conditions in the methodology section, full weather details are recorded for each survey and provided on the data sheets in Appendix C of the NETR. The 2019 spring season had a cool and wet start, providing limited 'ideal condition' days for surveying for reptile species. Although reptile surveys do have 'ideal condition' temperatures and general condition guidelines, these are not always the set standard. Other considerations in determining suitable weather conditions include past weather patterns (i.e., weather leading up to the day of survey) and reptile behaviour in the local landscape (information obtained from the provincially recognized Reptile Course on Beausoleil Island, 2017). Turtle basking surveys are considered appropriate between ice-off and mid-June. Surveys should occur between 6 and 25 degrees during sunny or partly cloudy conditions and be above 15 degrees in fully cloudy, but not stormy, conditions. These conditions were all satisfied when completing the turtle basking surveys in 2019. One of the more important considerations when deciding to commence turtle basking surveys is to ensure that the air temperature is warmer than the water temperature, along with the previous and current weather conditions. April 22: Survey was completed in partial overcast/partially sunny conditions (with a mix of sun and cloud presence – cloud presence was the highest in the morning and decreasing into the afternoon) after a weekend with cool, rainy weather. The previous two days prior to the basking surveys included a partially sunny day, even with temperatures below 15 degrees Celsius, resulting in more active basking observations in the surrounding geographic area. Additionally, the air temperature was higher than the water temperature, further supporting basking conditions. May 10: The two days prior to the survey were cool, and the day prior was rainy. The morning of May 10 was the warmest portion of the day (hovering at 17 degrees) with a mix of sun and cloud conditions. Additionally, the air temperature was higher than the water temperature, further supporting basking conditions.	

				June 11: This survey date falls within the ice-off and mid-June timing window and meets the ideal conditions previously specified. Additionally, the wet and cool spring conditions in 2019 support an early June survey date due to a delayed spring season. The potential basking features that were surveyed are primarily characterized by open irrigation ponds that are mowed to the feature edge and provide limited basking opportunities, given the sloped edges, lack of basking habitat (e.g., rocks, logs) and open water conditions with no vegetation to create visual barriers from predators. The features are deep and generally hold water cooler than the air temperature. Based on the above, this SWH type is still considered absent. As indicated in section 4.2.6, suitable nesting micro-habitat characteristics included open, sunny areas of looser sand and gravel mineral soils adjacent to undisturbed shallow weedy areas of marsh habitat. Such habitat conditions were absent from the Study Area. Turtle nesting surveys were not completed due to absence of suitable habitat. Blanding's Turtle survey effort was discussed with MECP and addressed in the MECP response letter after completing Blanding's Turtle surveys, as per MECP direction, in 2021. No Blanding's Turtle or its habitat were observed and are considered absent from the Study Area.	
55.	Times and weather conditions for snake surveys are important, but have not been provided for each survey. It is noted that visual encounter surveys were conducted on mild spring mornings, but the following sentence says they were conducted between 8:00 AM and 5:00 PM, which means not all were conducted in the morning. The first sentence notes that survey methods are based on MNRF species at risk protocols, but the final sentence on the first paragraph of this section notes that specific protocols were not applied as no threatened or endangered snakes have been recorded in the area based on the species desktop summary. Milksnake (a species of Federal Special Concern) has been recorded in this area by the Ontario Herpetofaunal Atlas, so the MNRF protocol for Milksnake surveys (which are often used to guide surveys for non-SAR species generally) could have been followed.	Section 4.2.7. Snake Habitat and Visual Encounter Methodology	North-South Environmental Inc.	In addition to the general notes about weather conditions in the methodology section, full weather details are recorded for each survey and provided on the data sheets in Appendix C of the NETR. The 2019 spring season had a cool and wet start, providing limited 'ideal condition' days for surveying for reptile species. Although reptile surveys do have 'ideal condition' temperatures and general condition guidelines, these are not always the set standard. Other considerations in determining suitable weather conditions include past weather patterns (i.e., weather leading up to the day of survey) and reptile behaviour in the local landscape (information obtained from the provincially recognized Reptile Course on Beausoleil Island, 2017).	

				Snake visual encounter surveys are considered appropriate between April and September (though spring emergence is ideal between April and leaf-out). It is also recommended that surveys should occur between 10 and 30 degrees during sunny or partly cloudy conditions, and above 15 degrees in fully cloudy, but not stormy, conditions. These conditions were all satisfied when completing the visual encounter surveys in 2019. In addition to the weather condition parameters that are recommended during the survey, the weather conditions and pattern from the previous days leading up to the survey date are also of importance. April 22: Survey was completed in partial overcast/partially sunny conditions (with a mix of sun and cloud presence – cloud presence was the highest in the morning and decreasing into the afternoon) after a weekend with cool, rainy weather. The previous two days prior to the basking surveys included a partially sunny day, even with temperatures below 15 degrees Celsius, resulting in more observations in the surrounding geographic area. Additionally, the majority of the snake surveys were completed in the afternoon with cloud cover between 40-60%, providing suitable sunny conditions. May 10: The two days prior to the survey were cool, and the day prior was rainy. The morning of May 10 was the warmest portion of the day (hovering at 17 degrees) with a mix of sun and cloud conditions, and the afternoon was mostly sunny. June 11: This survey was completed within the suitable timing window (April to leaf-out) and during suitable weather conditions. Due to the cool and delayed start of spring in 2019, leaf emergence occurred into early June. Based on the above, this SWH type is still considered absent.	
56.	It is stated that the MNRF Guidelines for Bobolink and Eastern Meadowlark point counts were followed. These guidelines state that 3 surveys should be conducted, in the early, mid and late season. A third survey date for these species is not listed.	Section 4.2.8. Breeding Bird Surveys	North-South Environmental Inc.	Historical communication with MNRF confirmed that two surveys are sufficient if the species was observed during survey rounds one or two. Bobolink was observed on the Camisle Golf Course, adjacent to the proposed South Extension; therefore, a third survey was not required due to confirming presence with first two rounds.	

57.	It is noted in this section that survey methods targeted habitat for Little Brown Myotis, Northern Myotis and Tri-colored Bat, but that surveys were conducted in leaf-off condition, focusing on tree cavity assessment. However, surveys for Tri-colored bat habitat must be conducted in leaf-on condition, as Tri-colored Bats nest in leaf clusters.	Section 4.2.9. Bat Habitat Assessment Survey Methodology	North-South Environmental Inc.	As noted in section 4.2.9, survey methods applied for the 2019 bat habitat assessment surveys include a combination of protocols established by the MNRF (MNR 2011 and MNRF 2017), discussions with MECP and professional experience. Bat habitat survey guidance from the province has been in flux since the release of the MNR 2011 document due to the incorporation of on-going bat research, and therefore discussions with provincial authorities is the preferred approach to establishing survey methods. MECP guidance for assessing forest/woodland habitats for maternity roosting bats does not recommend surveys for leaf clusters. Tri-coloured Bats are known to prefer leaf clusters, with data showing a preference for dead leaf clusters in particular, though cavity and peeling bark roosts have also been identified as roosting habitat for this species. All FO/SW ELC communities (eight were identified) were considered potential habitat for SAR bats (tree cavities, peeling bark and leaf clusters are typically present in all FO/SW communities, so none of these habitats were overlooked). Of these eight communities, three of them fell within the proposed limit of extraction and were further surveyed using acoustic methods to determine species presence.	
58.	It is noted on page 29 that "any calls with a positive identification were manually vetted by a wildlife ecologist with training in bat species identification by sonagram." Calls noted as "NoID" should also be vetted by an ecologist with training, as Myotis sp. calls are frequently recorded without identification to species. The three Myotis species that occur in southern Ontario (as well as the Tricoloured Bat Perimyotis subflavus) have very similar calls that cannot always be identified by auto-ID algorithms, but all Myotis and Perimyotis species are considered Endangered.	Section 4.2.10. Bat Acoustic Survey Methodology	North-South Environmental Inc.	Correct. To help emphasize the effort applied to the assessment of bat acoustic recordings please note the following clarification to the bat acoustic survey methodology. Due to the challenge in identifying some high frequency calls, wildlife ecologists trained in bat species frequency identification individually assessed the high frequency calls to ensure that the auto-ID results were accurate. If a call could not be identified beyond *Myotis* sp., it was left as *Myotis* sp. and included in the SAR results.	
59.	Typically, an assessment of potential HDF is done prior to going on site using orthoimage interpretation or ArcHydro analysis to look for drainage features that have a catchment of 2.5 hectares or larger. The report should describe how this was completed.	Section 4.3.1. Headwater Drainage Feature Assessment	North-South Environmental Inc.	Aerial photo interpretation was completed to identify potential HDFs that may need to be looked at and the results of a November 2018 site reconnaissance were considered prior to completion of HDFA Round 1. However, the entire proposed West Extension Subject Lands and South Extension Licensed Boundary and all areas within 120 m were walked during HDFA Round 1 to identify potential HDFs. Therefore, it was not necessary to rely on arc-hydro	

				mapping to identify features, as this was done through field investigation.	
60.	Please discuss how the delay in the Headwater Drainage Feature (HDF) Assessment timing impacted the results of the assessment and provide additional mitigation as necessary. For example, the first round of the HDF Assessment was completed on April 18, 2019 with a temperature of 22.0 degrees, which is outside of the spring freshet of that year. The second round was completed outside of its typical period (June 3, 3019 vs Late April – May) and the last round was at the very end of the window as well (August 26, 2019 vs July-August).	Page 29 Section 4.3.1. Headwater Drainage Feature Assessment	Conservation Halton	Round 1 in 2019 was just beyond the typical window identified by the HDFA Guideline (late March – mid-April) and while not at the peak of the freshet, the timing was sufficient to identify HDFs on the landscape. OSAP (Section 4: Module 11) notes that round 1 should be completed after the spring freshet. Mid to late spring 2019 was very wet and as a result of waiting to get a period of at least 48 hours with no rain (and preferably 72 hours as noted in OSAP Section 4: Module 11), delay until early June was required to achieve appropriate baseflow conditions, per guidelines. The OSAP (Section 4: Module 11) indicates sample event 3 is conducted in July to mid-September following at least 3 days with no flow generating precipitation event. The round 3 survey on August 26, 2019, meets these requirements. The intent of Round 3 is to identify permanent flowing or wetted features during summer baseflow, and this was achieved.	
61.	This section describes the fish community sampling that was completed on June 17 and 24, 2019. Backpack electrofishing (using a Halltech HT-2000 electrofishing unit) and seine netting (using a 30.5-metre long by 1.83-metre high, small mesh seine net) were used in combination to survey all habitats present. The other excavated golf course ponds were steep-sided and too deep to wade; therefore, visual observations of fish presence were recorded. As fish sampling methods are known to be selective to fish, discussion of biases associated with these methods should have been included in this section as the methodology used for fish sampling is biased to larger fish. No attempt was made for example, to use minnow traps in areas that are too deep to wade to obtain an understanding of smaller bodied fish species. Visual fish observations yield limited information and accuracy of fish identification is based on the experience of the observer. At the very least, the mesh size of the netting should have also been indicated as well as catch per unit effort to understand the relative abundance of fish. If the objective of the fish sampling was to demonstrate an understanding of the fish community, including the presence/absence and types of fish inhabiting various watercourses in the study area, a discussion on gear selection and deployment should have been included. The presence or absence of fish is a useful indicator in determining a particular pond's potential to support other species such as the Jefferson Salamander.	Section 4.3.3 Fish Community	Matrix Solutions Inc.	We note these comments relate to the anthropogenic ponds on the golf course, which has been confirmed as not being fish habitat by DFO. We note the following: • Although catch per unit effort was not specifically noted in the report or the results table (Table 14) it can be readily calculated based on the reported numbers and effort (electrofishing seconds). However, in our opinion, little relevant information can be garnered from a calculation of catch per unit effort that cannot already be readily discerned from looking at the raw results. • Electrofishing within the interconnecting channels between ponds is considered to be a completely effective method to sample the fish community in those areas. • DFO has confirmed (via email on June 23, 2021, which accompanied the Letter of Advice) that the ponds and interconnecting channels on the golf course are not considered fish habitat.	

				• It is acknowledged that deep water sampling was not completed in the anthropogenic ponds. However, we suggest that the visual assessment methodology was very effective in identifying the species of fish that were observed, given that Largemouth Bass, including YOY, juveniles and adults are readily identifiable to species and viewing conditions during the survey were excellent. It is our opinion that there was no opportunity to inaccurately identify those fish that were visually observed in the ponds. Further, the active sampling that was completed in the ponds and interconnecting channel only identified the presence of Largemouth Bass, thereby validating the visual observations of only one species. • We cannot discount the possibility that other species could potentially be present in the anthropogenic ponds in areas that were not sampled. It is well documented that fish can invade ponds through a number of means of transport including human induced stocking, accidental release, birds and migration from downstream watercourses. Therefore, is possible that if other gear was utilized, additional fish species could potentially have been captured. However, regardless of whether or not other species were present in the anthropogenic ponds on the golf course, our opinion of whether or not these ponds are characterized as fish habitat under the Fisheries Act would not change for the reasons outlined in Section 6.6.1 of the NETR. Again, DFO has confirmed in letter dated June 23, 2021 that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat. • Further to this, regardless of the fish composition of the ponds, in our opinion, it is inarguable that the ponds and interconnecting channels do not provide an important ecological function for the natural fish community in Willoughby Creek. As expanded upon in the NETR, it is our opinion that removal of the ponds and irrigations channels would have a net benefit for the natural watercourse downstream. Therefore, in our opinion, any further studies in these ponds are not warranted, since the long-term	

				management remains the same (i.e., removal). Based on our experience in similar areas, fish from man-made ponds such as this are not typically permitted to be transferred back to the natural environment elsewhere, given the potential for diseases and contaminants. • Largemouth Bass have been visually confirmed in all of the Golf Course ponds and this has been considered in the assessment of potential to provide Jefferson Salamander habitat.	
62.	Giant Swallowtail (S3) was not included in the mapping of significant species on Figures 7a and 7b. It was omitted because its host plant, Prickly Ash, was not observed within the areas where the butterfly was observed. However, nectaring habitat is important for butterfly species and this species should have been added to the mapping in order to inform mitigation.	Section 5.2.1. Insects	North-South Environmental Inc.	Giant Swallowtail observations were made of two individuals moving through the golf course. Therefore, lack of habitat and behaviour of observed species concluded that habitat for this species is considered absent from the Study Area. However, pollinator plant species are recognized as an important component to open areas, and therefore, as noted in the Site Plans, appropriate seed mixes will be applied following Conservation Halton guidelines.	
63.	Please provide the number of surveys, location of sites and dates of the egg mass surveys.	Page 35 Section 5.2.4. Egg Mass Survey Results	Conservation Halton	Egg mass observations were being reported on various message forums for the Burlington and Milton areas in early April. Therefore, as provided in section 4.2.4 and Table 1, egg mass surveys were completed at features V1, V2, V3 and V4 on April 10, 2019.	
64.	The report indicates that no amphibians were heard calling from ACC11 however wetland 13037 (PSW12) is identified as an amphibian breeding area in the MNRF Grindstone Creek Headwaters PSW evaluation. Recommend referencing the evaluation and discussing in the report.	Page 36 Section 5.2.5. Amphibian Call Count Survey Results	Conservation Halton	The Grindstone Creek Headwaters Wetland Complex Wetland Evaluation Report (MNRF 2007) does not identify wetland 13037 (PSW12) as amphibian breeding habitat; however, it does indicate so for PSW11, which is what I'm assuming is meant in this comment. The data for this report is dated 2007. As of 2019, amphibians were not heard calling from this feature, nor was any amphibian captured during salamander trapping surveys in 2019.	
65.	It should be noted that Midland Painted Turtle's S4 status does not indicate "common and secure" as stated on page 36. The S4 status definition, according to NatureServe Conservation Status Ranks (which are used by NHIC) is: "Apparently Secure— At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors." In addition, Midland Painted Turtle has recently been evaluated by the Committee on the Status of Species at Risk in Canada (COSEWIC, 2018) as a Species at Risk in Canada with a status of Special Concern, indicating a greater level of concern about its status.	Section 5.2.6. Turtle Basking Habitat and Nesting Survey Results	North-South Environmental Inc.	Golf course sand traps and active agricultural fields are not considered suitable turtle nesting habitat and would therefore not be considered candidate habitat requiring further assessment. These areas are not suitable for nesting due to disturbances associated with frequent sand trap raking (e.g., multiple times daily) and disturbances associated with agricultural activities or shading from planted crop vegetation that will prevent the	

	On page 27, it was stated that turtle nesting surveys were not completed due to absence of suitable habitat, so this section should not refer to nesting survey results. It is possible that both turtles observed on the golf course (Snapping Turtle and Midland Painted Turtle) nest on the golf course or in the southern extension study area and surveys should be conducted for nesting habitat. The finding of a Snapping Turtle walking on land from one irrigation pond to another on June 11, 2019 (and described as an observation of a turtle "moving through the area"), is within the nesting window for this species and this was just as likely to have been an observation of a turtle searching for nesting habitat. Locations of turtle observations should have been shown on Figure 7a (Significant Wildlife Habitat and Species at Risk Observations).			successful incubation and hatching of any eggs, should any be laid in these areas. The EcoRegion Schedule (MNR 2015) does not explicitly state that the species of Special Concern must be on the SARO List; however, it is a document that is an extension and guidance for the SWH Technical Guide (MNR 2000), and it does state that the information within the schedule will require periodic updating to keep pace with changes to wildlife species status in the Species at Risk in Ontario (SARO) list, or as new scientific information pertaining to wildlife habitats becomes available. The SWH EcoRegion Schedule is also a provincial guidance document; therefore, if a species does not have a provincial status of Special Concern, it should not be considered as Special Concern for the purposes of SWH.	
66.	Headwater Drainage Features are discussed in a separate report by a member of the Study Team.	Section 5.3.1. Headwater Drainage Feature and Aquatic Habitat Results	Matrix Solutions Inc.	Acknowledged.	
67.	Please note that the identified H2 is a regulated watercourse under Ontario Regulation 162/06 and not a headwater drainage feature as discussed in the report. Please revise the table accordingly.	Page 39 Section 5.3.1. Headwater Drainage Feature and Aquatic Habitat Results	Conservation Halton	In our experience elsewhere in Halton Region, H2 would appear to meet the criteria to be considered a headwater drainage feature. The feature consists of a headwater wetland (which per the TRCA/CVC HDFA Guidelines is considered to be a headwater drainage feature) and a short interconnecting channel. This is a first order feature, is intermittently flowing and has a drainage area less than 50 ha (which has been used as a general guideline threshold to differentiate HDFs from watercourses in other areas of Halton). Based on this, we suggest H2 does meet typical criteria to be an HDF and not a watercourse. We would appreciate further clarification from Conservation Halton as to what criteria has been used to designate H2 as a watercourse and not an HDF and explanation as to how this is consistent with approaches taken elsewhere in Halton Region. In our opinion, whether or not it is classified as a watercourse or HDF does not have any implications for the assessment of potential impacts in the NETR, nor any other project related implications.	

68.	The information provided in this section describes the watersheds associated with the West Extension and the South Extension of the Burlington Quarry. West Extension primarily affects the outflow to the Willoughby Creek Tributary and an unnamed tributary that comes from the Medad Valley which are both in the Bronte Creek Watershed. The South Extension primarily affects the outflow to the Mount Nemo Tributary, which is part of the Grindstone Creek Watershed. The degree to which fish assessment is discussed is not only limited to within 120.0 metres, but the fish sampling is limited to areas where Savanta has been given land access, and where they have been able to sample. This not only provides a limited fish species list but also a much smaller sampling study area. As the reach of Willoughby Creek north of Colling Road was not sampled or visited due to private ownership, characterization of fish habitat and fish presence was inferred from past reports. Given the magnitude of the proposed West Extension and implications on the downstream reaches, information regarding downstream effects is sparse. It is not surprising that only very few fish species are observed and reported in this section. As access has presumably been granted to others such as Worthington to directly observe karsts within the Willoughby Tributary, the applicant should explain if landowner consent to enter private property for the purposes of sampling and investigation was attempted. The baseline aquatic habitat for these receiving stream systems are described in historical ecological reports (e.g., 2004 and 2006 electrofishing surveys). The significance of the Willoughby tributary in terms of fisheries is highlighted within these historical reports. These reports, completed by Stantec as 2004 Level 2 NETR (Stantec 2004) and 2006 Level 2 NETR (Stantec 2006) discuss natural features within a 5.0 kilometre radius of the study area, and was focused on identifying ecological links to environments not immediately adjacent to the Subject Lands. These reports state that "these links are important to understand Regional environmental features that could be impacted by on site operations". Justification should be provided why a different approach was used in the 2020 Level 1 and 2 NETR.	Section 5.3.2. Fish and Fish Habitat Assessment Results	Matrix Solutions Inc.	See previous responses regarding fish habitat. More details are provided in the attached Watercourse Characterization Summaries.	
69.	This section discusses how the presence/absence of natural heritage features as defined in the PPS (MMAH 2020) within the Study Area is assessed. The NHRM (MNR 2010), NEP (2017), Halton Region OP (2018) and City of Burlington OP, which provide technical guidance for implementing the natural heritage policies of the PPS, were referenced to assess the potential significance of natural areas and associated functions. Under Subsection 6.6 however, the discussion on Fish Habitat is only limited to what waterbodies are considered fish habitat under the *Fisheries Act*. Key pieces of policy information such as (a) identification of the connections and linkages between natural heritage features and areas, surface water features and groundwater features; and (b) how the diversity and connectivity of the natural features in an area and the long-term ecological function and biodiversity of the natural heritage system can be maintained, restored or where possible improved as they pertain to fish habitat is omitted from this discussion.	Section 6. Natural Heritage Feature Assessment	Matrix Solutions Inc.	The purpose of this section was to identify where direct and indirect fish habitat was present. Reference to potential significance assessment is relevant to other types of natural heritage features and areas (i.e., Significant Woodlands, Significant Wildlife Habitat), but in our opinion, there is no similar "significance" assessment for fish habitat under the PPS; it either is or is not fish habitat for the purposes of this assessment. That is not to say that some fish habitat is not more significant (outside the PPS context of significant natural features and areas). Therefore, it is not clear how the requested content is consistent with the intent of this section of the report. Any discussion on points a) and b) as identified in the comment, would appear more appropriate for the impact assessment section of the report and it is not clear what value they would add to this section, nor how it would be consistent with the other sections in this report (which focus on determining the presence/absence of significant	

				natural features and areas as defined in the natural heritage policies of the PPS).	
70.	Once the additional hydroperiod information for the wetlands is complete, please revise and include an ecological interpretation of the data in this report. The data should be assessed from a dry, wet and average climate conditions perspective to ensure that proposed changes do not exacerbate natural dry conditions.	Page 46 Section 6.1.2. Significant Wetlands – 120 m Adjacent Lands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
71.	The MNRF Grindstone Creek Headwaters PSW Evaluation notes that the larger wetland of the 13037 (PSW12) is seepage-fed and contains a seep that can be seen discharging to the surface, whereas the report indicates that this wetland is precipitation and surface runoff fed with groundwater contribution to be less than 2.0%. Recommend referencing the evaluation and discussing in the report.	Page 46 Section 6.1.2. Significant Wetlands – 120 m Adjacent Lands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
72.	All of the PSWs within the zone of influence of the quarry should be discussed in this report, regardless if they are within the 120.0 metres adjacent lands. There are number of PSWs in the Grindstone Creek PSW Complex that may be impacted by the quarry that are not discussed in the report.	Page 46 Section 6.1.2. Significant Wetlands – 120 m Adjacent Lands	Conservation Halton	The Wetland Characterization Summaries (attached) provide feature characteristics, impact assessments by each Phase and mitigation measures.	
73.	Please confirm the source of water input for the SAS1 inclusion within the MAM2-2/SWT2-2.	Page 49 Section 6.1.3. Other Wetlands within the 120 m Adjacent Lands	Conservation Halton	The SAS1 inclusion is an online pond on the West Arm of the West Branch of the Mount Nemo Tributary. The source of water for this is primarily quarry discharge from Sump 0200.	
74.	This section should include a detailed discussion of why the analysis came to a different conclusion regarding the significance of woodlands E, F and G from the Regional Natural Heritage System's analysis. The potential functions of these woodlands to provide connectivity (i.e., stepping stone function) of Woodland D to adjacent features should be discussed. Review of aerial photography for this area indicates that Woodland E is less than 20.0 metres from Woodland D, and should be investigated as a continuous part of Woodland D, as it is noted in Section 6.2.1 that woodlands within 20.0 metres should be treated as a continuous unit.	Section 6.2. Significant and Other Woodlands	North-South Environmental Inc.	Wooded features E, F, G do not meet the definition of Woodland under the ROP (2018), (0.48 ha; 0.22 ha; 0.48 ha, respectively) and are all greater than 20 m apart. Therefore, these are not features, nor should they be considered 'stepping stones' due to their size and distance apart from each other.	
75.	The significance and role of Woodland E relating to the RNHS should be expanded upon. Provide further analysis to confirm the functions and contributions of Woodland E for: • SWH (Eastern Wood-Pewee Habitat, Bat Maternity Roost Habitat); • Separation distance from Woodland D; • Overall connectivity/ linkage opportunities within the RNHS; and • Overall significance. It is recommended that detailed avoidance rationale be provided to reflect the role Woodland E plays within the larger RNHS and all associated impacts.	Page 53 Section 6.2.2. Halton Region Official Plan	Conservation Halton	Wooded feature E is described in detail in Table 2 of the report. It is an area that is <0.5 ha made up of mid-age to mature canopy trees mostly of Sugar Maple. There is no subcanopy or understorey. The ground cover consists of maintained turf grass, Garlic Mustard and some Herb-Robert, all of which is mowed regularly. Paved golf cart paths also make up part of the ground cover in this small stand of trees, serving as an aesthetic feature for the golf course. It is small and isolated (<20 m from other treed areas). High bat activity may serve more of an indicator that this polygon is situated in the flight path of bats moving between the Medad Valley and the open water areas of the active quarry for foraging purposes.	
76.	This section notes that species of conservation concern include "species listed as S1 to S3 or SH by SRANKS and those listed on the Species at Risk in Ontario List as Special Concern."	Section 6.4. Significant Wildlife Habitat	North-South Environmental Inc.	The EcoRegion Schedule (MNR 2015) does not explicitly state that the species of Special Concern must be on the SARO List; however, it is a document	

	However, neither the Natural Heritage Reference Manual nor the Ecoregion Schedules state that the species of Special Concern must be on the Species at Risk in Ontario List. As noted in Section 7.4.2.2, Midland Painted Turtle has been evaluated as a Species at Risk in Canada by COSEWIC, and should have been discussed here; its location should also be shown on Figure 7b. The location of the Snapping Turtle (a Species of Special Concern) should have been shown on Figure 7a. This species should have been discussed, as it can rely on human-made habitat. While human-made habitat is excluded from some SWH (such as turtle overwintering habitat) it is not excluded as SWH for species of conservation concern.			that is an extension and guidance for the SWH Technical Guide (MNR 2000), and it does state that the information within the schedule will require periodic updating to keep pace with changes to wildlife species status in the Species at Risk in Ontario (SARO) list, or as new scientific information pertaining to wildlife habitats becomes available. SWH EcoRegion Schedule is also a provincial guidance document; therefore, if a species does not have a provincial status of Special Concern, it should not be considered as Special Concern for the purposes of SWH.	
77.	The FOD7-4 community is rare in the Province and is therefore confirmed SWH, regardless of its frequency in Halton Region. The report should provide the full 30.0 metre buffer for this woodland, an impact assessment for this feature and mitigation measures developed as necessary.	Page 57 Section 6.4.1. SWH Assessment Summary, Table 19	Conservation Halton	A 30 m setback will be applied for this feature, and the site plans will be revised to identify this buffer and the mitigation measures to protect and enhance this feature.	
78.	The Grindstone Creek Headwaters PSW Evaluation notes that a number of the wetlands adjacent to the proposed south extraction support amphibian breeding. Further discussion on the potential use of these wetlands by amphibians and potential SWH should be provided. Recommend referencing the evaluation and discussing in the report.	Page 57 Section 6.4.1. SWH Assessment Summary	Conservation Halton	The Grindstone Creek Headwaters Wetland Complex Wetland Evaluation Report (MNRF 2007) is dated 2007. The existing surface water and ground water reports state that there will be no impacts to the features, once mitigation measures have been applied. Further details are also provided in the attached Wetland Characterization Summaries.	
79.	This subsection starts with providing a definition of what is fish habitat. The paragraph goes on to state that “definition of fish habitat includes direct fish habitat (i.e., habitat that may be occupied by fish on a permanent or periodic basis) and indirect fish habitat (i.e., habitat that would not be used directly by fish, but that may be important for downstream direct fish habitat).” The rest of this section goes on to say that there is no fish habitat in the proposed limit of extraction. The reasons provided for not considering these areas as fish habitat should include justification to explain why these habitats do not fit the definition of fish habitat.	Section 6.6. Fish Habitat	Matrix Solutions Inc.	DFO has confirmed in letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
80.	The rest of this section goes on to assign fish habitat categories based on their support function to fisheries. As the basis for fish habitat designations appear to be related to hydrologic connections rather than the fish occupancy, as well as origin, and whether the fish population is considered “natural” to the area, this needs to be rationalized back to the *Fisheries Act* (i.e., the basis under the *Act* that these habitat classifications are warranted).	Section 6.6. Fish Habitat	Matrix Solutions Inc.	DFO has confirmed in letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
81.	Confirmation from DFO is needed on the status of fish habitat on the site. Until this is confirmed, it is premature to state that no fish habitat is present.	Page 59 Section 6.6. Fish Habitat	Conservation Halton	DFO has confirmed in letter dated June 23, 2021, that the constructed golf course ponds and interconnecting channels are not considered to be fish habitat.	
82.	Recommend additional impact assessment as it pertains to fish habitat outside of the project footprint, given the potential impact to the water inputs to the offsite watercourses. Until such time that this occurs or direction from DFO is received, a precautionary approach should be taken.	Page 59 Section 6.6. Fish Habitat	Conservation Halton	DFO has provided a Letter of Advice, dated June 23, 2021, indicating that in their opinion no harmful alteration, disruption or destruction (HADD) of fish habitat will occur provided the recommendations in the letter of advice are followed.	

83.	As noted in Section 7.2 above, there are additional species that are listed in the background review sources that should be discussed in this section. Of these, there is the potential for two of these species to occur in the study area: • Blanding's Turtle • Jefferson Salamander In addition, Snapping Turtle should be added to the discussion of SAR within the Limit of Extraction.	Section 6.7. Habitat of Endangered and Threatened Species	North-South Environmental Inc.	Jefferson Salamander is discussed in Sections 6.7 and 7.2.5. Blanding's Turtle survey effort was discussed with MECP and addressed in the MECP response letter after completing Blanding's Turtle surveys, as per MECP direction, in 2021. No Blanding's Turtle or its habitat were observed and are considered absent from the Study Area. Snapping Turtle is a species of special concern (SC) and therefore is not discussed within Habitat of Endangered or Threatened Species.	
84.	Recommend consultation with MECP regarding Species at Risk for this project to determine if the surveys and associated survey efforts are acceptable and to determine the current regulation limits for those identified. Any feedback from MECP should be provided to JART.	Page 62 Section 6.7. Habitat of Endangered and Threatened Species	Conservation Halton	Species at risk discussions are on-going with MECP. Of note, MECP confirmed that the golf course irrigation ponds are not habitat for Jefferson Salamander and did not need to be surveyed. We are continuing to work with MECP for all SAR related matters and are adhering to their survey recommendations and protocols.	
85.	Recommend that the general mitigation measures discuss the potential impacts associated with blasting. Currently, blasting is discussed for wetlands, but as there are other natural heritage features present, this should be expanded to a general list.	Page 66 Section 7.1. General Mitigation Measures	Conservation Halton	As per the Memorandum titled *Blast Vibration and Water Overpressure at Adjacent Waterbodies* (Explotech 2021), mitigation has been recommended to prevent negative impacts on fish and fish habitat in adjacent waterbodies during blasting activities. Specifically, maximum recommended explosive loads per delay have been provided for varying separation distances from fish habitat. During the spawning season, maximum vibration limits of 13 mm/s at the closest spawning habitat have been recommendation. Vibration monitoring has also been recommended to confirm compliance with DFO limits for ground vibration.	
86.	Without having access to the approved Spills Action Centre report for the existing quarry, it is challenging to know if what is contained in it is appropriate for the proposed expansion. Recommend including this detail in the application.	Page 67 Section 7.1.2. Accidental Spills	Conservation Halton	The Spill Contingency and Pollution Prevention Plan is attached.	
87.	This section discusses the Level 2 evaluation of the potential impacts due to the quarry development and operation. The Level 2 assessment also includes recommendations regarding any mitigation and/or enhancement measures, as well as rehabilitation plans. The discussion pertaining to fish habitat is in Subsection 7.2.4 where the discussion pertaining to fish habitat impacts are simplified.	Section 7. Level 2 Impact Assessment	Matrix Solutions Inc.	Comment noted – responses to other comments address this general statement.	
88.	The location of the berm adjacent to the weir pond should be changed to 30.0 metres from the wetland, rather than 14.0 metres as currently proposed, to ensure the hydrologic and ecologic function of this pond is not impacted.	Page 68 Section 7.2.1. Wetlands	Conservation Halton	A 30 m setback will be applied to this feature, and the site plans will be revised to identify this buffer and the mitigation measures to protect and enhance this feature.	

89.	For indirect water quality impacts, recommend including turbidity in the assessment.	Page 68 Section 7.2.1. Wetlands	Conservation Halton	See water resources report. This report addresses the water quality of discharged water.	
90.	More information has been requested with respect to the water balance assessment for the wetlands adjacent to the extraction areas. Please refer to comments on the Surface Water Assessment and the Level 1 and 2 Hydrogeologic and Hydrologic Impact Assessment. The Natural Environment Report should be revised to provide an ecological interpretation of those changes, as applicable.	Page 68 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
91.	All of the wetlands that have the potential to be impacted by the quarry application should be discussed in this report. The zone of influence of the quarry is identified as 800.0 metres away and there is potential impact in those PSWs between 120.0 metres to 800.0 metres from the quarry. The Natural Environment Report should be revised to discuss all of the potential features impacted and mitigation measures discussed to ensure they are not impacted. This will ensure that all of the connections and linkages between the NHF, surface water features and groundwater features are identified.	Page 68 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
92.	Please provide the details of the monitoring collected in the spring 2020 wetlands 13200, 13201 and 13202.	Page 69 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries. Additional data that is being collected will assist in the development of the AMP in consultation with the agencies.	
93.	Is it suggested that the catchment areas of the wetlands to the east of the extraction will be maintained, however as noted in the Surface Water Assessment drawings DP-1 and DP-2, it appears that there will be changes to the catchment areas of the wetlands. Please confirm and revise as necessary.	Page 70 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
94.	Please include a discussion on the potential impacts of reduced groundwater flows on the wetlands. For example, will less saturated soils lead to a great drawdown in water levels? Will there be impacts to the temperature of these wetlands from less groundwater and will this impact amphibian breeding?	Page 70 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
95.	In the Hydrogeological Report, Wetland 21 (13201) is considered to be compromised due to the road and culvert, and its water budget is not considered representative of future conditions. Please confirm how changes to this wetland will be assessed and mitigated, especially as this wetland is adjacent to a rare vegetation community.	Page 70 Section 7.2.1. Wetlands	Conservation Halton	More details are provided in the attached Wetland Characterization Summaries.	
96.	This section discusses indirect impacts to this wetland, but the discussion is restricted to the hydroperiod. This wetland (and the surrounding woodlands) will become isolated from the surrounding landscape; they will be surrounded by the existing quarry to the east, and the quarry extension to the north, west and south. The removal of stepping-stone connections provided by Woodlands E and F will exacerbate the isolation of Woodland D containing the wetlands. Connections to the west will be severed. The remaining patch of natural habitat will be perched above the quarry floor on all sides. The impacts of fragmentation on this wetland should be discussed. Impacts to wetland unit within this area would likely include a more rapid rate of drying in wetland and woodland soils, as well as increased temperature extremes because of increased winds, the increased heat island effect induced by the quarry's exposed rock, and increased ambient sunlight. This would likely affect Significant Woodlands and Significant Wildlife Habitat (Eastern Wood-pewee and Large Toothwort) as well as the wetland environment. A 15.0 metre buffer would likely not mitigate this impact, as physical edge effects can be seen at a distance of greater than 15.0 metres from the edge. Additional mitigation (in addition to the 15.0 metre buffer) and monitoring for this impact should be discussed.	Section 7.2.1. Wetlands (Specifically Units SWD3-2a (Wetland 13200))	North-South Environmental Inc.	As summarized in section 6.2.1, woodland D is relatively isolated and located on the golf course, adjacent to the existing quarry. While a portion of this woodland is native, the cultural woodland area is non-native, with an abundance of Black Locust, an undesirable tree species, and the FOD5/DIST area contains only a canopy layer, along with turf grass and paved golf cart paths in the ground layer (sub-canopy and understory vegetation are absent). There is high potential to enhance this woodland both in species diversity and composition. The proposed rehabilitation plans will create a system that is better connected and functional that what currently exists in the golf course and adjacent quarry.	

97.	As discussed with wetlands, the woodlands within the West Extension will be physically isolated and fragmented by the cumulative effect of the surrounding quarries, especially since the woodlands will become perched above the quarry floors. Woodland D, in particular, will be subject to high levels of drying winds, increased albedo from the surrounding quarries, and their function will decline. In turn, these impacts will likely lead to declines in insect populations that are important as prey species. Connections to the Medad Valley (identified as a Regional linkage) to the west are severed, and this connection would be highly important to animal movement through the landscape and persistence of meta-populations within Woodland D.	Section 7.2.2. Woodlands	North-South Environmental Inc.	As summarized in section 6.2.1, woodland D is relatively isolated and located on the golf course, adjacent to the existing quarry. While a portion of this woodland is native, the cultural woodland area is non-native, with an abundance of Black Locust, an undesirable tree species, and the FOD5/DIST area contains only a canopy layer, along with turf grass and paved golf cart paths in the ground layer (sub-canopy and understory vegetation are absent). There is high potential to enhance this woodland both in species diversity and composition. The proposed rehabilitation plans will create a system that is better connected and functional that what currently exists in the golf course and adjacent quarry. The proposed Extension Areas are sited within an active golf course and agricultural area. There is a Regional and Provincial NHS that does run north-south; however, the area of the proposed expansion does not appear to negatively affect the redundancy of these smaller branches of the RNHS. The major areas of the NHS run along the Medad Valley, which is west of the proposed West Extension, as well as along the Mount Nemo Plateau and Grindstone Creek Complex, located east of the proposed South Extension. The proposed Extension areas are located between these two RNHS branches and are not impeding or removing any of the features that make up these two branches; the Extension areas are well outside of these two large systems. Based on the Region's NHS mapping, there are some smaller systems that lie parallel to, and between, these two major systems; however, these smaller systems do not connect to the larger NHS, north of the Study Area. These smaller branches of the overall NHS do not provide connectivity to begin with, and therefore, the removal or disturbance of golf course features and their potential for enhancement and future connectivity opportunities can only add to the limited contribution being made to the smaller NHS.	
98.	The report indicates that bat maternity colonies in the study are not unique in the subject lands or even the landscape. The Significant Wildlife Habitat Mitigation Support Tool (2014), Index 12, states that Bat Maternity Colonies are critical to the survival of local bat populations and the loss of any site has significant impacts on bat populations. Recommend that this discussion be revised to reflect Provincial policy and direction as it pertains to this type of SWH.	Page 72 Section 7.2.3. Significant Wildlife Habitat	Conservation Halton	The Significant Wildlife Habitat Mitigation Support Tool (SWHMiST; OMNR 2014) was created as a guide for planners to better understand the functions of habitat, potential impacts and possible mitigation techniques. It is a tool that can be considered for mitigation purposes after significant wildlife habitat	

				has been confirmed. It is not a tool that mitigates for candidate features. The management options listed within the SWHMiST are based on the best available information at the time of its publication (e.g., 2014) and are not meant to limit the use of other relevant mitigation information. Therefore, other resources can, and should, be consulted when assessing appropriate and feasible mitigation measures. This will help ensure that those measures provided are consistent with current practices and policies. The SWHMiST also states that suitable maternity sites are limited and that the loss of any site has significant impacts on bat populations. The behavioural activity of the bats when the recordings were collected indicated foraging behaviours. This polygon is surrounded by irrigation ponds on the golf course and open water in the existing quarry. Foraging opportunities are abundant in the area, and this polygon is likely situated in a flight path of foraging bats. There is a total of 0.48 ha of bat maternity colony habitat within polygon E. There is more than 6 ha of FOD and SWD within the 120 m Adjacent Lands northeast and southeast of the Limit of Extraction. There is an even larger tract of NHS that is immediately adjacent to the 120 m Adjacent Lands, that contains the Medad Lake Valley, a significant valleyland and wetland complex. It is not anticipated that the removal of 0.48 ha of highly disturbed habitat will have a negative impact on maternity colonies due to the large contiguous tracts of candidate habitat surrounding the Study Area. Recommended mitigation measures include site selection, minimization of affected habitat (states this is a satisfactory mitigation option), timing, habitat restoration and preservation of bat foraging habitat are all included in the SWHMiST. Each of these measures is addressed and will be achieved.	

99.	The Rare Vegetation Community FOD7-4 is not discussed in this section. As this is a confirmed SWH in the study area (confirmed in Table 19 as well) and as it may be impacted by the proposed quarry, this SWH should be discussed.	Page 72 Section 7.2.3. Significant Wildlife Habitat, Table 19	Conservation Halton	As noted in previous responses, the site plans will be revised to include a 30 m setback to this feature and include mitigation measures to protect and enhance this feature.	
100.	FOD7-4 is not fully protected as it extends out past where the buffer is located. This SWH should be protected with a 30.0 metres just as the rest of the natural features are. Please revise.	Page 72 Section 7.2.3. Significant Wildlife Habitat. Figure 8a	Conservation Halton	In the West Extension, there will be a 30 m setback from the edge of the FOD7-4 to the proposed limit of extraction, as well as to the edge of the berm. In the South Extension, there will be a 30 m setback from the FOD7-4 to the edge of the berm.	
101.	In addition to the SWH discussed, Amphibian Movement Corridors should be discussed as this is identified in Table 19 as present.	Page 74 Section 7.2.3. Significant Wildlife Habitat	Conservation Halton	The amphibian movement corridor will remain untouched. No direct impacts are anticipated due to its location outside of the Study Area at the far edge of the 120 m adjacent lands. Potential hydrological impacts and associated mitigation measures are provided in detail in the Wetland Characterization Summaries – wetland 13203 – appended to this response submission.	
102.	Fish Habitat, the potential direct and indirect impacts of the proposed development, including during the temporary construction phase, the long-term operations phase and the post-operations rehabilitation phase, are assessed based on direct impacts and indirect impacts. Direct are deemed non-existent in the proposed Limit of Extraction within either the South or West Extension areas as there is no fish habitat present there. Indirect impacts are dealt with as being minimal due to minimal construction work and lack of intrusion outside of the extraction area and continuing to pump quarry water to supplement flow as recommended by the Surface Water Assessment Report (Tatham 2020). The basis for flow supplementation in terms of volume, water quality and quantity should be explained in terms of its effects on fish habitat downstream of the quarry extension areas. In 2006 Level 2 NETR Report (Stantec 2006) Willoughby Creek has been described in previous reports as “the watercourse of greatest ecological sensitivity” as this Bronte Creek tributary was noted to support critical brook trout spawning and rearing habitat, as noted with the presence of juvenile brook trout captured during 2003 surveys. The Level 2 Natural Environment Technical Report notes that Brook Trout are reliant on groundwater for virtually all portions of their life cycle: spawning, incubation, nursery refugia, and thermal refugia during summer. The loss of groundwater discharge to this system would represent a negative effect. The basis for the maintenance of the quarry water in terms of how flow regime quantity and water quality will be maintained is lacking in this section. In the 2004 Level 2 NETR (Stantec 2004), fisheries inventory of the station (Station 1) reports a healthy population of juvenile Brook Trout in the reaches of Britannia Road and Cedar Springs Road Intersection and 80.0 metres downstream, which is located approximately 1.2 kilometres from the confluence of the Willoughby unnamed tributary to the mainstem of Willoughby Creek. This is consistent with the Bronte Creek Watershed Study, which noted extensive spawning activity in the area of the Cedar Springs community and Cedar Springs Road. The details for maintaining flow should be discussed in this section extending beyond 120.0 metres as the reports of the water levels in the Willoughby creek running dry were reported by conservation authority staff and maintaining flow during periods of drought is a concern	Section 7.2.4 Fish Habitat	Matrix Solutions Inc.	DFO has provided a Letter of Advice, dated June 23, 2021, indicating that in their opinion no HADD of fish habitat will occur provided the recommendations in the letter of advice are followed. See additional details in the Watercourse Characterization summary. DFO’s guidance and conditions were provided after the Summary tables were prepared and circulated. Nelson is happy to work through the tables with JART to ensure that all DFO conditions and mitigation measures are included in the AMP and that all threshold and trigger values are updated, if needed, based on DFO recommendations.	

	(Bronte Creek, Urban Creeks and Supplemental Monitoring conducted by Conservation Halton 2012).				
103.	The proposed settling pond outlet at the bank of the West Arm watercourse and associated longer term sump should be assessed in further detail so that the outlet does not impact the natural features present. Mitigation measures should be developed to limit impact, such as the use of a flow spreader to reduce bank erosion.	Page 76 Section 7.2.4. Fish Habitat	Conservation Halton	Tatham has completed a preliminary design for the outlet of the temporary settling pond/longer term sump in the south extension. As suggested by Conservation Halton, the proposed outlet consists of a stone core wetland pocket set back approximately 5 m from the average annual high-water mark of the West Arm of the West Branch. The wetland pocket will have a level spreader around the perimeter to promote dispersed discharge when flows exceed the storage/infiltration capacity of the structure. This will negate the need for any direct conveyance structure or channel that would directly impact the watercourse and riparian vegetation. The wetland pocket will consist of a 450-mm thick base layer of 100 to 300 mm riverstone. The voids in the riverstone will be filled with topsoil and planted with suitable native wetland vegetation species. The proposed design of the outfall prevents direct impacts on fish habitat in the watercourse as there is no requirement for any in-water work. Alterations to riparian vegetation between the wetland pocket and the watercourse will be minimized to the extent possible with activities of the contractor generally restricted to the landward side of the outfall. An erosion and sedimentation control plan shall be prepared and implemented throughout construction. All areas temporarily disturbed during installation of the outfall will be restored with suitable native vegetation species following construction. ESC measures will remain in place until the disturbed area around the outfall is sufficiently revegetated. Post-construction monitoring will be completed to verify that the outfall is performing as intended and that no unanticipated impacts are occurring as a result of operation. If impacts are observed during monitoring (e.g., unexpected erosion downstream from the outfall) remedial measures will be implemented.	
104.	Please confirm winter target numbers for baseflow upstream of Colling Road, as only spring, summer and fall are provided.	Page 77 Section 7.2.4. Fish Habitat	Conservation Halton	This will be addressed though the provisions of the AMP to ensure the pumping regime maintains base flow and seasonal flow of water.	
105.	The potential impact of a 3.0% reduction in groundwater in the creeks and wetlands as it relates to temperature changes has not been provided. Even a small reduction can alter the ecological function of these features and this should be assessed in the report. In addition, consider temperature changes from the proposed mitigation pond.	Page 80 Section 7.2.4. Fish Habitat	Conservation Halton	Given that groundwater discharge only occurs on a seasonal basis and that these wetlands and downstream creeks that are being referenced in this comment (East Arm of the West Branch of the Mount Nemo Tributary and the Unnamed Tributary of Lake Medad) are typically dry from late spring through	

				summer, which corresponds to the time period when resident fish communities are typically most sensitive to water temperature increases. Therefore, the potential effect of water temperature changes on fish is expected to be mitigated by the intermittent nature of the wetlands and watercourses.	
106.	Please discuss and quantify how the 4.0-6.0% reduction in runoff volume compares to a dry year and the potential impacts of this on the creeks and wetlands.	Page 80 Section 7.2.4. Fish Habitat	Conservation Halton	More details are provided in the attached Watercourse Characterization Summaries and will also be provided and discussed in the AMP.	
107.	There is a disagreement about the justification provided with respect to the connectivity of the area. While the proposed expansion lands are currently in a non-natural state, there are limited barriers to obstruct the movement of species across the landscape. The connectivity that these lands currently provide would be lost based on the proposal. The diversity and connectivity of the overall Mount Nemo Plateau should be considered to ensure that the proposal does not restrict wildlife movement.	Page 80 Section 7.2.4. Fish Habitat	Conservation Halton	As summarized in section 6.2.1, woodland D is relatively isolated and located on the golf course, adjacent to the existing quarry. While a portion of this woodland is native, the cultural woodland area is non-native, with an abundance of Black Locust, an undesirable tree species, and the FOD5/DIST area contains only a canopy layer, along with turf grass and paved golf cart paths in the ground layer (sub-canopy and understory vegetation are absent). There is high potential to enhance this woodland both in species diversity and composition. The proposed rehabilitation plans will create a system that is better connected and functional that what currently exists in the golf course and adjacent quarry. The proposed Extension Areas are sited within an active golf course and agricultural area. There is a Regional and Provincial NHS that does run north-south; however, the area of the proposed expansion does not appear to negatively affect the redundancy of these smaller branches of the RNHS. The major areas of the NHS run along the Medad Valley, which is west of the proposed West Extension, as well as along the Mount Nemo Plateau and Grindstone Creek Complex, located east of the proposed South Extension. The proposed Extension areas are located between these two RNHS branches and are not impeding or removing any of the features that make up these two branches; the Extension areas are well outside of these two large systems. Based on the Region's NHS mapping, there are some smaller systems that lie parallel to, and between, these two major systems; however, these smaller systems do not connect to the larger NHS, north of the Study Area. These smaller branches of the overall NHS do not provide connectivity to begin with, and therefore, the removal or disturbance of golf course features and their potential for enhancement and	

				future connectivity opportunities can only add to the limited contribution being made to the smaller NHS.	
108.	A reduced buffer to some Significant Woodlands is proposed, however justification for this reduction is not included. As these woodlands are also supporting other natural features and functions, and as the site can accommodate full 30.0 metre buffers, this reduction is not supported.	Page 82 Section 8. Niagara Escarpment Plan	Conservation Halton	In the West Extension, there will be a 30 m setback from the edge of the FOD7-4 to the proposed limit of extraction, as well as to the edge of the berm. In the South Extension, there will be a 30 m setback from the FOD7-4 to the edge of the berm.	
109.	As SWH is a Key Natural Heritage Feature, the vegetation protection zone should be 30.0 metres from these features. Please revise.	Page 82 Section 8. Niagara Escarpment Plan	Conservation Halton	In the West Extension, there will be a 30 m setback from the edge of the FOD7-4 to the proposed limit of extraction, as well as to the edge of the berm. In the South Extension, there will be a 30 m setback from the FOD7-4 to the edge of the berm.	
110.	The only mitigation proposed for the loss of a unit of Significant Wildlife Habitat (Woodland E) is compensation through the rehabilitation plan. As noted in Halton's EIS guidelines, section 3.7.2., "It is important to note that compensation for feature removal or anticipated negative impacts is not acceptable under the ROP." Thus, removal of this woodland would result in negative impacts to the Natural Heritage System. Avoidance is preferred over compensation. As noted previously, the function of Woodland E to provide linkage and other benefits to the Natural Heritage System should be further examined, particularly as this woodland is considered part of the Regional NHS and is in very close proximity to Woodland D. In Google imagery, the closest distance between Woodland D and Woodland E appears to be approximately 10.0-15.0 metres (i.e. it is not greater than the 20.0 metres considered to be the threshold for considering Woodland E separately), and so the function of Woodland E as a potential part of Woodland D should also be examined. The role of Woodland E in contributing to Eastern Wood-pewee and bat maternity roost habitat (for example in terms of numbers of nest sites, habitat area, foraging habitat, etc., as well as the potential importance of this area in the future when the connections to the north and south are removed) should also be considered in more detail. The rationale for avoidance of, rather than compensation for, impacts should be considered.	Section 9. Regional Official Plan	North-South Environmental Inc.	Wooded feature E is described in detail in Table 2 of the report. It is an area that is <0.5 ha made up of mid-age to mature canopy trees mostly of Sugar Maple. There is no subcanopy or understorey. The ground cover consists of maintained turf grass, Garlic Mustard and some Herb-Robert, all of which is mowed regularly. Paved golf cart paths also make up part of the ground cover in this small stand of trees, serving as an aesthetic feature for the golf course. It is small and isolated (<20 m from other treed areas). High bat activity may serve more of an indicator that this polygon is situated in the flight path of bats moving between the Medad Valley and the open water areas of the active quarry for foraging purposes.	
111.	Please expand the SWH section to include the rare vegetation community FOD7-4 identified in the Level 1 Report. Discussion on how will be protected and any additional mitigation measures should be provided in addition to the SWH included in this section.	Page 84 Section 9. Regional Official Plan	Conservation Halton	As noted in previous responses, the site plans will be revised to include a 30 m setback to this feature and include mitigation measures to protect and enhance this feature.	
112.	Cumulative impacts discussed in the report are limited. Recommend that this section be expanded upon to provide more detail and discussion on what the cumulative impacts of the proposed quarry might be. For example, the existing quarry began in the 1950s and has impacted the natural environment since then. If the existing quarry is continued to be used, rather than rehabilitated as originally planned, then this would result in longer, cumulative impacts on the area.	Page 86 Section 10. Regional Official Plan Guidelines – Aggregate Resources Reference Manual	Conservation Halton	See response to Comment 13.	
113.	This section notes (Paragraph 1) that: "despite that no direct or indirect impacts will occur to Jefferson Salamanders or their habitat, habitat creation and enhancement opportunities have been identified for this species." It is proposed to restore 4.0 hectares of agricultural land between the eastern woodland south of the quarry, where Jefferson Salamander has been noted breeding, to an adjacent woodland to the west, where Jefferson Salamander has not	Section 11.2. Jefferson Salamander Habitat Creation	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	

	been observed despite repeated surveys in several years, and despite apparently suitable habitat. The objective of the habitat creation is stated in paragraph 3 of this section: "This would enhance JESA habitat by providing increased coverage of summer refuge and overwintering habitat and improve connectivity between the two existing woodlands… The design of this restoration could also increase opportunity for JESA breeding by incorporating pit and mound construction techniques." Though it is not stated in the NETR, it is clearer in the Progressive and Final Rehabilitation and Monitoring Study that the proposed restoration is to address Section 110 of the Regional Official Plan, especially C: C) Priorities for restorations or enhancements to the Greenbelt and/or Regional Natural Heritage Systems through post-extraction rehabilitation shall be based on the following in descending order of priority: [i] restoration to the original features and functions on the areas directly affected by the extractive operations, [ii] enhancements to the Greenbelt and/or Regional Natural Heritage Systems by adding features and functions on the balance of the site, [iii] enhancements to the Greenbelt and/or Regional Natural Heritage Systems by adding features and functions in areas immediately surrounding the site, [iv] enhancements to that part of the Greenbelt and/or Regional Natural Heritage Systems in the general vicinity of the site, and [v] enhancements to other parts of the Greenbelt and/or Regional Natural Heritage Systems in Halton. D) Restorations or enhancements shall proceed immediately after extraction in a timely fashion.	and Enhancement Opportunities			
114.	Comments on the proposed restoration and enhancement are as follows: • This proposal is speculative, without even rudimentary detail to support feasibility. There is no certainty that created ponds would provide a sufficient hydroperiod and water quality for Jefferson Salamander to breed. There are no goals or objectives that drive the restoration, so no assurance that the restoration would create persistently suitable habitat for the long term.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	
115.	Comments on the proposed restoration and enhancement are as follows: • Jefferson Salamander has a high fidelity to its habitat, and is a notable habitat specialist. If Jefferson Salamanders are not present in the western woodland, there is no basis to speculate that they would use the restored habitat. The western woodland may not be suitable for Jefferson Salamander. There are many habitat needs that must be met for this species that have not been explored, such as the presence of breeding ponds with suitable hydro period and water quality, small mammal burrows to provide overwintering habitat, invertebrate prey populations, and downed woody debris to provide refuge for post-breeding adults and transforming juveniles.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	

116.	Comments on the proposed restoration and enhancement are as follows: • Salamander breeding and overwintering habitat is associated with mature woodlands, with their associated attributes of deep shade, leaf litter, high soil humidity, small mammal populations to provide burrows and abundant ground dwelling invertebrates to provide prey. It would take decades for the restored area to provide sufficient shade, humidity and hibernation sites to become suitable for Jefferson Salamander. If the quarry extensions had impacts on groundwater, the restoration site (even if it were feasible) would likely be too late to restore sufficient habitat to ensure Jefferson Salamander survival in this area.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	
117.	Comments on the proposed restoration and enhancement are as follows: • Jefferson Salamander movements are difficult to predict without movement studies. There is no evidence to show that salamanders would move in this western direction so that it could function as a linkage. More detailed studies of salamander movements and habitat needs should be conducted.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	
118.	Comments on the proposed restoration and enhancement are as follows: • The potential for creating an ecological sink should be considered. The western woodland and restoration site would be within 120.0 metres of the southern extension boundary, with the potential that these could be affected by the quarry.	Section 11.2	North-South Environmental Inc.	It is unclear what features are noted and what is being asked.	
119.	Comments on the proposed restoration and enhancement are as follows: • This proposal does not address the primary recommendation in the Jefferson Salamander Recovery Strategy (2018): The short-term recovery approaches should focus on the protection of existing populations of the Jefferson Salamander and Unisexual Ambystoma (Jefferson Salamander dependent population) by minimizing further loss or degradation of known habitat or potential recovery habitat. Recovery approaches should also focus on verifying, documenting, and monitoring the distribution and habitats used by extant, historic, and potential subpopulations. Developing and evaluating mitigation and restoration techniques, actively conducting research, and developing long-term management activities should also be prioritized to ensure the recommended recovery goal will be achieved.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	
120.	There is no evidence that this proposed restoration would enhance habitat for Jefferson Salamander. The restored area would likely function as a small patch of disturbed forest habitat. Sufficient baseline detail should be supplied to show that it is at least potentially feasible. Goals and objectives should be provided to guide the restoration. Even as a preliminary suggestion, the restoration should be proposed according to “SMART” principles: the restoration goals should be “specific, measurable, agreed-upon, realistic and timebound”.	Section 11.2	North-South Environmental Inc.	Restoration details and implementation will be determined with MECP and the Registration process.	
121.	Recommend including the smaller portion of wetland 13037 on the ELC map. It is currently not identified.	Figure 3b	Conservation Halton	This is included in the Wetland Characterization Summary Tables.	
122.	Please discuss why amphibian monitoring was not conducted in the SWS3-2a/b communities in the western expansion area and the SWS/MAM2-2 associated with the West Arm. Table 2 notes that surface water in SWS3-3b was usually present in the spring as well as July and September. Should suitable habitat be present, then recommend that amphibian monitoring occur.	Figure 4a and Table 2	Conservation Halton	There is no SWS3-2a/b; however, it is assumed that this comment is intended for SWD3-2a/b. Therefore, wetland 13200 (SWD3-2a) did not contain water, and therefore was not considered a suitable feature to survey for amphibian breeding. Wetland 13201 (SWD3-2b) did contain water and therefore amphibian call count stations ACC8 and ACC9 (Figure 4a) were surveyed in 2019.	

123.	Recommend that all of the hedgerows in the proposed extraction areas be assessed for potential bat habitat.	Figure 5a and Figure 5b	Conservation Halton	Section 5.2.9 notes that the 7E Criteria Schedule (MNR 2015) indicates that candidate bat maternity colony habitat is limited to FOD, FOM and SWD and SWM communities that contain a minimum density of >10 habitat trees with a dbh > 25 cm per hectare. Recent and on-going correspondence with MECP indicates that only FO and SW communities (no minimum density requirements) are potential roosting habitat. Therefore, hedgerows were not surveyed based on current provincial guidance at the time of study.	
124.	Please clarify why the FOD5-6 south of the proposed south extraction area was not assessed for bats. If suitable habitat is present, recommend that this assessment occur.	Figure 5b	Conservation Halton	This area is assumed candidate habitat for bat roosting habitat, and FOD5-6 is already protected based on the setback and mitigation measures shown on the site plans.	
125.	Seeps were identified by the MNRF PSW evaluation in wetland 13037. This SWH should be considered as candidate and additional surveys done to determine the presence of these seeps.	Table 19	Conservation Halton	See additional details in the Wetland Characterization Summaries. There will be no negative impacts to the ecological features and functions of this wetland.	
126.	Recommend that additional targeted surveys be undertaken to assess the potential for turtle habitat. It is noted that turtles have been known to use irrigation ponds and as there were limitations to being able to sample some of the deeper irrigation ponds, habitat may be present.	Table 19	Conservation Halton	A total of six turtle basking stations were established to survey five features within the Study Area, including the irrigation ponds (see Figure 4a from report). In addition, Blanding's Turtle survey effort was discussed with MECP and addressed in the MECP response letter after completing Blanding's Turtle surveys, as per MECP direction, in 2021. No Blanding's Turtle or its habitat were observed and are considered absent from the Study Area.	
127.	The table notes that monarchs were not observed during the insect surveys, however the CUM field sheets note four individuals on Sept 11 and 19. Recommend that host and feeding pollinating plant species be considered when developing restoration plans.	Table 19 and Field Sheets	Conservation Halton	Pollinator plant species are recognized as an important component to open areas, and therefore, as noted in the Site Plans, appropriate seed mixes will be applied following Conservation Halton guidelines.	
128.	The ELC field notes are not complete as soils were not competed. Please discuss how this may impact the classification of the vegetation communities.	Field Sheets	Conservation Halton	The ELC communities range from dry-fresh to fresh-moist, to wetland – showing community type variability was captured. Soil moisture was based on species composition, which effectively informed the accurate classification of vegetation communities. Outside of hydrology, influences associated with soil texture (e.g., sand vs. clay) or influences associated with parent material (e.g., depth to sedimentary bedrock) would also be reflected in the species composition. While soil data can be useful to support above-ground observations, it is not anticipated that	

				the absence of this data will have a significant influence on overall classification.	

Attachment 1 – Wetland Characterization

Wetland Characterization Summaries Proposed Burlington Quarry Extension, Nelson Aggregates Co.

Prepared for:

NELSON AGGREGATES

March 2021
Version 1.0

Earthfx Incorporated SAVANTA A GEI Company TATHAM ENGINEERING

March 2021

Nelson Aggregate Co.
2433 No. 2 Sideroad
Burlington, Ontario
L7P 0G8

Attention: Mr. Quinn Moyer, President

RE: Burlington Quarry Wetland Characterization Summaries

Dear Mr. Moyer,

Earthfx Incorporated, Savanta Inc. and Tatham Engineering Limited are pleased to provide Nelson Aggregates Co. with the enclosed wetland characterization summaries in support of the Proposed Burlington Quarry Extension. The wetland characterization summaries have been prepared in response to comments received by the Ministry of Natural Resources and Forestry.

The wetland characterization summaries have been prepared to summarize the wetland information provided in the Level 1 and Level 2 Hydrogeological Impact Assessment, Level 1 and Level 2 Natural Environment Technical Report, and Surface Water Assessment. The hope is the wetland characterization summaries will aid in the review of the reports and expedite the review process.

Regards,

Dirk Kassenaar, M.Sc., P.Eng.
President, Eartfx Incorporated

Shannon Catton, MSc.
Branch Manager & Senior Ecologist, Savanta Inc.

Daniel Twigger, B.Sc.Eng., P.Eng.
Senior Engineer, Group Leader, Tatham Engineering Limited

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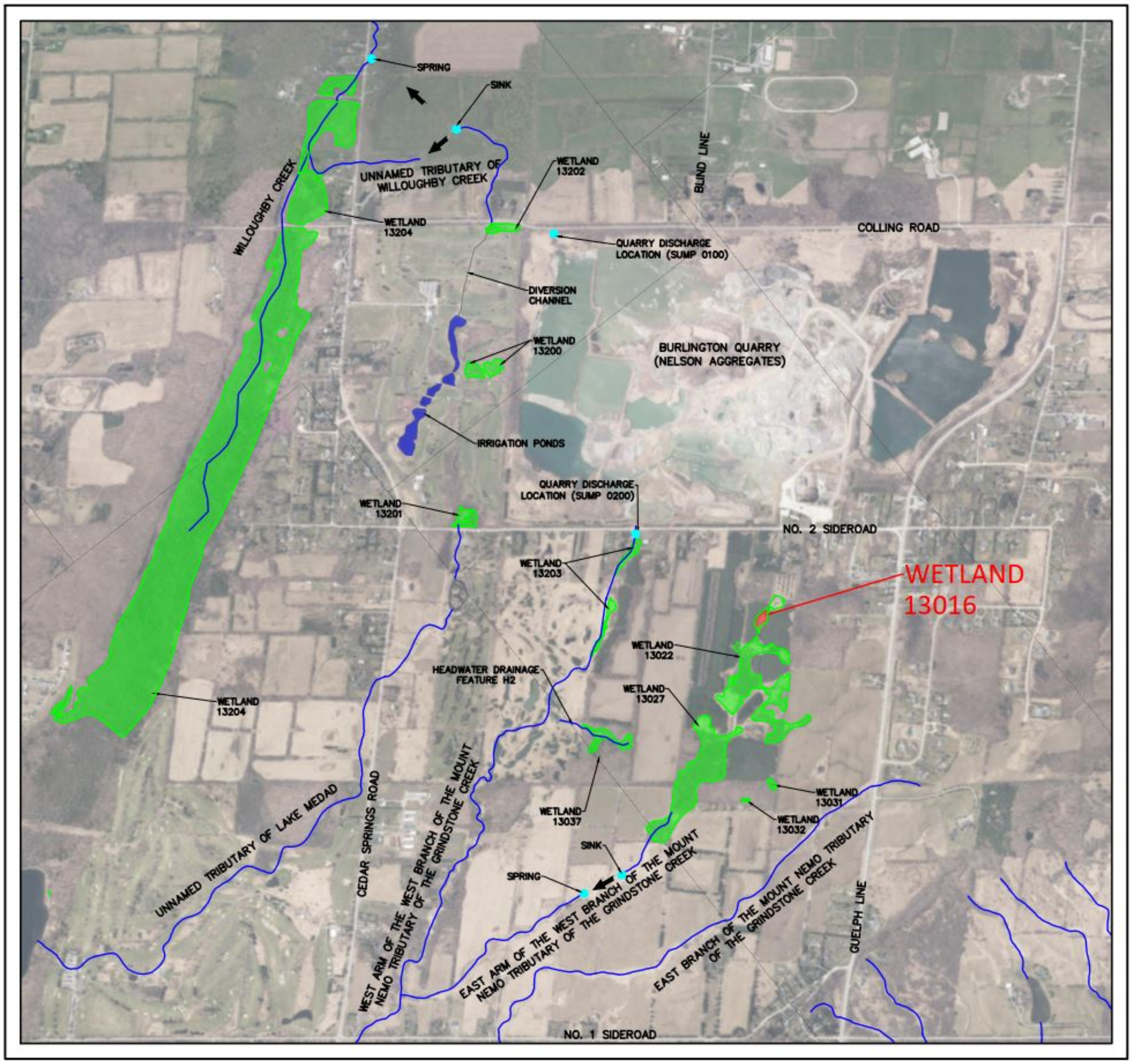
WETLAND 13016



Legend

- 120 m Adjacent Lands
- Subject Lands
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Mini Piezometer (Golder)

ELC Legend

CUM1, Mineral Cultural Meadow
CUP3-2, White Pine Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUT1-1, Sumac Cultural Thicket
CUW1, Mineral Cultural Woodland
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
RES, Residential
SWD2-2, Green Ash Mineral Deciduous Swamp

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 1
Wetland Characterization

Wetland 13016 - South Extension

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N

GEI Consultants
Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_mapbook.mxd Date Saved: January 11, 2021

Wetland 13016

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF - 67567121 (OGF ID 67657140) Earthfx - 11 Tatham - 13016 Savanta - 13016 Golder (Background) - 13016			
Wetland Area (ha):	LIO/MNRF - 0.28 Savanta - 0.22			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	1.48		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S118		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream wetland; cascading)			
Condition:	Natural			
Bathymetry:	A bathymetry survey of Wetland 13016 was completed by Tatham Engineering Limited and incorporated into the integrated model (see Earthfx Section 18.3, p.381). Wetland lakes were assigned to Layer 1 of the integrated model by adjusting the base of Layer 1 to correspond with the interpolated bottom elevation. Care was taken to ensure that the lowest elevation observed in the wetland was honored in the assigned elevations.	Figure 1	HHIAR (Earthfx, April 2020)	18.3 (page 381)
Outlet:	Downstream wetland (MNRF - OGF ID 67567143; Earthfx - 12; Tatham - 13018; Savanta - 13022; Golder {Background} - 13018)			
Hydroperiod:	Spring hydroperiod (date wetland dries out) - May 16th - July 22nd Fall hydroperiod (start of hydroperiod) - November 15th - February 18th	Graph 1	SWA (Tatham, April 2020)	2.2.4, 3 and Appendix F
Surface Water Monitoring:	ID: SW13A (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 591177.323, Northing 4805244.509	Graph 1	SWA (Tatham, April 2020)	2.2.4, 3 and Appendix F

<table>
<tr><th rowspan="2">Natural Heritage and Habitat Features</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Wetland Name & Provincial Significance Evaluation:</td><td>Grindstone Creek Headwaters Wetland Complex – Provincially Significant</td><td></td><td>NETR (Savanta, April 2020)</td><td>6.1.2</td></tr>
<tr><td>ELC Unit(s):</td><td>Reed-canary Grass Mineral Meadow Marsh: MAM2-2</td><td></td><td></td><td></td></tr>
<tr><td>Regulated Habitat (MECP):</td><td>Yes – Jefferson Salamander (not field verified during 2019 field program; regulated based on historical data)
Hydroperiod sensitive species; water presence necessary until end of June</td><td></td><td>NETR (Savanta, April 2020)</td><td>6.1.2</td></tr>
<tr><td>Significant Wildlife Habitat:</td><td>Unknown – outside of 120 m adjacent lands</td><td></td><td></td><td></td></tr>
<tr><td>Fish Habitat:</td><td>None</td><td></td><td></td><td></td></tr>
<tr><td>Habitat of Endangered and Threatened Species:</td><td>Unknown – outside of 120 m adjacent lands</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2" colspan="6">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td colspan="6">Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td colspan="6">Integrated Model (Earthfx) – The hydraulic conductivity for Golder MP19 was 1x10^{-9} m/s. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2x10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6x10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.
Wetland Water Balance (Tatham) – 8.2x10^{-9} m/s.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td colspan="6">The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland does not receive significant groundwater inflow and is isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td>Shallow Groundwater (Mini-piezometer) Monitoring:</td><td colspan="6">ID: SW13B (Tatham)
Installation Date: October 23, 2018
Data Collection: Continuous water level and temperature and manual monthly water level measurements
Coordinates of Monitoring Station: Easting 591177.323, Northing 4805244.509</td><td>Graph 2</td><td>SWA (Tatham, April 2020)</td><td>2.3 and Appendix G</td></tr>
<tr><td rowspan="3">Background Shallow Groundwater (Mini-piezometer) Monitoring:</td><td>Mini-piezometer ID</td><td>Ground Elevation</td><td>Bottom Elevation</td><td>Average WL</td><td>Logger</td><td>Manual Meas.</td><td rowspan="3">Graph 3</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Golder MP19</td><td>278.56</td><td>277.36</td><td>276.90</td><td>-</td><td>2007 - 2013</td></tr>
<tr><td>Golder MP20</td><td>278.36</td><td>277.16</td><td>276.86</td><td>-</td><td>2007 - 2013</td></tr>
<tr><td rowspan="3">Groundwater Monitoring (Monitoring Wells):</td><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td><td rowspan="3">Graph 3</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>OW03-31A</td><td>122 (NE)</td><td>Bedrock</td><td>278.5</td><td>268.6 - 263.2</td><td>275.3</td></tr>
<tr><td>OW03-31B</td><td>122 (NE)</td><td>Bedrock</td><td>279.7</td><td>276.2 - 270.8</td><td>274.1</td></tr>
<tr><td rowspan="3">Water Budget Results:</td><td colspan="6">A detailed average water budget, as simulated by the integrated model, was not presented in the Main report but is provided in Figure 2a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13016 (Earthfx Wetland 11) for baseline conditions is discussed in Section 7 of the main report.</td><td rowspan="3">Figure 2a</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Wetland 13016</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td colspan="3"></td></tr>
<tr><td>Baseline (Existing)</td><td>3.97</td><td>0.00</td><td colspan="3"></td></tr>
</table>

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Integrated Model Calibration:	Two mini-piezometers provide multiple years of monitoring in the soil zone and weathered Halton Till materials. These monitors correspond to the PRMS soil zone and upper-most part of Layer 1 of the GSFLOW model. A comparison of the mini-piezometer data to the simulated soil moisture conditions demonstrates that the model is closely matching both the soil moisture and hydroperiod of the shallow subsurface at this wetland.	Graphs 4 & 5		
	Earthfx Figure 19.41 (p.442) in the Main Report shows a hydrograph for SW13A along with simulated shallow water levels. The figure is reproduced in Graph 6. The total range in observed water level fluctuation is about 70 cm. A brief discussion of the Wetland 13016 (Earthfx Wetland 11) is contained in Appendix E, Section 19.6 (p. 441).	Graph 6	HHIAR (Earthfx, April 2020)	441 - 442

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is not provided in the Main report. The water budget results for Scenario P12 are reproduced in Figure 2b. Results for nearby wetlands are provided in the Main Report. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13016 (Earthfx Wetland 11) for each scenario are discussed in Section 8 of the main report.	Figure 2b	HHIAR (Earthfx, April 2020)	191 - 303
Change on Soil Moisture Conditions:	The Water Budget figures indicate that there is no groundwater seepage entering the wetland under baseline conditions, so there will be no change under P12 conditions.			
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13016	GW Outflow (%)	GW Inflow (%)	∆ in Outflow (%)	∆ in Inflow (%)
Baseline (Existing)	3.97	0.00	-	-
Operations Ph 1 & 2	3.90	0.00	-0.07	0.00

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

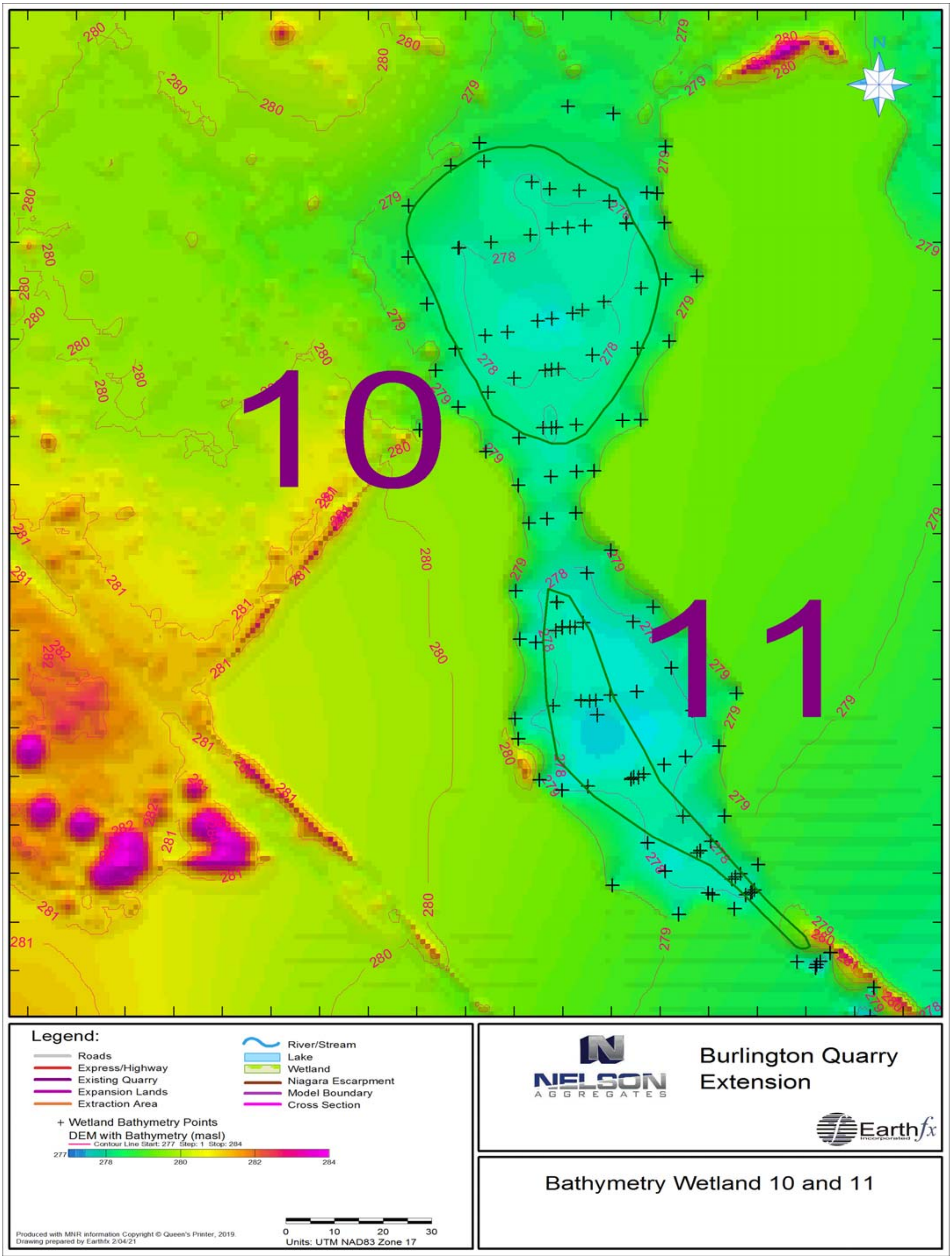
Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is not provided in the Main report. The water budget results for Scenario P3456 are reproduced in Figure 2c. Results for nearby wetlands are provided in the Main Report. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13016 (Earthfx Wetland 11) for each scenario are discussed in Section 8 of the main report.	Figure 2c	HHIAR (Earthfx, April 2020)	191 - 303
Change on Soil Moisture Conditions:	The Water Budget figures indicate that there is no groundwater seepage entering the wetland under baseline conditions, so there will be no change under P3456 conditions.			
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13016	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	3.97	0.00	-	-
Operations Ph 3 - 6	4.00	0.00	0.03	0.00

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

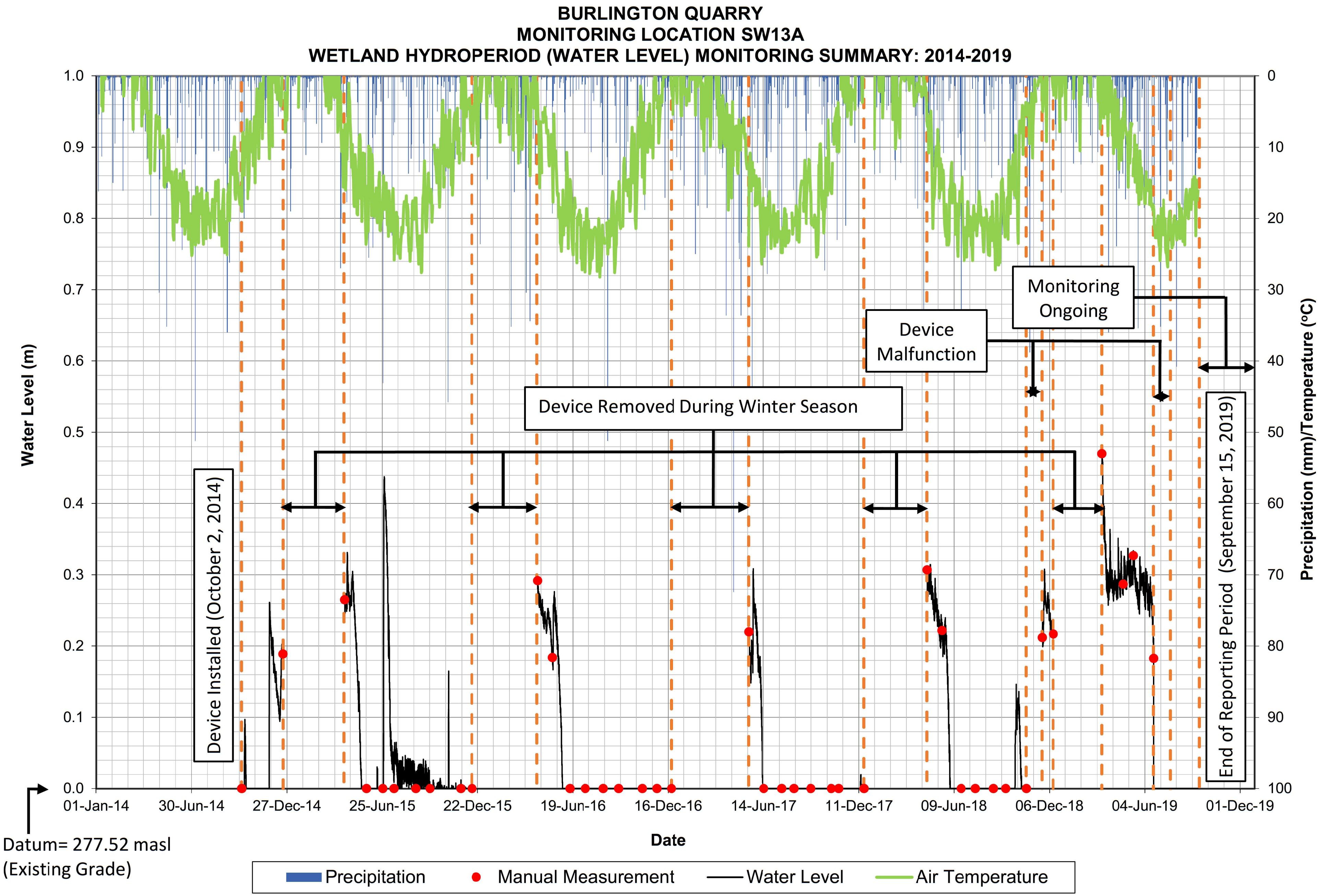
<table>
<tr><th rowspan="2">Impact Assessment (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1 & Drawing DP-3</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget as simulated by the integrated model is not provided in the Main report. The water budget results for Scenarios RHB1 and RHB2 are reproduced in Figures 2d and 2e. Results for nearby wetlands are provided in the Main Report. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13016 (Earthfx Wetland 11) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13016</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>3.97</td><td>0.00</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>4.15</td><td>0.00</td><td>0.18</td><td>0.00</td></tr>
<tr><td>Rehab Scenario 2</td><td>3.47</td><td>0.00</td><td>-0.05</td><td>0.00</td></tr>
</table></td><td>Figure 2d and 2e</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Change on Soil Moisture Conditions:</td><td>The Water Budget figures indicate that there is no groundwater seepage entering the wetland under baseline conditions, so there will be no change under Rehab Scenario 1 and 2 conditions.</td><td></td><td></td><td></td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

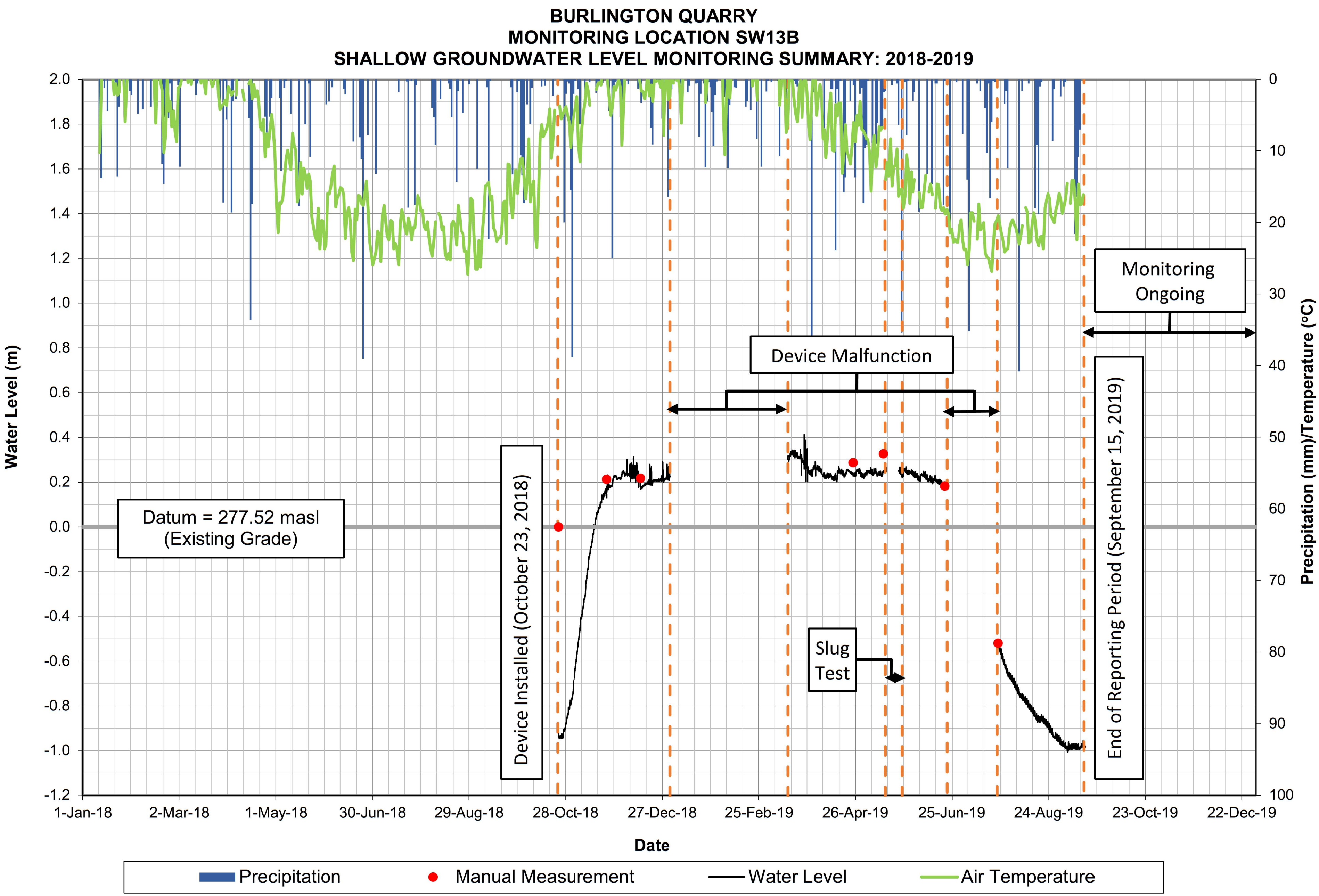


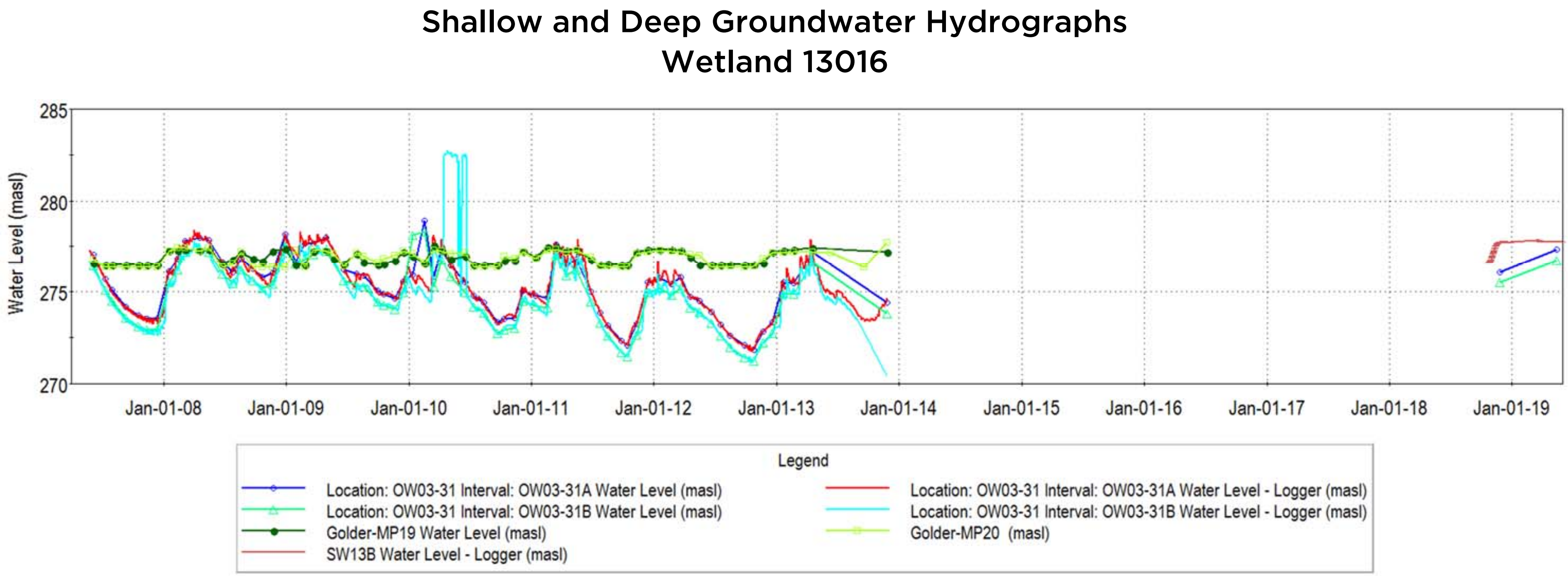
10
11
Legend:
Roads
Express/Highway
Existing Quarry
Expansion Lands
Extraction Area
River/Stream
Lake
Wetland
Niagara Escarpment
Model Boundary
Cross Section
+ Wetland Bathymetry Points
DEM with Bathymetry (masl)
Contour Line Start: 277 Step: 1 Stop: 284
277
278
280
282
284
NELSON AGGREGATES
Burlington Quarry Extension
Earthfx Incorporated
Bathymetry Wetland 10 and 11
Produced with MNR information Copyright © Queen's Printer, 2019.
Drawing prepared by Earthfx 2/04/21
0 10 20 30
Units: UTM NAD83 Zone 17

WETLAND 13016 - GRAPH 1



WETLAND 13016 - GRAPH 2




Shallow and Deep Groundwater Hydrographs
Wetland 13016
Water Level (masl)
285
280
275
270
Jan-01-08
Jan-01-09
Jan-01-10
Jan-01-11
Jan-01-12
Jan-01-13
Jan-01-14
Jan-01-15
Jan-01-16
Jan-01-17
Jan-01-18
Jan-01-19
Legend
Location: OW03-31 Interval: OW03-31A Water Level (masl)
Location: OW03-31 Interval: OW03-31B Water Level (masl)
Golder-MP19 Water Level (masl)
SW13B Water Level - Logger (masl)
Location: OW03-31 Interval: OW03-31A Water Level - Logger (masl)
Location: OW03-31 Interval: OW03-31B Water Level - Logger (masl)
Golder-MP20 (masl)

WETLAND 13016

FIGURE 2A

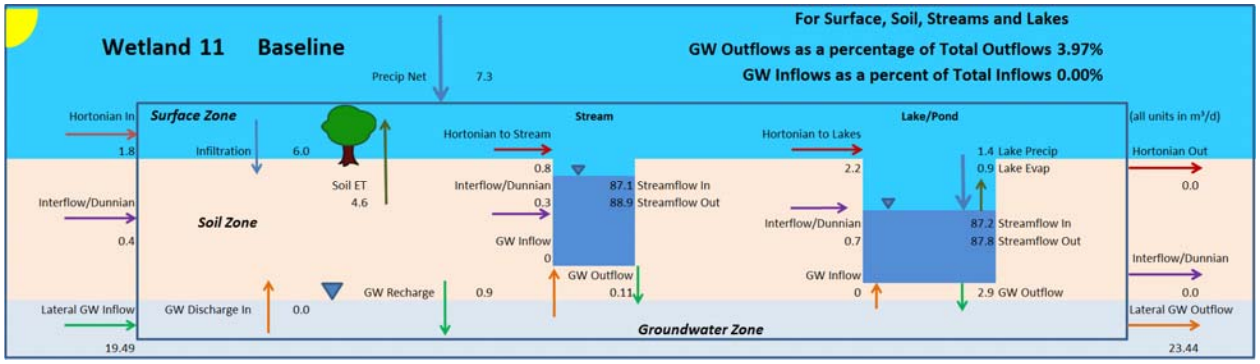


FIGURE 2B

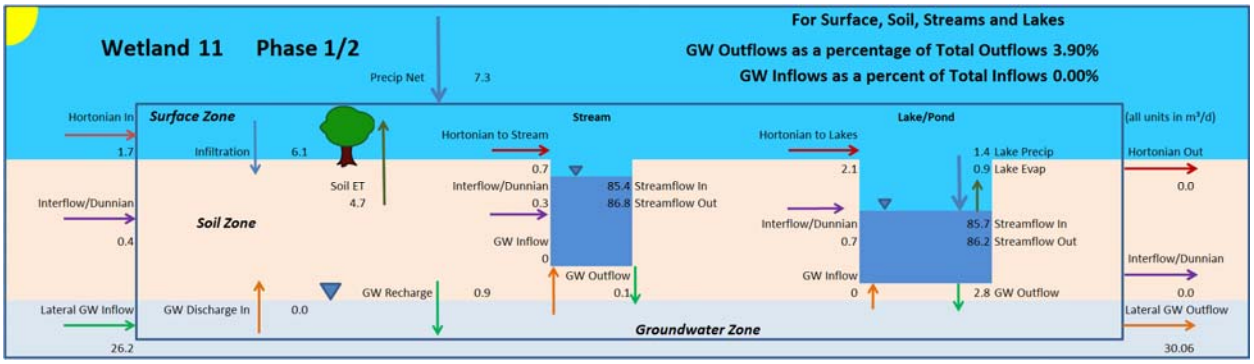


FIGURE 2C

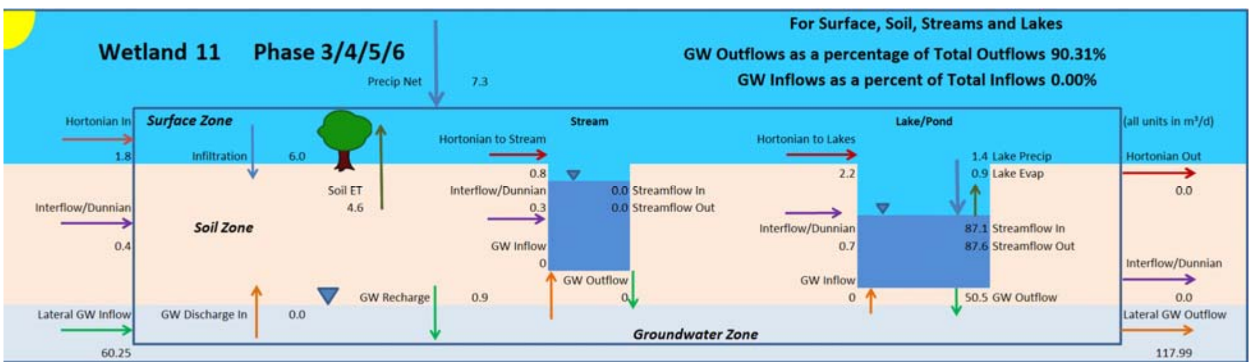


FIGURE 2D

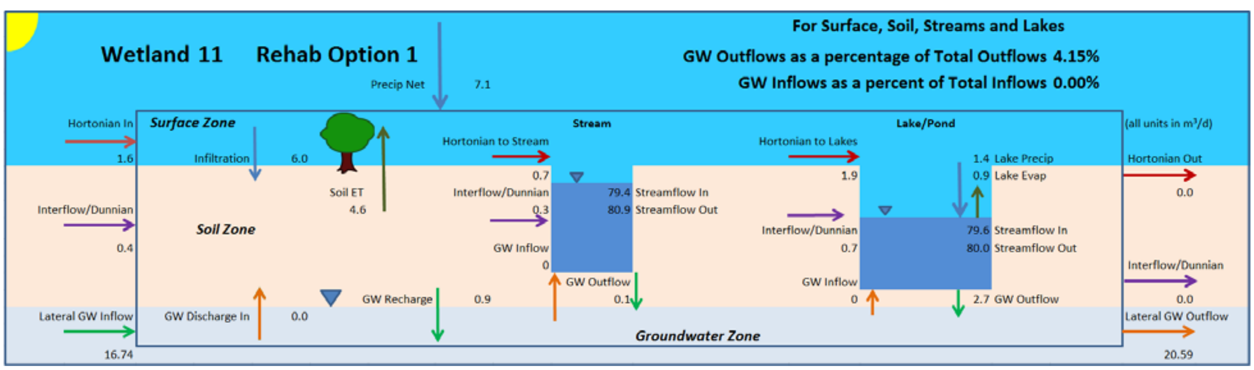
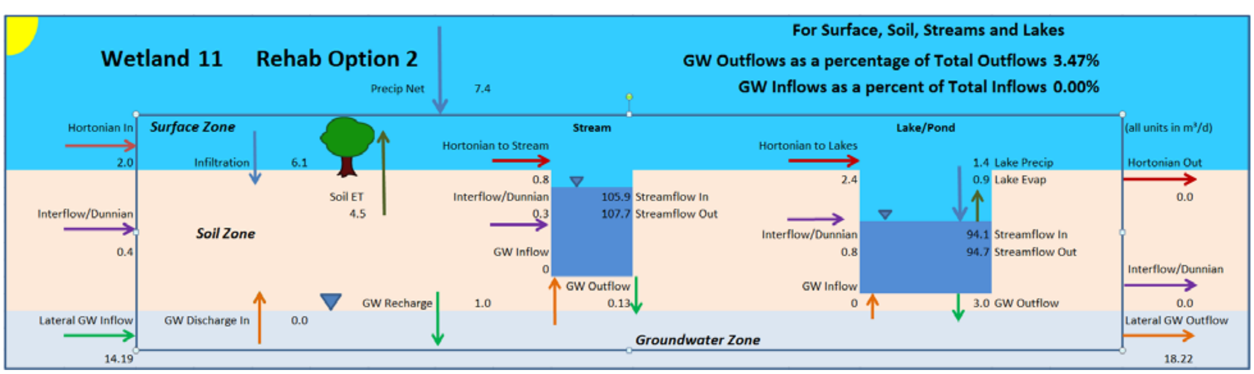
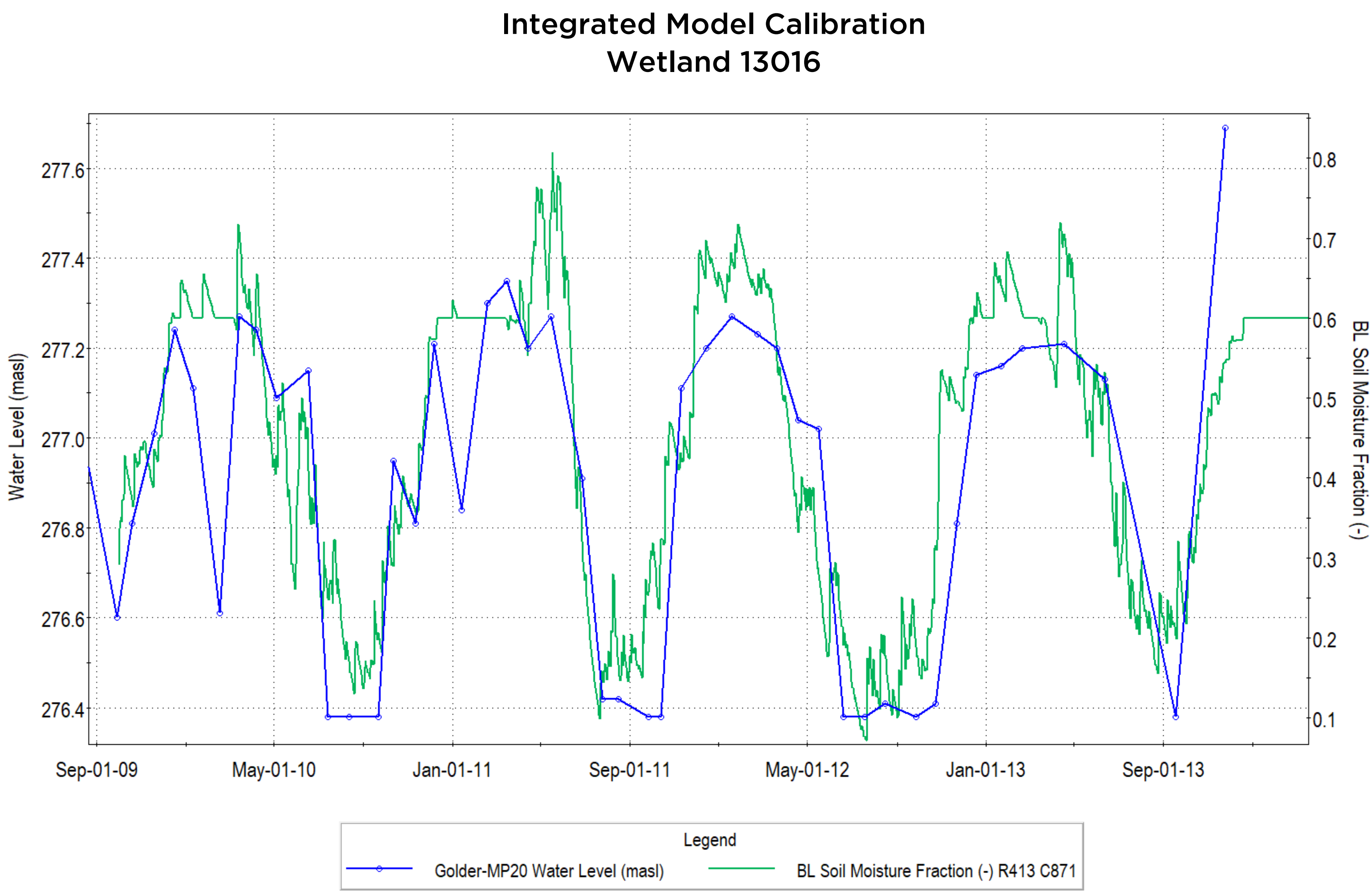


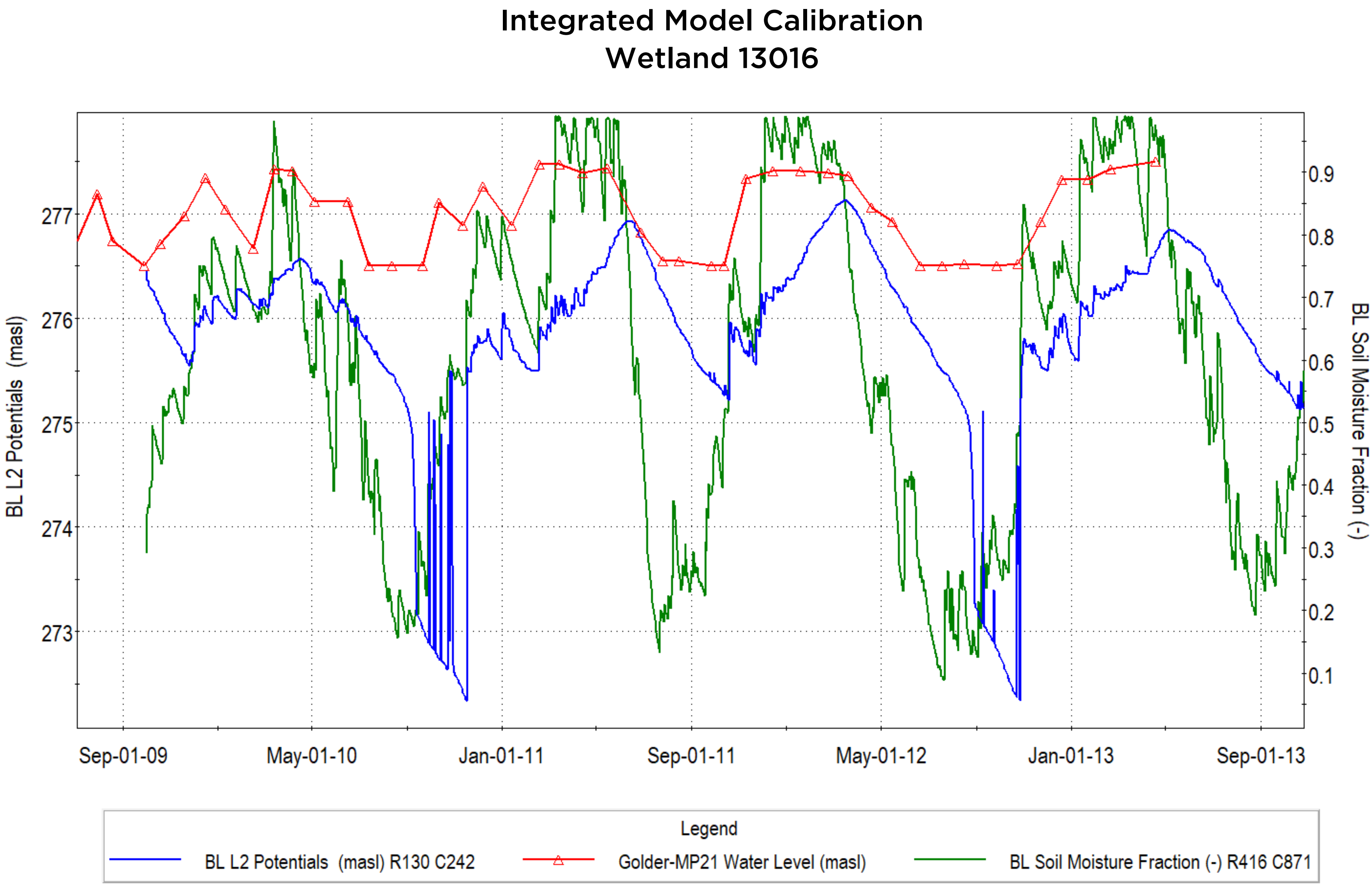
FIGURE 2E

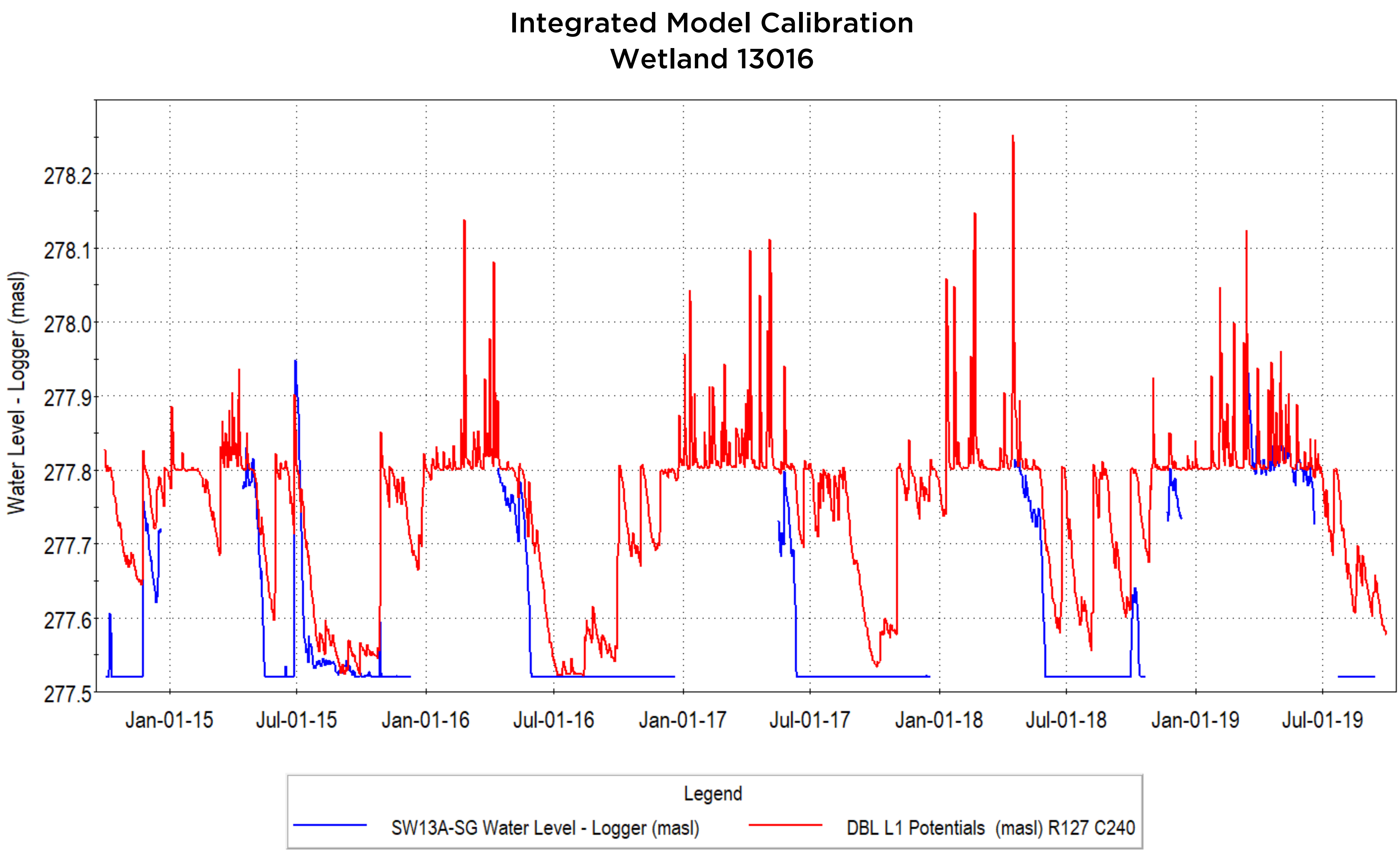


WETLAND 13016 - GRAPH 4

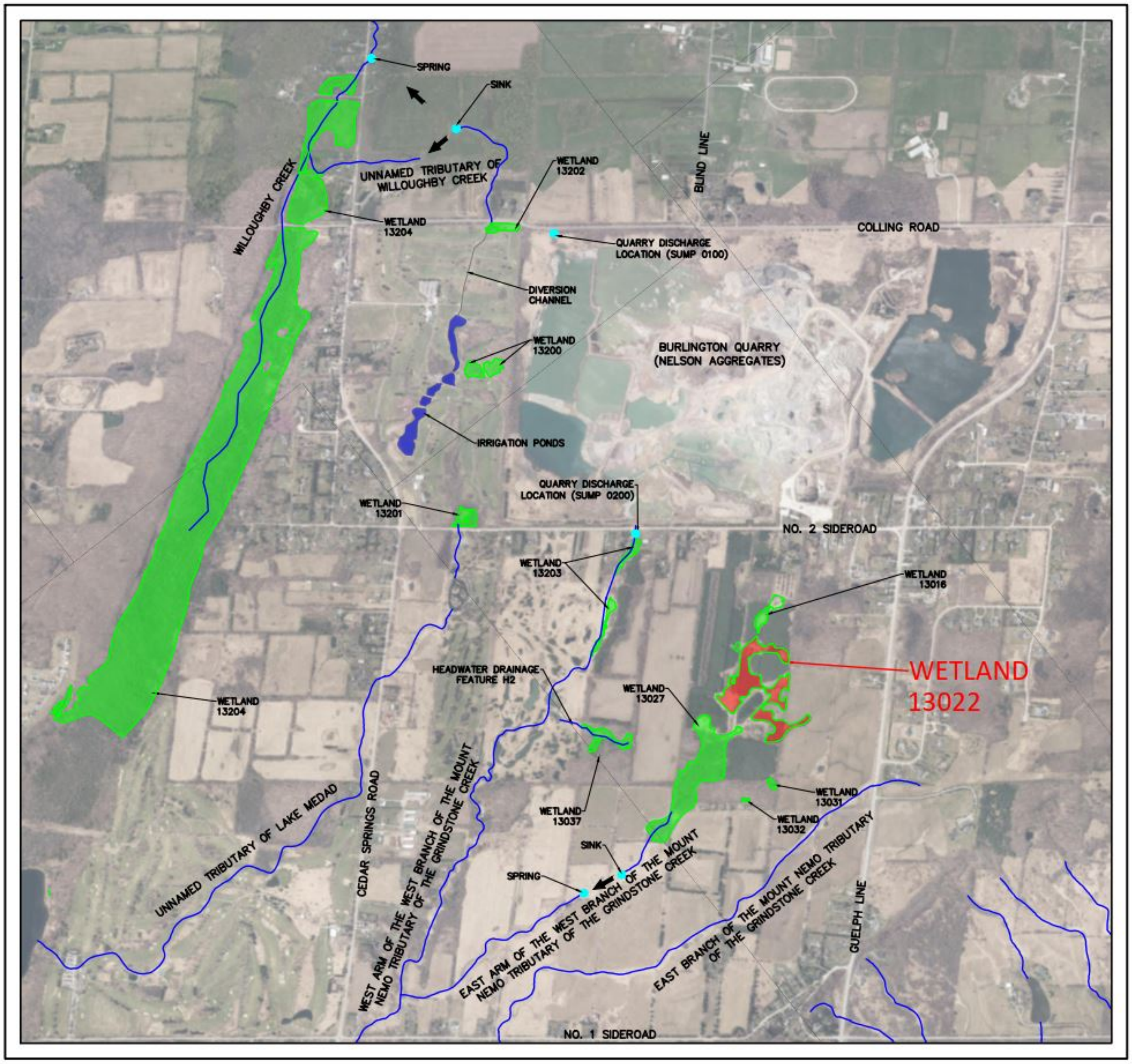


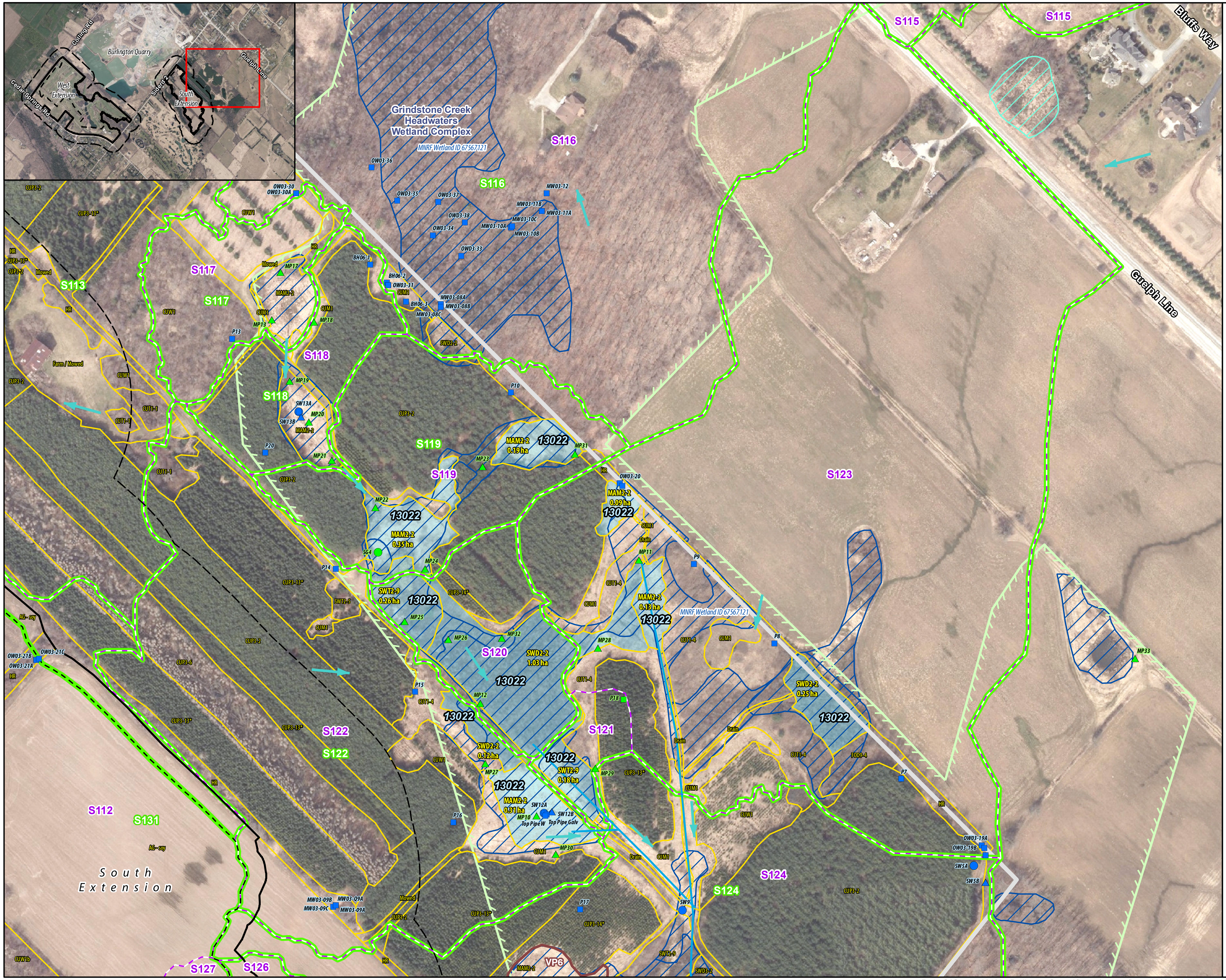
WETLAND 13016 - GRAPH 5




Integrated Model Calibration
Wetland 13016
Water Level - Logger (masl)
278.2
278.1
278.0
277.9
277.8
277.7
277.6
277.5
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
SW13A-SG Water Level - Logger (masl)
DBL L1 Potentials (masl) R127 C240

WETLAND 13022





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- Wetland - Not Evaluated per OWES (MNRF/LIO, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3-2, White Pine Coniferous Plantation
CUP3-6, European Larch Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1-1, Sumac Cultural Thicket
CUT1-4, Gray Dogwood Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD9-4, Fresh – Moist Shagbark Hickory Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
RES, Residential
SWD2-2, Green Ash Mineral Deciduous Swamp
SWD3-2, Silver Maple Mineral Deciduous Swamp
SWT2-5, Red-osier Dogwood Mineral Thicket Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 2
Wetland Characterization
Wetland 13022 - South Extension

0 50 m
1:3,000
N

GEI Consultants
Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_mapbook.mxd Date S uary 11, 2021

Wetland 13022

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – 67567121 (OGF ID 67567134, 67567144, 67567123, 67567137, 67567136, 67567146, 67567133, 67567146, 67567151) Earthfx – 12, 13, 14, 15, 16 Tatham – 13017, 13018, 13019, 13020, 13021, 13022, 13023, 13029, 13030, 13051 Savanta – 13022 Golder (Background) - 13017, 13018, 13019, 13020, 13021, 13022, 13023, 13029, 13030, 13051			
Wetland Area (ha):	LIO/MNRF - 4.45 Savanta - 2.91			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	30.45		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S119, S120, S121, S122, S123		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream wetland; cascading)			
Condition:	Natural			
Bathymetry:	A bathymetry survey of Wetland 13022 was completed by Tatham Engineering Limited and incorporated into the integrated model (see Earthfx Section 18.3, p.381). Wetland lakes were assigned to Layer 1 of the integrated model by adjusting the base of Layer 1 to correspond with the interpolated bottom elevation. Care was taken to ensure that the lowest elevation observed in the wetland was honored in the assigned elevations.	Figure 1	HHIAR (Earthfx, April 2020)	18.3 (page 381)
Outlet:	Downstream wetland (MNRF – OGF ID 67567149; Earthfx – 17, Tatham – 13049; Savanta – 13027; Golder {Background} – 13049)			
Hydroperiod:	Spring Hydroperiod (date wetland dries out) – March 20th – July 5th Fall Hydroperiod (start of hydroperiod) – October 8th – January 25th	Graph 1	SWA (Tatham, April 2020)	2.2.3, 3 and Appendix F
Surface Water Monitoring:	ID: SW12A (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 591126.758, Northing 4805392.503	Graph 1	SWA (Tatham, April 2020)	2.2.3, 3 and Appendix F

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Grindstone Creek Headwaters Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Reed-canary Grass Mineral Meadow Marsh: MAM2-2 Gray Dogwood Mineral Thicket Swamp: SWT2-9 Green Ash Mineral Deciduous Swamp: SWD2-2		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	Yes – Jefferson Salamander (not field verified during 2019 field program; regulated based on historical data) Hydroperiod sensitive species; water presence necessary until end of June		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	Unknown – outside of 120 m adjacent lands			
Fish Habitat:	Indirect		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	Unknown – outside of 120 m adjacent lands			

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2" colspan="6">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td colspan="6">Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td colspan="6">Integrated Model (Earthfx) - The hydraulic conductivity for Golder MP10 was $9x10^{-10}$ m/s. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.
Wetland Water Balance (Tatham) – $3.8x10^{-9}$ m/s.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td colspan="6">The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. None of the wetlands receive significant groundwater inflow, and are thus isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td>Shallow Groundwater (Mini-piezometer) Monitoring:</td><td colspan="6">ID: SW12B (Tatham)
Installation Date: October 23, 2018
Data Collection: Continuous water level and temperature and manual monthly water level measurements
Coordinates of Monitoring Station: Easting 591126.758, Northing 4805392.503</td><td>Graph 2</td><td>SWA (Tatham, April 2020)</td><td>2.3 and Appendix G</td></tr>
<tr><td rowspan="16">Background Shallow Groundwater (Mini-piezometer) Monitoring:</td><td>Mini-piezometer ID</td><td>Ground Elevation</td><td>Bottom Elevation</td><td>Average WL</td><td>Logger</td><td>Manual Meas.</td><td rowspan="16">Graph 3 & 4</td><td rowspan="16"></td><td rowspan="16"></td></tr>
<tr><td>Golder MP10</td><td>278.17</td><td>276.97</td><td>275.13</td><td>2006-2013</td><td>2006-2013</td></tr>
<tr><td>Golder MP11</td><td>279.5</td><td>278.3</td><td>276.53</td><td>2007-2013</td><td>2007-2013</td></tr>
<tr><td>Golder MP12</td><td>278.07</td><td>276.87</td><td>275.29</td><td>2006-2013</td><td>2006-2013</td></tr>
<tr><td>Golder MP15</td><td>278.76</td><td>277.9</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Golder MP22</td><td>278.41</td><td>277.21</td><td>276.08</td><td>-</td><td>2012-2013</td></tr>
<tr><td>Golder MP23</td><td>280.17</td><td>278.97</td><td>277.26</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP24</td><td>279.69</td><td>278.49</td><td>275.78</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP25</td><td>278.35</td><td>277.15</td><td>275.6</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP26</td><td>278.22</td><td>277.02</td><td>275.57</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP27</td><td>278.61</td><td>277.41</td><td>275.23</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP28</td><td>279.32</td><td>278.12</td><td>276.57</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP29</td><td>277.66</td><td>276.46</td><td>276.23</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP 30</td><td>279.12</td><td>277.92</td><td>275.31</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP 31</td><td>280.63</td><td>279.43</td><td>277.26</td><td>-</td><td>2007-2013</td></tr>
<tr><td>Golder MP 32</td><td>276.6</td><td>275.53</td><td>275.99</td><td>-</td><td>2007-2013</td></tr>
<tr><td rowspan="7">Groundwater Monitoring (Monitoring Wells):</td><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td><td rowspan="7">Graphs 5 & 6</td><td rowspan="7"></td><td rowspan="7"></td></tr>
<tr><td>MW03-09A</td><td>180 (WSW)</td><td>Bedrock</td><td>278.5</td><td>268.6 - 263.2</td><td>276.29</td></tr>
<tr><td>MW03-09B</td><td>180 (WSW)</td><td>Bedrock</td><td>279.7</td><td>276.2 - 270.8</td><td>276.68</td></tr>
<tr><td>MW03-09C</td><td>180 (WSW)</td><td>Overburden</td><td>279.7</td><td>276.2 - 270.8</td><td>277.60</td></tr>
<tr><td>OW03-20A</td><td>266 (NNW)</td><td>Overburden</td><td>277.68</td><td>259.0 - 252.2</td><td>277.03</td></tr>
<tr><td>OW03-20B</td><td>266 (NNW)</td><td>Overburden</td><td>277.69</td><td>275.2 - 268.2</td><td>276.90</td></tr>
<tr><td>OW03-20C</td><td>266 (NNW)</td><td>Overburden</td><td>277.66</td><td>275.5 - 273.9</td><td>276.74</td></tr>
<tr><td rowspan="3">Water Budget Results:</td><td colspan="6">A detailed average water budget for Wetland 13022 (Earthfx Wetland 16), as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.24, p. 186). The baseline water budget is reproduced in Figure 1a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13022 (Earthfx Wetland 16) for baseline conditions are discussed in Section 7 of the main report. Wetland budgets for Wetlands 12 to 15 are also provided.</td><td rowspan="3">Figure 2a</td><td rowspan="3">HHIAR (Earthfx, April 2020)</td><td rowspan="3">186</td></tr>
<tr><td>Wetland 13022</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>Baseline (Existing)</td><td>1.25</td><td>0.34</td></tr>
</table>

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Integrated Model Calibration:	Six mini-piezometers in the vicinity of this wetland provide multiple years of monitoring in the soil zone and weathered Halton Till materials. These monitors correspond to the PRMS soil zone and upper-most part of Layer 1 of the GSFLOW model. A comparison of the mini-piezometer data to the simulated soil moisture conditions demonstrates that the model is closely matching both the soil moisture and hydroperiod of the shallow subsurface at this wetland. Wetland 16 is not discussed in the Main Report. Other nearby wetlands are discussed in Appendix E, Section 19.6.	Graphs 7, 8, 9, 10, 11 & 12		

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget for Wetland 13022 (Earthfx Wetland 16), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.24, p. 186); Scenario P12 (Figure 8.31, p. 221); P3456 (Figure 8.63, p. 248); RHB1 (Figure 8.99, p. 277), and RHB2 (Figure 8.126, p. 299). The water budget results for Scenario P12 are reproduced in Figure 2b. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13022 (Earthfx Wetland 16) for each scenario are discussed in Section 8 of the main report.	Figure 2b	HHIAR (Earthfx, April 2020)	191 - 303

Wetland 13022	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	1.25	0.34	-	-
Operations Ph 1 & 2	1.31	0.00	0.06	-0.34

Change on Soil Moisture Conditions:	The soil moisture and surface discharge patterns in Wetland 13 are shown in Graph 13, and pond leakage is shown in Graph 14 (Note the scale range is very small). The effects of development can be illustrated by comparing the average soil moisture in Wetland 13 under Baseline and P12 development conditions. Graph 13 shows average daily soil moisture for Baseline conditions as a blue line. The soil moisture under P12 development is shown in red, and it overlies (covers) the Baseline for much of the time period. Under P12 development, soil moisture is essentially identical in the winter and spring, but slightly dryer in the summer and fall during a wet year. Wetland 13 lake seepage (Graph 14) under Baseline (Blue) and P12 conditions (Red) are shown in Graph 13. Under Baseline conditions, the ponds leak water to the groundwater system for most of the year, and only receive upwelling (negative leakage or seepage) for short periods of the wetter years when the water table is higher (generally in late spring). Under P12 conditions (red line), the ponds leak water to the groundwater system at varying rates throughout the year; generally higher in the spring and declining through the summer.	Graphs 13 & 14		
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget for Wetland 13022 (Earthfx Wetland 16), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.24, p. 186); Scenario P12 (Figure 8.31, p. 221); P3456 (Figure 8.63, p. 248); RHB1 (Figure 8.99, p. 277), and RHB2 (Figure 8.126, p. 299). The water budget results for Scenario P3456 are reproduced in Figure 2c. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13022 (Earthfx Wetland 16) for each scenario are discussed in Section 8 of the main report.	Figure 2c	HHIAR (Earthfx, April 2020)	191 - 303

Wetland 13022	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	1.25	0.34	-	-
Operations Ph 3 - 6	1.34	0.00	0.09	-0.34

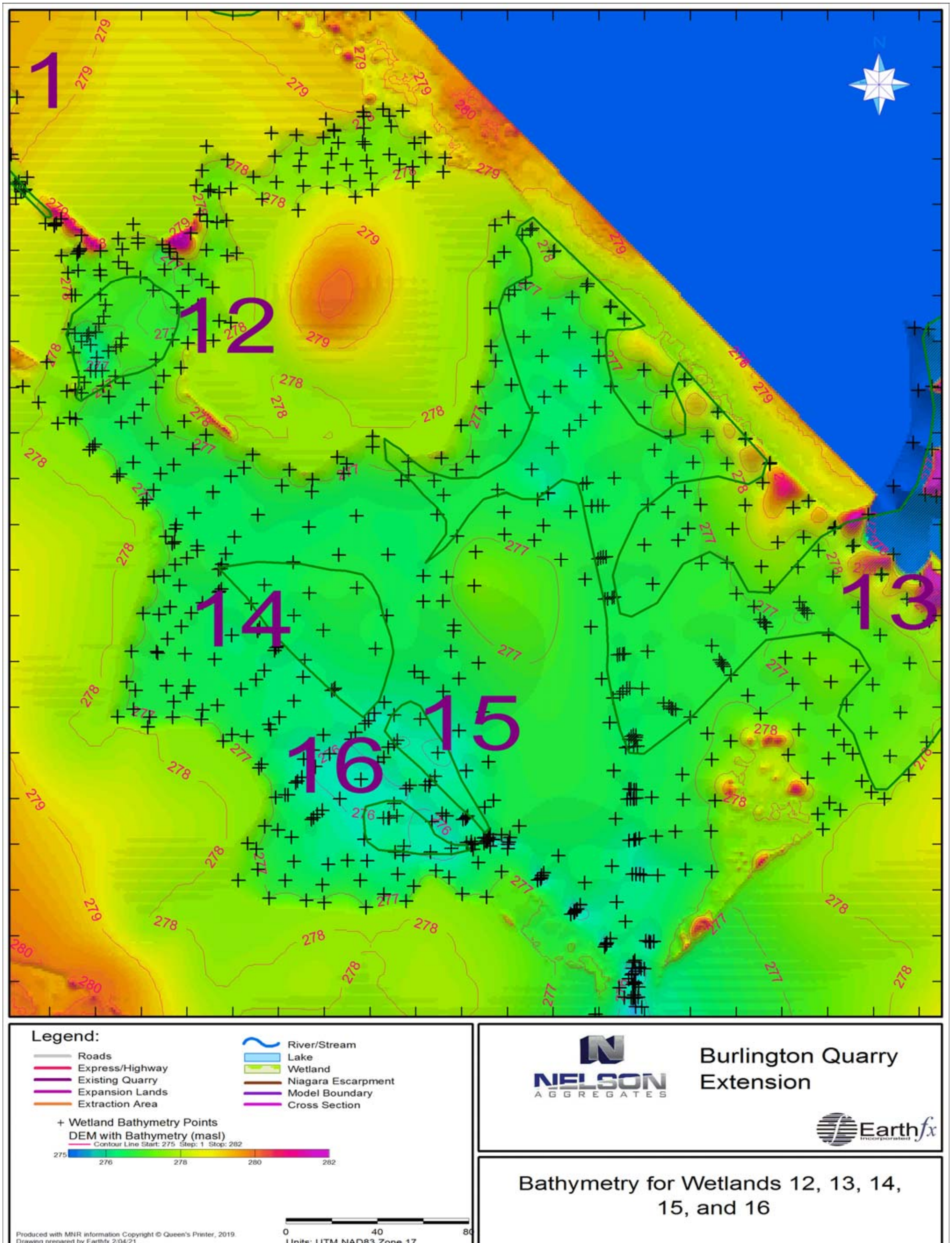
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

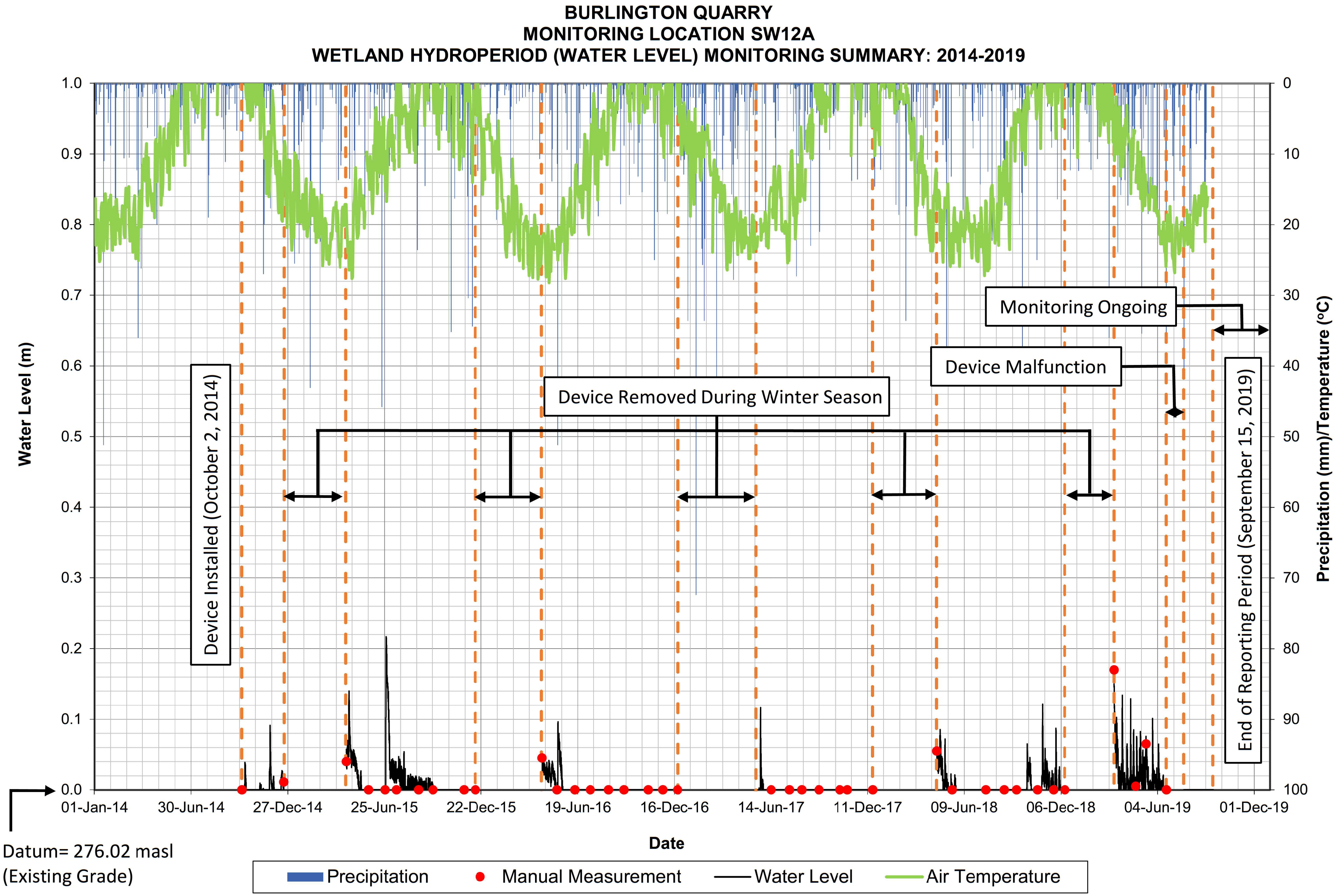
Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

<table>
<tr><th rowspan="2">Impact Assessment (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1 & Drawing DP-3</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget for Wetland 13022 (Earthfx Wetland 16), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.24, p. 186); Scenario P12 (Figure 8.31, p. 221); P3456 (Figure 8.63, p. 248); RHB1 (Figure 8.99, p. 277), and RHB2 (Figure 8.126, p. 299). The water budget results for Scenarios RHB1 and RHB2 are reproduced in Figures 2d and 2e. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13022 (Earthfx Wetland 16) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13022</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>1.25</td><td>0.34</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>1.37</td><td>0.02</td><td>0.12</td><td>-0.32</td></tr>
<tr><td>Rehab Scenario 2</td><td>1.17</td><td>0.04</td><td>-0.08</td><td>-0.30</td></tr>
</table></td><td>Figure 2d and 2e</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td></td><td></td></tr>
</table>

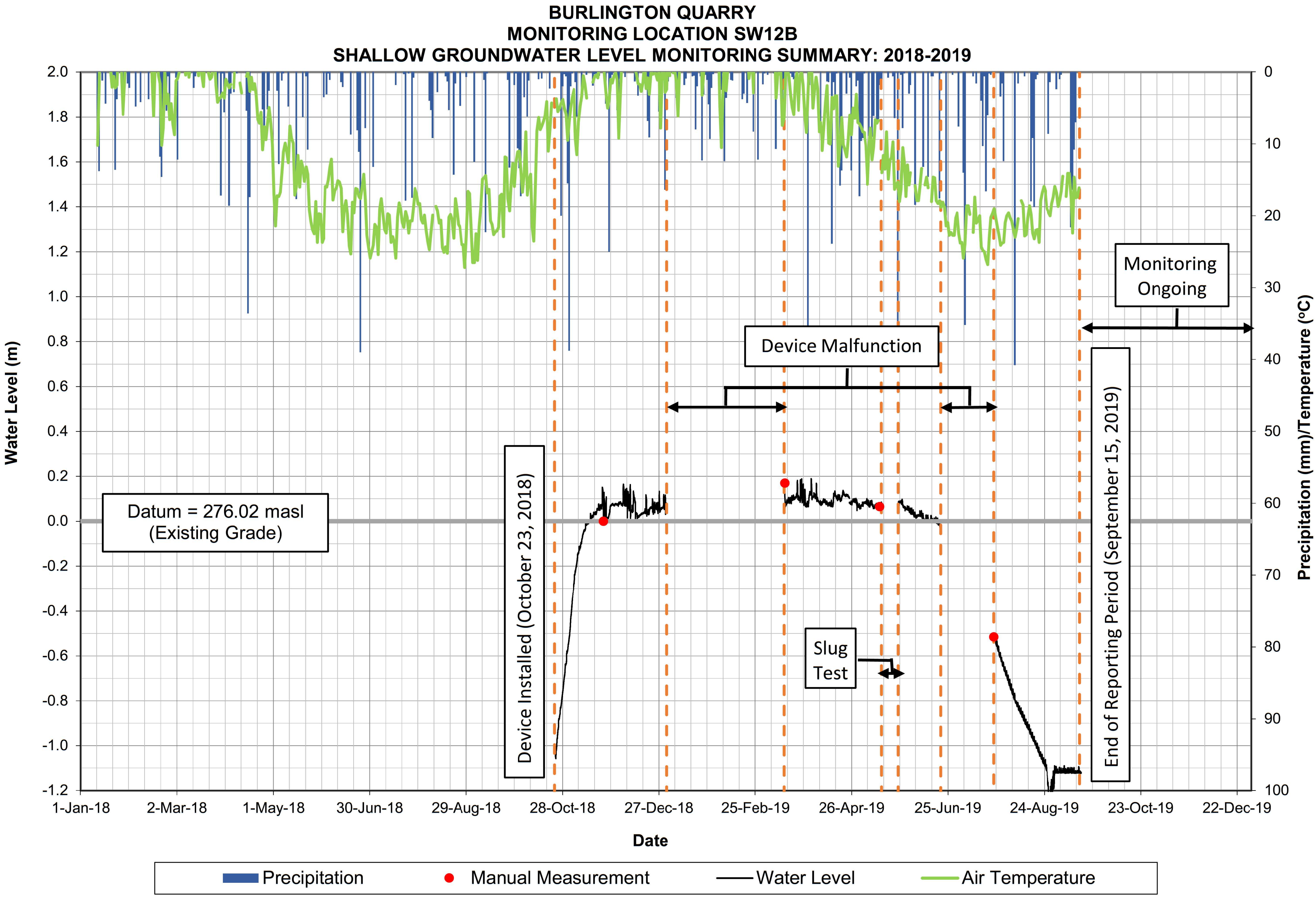
<table>
<tr><th rowspan="2">Mitigation (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

WETLAND 13022 - FIGURE 1

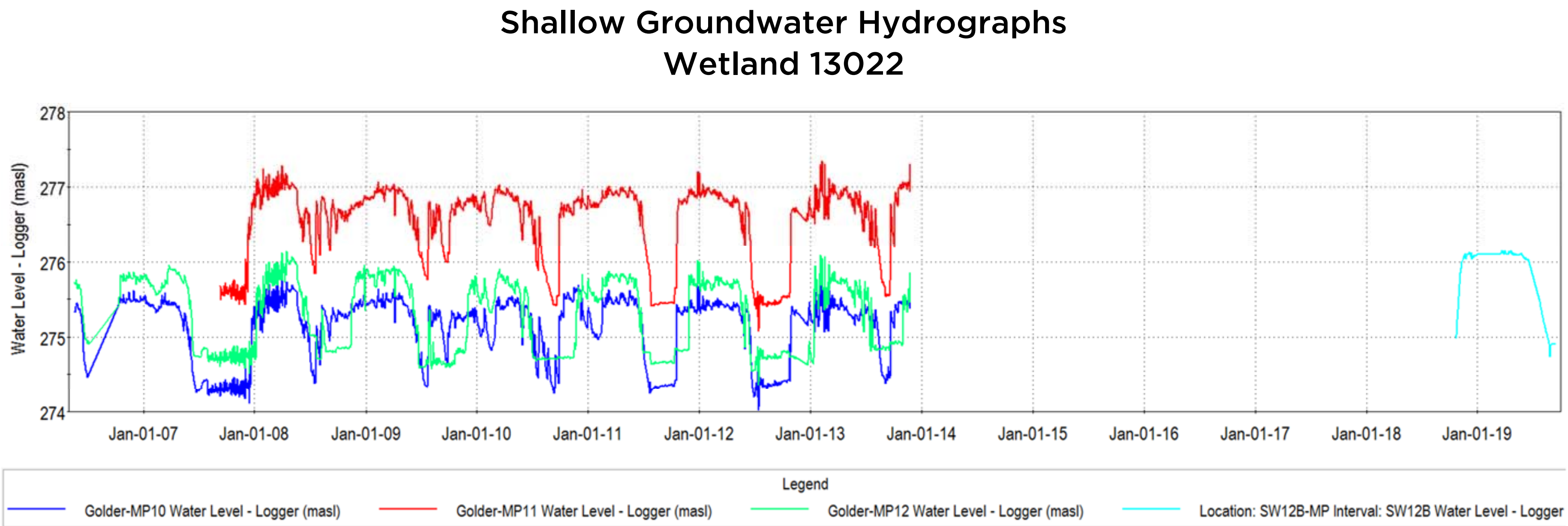



BURLINGTON QUARRY
MONITORING LOCATION SW12A
WETLAND HYDROPERIOD (WATER LEVEL) MONITORING SUMMARY: 2014-2019
Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm)/Temperature (°C)
0
10
20
30
40
50
60
70
80
90
100
Device Installed (October 2, 2014)
Device Removed During Winter Season
Device Malfunction
Monitoring Ongoing
End of Reporting Period (September 15, 2019)
01-Jan-14
30-Jun-14
27-Dec-14
25-Jun-15
22-Dec-15
19-Jun-16
16-Dec-16
14-Jun-17
11-Dec-17
09-Jun-18
06-Dec-18
04-Jun-19
01-Dec-19
Date
Datum= 276.02 masl
(Existing Grade)
Precipitation
Manual Measurement
Water Level
Air Temperature

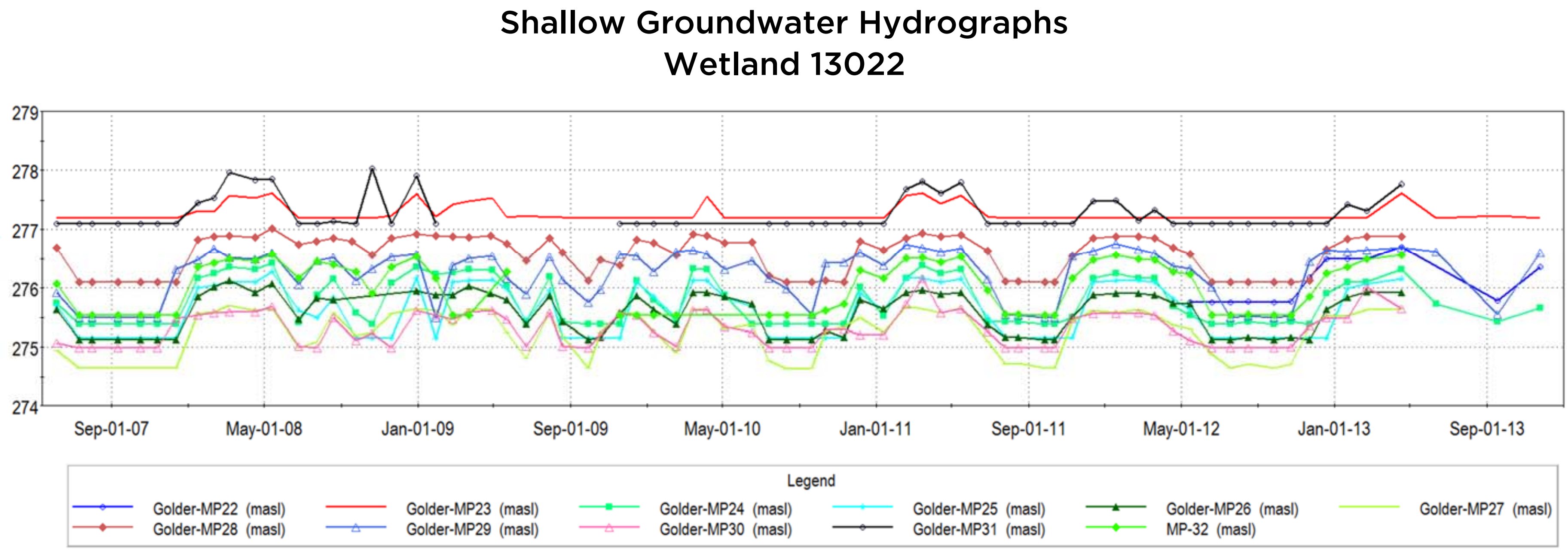
WETLAND 13022 - GRAPH 2

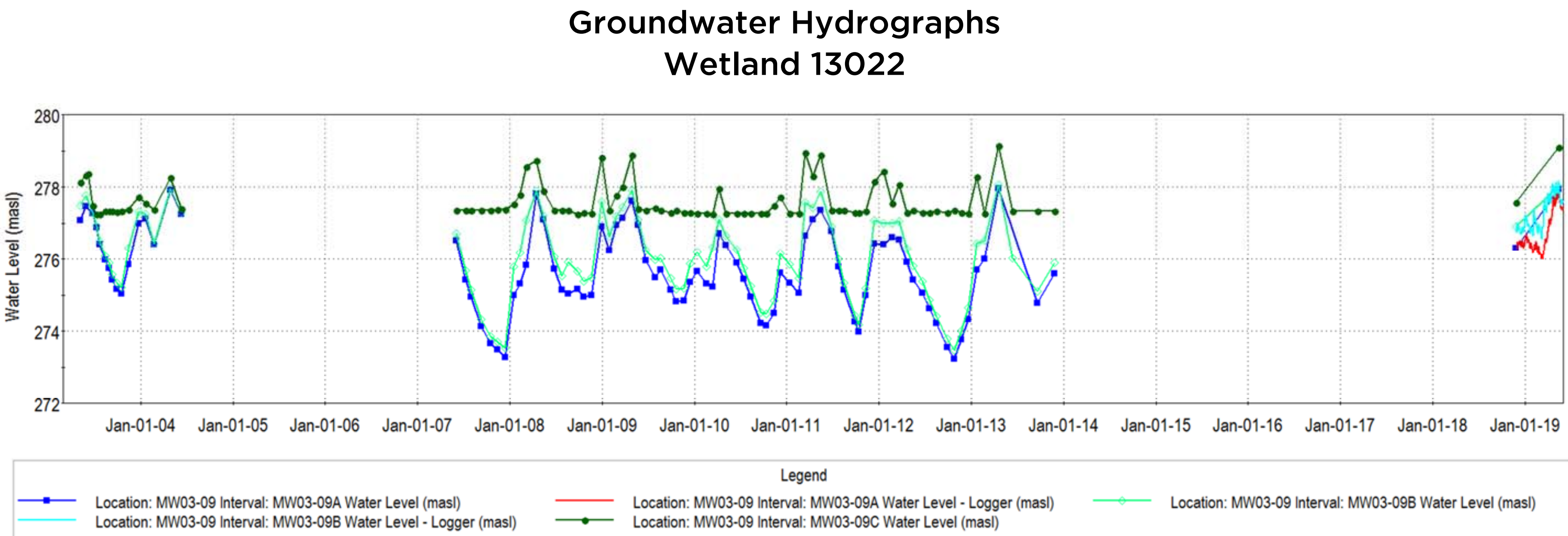


WETLAND 13022 - GRAPH 3

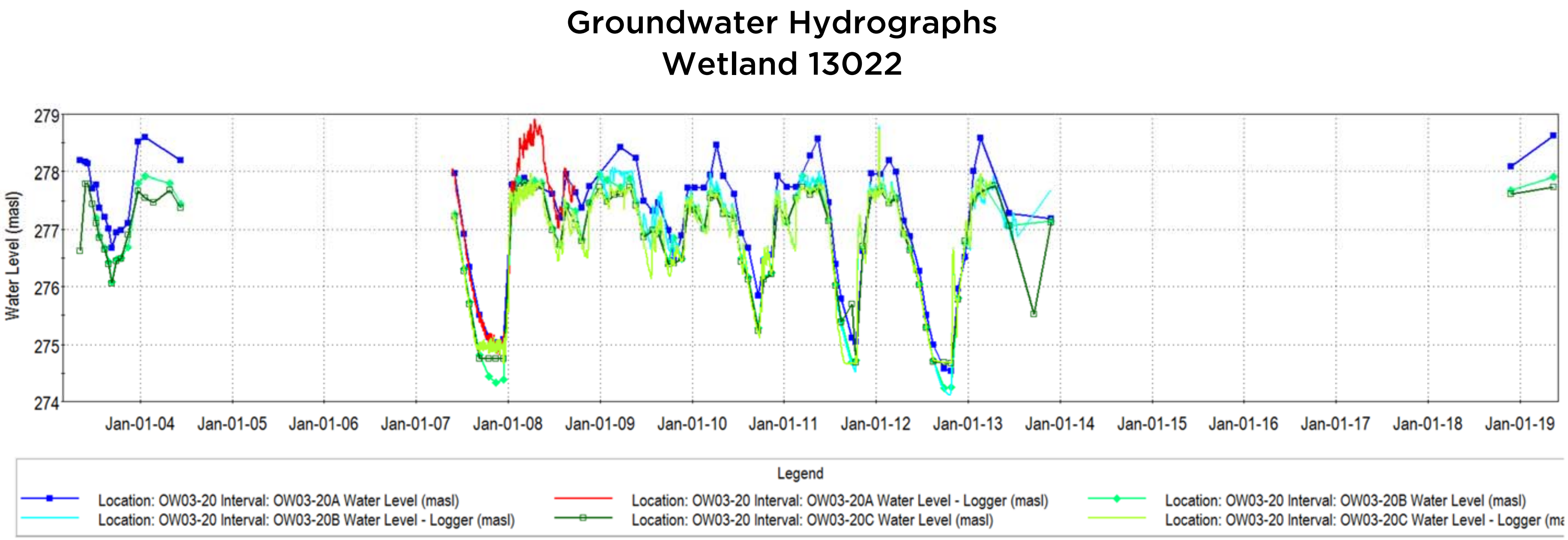


WETLAND 13022 - GRAPH 4




Groundwater Hydrographs
Wetland 13022
Water Level (masl)
280
278
276
274
272
Jan-01-04
Jan-01-05
Jan-01-06
Jan-01-07
Jan-01-08
Jan-01-09
Jan-01-10
Jan-01-11
Jan-01-12
Jan-01-13
Jan-01-14
Jan-01-15
Jan-01-16
Jan-01-17
Jan-01-18
Jan-01-19
Legend
Location: MW03-09 Interval: MW03-09A Water Level (masl)
Location: MW03-09 Interval: MW03-09A Water Level - Logger (masl)
Location: MW03-09 Interval: MW03-09B Water Level (masl)
Location: MW03-09 Interval: MW03-09B Water Level - Logger (masl)
Location: MW03-09 Interval: MW03-09C Water Level (masl)

WETLAND 13022 - GRAPH 6



WETLAND 13022

FIGURE 2A

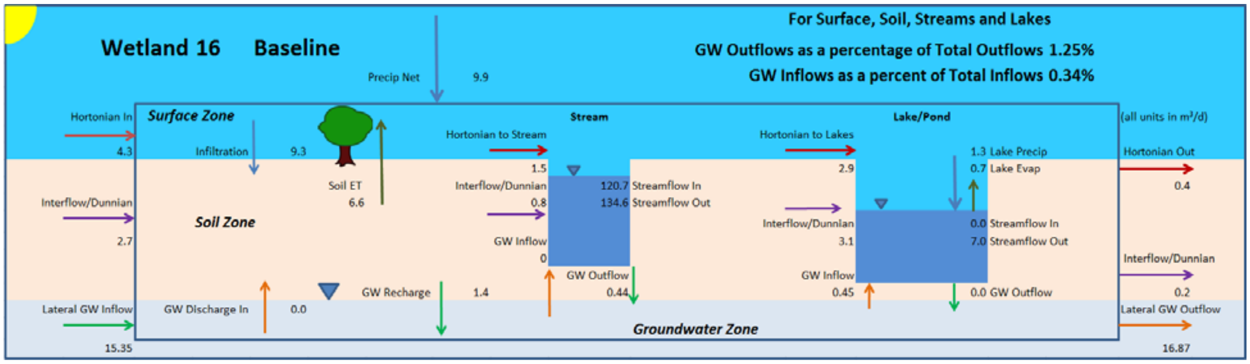


FIGURE 2B

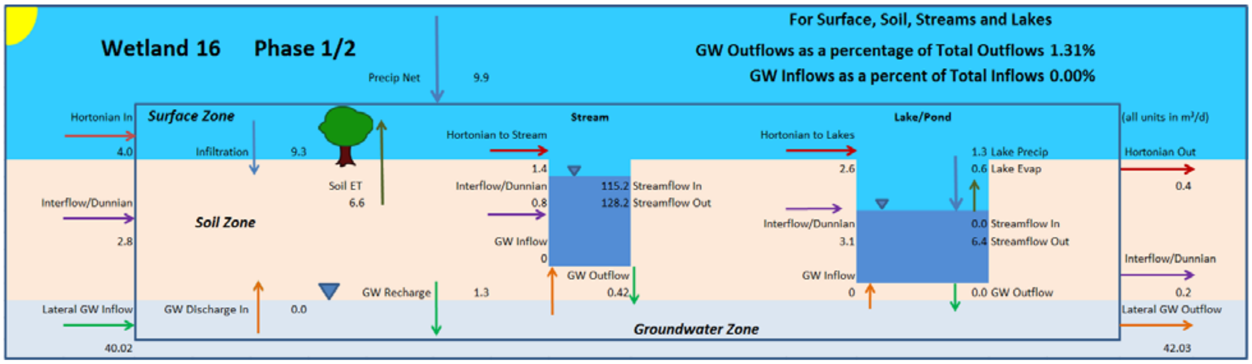


FIGURE 2C

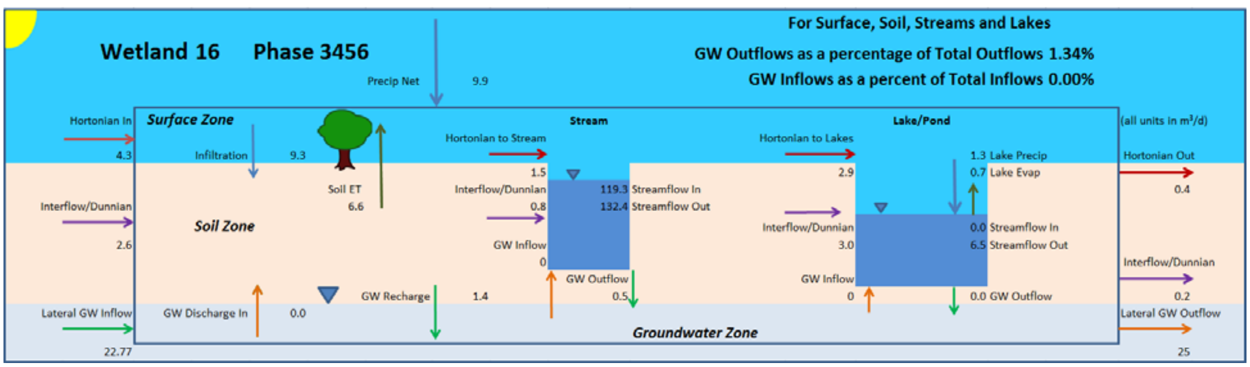


FIGURE 2D

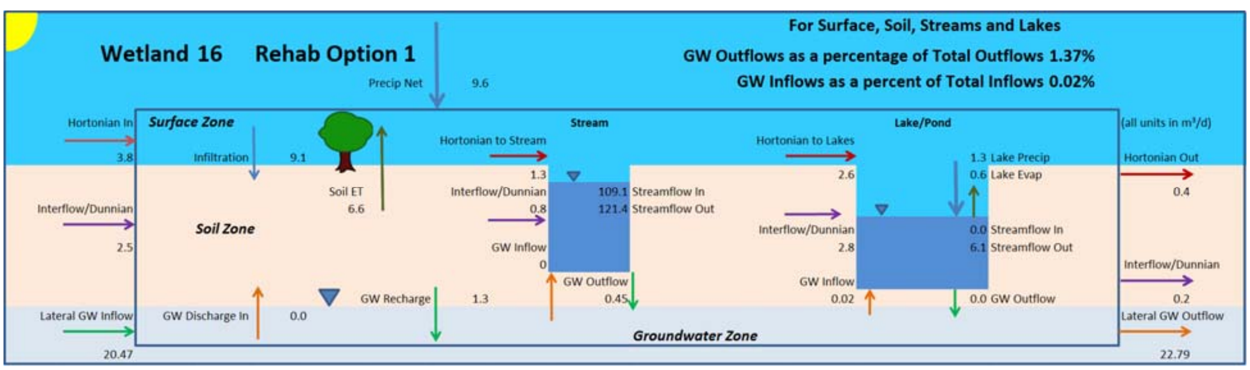
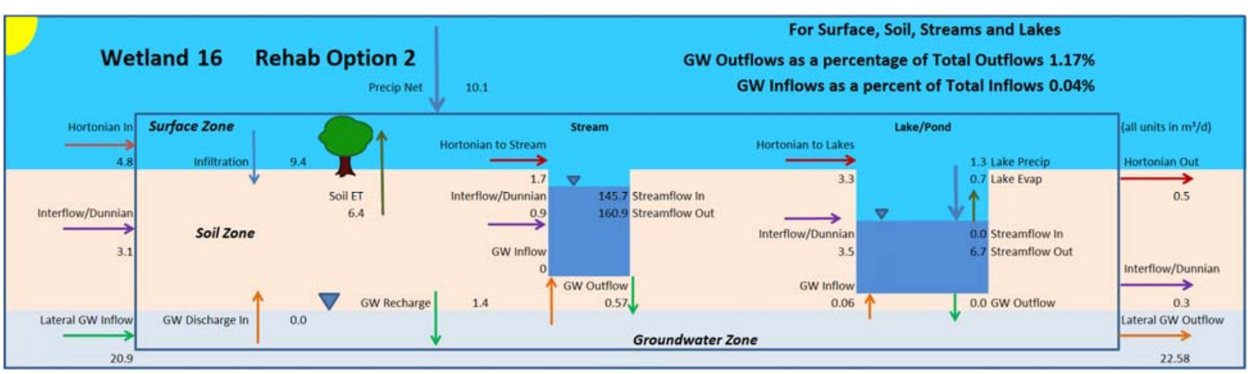
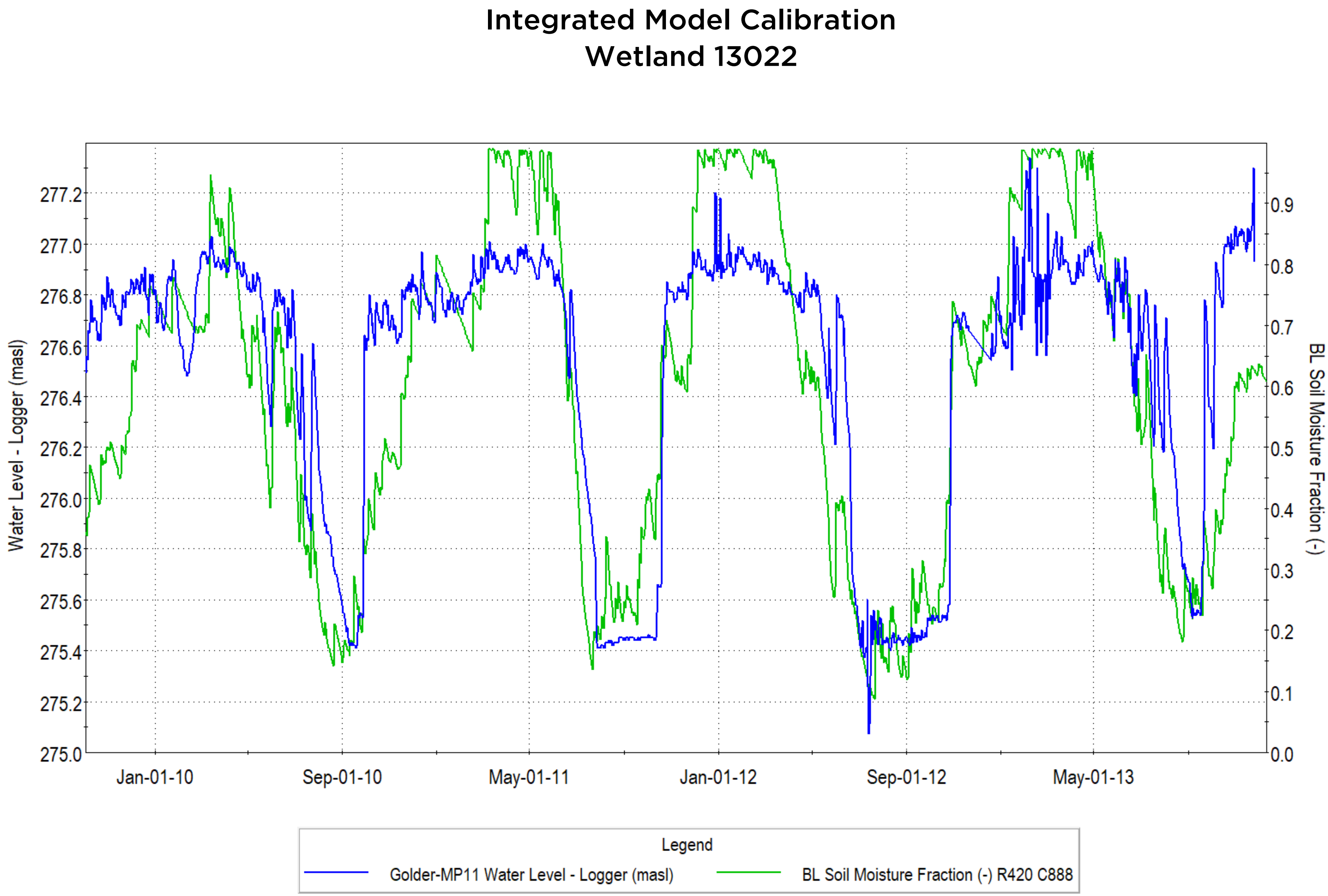


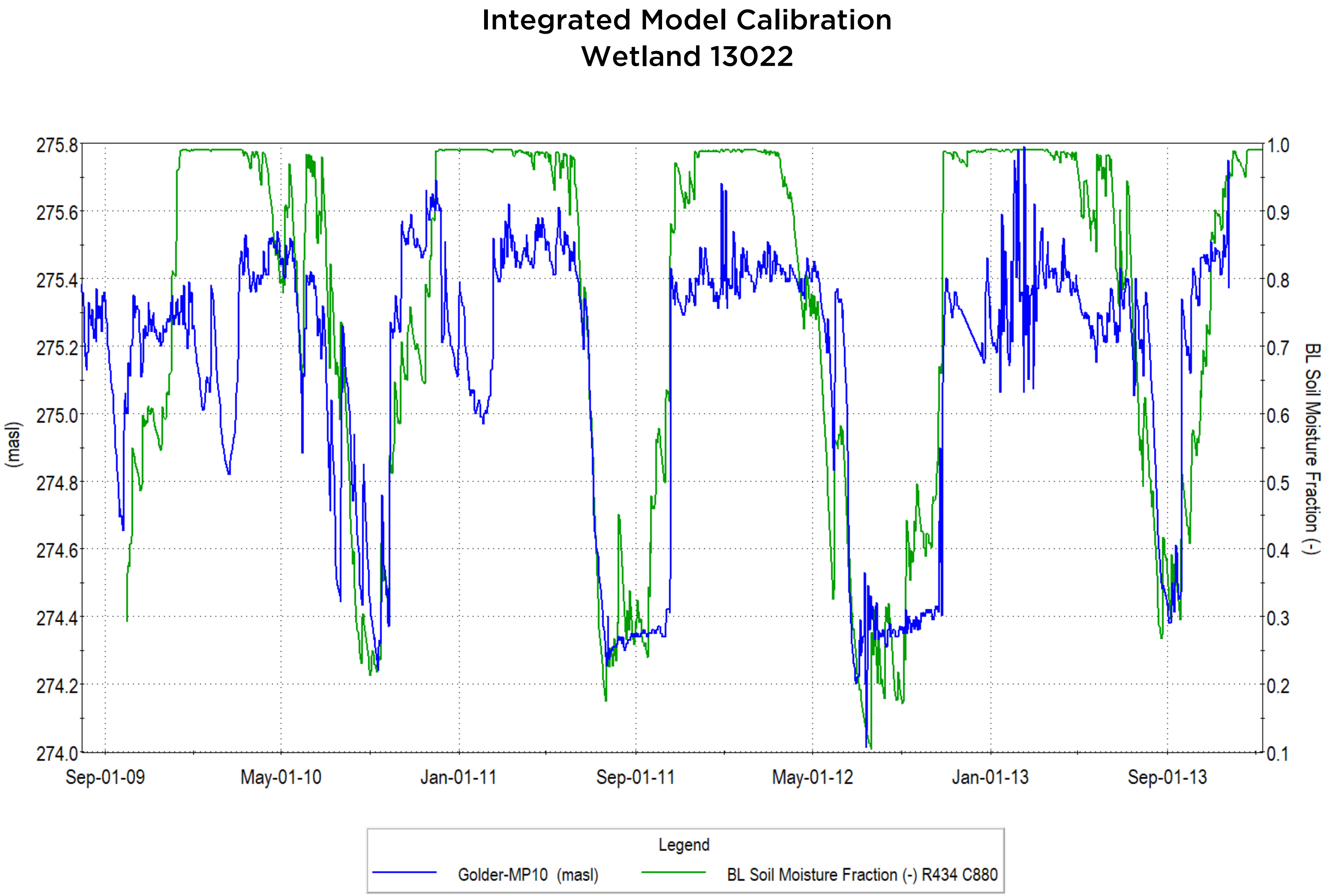
FIGURE 2E



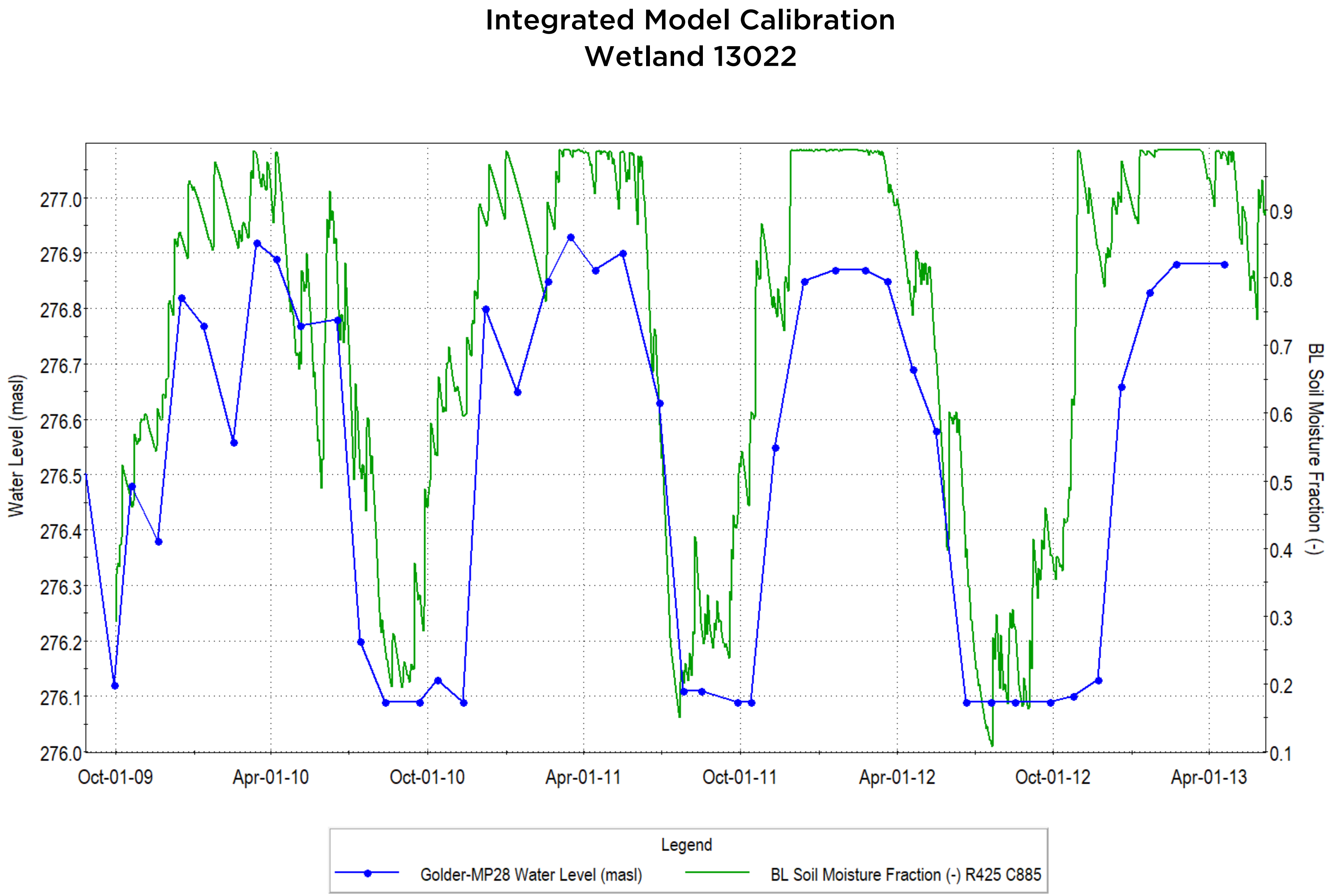
WETLAND 13022 - GRAPH 7

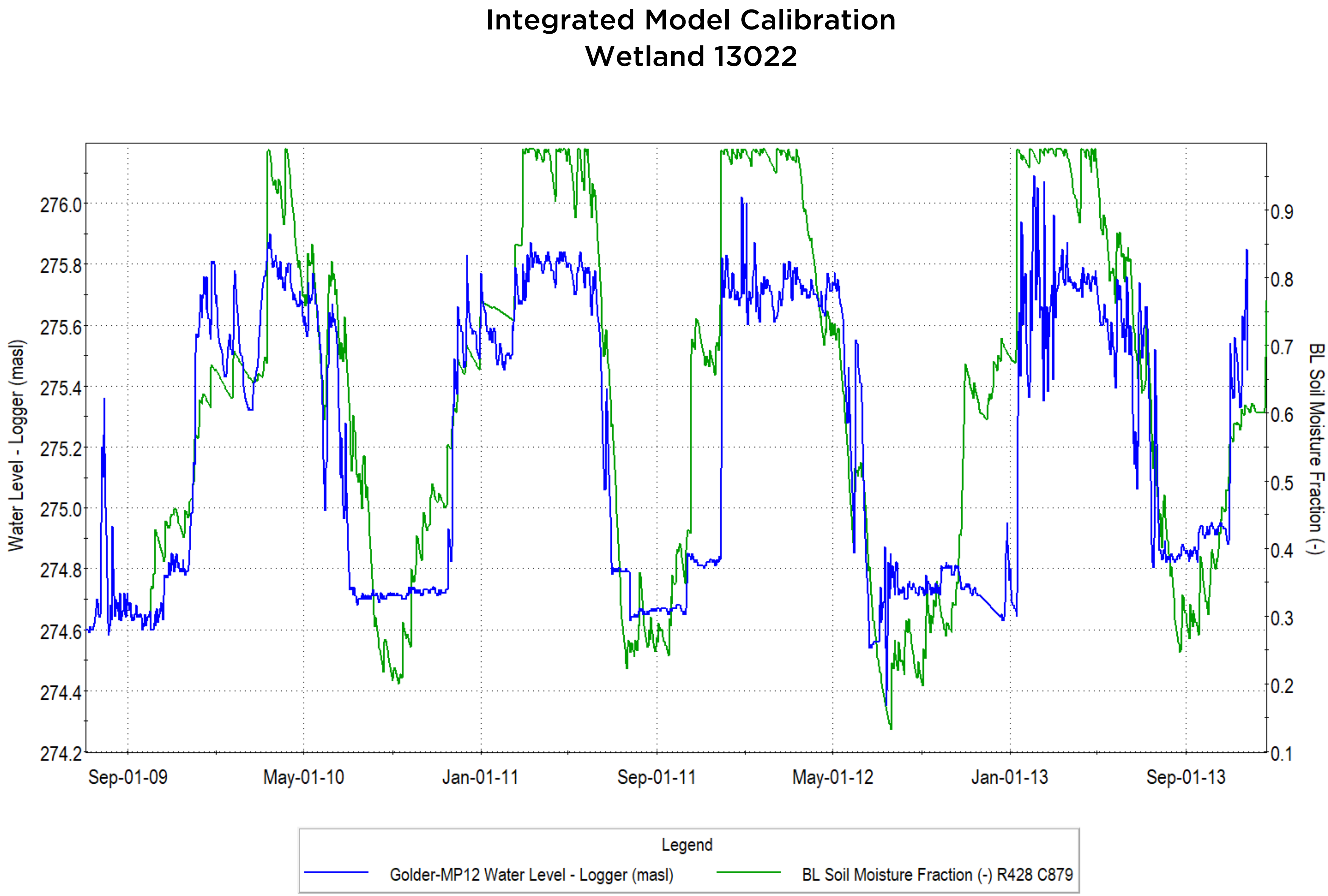


WETLAND 13022 - GRAPH 8

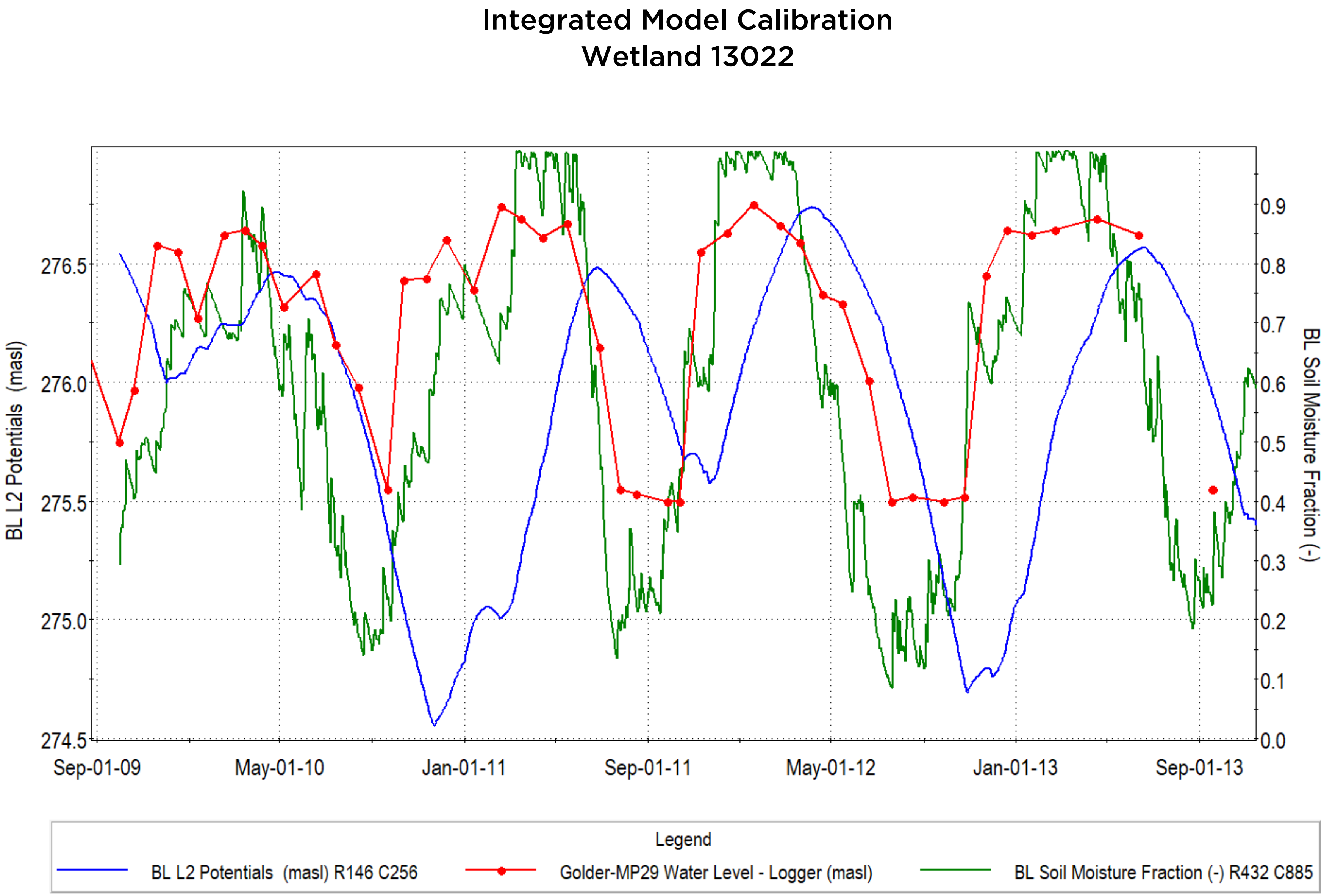


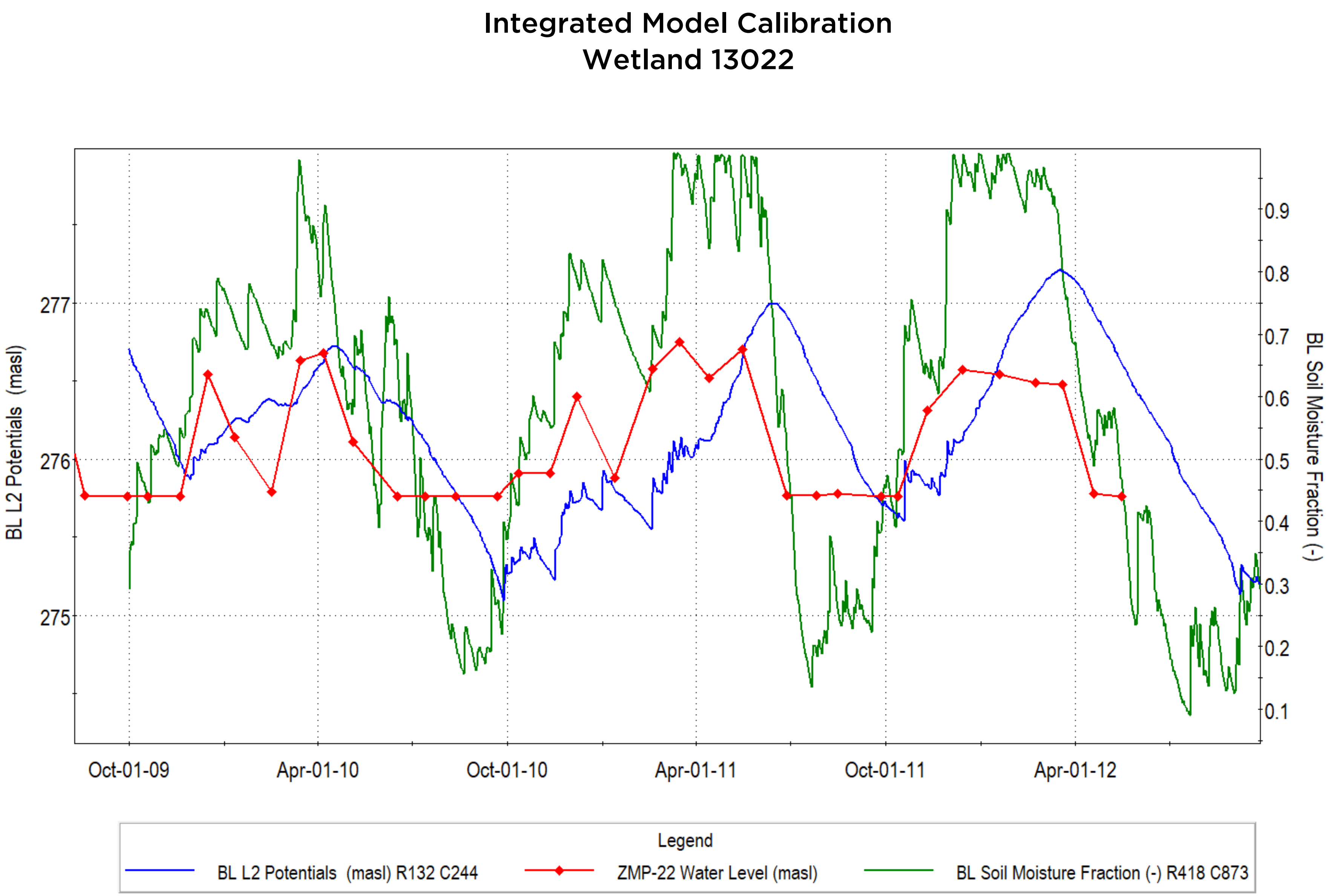
WETLAND 13022 - GRAPH 9



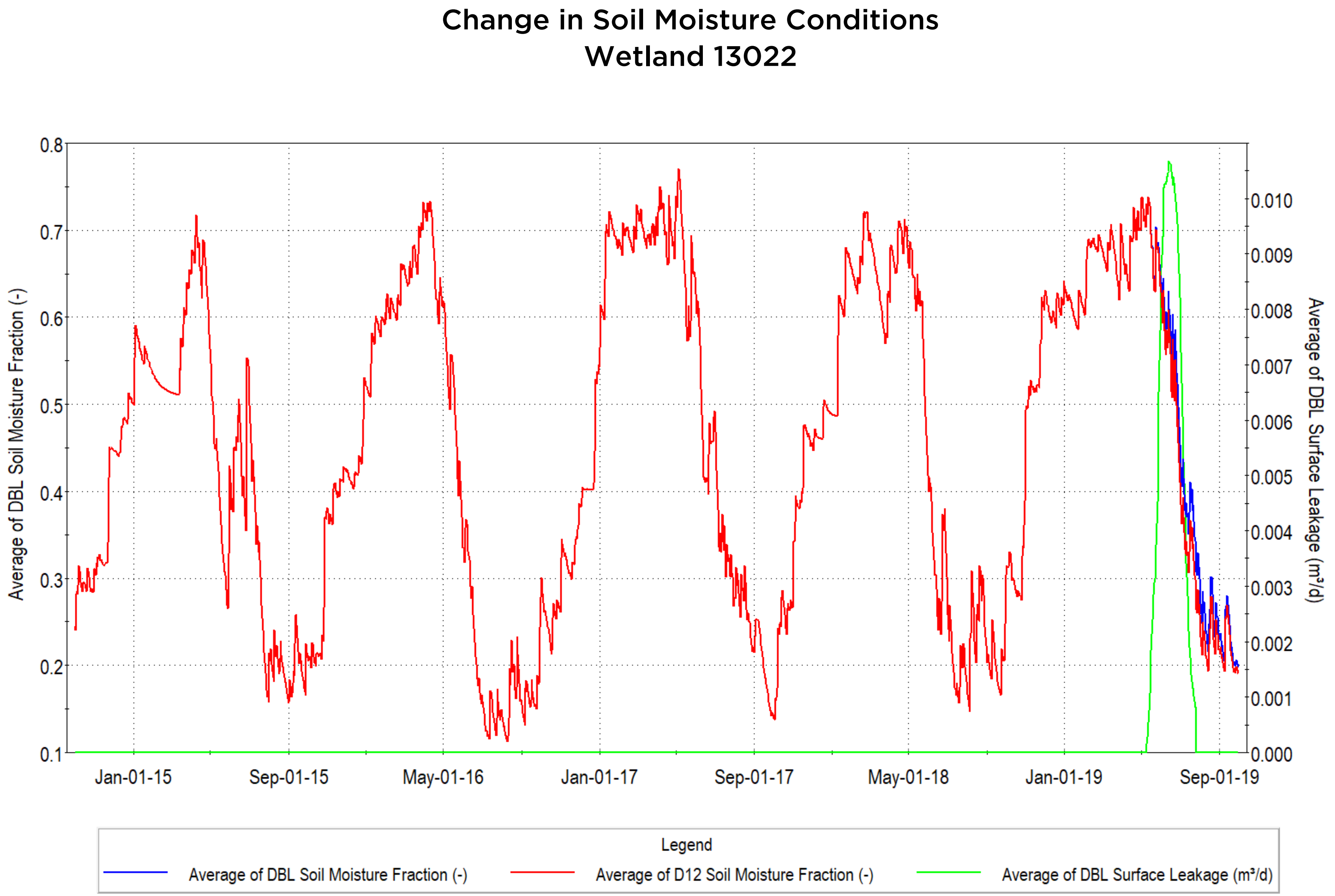

Integrated Model Calibration
Wetland 13022
Water Level - Logger (masl)
BL Soil Moisture Fraction (-)
276.0
275.8
275.6
275.4
275.2
275.0
274.8
274.6
274.4
274.2
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Sep-01-09
May-01-10
Jan-01-11
Sep-01-11
May-01-12
Jan-01-13
Sep-01-13
Legend
Golder-MP12 Water Level - Logger (masl)
BL Soil Moisture Fraction (-) R428 C879

WETLAND 13022 - GRAPH 11



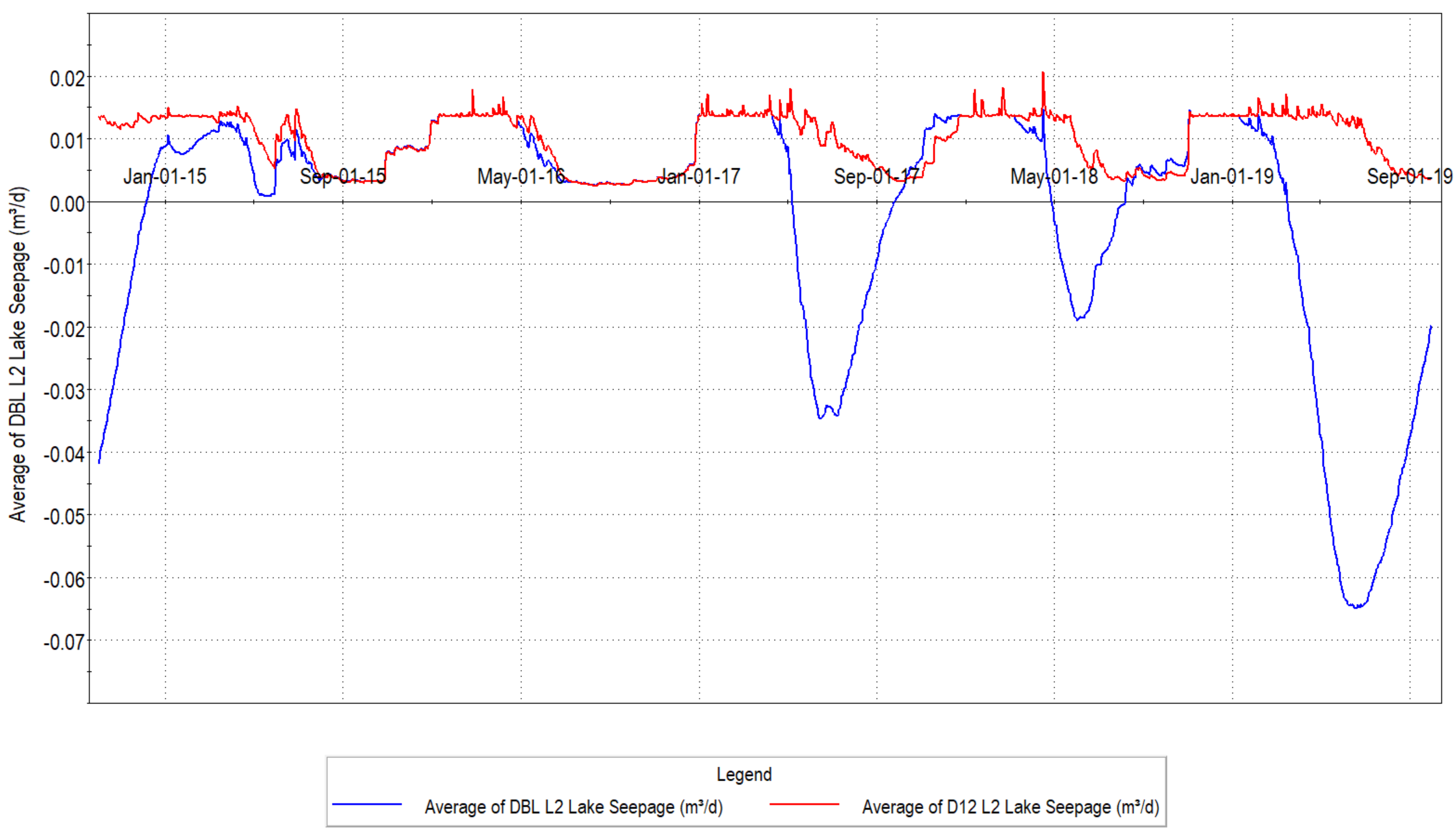

Integrated Model Calibration
Wetland 13022
277
276
275
BL L2 Potentials (masl)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
BL Soil Moisture Fraction (-)
Oct-01-09
Apr-01-10
Oct-01-10
Apr-01-11
Oct-01-11
Apr-01-12
Legend
BL L2 Potentials (masl) R132 C244
ZMP-22 Water Level (masl)
BL Soil Moisture Fraction (-) R418 C873

WETLAND 13022 - GRAPH 13

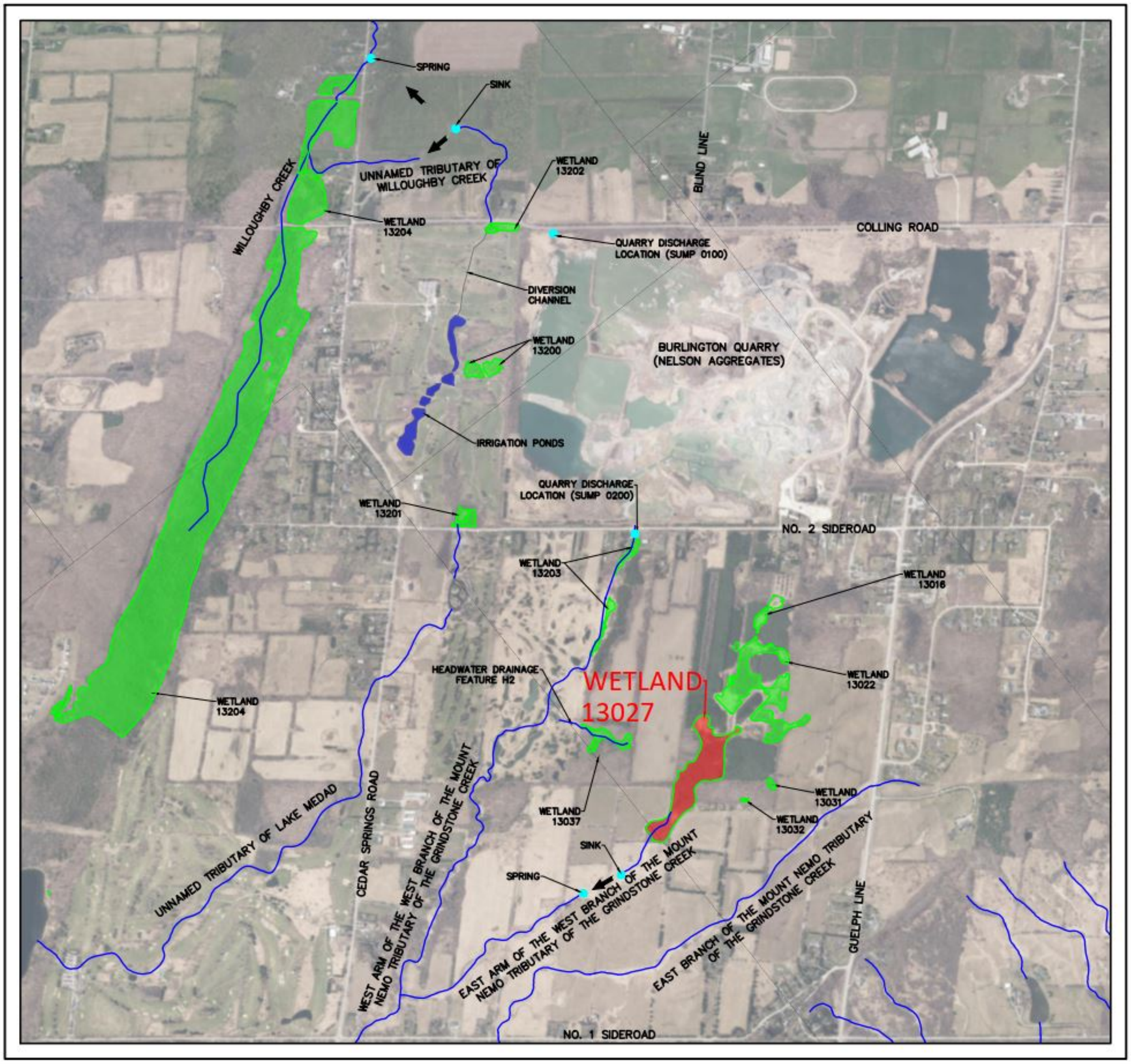


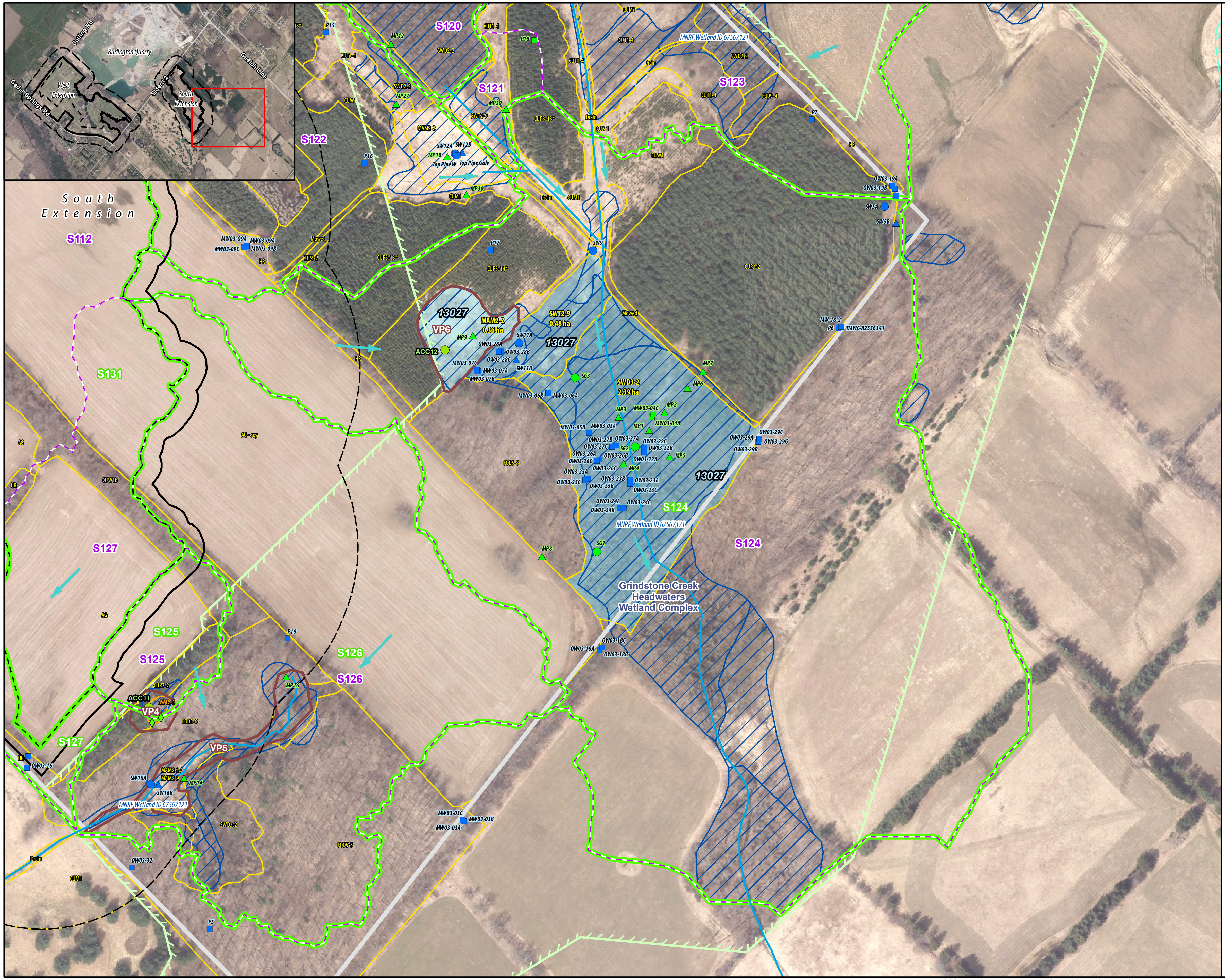
WETLAND 13022 - GRAPH 14

Change in Soil Moisture Conditions
Wetland 13022



WETLAND 13027





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Amphibian Call Count Station (2019)
- Salamander Trap (2019)
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Ecological Land Classification (Savanta, 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- Wetland - Not Evaluated per OWES (MNRF/LIO, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3-2, White Pine Coniferous Plantation
CUP3-6, European Larch Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1-4, Gray Dogwood Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD5-5, Dry – Fresh Sugar Maple – Hickory Deciduous Forest
FOD5-6, Dry- Fresh Sugar Maple-Basswood Deciduous Forest
FOD5-8, Dry – Fresh Sugar Maple – White Ash Deciduous Forest
FOD9-4, Fresh – Moist Shagbark Hickory Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
MAM2-9, Jewelweed Mineral Meadow Marsh
SWD2-2, Green Ash Mineral Deciduous Swamp
SWD3-2, Silver Maple Mineral Deciduous Swamp
SWT2-5, Red-osier Dogwood Mineral Thicket Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 3
Wetland Characterization

Wetland 13027 - South Extension

0 50 m

1:3,000

N

GEI Consultants
Savanta Division

Wetland 13027

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – 67567121(OGF ID 67567149, 67567122, 67567135, 67567124, 67567123, 67567127) Earthfx – 17 Tatham – 13049, 13027, 13048, 13038, 13035, 13034 Savanta – 13027 Golder (Background) - 13049, 13027, 13048, 13038, 13035, 13034			
Wetland Area (ha):	LIO/MNRF - 6.53 (excludes wetland area on neighbouring property) Savanta - 3.23 (excludes wetland area on neighbouring property)			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	22.04		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S124		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream watercourse)			
Condition:	Natural			
Bathymetry:	A bathymetry survey of Wetland 13027 was completed by Tatham Engineering Limited and incorporated into the integrated model (see Earthfx Section 18.3, p.381). Wetland lakes were assigned to Layer 1 of the integrated model by adjusting the base of Layer 1 to correspond with the interpolated bottom elevation. Care was taken to ensure that the lowest elevation observed in the wetland was honored in the assigned elevations.	Figure 1	HHIAR (Earthfx, April 2020)	18.3 (page 381)
Outlet:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Hydroperiod:	Spring Hydroperiod (date wetland dries out) – April 7th – July 17th Fall Hydroperiod (start of hydroperiod) – September 4th –December 27th	Graph 1	SWA (Tatham, April 2020)	2.2.2, 3 and Appendix F
Surface Water Monitoring:	ID: SW11A (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 591177.323, Northing 4805244.509	Graph 1	SWA (Tatham, April 2020)	2.2.2, 3 and Appendix F

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Grindstone Creek Headwaters Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Reed-canary Grass Mineral Meadow Marsh: MAM2-2 Gray Dogwood Mineral Thicket Swamp: SWT2-9 Green Ash Mineral Deciduous Swamp: SWD2-2		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	Yes – Jefferson Salamander (not field verified during 2019 field program; regulated based on historical data) Hydroperiod sensitive species; water presence necessary until end of June		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	Unknown – outside of 120 m adjacent lands			
Fish Habitat:	Indirect		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	Unknown – outside of 120 m adjacent lands			

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Lithology:	Halton Till			
Hydraulic Conductivity:	Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till. Wetland Water Balance (Tatham) – 8.2×10^{-9} m/s.			
Surface Water/Groundwater Interaction:	The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland receives some groundwater inflow but is relatively isolated from any changes in the water table due to quarry development.			
Shallow Groundwater (Mini-piezometer) Monitoring:	ID: SW11B (Tatham) Installation Date: October 25, 2018 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 591177.323, Northing 4805244.509	Graph 2	SWA (Tatham, April 2020)	2.3 and Appendix G
Background Shallow Groundwater (Mini-piezometer) Monitoring:	See table below	Graph 3		

Mini-piezometer ID	Ground Elevation	Bottom Elevation	Average WL	Logger	Manual Meas.
Golder-MP1	275.05	273.55	274.65	-	2007-2013
Golder-MP2	275.28	273.78	274.95	-	2007-2013
Golder-MP3	275.15	273.65	274.85	-	2007-2013
Golder-MP4	275.15	273.65	274.8	-	2007-2013
Golder-MP5	275.04	273.54	274.75	-	2007-2013
Golder-MP6	276.48	274.98	275.18	-	2007-2013
Golder-MP7	276.32	274.82	274.74	-	2007-2013
Golder-MP9	278.71	277.51	275.12	2006-2013	2006-2013

Groundwater Interaction	Description						Figure / Graph	Reference	
								Report	Section / Page
Groundwater Monitoring (Monitoring Wells):	Monitoring Well ID	Distance (Dir.)	Geologic Unit	Ground Elevation	Monitoring Elev	Average WL	Graphs 4, 5, 6 & 7		
	MW03-04A	16 (E)	Bedrock	274.92	257.24 - 253.28	274.79			
	MW03-04B	16 (E)	Bedrock	274.92	266.69 - 262.42	274.71			
	MW03-04C	17 (E)	Bedrock	274.86	273.46 - 271.66	274.66			
	MW03-05A	33 (ESE)	Bedrock	275.01	272.42 - 271.66	274.70			
	MW03-05B	33 (ESE)	Overburden	275.01	273.94 - 272.88	274.54			
	MW03-06A	65 (ENE)	Bedrock	275.01	273.03 - 272.6	274.83			
	MW03-06B	65 (ENE)	Overburden	275.01	273.79 - 273.33	274.82			
	MW03-07A	120 (ENE)	Bedrock	275.37	260.89 - 256.6	274.83			
	MW03-07B	120 (ENE)	Bedrock	275.38	269.74 - 267.46	275.03			
	MW03-07C	121 (ENE)	Bedrock	275.37	273.54 - 271.56	275.11			
	OW03-22A	10 (SSE)	Bedrock	275.01	255.41 - 247.31	274.15			
	OW03-22B	10 (SSE)	Bedrock	275.02	271.19 - 263.82	274.44			
	OW03-22C	10 (SSE)	Bedrock	274.92	273.22 - 271.62	274.58			
	OW03-23A	1 (S)	Bedrock	274.96	256.31 - 249.66	274.18			
	OW03-23B	1 (S)	Bedrock	274.91	270.88 - 264.21	274.44			
	OW03-23C	1 (S)	Bedrock	274.78	273.28 - 271.68	274.46			
	OW03-24A	9 (S)	Bedrock	274.88	256.75 - 250.13	274.16			
	OW03-24B	9 (S)	Bedrock	274.88	270.88 - 264.24	274.26			
	OW03-24C	6 (S)	Bedrock	274.74	272.97 - 271.39	274.35			
	OW03-25A	34 (SE)	Bedrock	275	255.9 - 247.48	274.14			
	OW03-25B	34 (SE)	Bedrock	274.99	270.69 - 264.22	274.43			
	OW03-25C	36 (SE)	Bedrock	274.99	273.19 - 271.59	274.50			
	OW03-26A	25 (SE)	Bedrock	275.02	255.82 - 248.42	274.16			
	OW03-26B	25 (SE)	Bedrock	275.03	272.04 - 263.7	274.46			
	OW03-26C	27 (SE)	Bedrock	275.005	272.71 - 271.11	274.22			
	OW03-27A	12 (SE)	Bedrock	275.05	256.05 - 247.28	274.19			
	OW03-27B	12 (SE)	Bedrock	275.06	270.91 - 263.88	274.50			
	OW03-27C	15 (SE)	Bedrock	275.04	272.74 - 271.14	274.48			
	OW03-28A	102 (ENE)	Bedrock	275.46	256.76 - 248.96	275.33			
	OW03-28B	102 (ENE)	Bedrock	275.46	272.36 - 265.66	275.07			
	OW03-28C	104 (ENE)	Bedrock	275.4	273.9 - 272.3	275.11			
	OW03-29A	99 (ENE)	Bedrock	277.06	256.46 - 248.92	274.84			
	OW03-29B	99 (ESE)	Bedrock	277.05	273.93 - 266.83	275.47			
	OW03-29C	100 (ESE)	Overburden	277.02	276.72 - 275.12	275.79			
	OW03-29G	100 (ESE)	Overburden	277.02					
Water Budget Results:	A detailed average water budget, as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.25, p. 187). The baseline water budget is reproduced in Figure 2a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 17 for baseline conditions are discussed in Section 7 of the main report.						Figure 2a	HHIAR (Earthfx, April 2020)	187
	Wetland 13027	GW Outflow (%)	GW Inflow (%)						
	Baseline (Existing)	2.51	1.31						

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Integrated Model Calibration:	Four mini-piezometers in Wetland 17 provide multiple years of monitoring in the soil zone and upper weathered Halton Till. These monitors correspond to the PRMS soil zone and upper-most part of Layer 1 of the GSFLOW model. A comparison of the mini-piezometer data to the simulated soil moisture conditions demonstrates that the model is closely matching both the soil moisture and hydroperiod in the shallow subsurface at this wetland (see Graphs 8 through 12).	Graphs 8, 9, 10, 11 & 12		
	Earthfx Figure 19.42 (p.442) in the Main Report shows a hydrograph for Golder SG-3 along with simulated shallow water levels. Earthfx Figure 6.31 (p.155) and Figure 19.43 (p.443) in the Main Report shows a hydrograph for Golder SG-2 and MP5 along with simulated shallow water levels. The results are reproduced in Graphs 13 and 14. A brief discussion of the Wetland 13027 (Earthfx Wetland 17) is contained in Earthfx Section 6.11.4 (p. 155). A more detailed discussion is provided in Appendix E, Section 19.6 (p. 441).	Graphs 13 & 14	HHIAR (Earthfx, April 2020)	155 and 441 - 443

<table>
<tr><th rowspan="2">Impact Assessment (Operations Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1 & Drawing DP-2</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget for Wetland 13027 (Earthfx Wetland 17), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.25, p. 187); Scenario P12 (Figure 8.32, p. 222); P3456 (Figure 8.64, p. 249); RHB1 (Figure 8.100, p. 278), and RHB2 (Figure 8.127, p. 300). The water budget results for Scenario P12 are reproduced in Figure 2b. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13027 (Earthfx Wetland 17) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><th>Wetland 13027</th><th>GW Outflow (%)</th><th>GW Inflow (%)</th><th>Δ in Outflow (%)</th><th>Δ in Inflow (%)</th></tr>
<tr><td>Baseline (Existing)</td><td>2.51</td><td>1.31</td><td>-</td><td>-</td></tr>
<tr><td>Operations Ph 1 & 2</td><td>5.71</td><td>0.00</td><td>3.20</td><td>-1.31</td></tr>
</table></td><td>Figure 2b</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Change on Soil Moisture Conditions:</td><td>The effects of development can be illustrated by comparing the average soil moisture in Wetland 17 under Baseline and P12 development conditions. Graph 15 shows average daily soil moisture for Baseline conditions as a blue line. The soil moisture under P12 development is shown in red, and it overlies (covers) the Baseline for much of the time period. Under P12 development, soil moisture is essentially identical in the winter and spring, but slightly dryer in the summer and fall. The Baseline groundwater discharge into Wetland 17 (seepage or “surface leakage” in GSFLOW) is shown as a green line on the graph (right hand scale). The decline in soil moisture under P12 is due to the loss of this groundwater discharge (due to the drawdown in groundwater levels near the excavation). Under baseline conditions, groundwater seepage occurs as water levels rise in the late spring in response to snowmelt. Seepage fluctuates significantly, however, due to natural inter-annual climate variability. During a dry year (2015-2016) groundwater levels are naturally low, there is no groundwater seepage, and so there is no difference in soil moisture between Baseline and P12. During an average year (2017-2018) there is small change in the late summer soil moisture conditions due to the loss of groundwater discharge during P12 development. During a wet year there is a modest loss of soil moisture in the May-September time frame. The water budget summary for Wetland 17 indicates that groundwater inflows account for only 1.31% of all inflows, and that this will be lost with development. Graph 16 illustrates how and when that loss of groundwater inflow will occur. The loss will primarily occur during the late summer of a wet year. There will be no impact during dry years when the wetland already experiences limited groundwater inflow. Additional surface water and groundwater interaction occurs through the bottom of the ponded water portions of Wetland 17 (Graph 15). The ponded water areas within the wetland are represented in the model as MODFLOW “Lakes”. Pond seepage is positive when the lake or pond is leaking water to the deeper groundwater system. Negative seepage indicates groundwater is upwelling into the pond. The pond seepage under Baseline (Blue) and P12 conditions (Red) are shown in Graph 15. Under Baseline conditions, the ponds leak water to the groundwater system for most of the year, and only receive upwelling (negative leakage or seepage) for short periods of the wetter years when the water table is higher (generally in late spring). Under P12 conditions (red line), the ponds leak water to the groundwater system at varying rates throughout the year; generally higher in the spring and declining through the summer. Overall, the pond leakage patterns under Baseline and P12 conditions are similar to that of soil moisture response.</td><td>Graphs 15 & 16</td><td></td><td></td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Operational Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

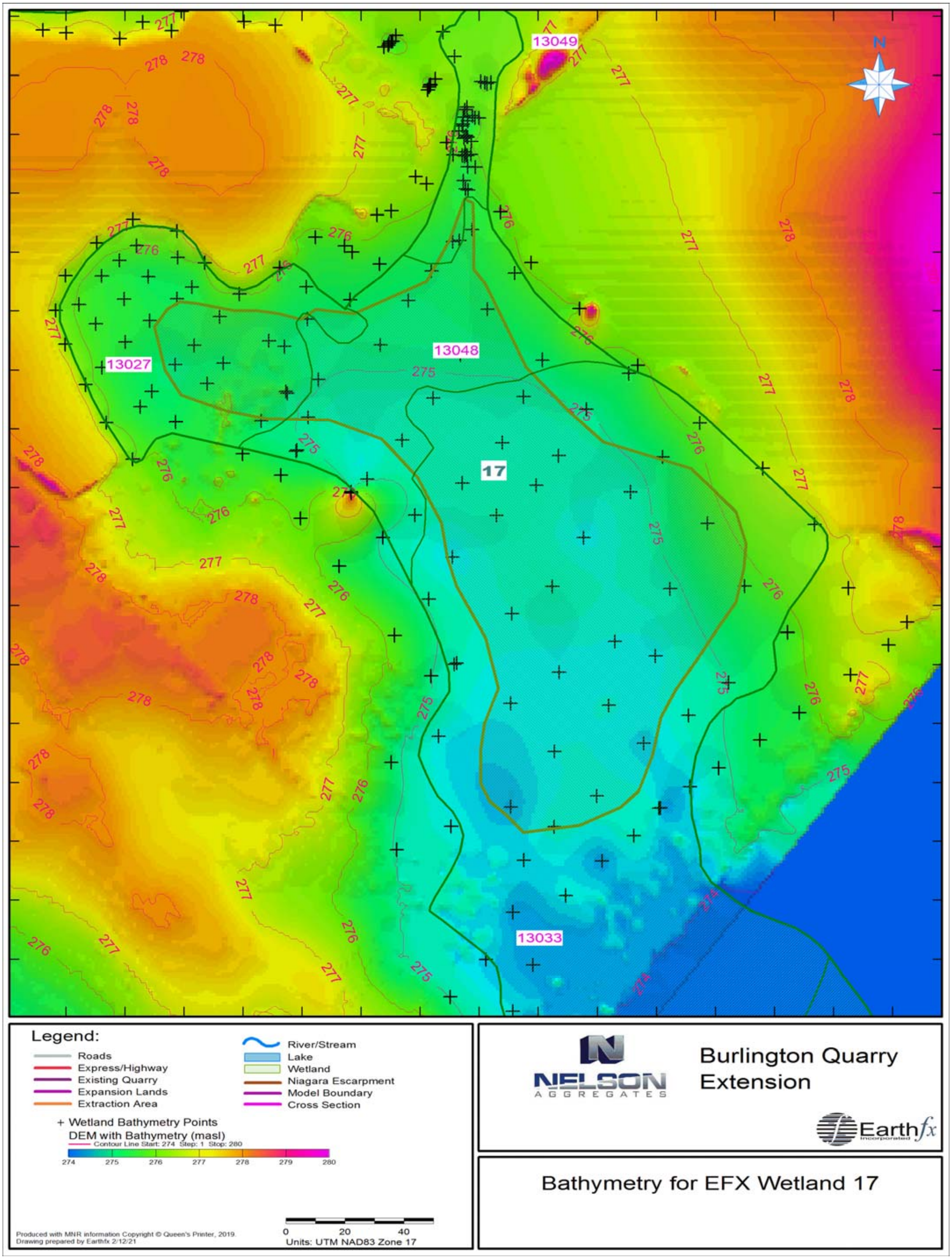
<table>
<tr><th rowspan="2">Impact Assessment (Operations Phases 3 - 6)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1 & Drawing DP-2</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget for Wetland 13027 (Earthfx Wetland 17), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.25, p. 187); Scenario P12 (Figure 8.32, p. 222); P3456 (Figure 8.64, p. 249); RHB1 (Figure 8.100, p. 278), and RHB2 (Figure 8.127, p. 300). The water budget results for Scenario P3456 are reproduced in Figure 2c. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13027 (Earthfx Wetland 17) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13027</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>2.51</td><td>1.31</td><td>-</td><td>-</td></tr>
<tr><td>Operations Ph 3 - 6</td><td>4.18</td><td>0.34</td><td>1.67</td><td>-0.97</td></tr>
</table></td><td>Figure 2c</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Operational Phases 3 - 6)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

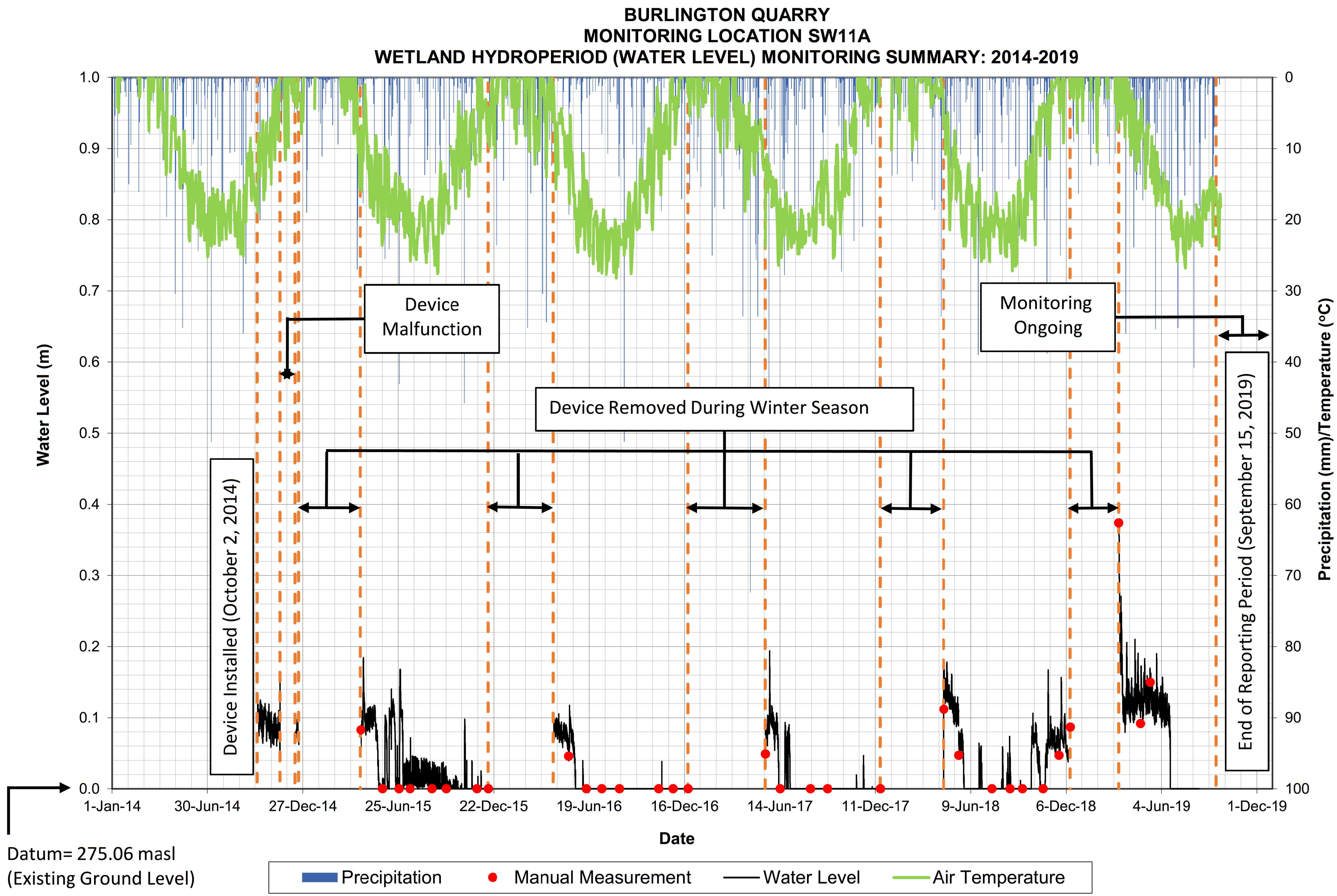
<table>
<tr><th rowspan="2">Impact Assessment (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1 & Drawing DP-3</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>5.4.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget for Wetland 13027 (Earthfx Wetland 17), as simulated by the integrated model, is provided in the Earthfx report for Baseline Conditions (Figure 7.25, p. 187); Scenario P12 (Figure 8.32, p. 222); P3456 (Figure 8.64, p. 249); RHB1 (Figure 8.100, p. 278), and RHB2 (Figure 8.127, p. 300). The water budget results for Scenario RHB1 and RHB2 are reproduced in Figure 2d and 2e. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13027 (Earthfx Wetland 17) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13027</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>2.51</td><td>1.31</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>3.65</td><td>0.55</td><td>1.14</td><td>-0.76</td></tr>
<tr><td>Rehab Scenario 2</td><td>3.38</td><td>0.45</td><td>0.87</td><td>-0.86</td></tr>
</table></td><td>Figure 2d and 2e</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project.</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

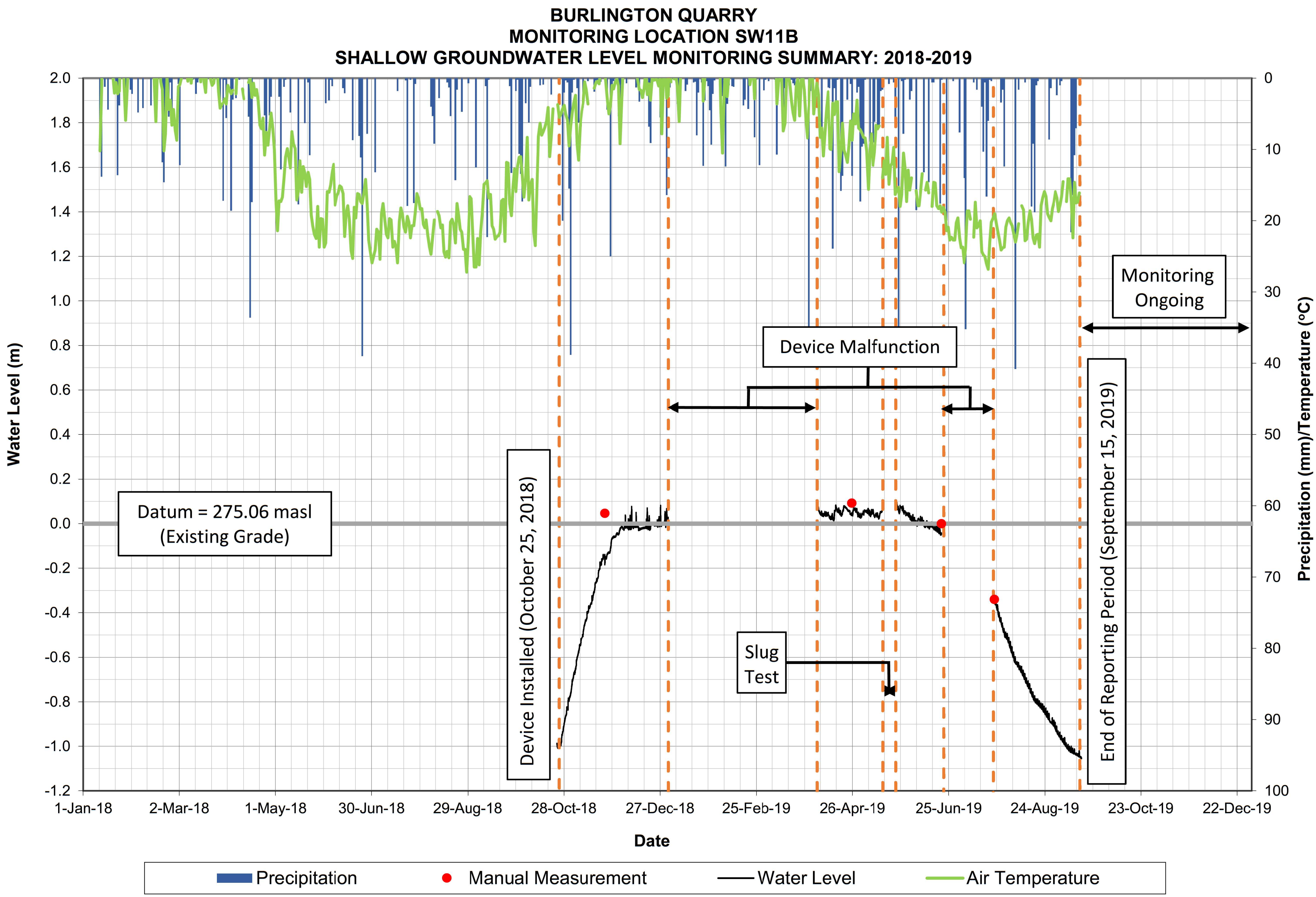
WETLAND 13027 - FIGURE 1



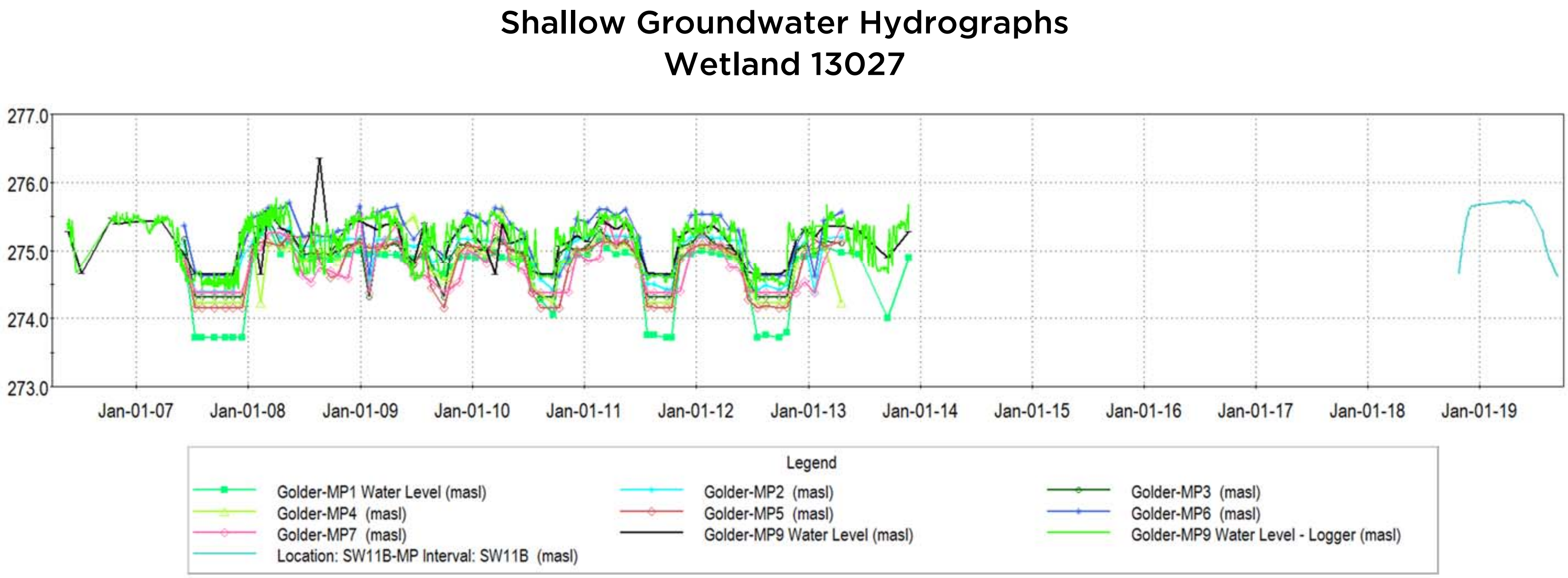
WETLAND 13027 - GRAPH 1

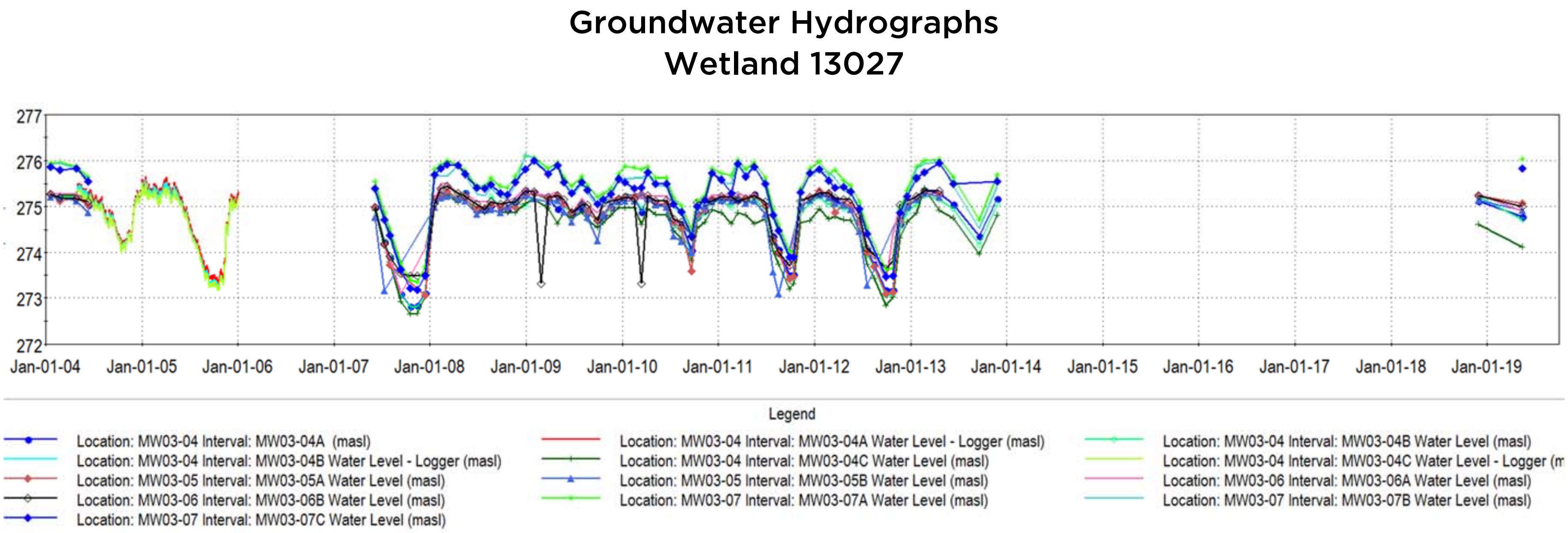


WETLAND 13027 - GRAPH 2

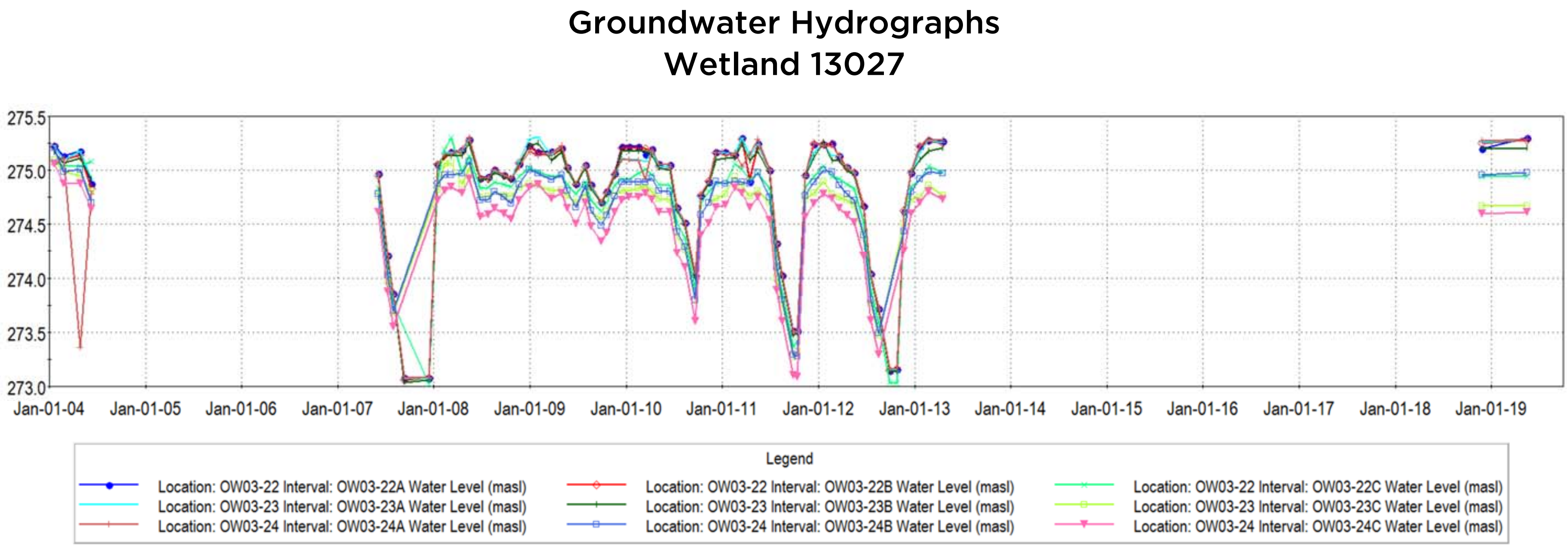


WETLAND 13027 - GRAPH 3

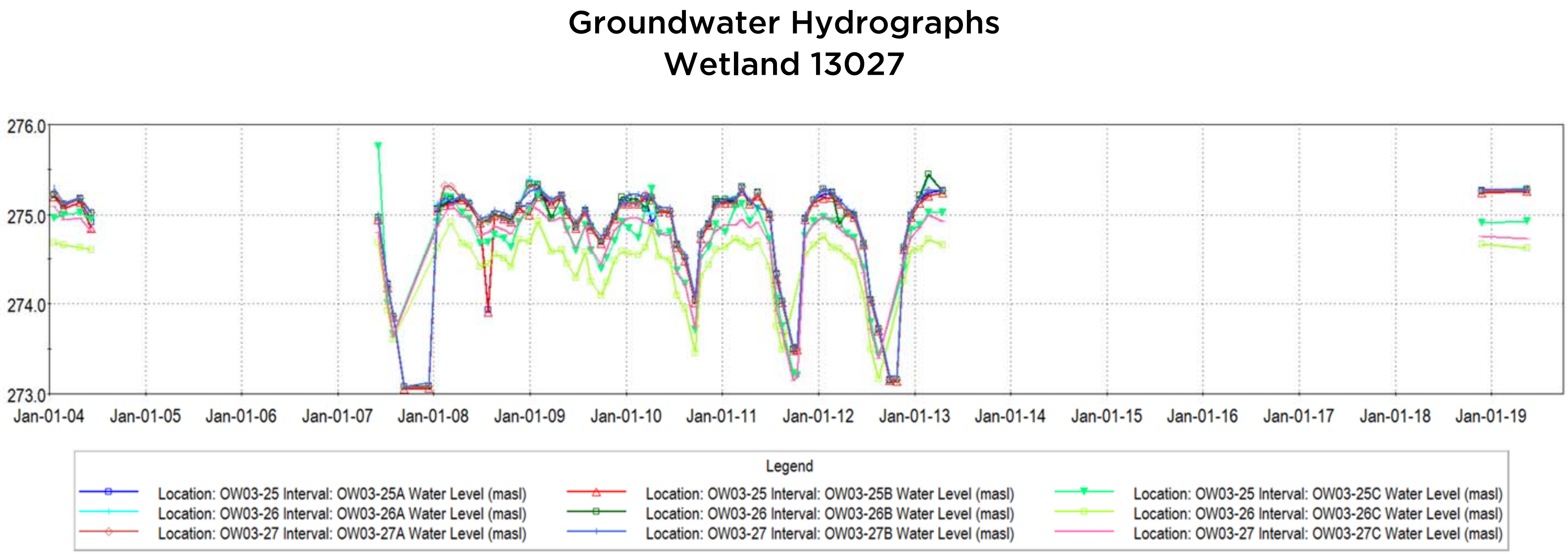


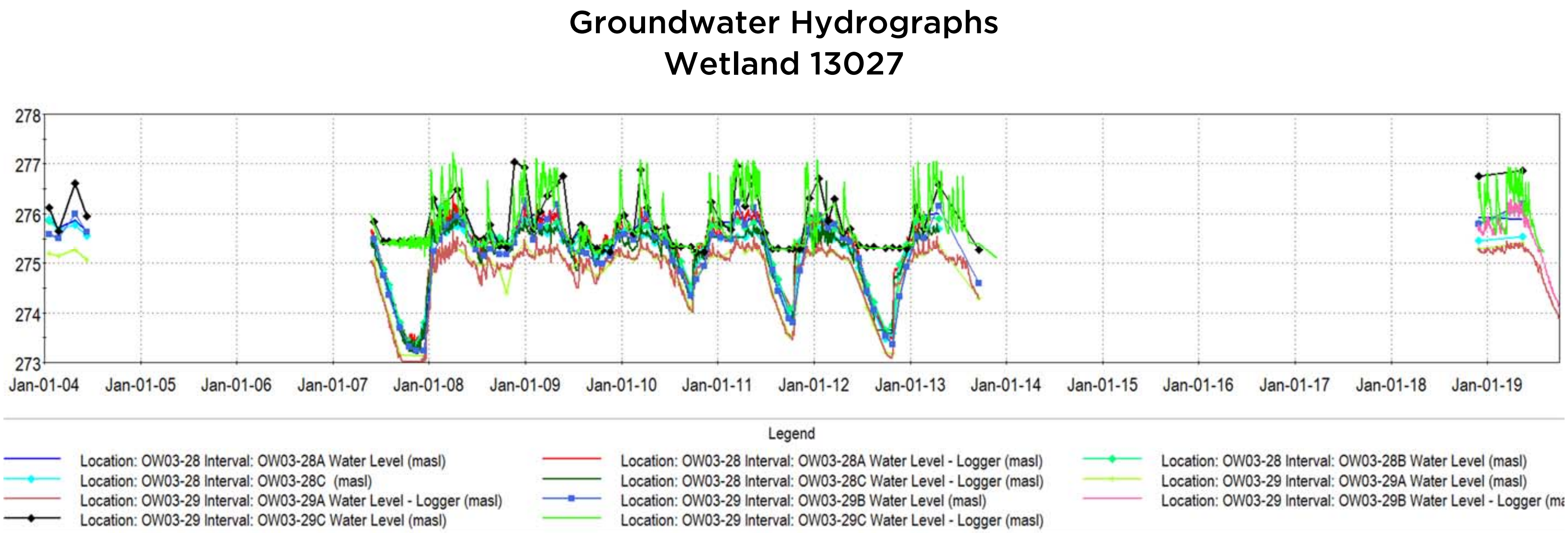

Groundwater Hydrographs
Wetland 13027
277
276
275
274
273
272
Jan-01-04
Jan-01-05
Jan-01-06
Jan-01-07
Jan-01-08
Jan-01-09
Jan-01-10
Jan-01-11
Jan-01-12
Jan-01-13
Jan-01-14
Jan-01-15
Jan-01-16
Jan-01-17
Jan-01-18
Jan-01-19
Legend
Location: MW03-04 Interval: MW03-04A (masl)
Location: MW03-04 Interval: MW03-04A Water Level - Logger (masl)
Location: MW03-04 Interval: MW03-04B Water Level (masl)
Location: MW03-04 Interval: MW03-04B Water Level - Logger (masl)
Location: MW03-04 Interval: MW03-04C Water Level (masl)
Location: MW03-04 Interval: MW03-04C Water Level - Logger (m
Location: MW03-05 Interval: MW03-05A Water Level (masl)
Location: MW03-05 Interval: MW03-05B Water Level (masl)
Location: MW03-06 Interval: MW03-06A Water Level (masl)
Location: MW03-06 Interval: MW03-06B Water Level (masl)
Location: MW03-07 Interval: MW03-07A Water Level (masl)
Location: MW03-07 Interval: MW03-07B Water Level (masl)
Location: MW03-07 Interval: MW03-07C Water Level (masl)

WETLAND 13027 - GRAPH 5



WETLAND 13027 - GRAPH 6




Groundwater Hydrographs
Wetland 13027
278
277
276
275
274
273
Jan-01-04
Jan-01-05
Jan-01-06
Jan-01-07
Jan-01-08
Jan-01-09
Jan-01-10
Jan-01-11
Jan-01-12
Jan-01-13
Jan-01-14
Jan-01-15
Jan-01-16
Jan-01-17
Jan-01-18
Jan-01-19
Legend
Location: OW03-28 Interval: OW03-28A Water Level (masl)
Location: OW03-28 Interval: OW03-28A Water Level - Logger (masl)
Location: OW03-28 Interval: OW03-28B Water Level (masl)
Location: OW03-28 Interval: OW03-28C (masl)
Location: OW03-28 Interval: OW03-28C Water Level - Logger (masl)
Location: OW03-29 Interval: OW03-29A Water Level (masl)
Location: OW03-29 Interval: OW03-29A Water Level - Logger (masl)
Location: OW03-29 Interval: OW03-29B Water Level (masl)
Location: OW03-29 Interval: OW03-29B Water Level - Logger (ma
Location: OW03-29 Interval: OW03-29C Water Level (masl)
Location: OW03-29 Interval: OW03-29C Water Level - Logger (masl)

WETLAND 13027

FIGURE 2A

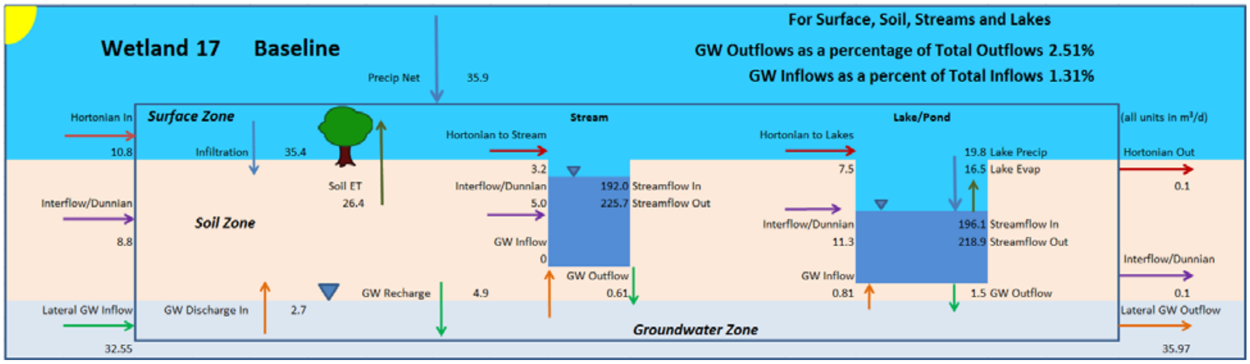


FIGURE 2B

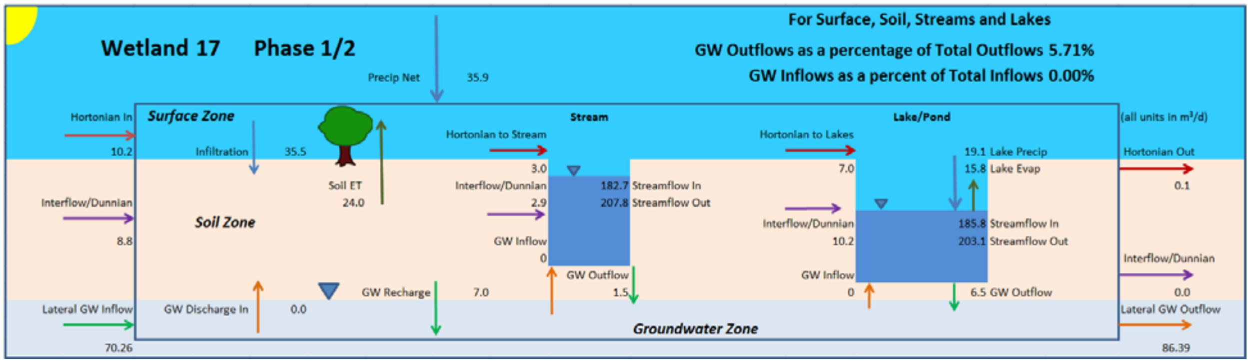


FIGURE 2C

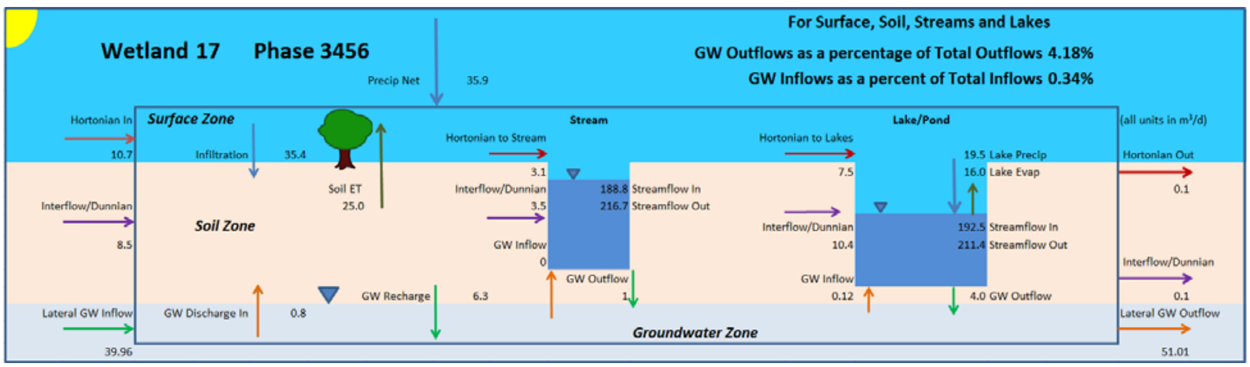


FIGURE 2D

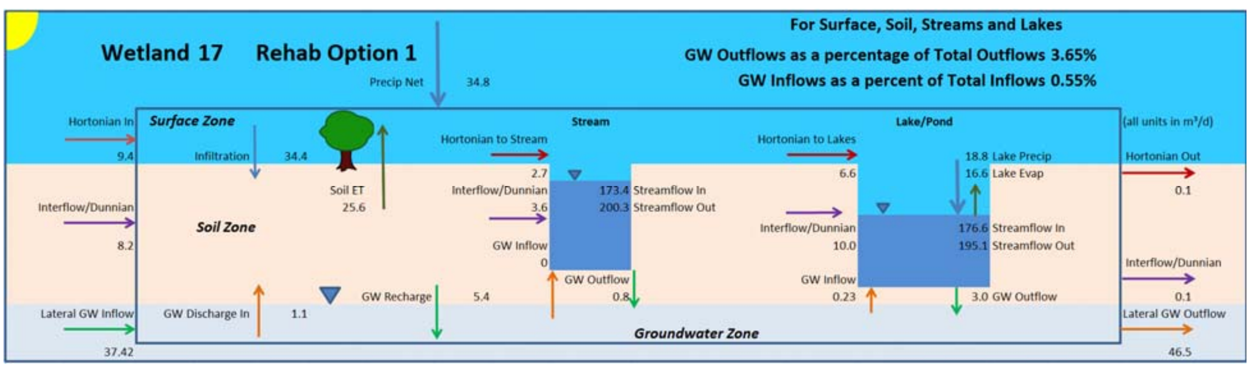
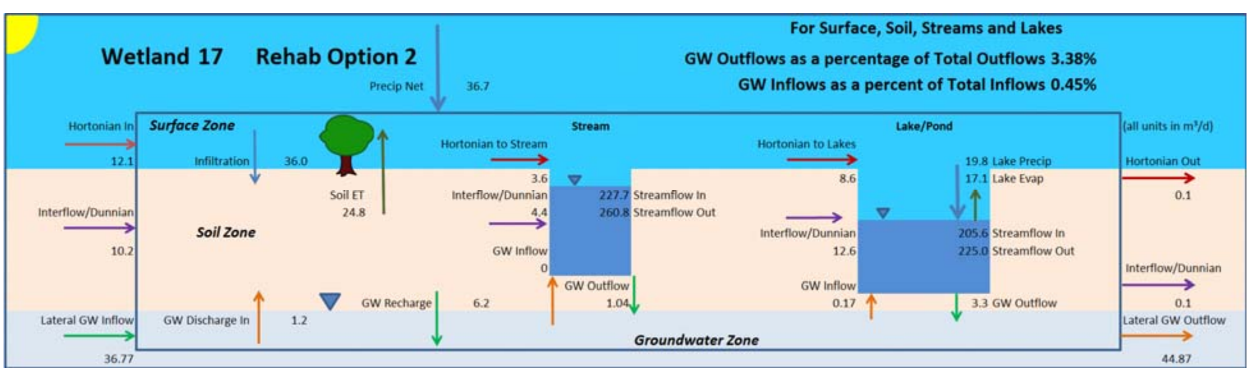
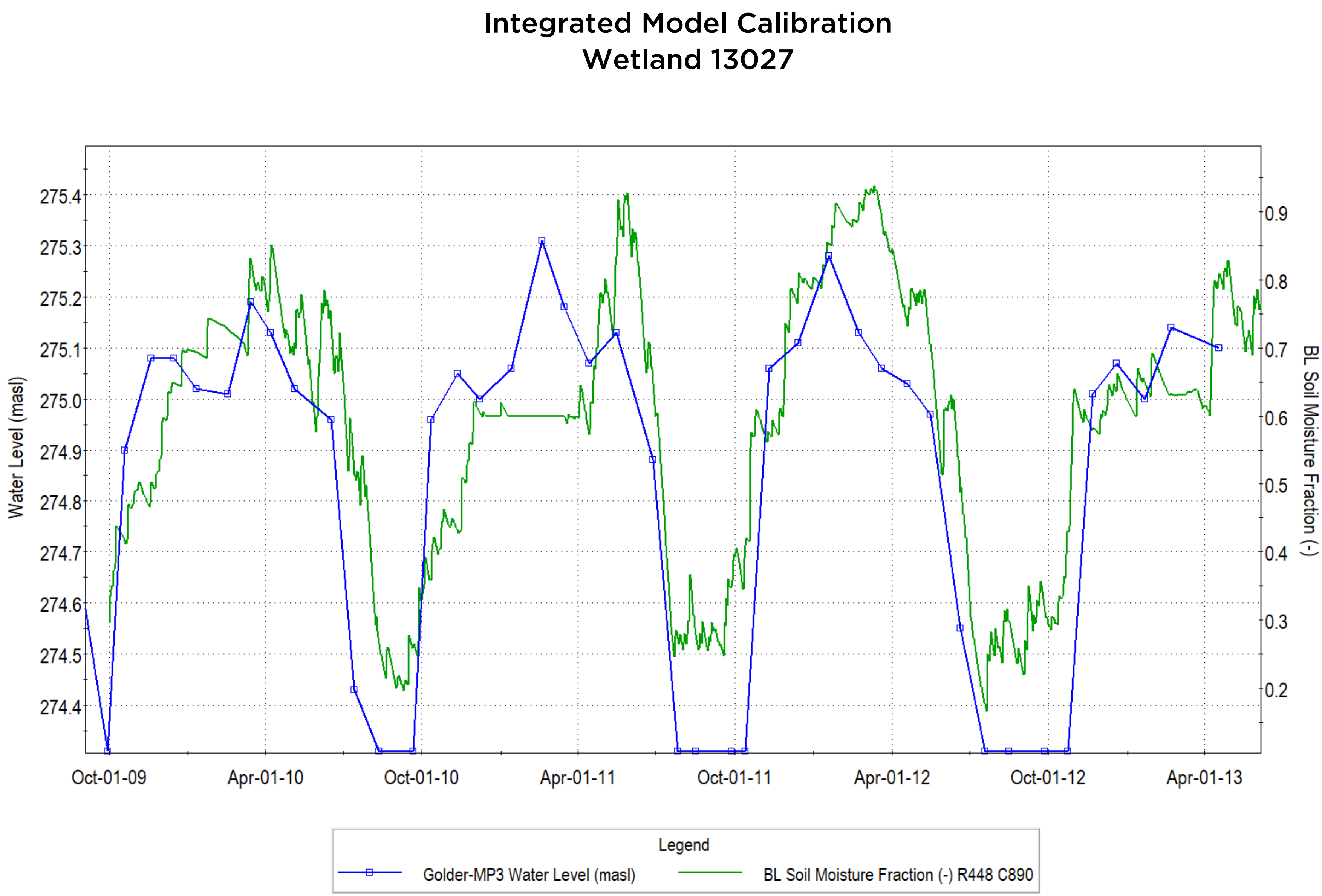
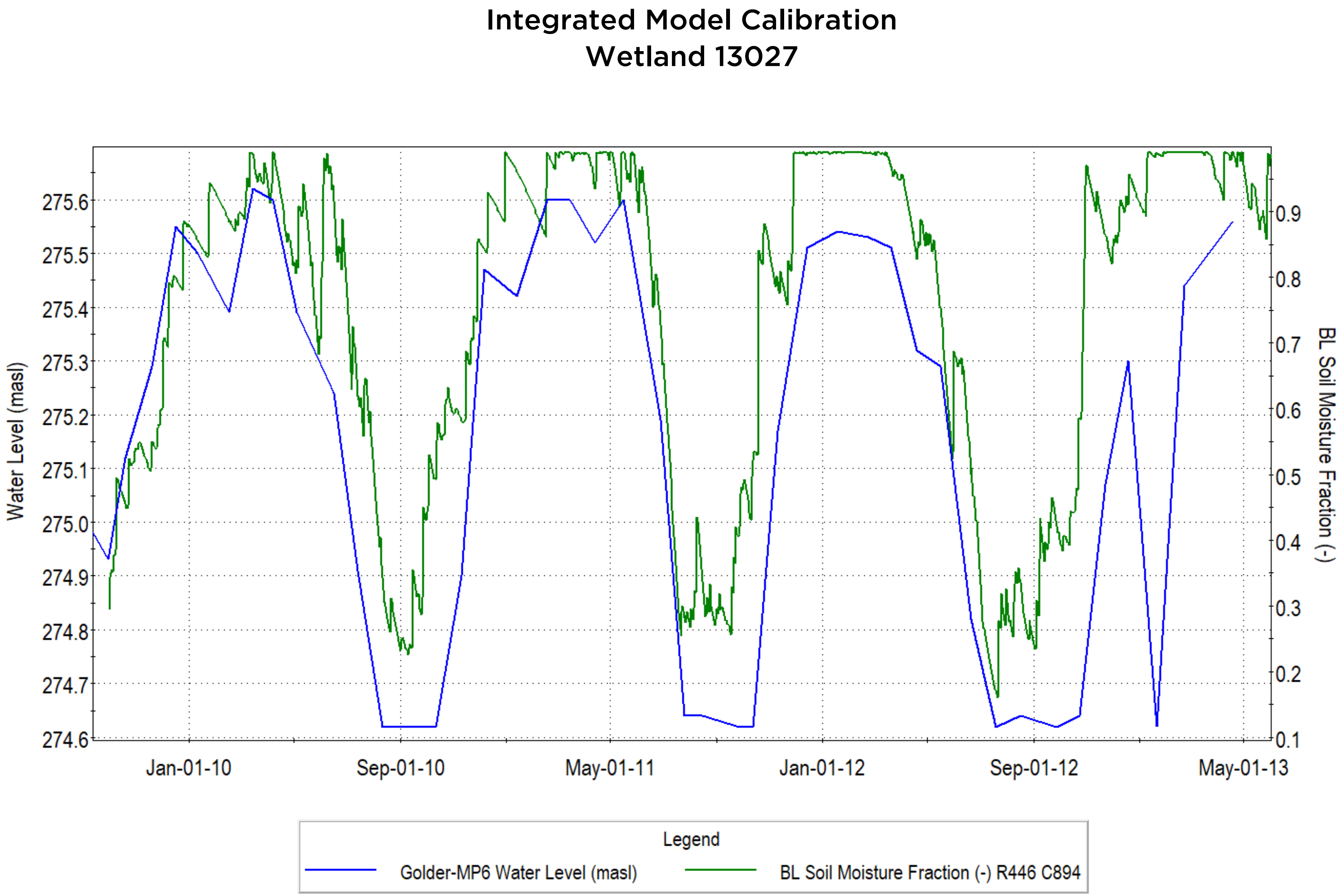


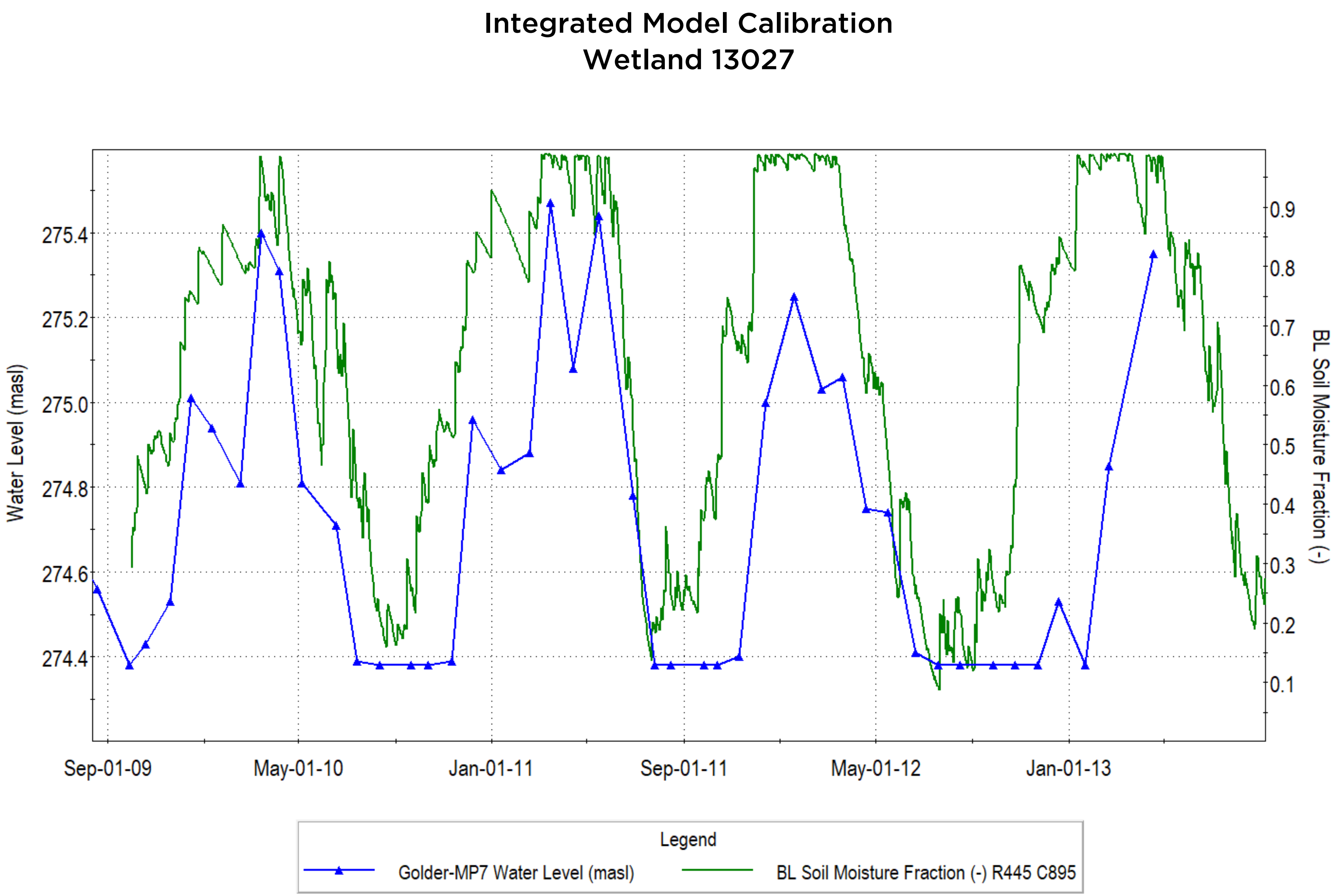
FIGURE 2E



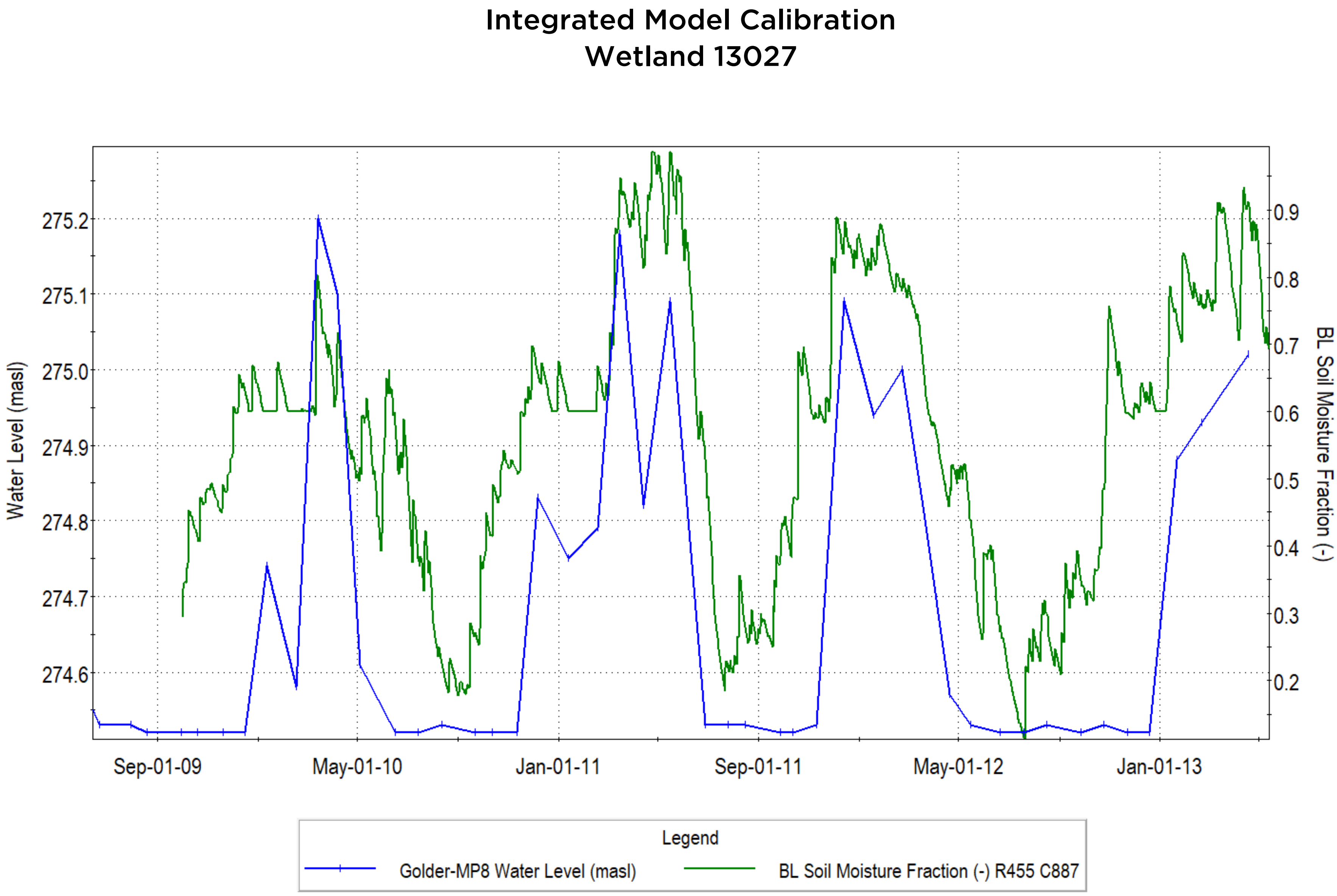
WETLAND 13027 - GRAPH 8



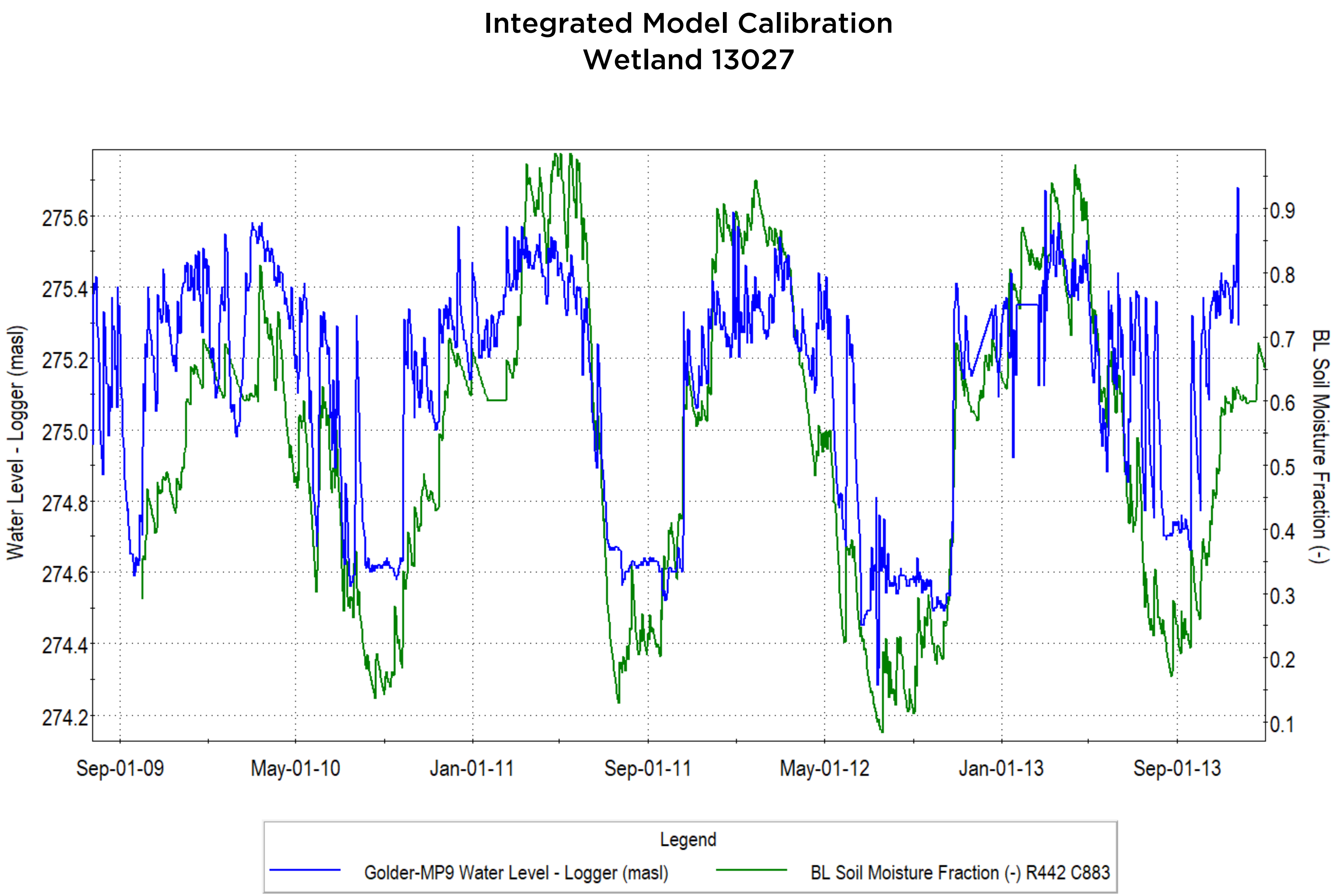

Integrated Model Calibration
Wetland 13027
Water Level (masl)
275.6
275.5
275.4
275.3
275.2
275.1
275.0
274.9
274.8
274.7
274.6
BL Soil Moisture Fraction (-)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Jan-01-10
Sep-01-10
May-01-11
Jan-01-12
Sep-01-12
May-01-13
Legend
Golder-MP6 Water Level (masl)
BL Soil Moisture Fraction (-) R446 C894


Integrated Model Calibration
Wetland 13027
Water Level (masl)
275.4
275.2
275.0
274.8
274.6
274.4
BL Soil Moisture Fraction (-)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Sep-01-09
May-01-10
Jan-01-11
Sep-01-11
May-01-12
Jan-01-13
Legend
Golder-MP7 Water Level (masl)
BL Soil Moisture Fraction (-) R445 C895

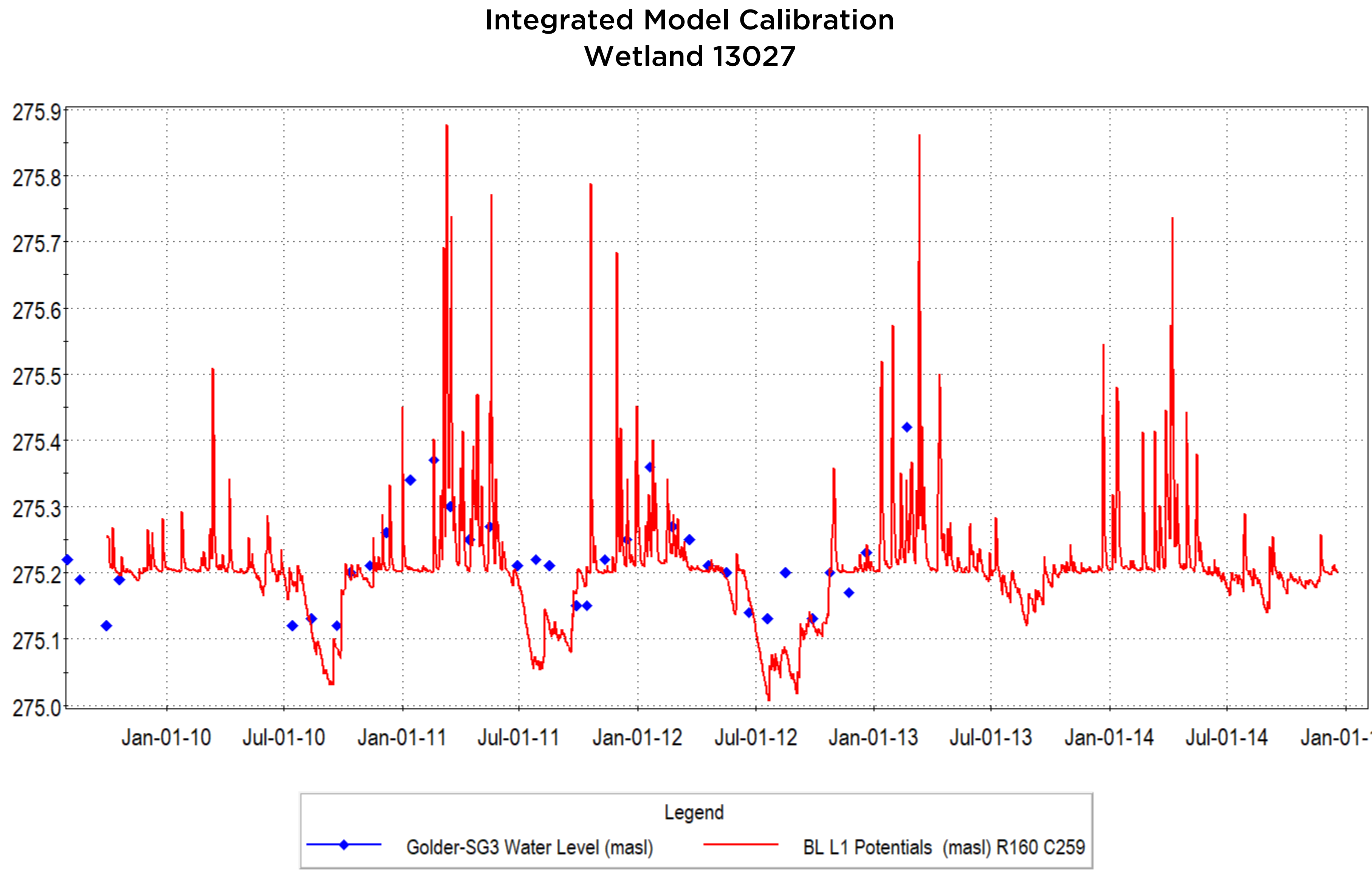
WETLAND 13027 - GRAPH 11

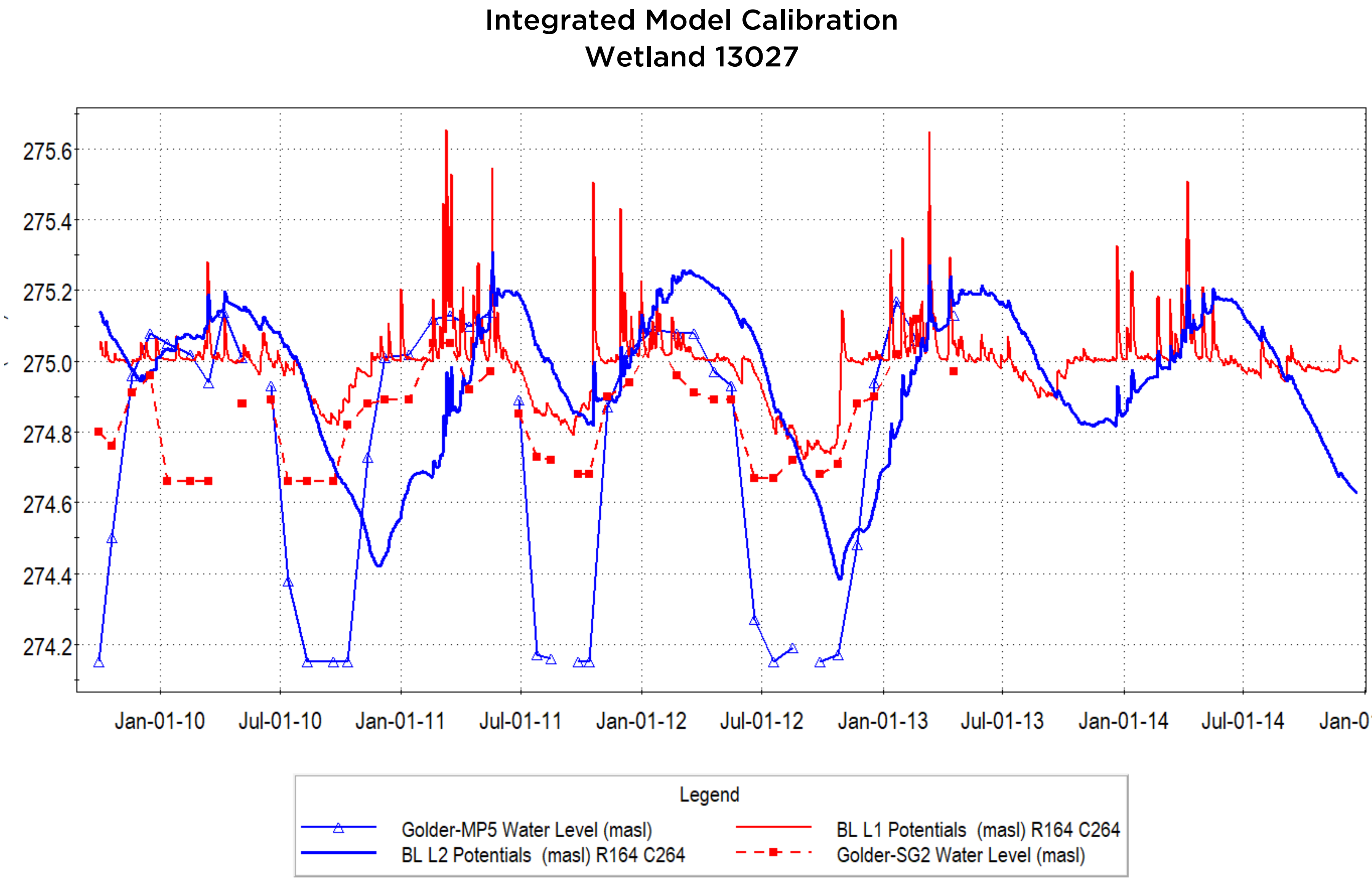


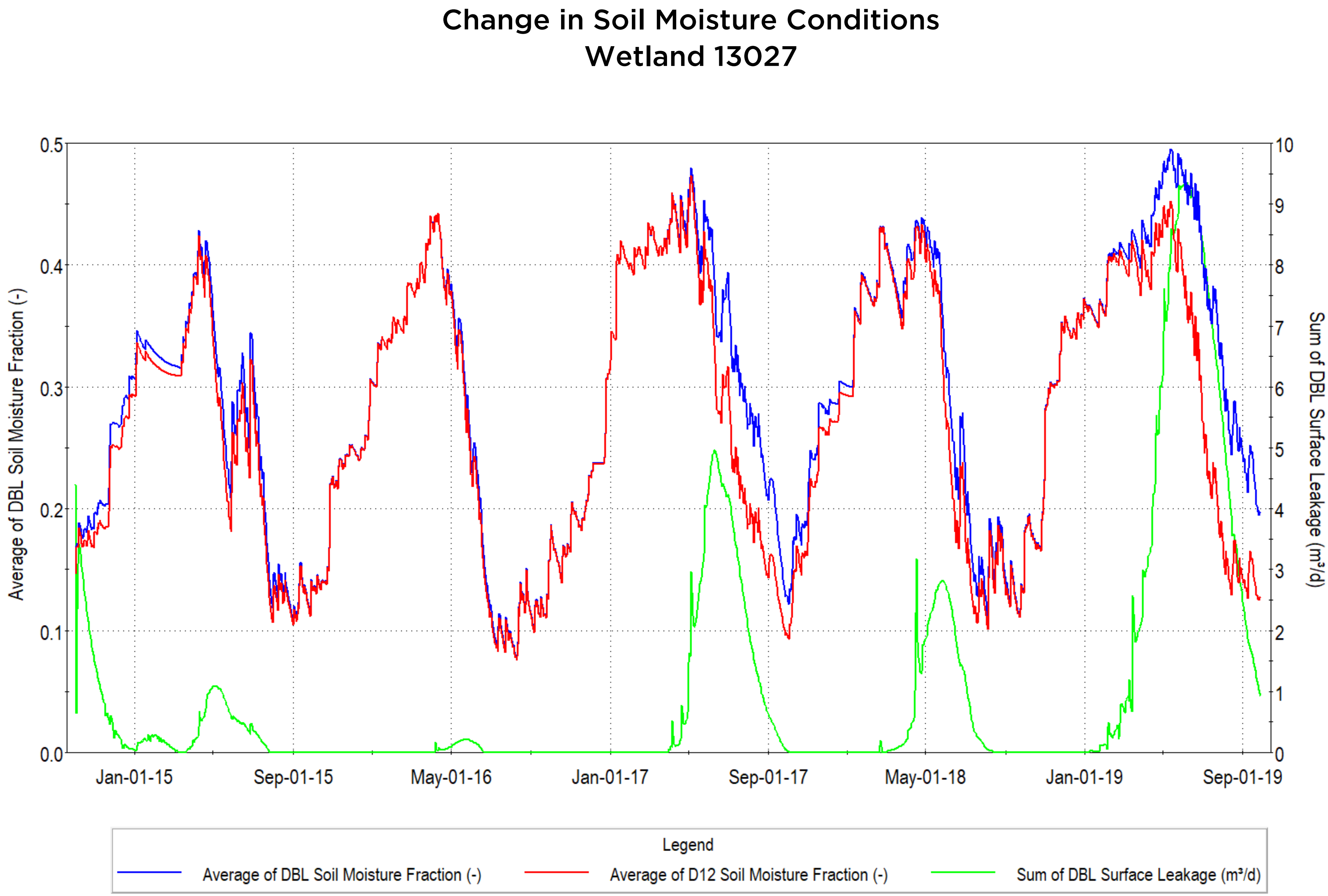
WETLAND 13027 - GRAPH 12



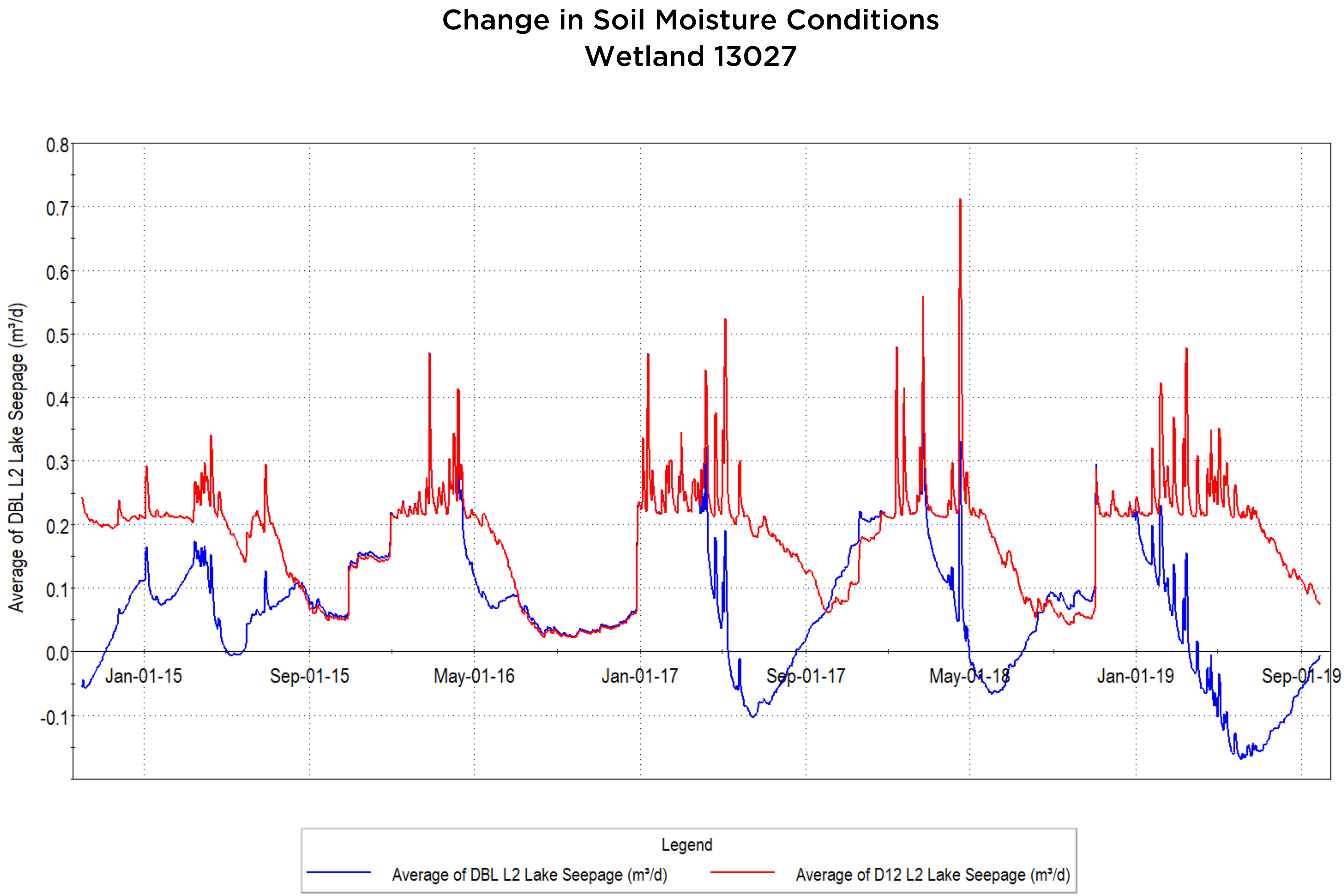
WETLAND 13027 - GRAPH 13



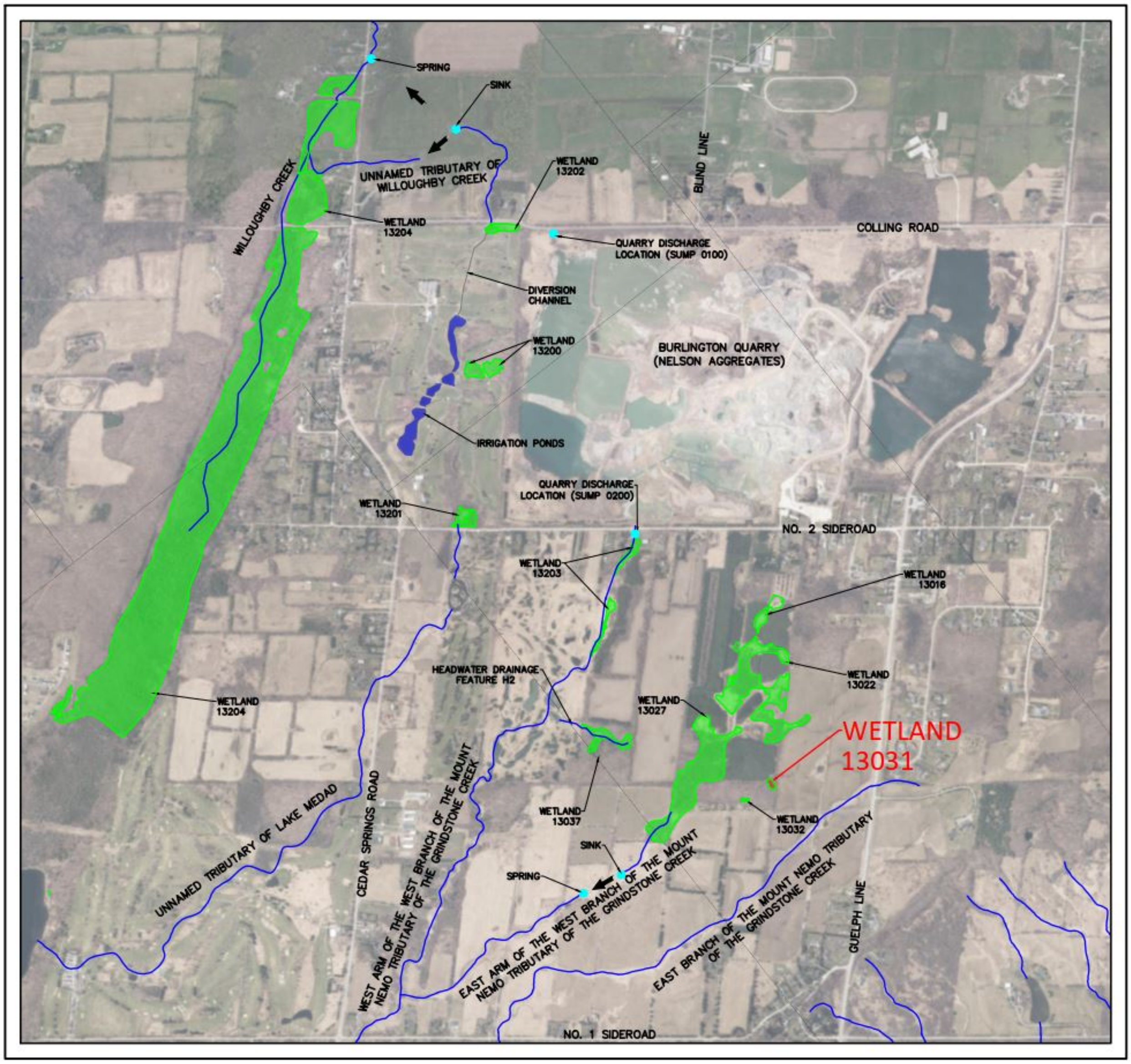

Integrated Model Calibration
Wetland 13027
275.6
275.4
275.2
275.0
274.8
274.6
274.4
274.2
Jan-01-10
Jul-01-10
Jan-01-11
Jul-01-11
Jan-01-12
Jul-01-12
Jan-01-13
Jul-01-13
Jan-01-14
Jul-01-14
Jan-01
Legend
Golder-MP5 Water Level (masl)
BL L2 Potentials (masl) R164 C264
BL L1 Potentials (masl) R164 C264
Golder-SG2 Water Level (masl)

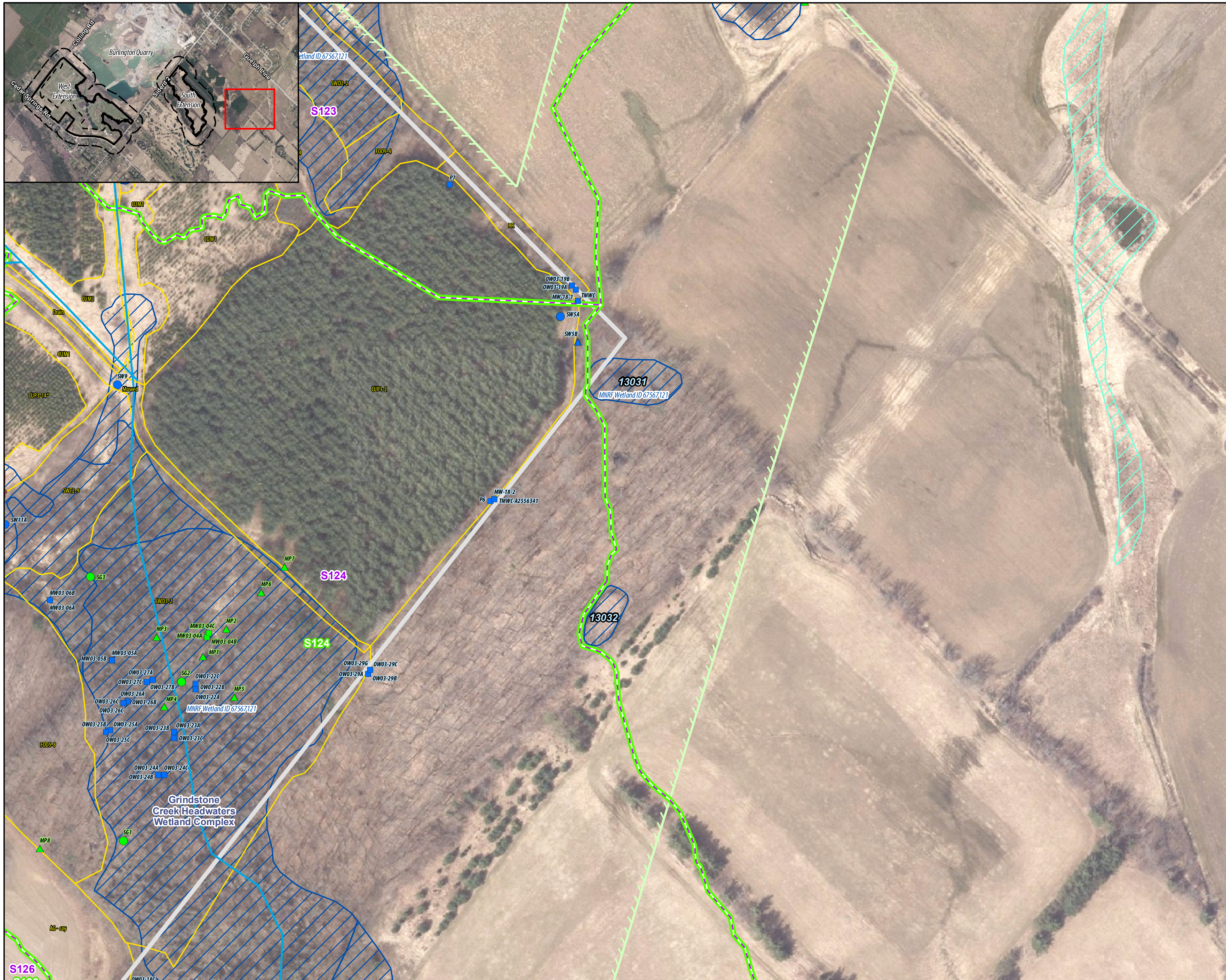

Change in Soil Moisture Conditions
Wetland 13027
Average of DBL Soil Moisture Fraction (-)
Sum of DBL Surface Leakage (m³/d)
0.0
0.1
0.2
0.3
0.4
0.5
0
1
2
3
4
5
6
7
8
9
10
Jan-01-15
Sep-01-15
May-01-16
Jan-01-17
Sep-01-17
May-01-18
Jan-01-19
Sep-01-19
Legend
Average of DBL Soil Moisture Fraction (-)
Average of D12 Soil Moisture Fraction (-)
Sum of DBL Surface Leakage (m³/d)

WETLAND 13027 - GRAPH 16



WETLAND 13031





Legend

- Subject Lands
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- Wetland - Not Evaluated per OWES (MNRF/LIO, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3-2, White Pine Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1-4, Gray Dogwood Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD5-8, Dry – Fresh Sugar Maple – White Ash Deciduous Forest
FOD9-4, Fresh – Moist Shagbark Hickory Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
SWD2-2, Green Ash Mineral Deciduous Swamp
SWD3-2, Silver Maple Mineral Deciduous Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 4
Wetland Characterization
Wetland 13031 and 13032 - South Extension

0 30 m
1:2,000

N

GEI Consultants
Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_mapbook.mxd Date S... ...uary 11, 2021

Wetland 13031

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – 67567121 (OGF ID 67567125) Earthfx – N/A Tatham – 13031 Savanta – 13031 Golder (Background) - 13031			
Wetland Area (ha):	LIO/MNRF - 0.09			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	N/A			
Catchment ID:	N/A			
Closed or Connected System:	Isolated Feature			
Condition:	Natural			
Bathymetry:	Bathymetry unavailable; off-site wetland without permission to survey.			
Outlet:	Isolated Feature			
Hydroperiod:	Spring Hydroperiod (date wetland dries out) – June 13th – July 24th Fall Hydroperiod (start of hydroperiod) – November 1st – N/A	Graph 1	SWA (Tatham, April 2020)	2.2.1, 3 and Appendix F
Surface Water Monitoring:	ID: SW5A (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 591476.534, Northing 4805331.03	Graph 1	SWA (Tatham, April 2020)	2.2.1, 3 and Appendix F

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Grindstone Creek Headwaters Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Unknown – outside of 120 m adjacent lands			
Regulated Habitat (MECP):	Yes – Jefferson Salamander (not field verified during 2019 field program; regulated based on historical data) Hydroperiod sensitive species; water presence necessary until end of June		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	Unknown – outside of 120 m adjacent lands			
Fish Habitat:	None			
Habitat of Endangered and Threatened Species:	Unknown – outside of 120 m adjacent lands			

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2" colspan="6">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td colspan="6">Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td colspan="6">Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td colspan="6">The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. None of the wetlands receive significant groundwater inflow, and are thus isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td>Shallow Groundwater (Mini-piezometer) Monitoring:</td><td colspan="6">ID: SW5B (Tatham)
Installation Date: October 23, 2018
Data Collection: Continuous water level and temperature and manual monthly water level measurements
Coordinates of Monitoring Station: Easting 591476.534, Northing 4805331.03</td><td>Graph 2</td><td>SWA (Tatham, April 2020)</td><td>2.3 and Appendix G</td></tr>
<tr><td rowspan="4">Groundwater Monitoring (Monitoring Wells):</td><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td><td rowspan="4">Graph 3</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>OW03-19A</td><td>50(NW)</td><td>Bedrock</td><td>284.87</td><td>262.1 - 255.4</td><td>268.62</td></tr>
<tr><td>OW03-19B</td><td>50(NW)</td><td>Bedrock</td><td>284.87</td><td>273.9 – 267.3</td><td>268.64</td></tr>
<tr><td>OW03-19C</td><td>50(NW)</td><td>Overburden</td><td>284.98</td><td>276.7 – 275.1</td><td>276.91</td></tr>
<tr><td>Water Budget Results:</td><td colspan="6">A detailed water budget was not produced for this wetland. The wetland is close to Wetland 13032 (Earthfx Wetland 19) and similar in size. The water budget for this wetland should be similar. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for baseline conditions is discussed in Section 7 of the main report.</td><td></td><td>HHIAR (Earthfx, April 2020)</td><td>165 - 190</td></tr>
<tr><td>Integrated Model Calibration:</td><td colspan="6">The calibration of this wetland is not discussed in the Earthfx Main Report. Section 6.11.6.3 discusses the calibration to nearby Wetland 13032 (Earthfx Wetland 19) in great detail. The calibration to nearby well OW03-19 is shown in Graph 4. The groundwater monitors are completed in the shallow and intermediate depth bedrock and exhibit similar water level elevations and fluctuations. The model simulations match the observations closely (the ground surface and model layer tops are shown as horizontal reference lines to illustrate the thickness of the till at this location).</td><td>Graph 4</td><td></td><td></td></tr>
</table>

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	Detailed water budgets were not prepared for this feature. A detailed average water budget as simulated by the integrated model is provided for nearby Wetland 13032 (Earthfx Wetland 19) Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project.			

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

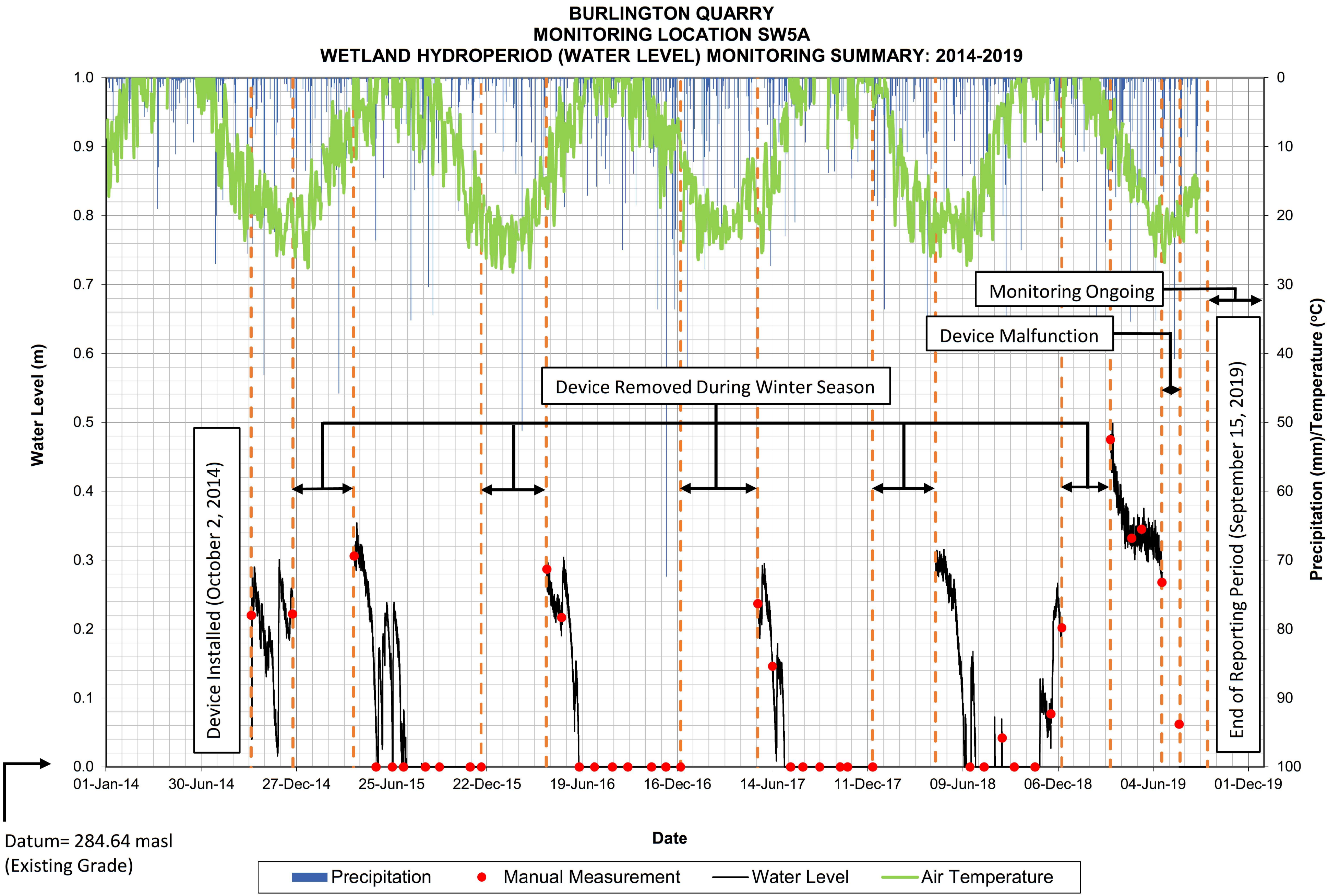
Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	Detailed water budgets were not prepared for this feature. A detailed average water budget as simulated by the integrated model is provided for nearby Wetland 13032 (Earthfx Wetland 19) Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

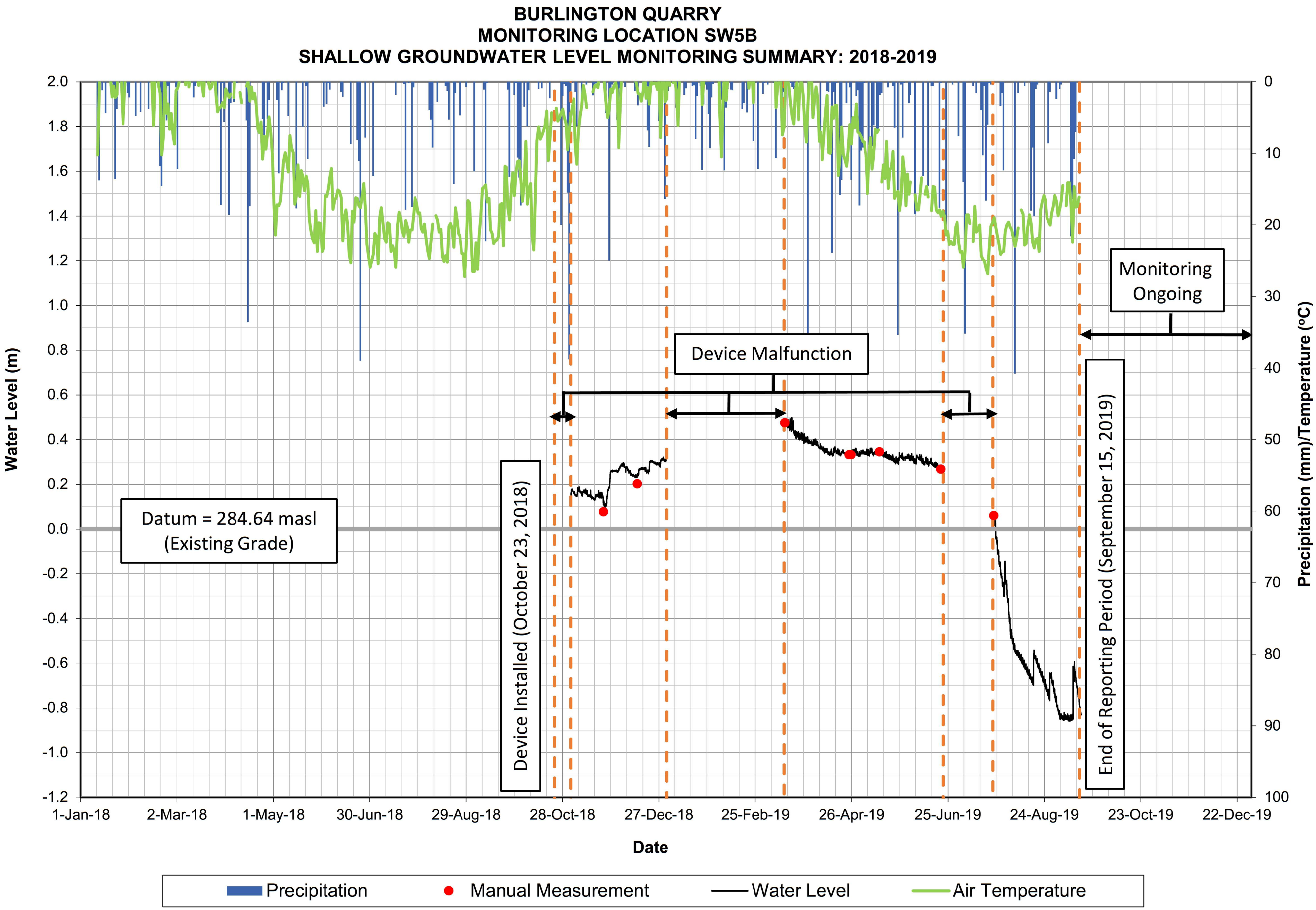
Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	5.4.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	5.4.1 & Drawing DP-3
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	5.4.1
Change in Water Budget:	Detailed water budgets were not prepared for this feature. A detailed average water budget as simulated by the integrated model is provided for nearby Wetland 13032 (Earthfx Wetland 19) Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

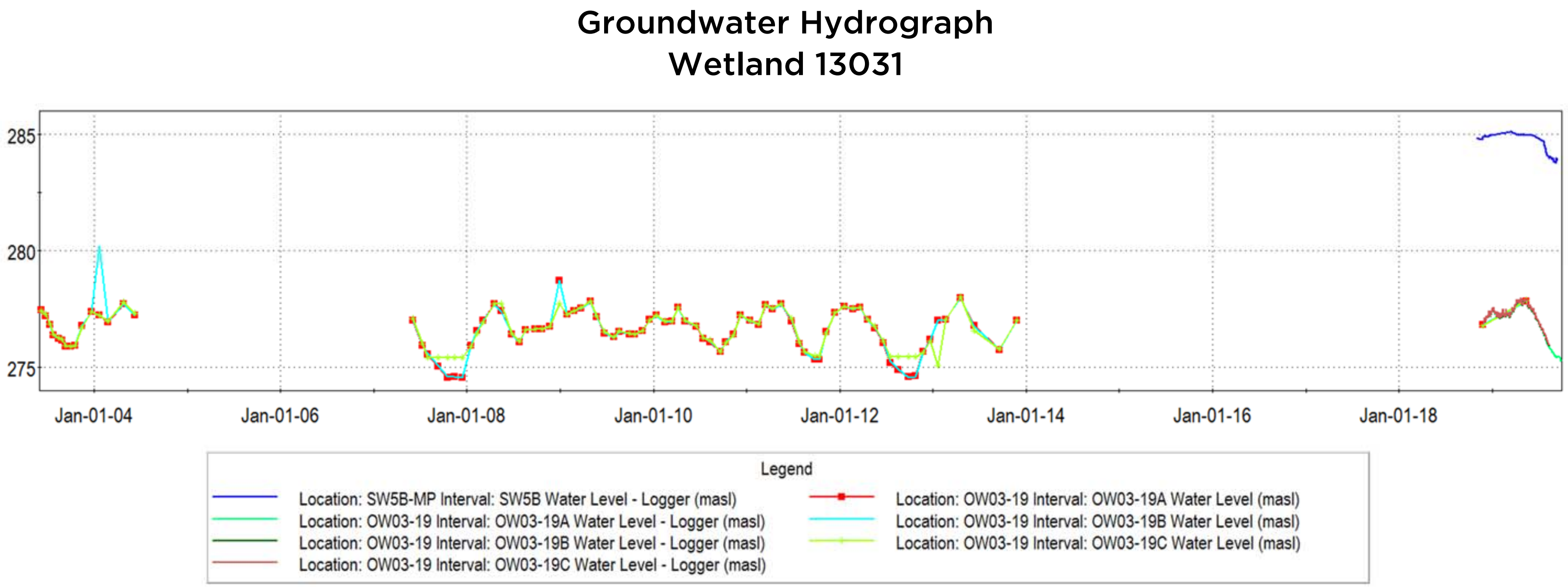
Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

WETLAND 13031 - GRAPH 1

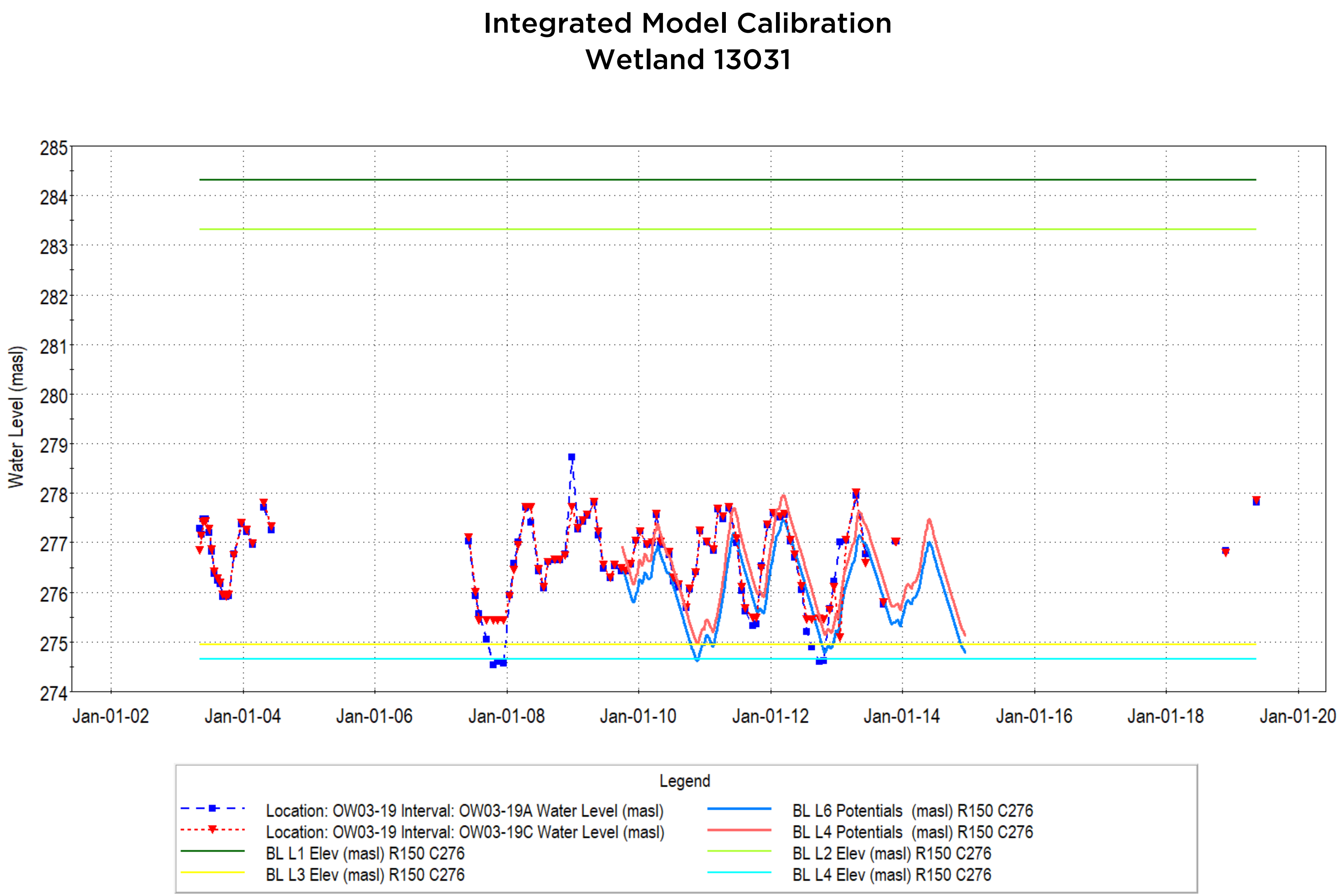


WETLAND 13031 - GRAPH 2

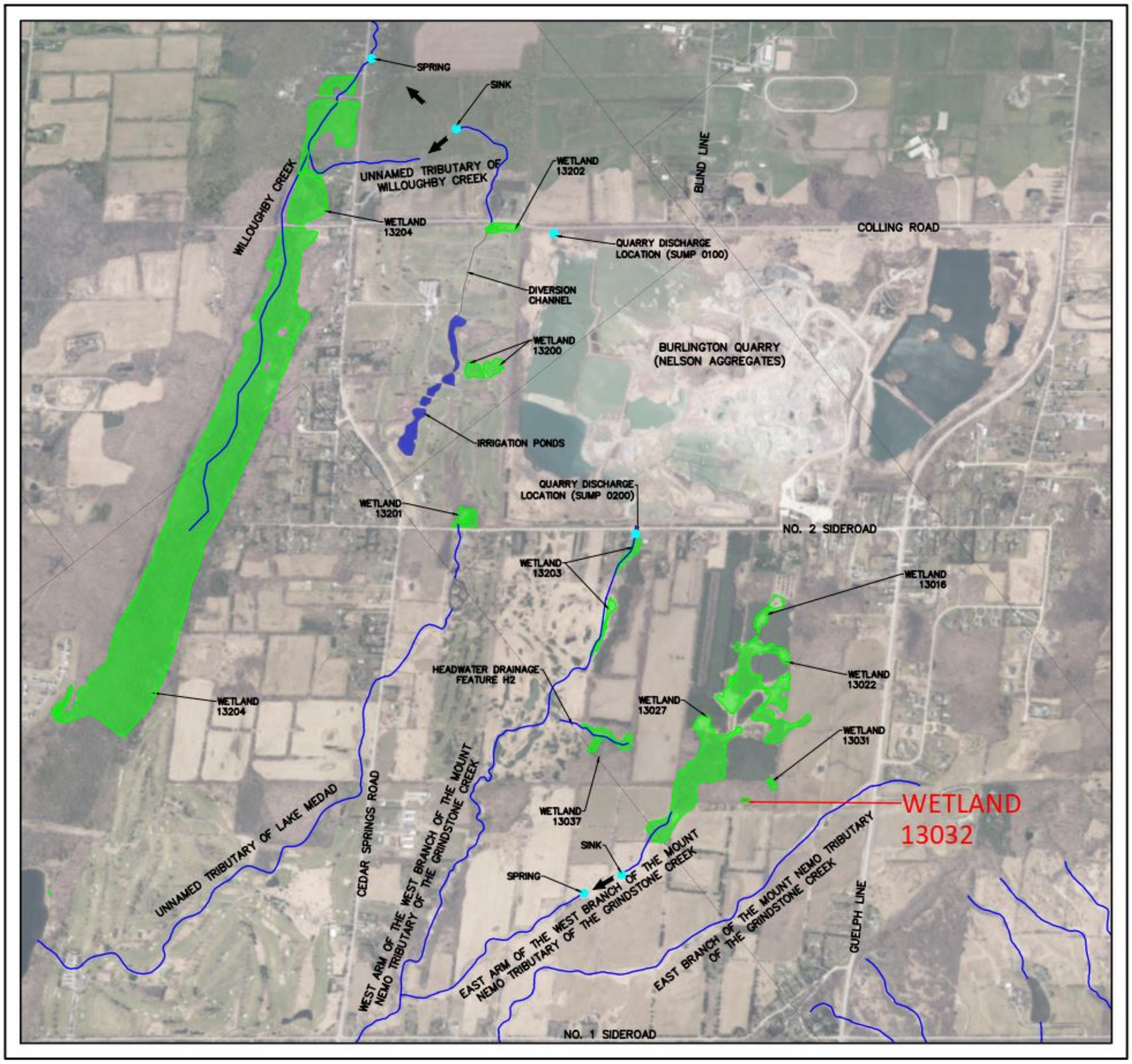


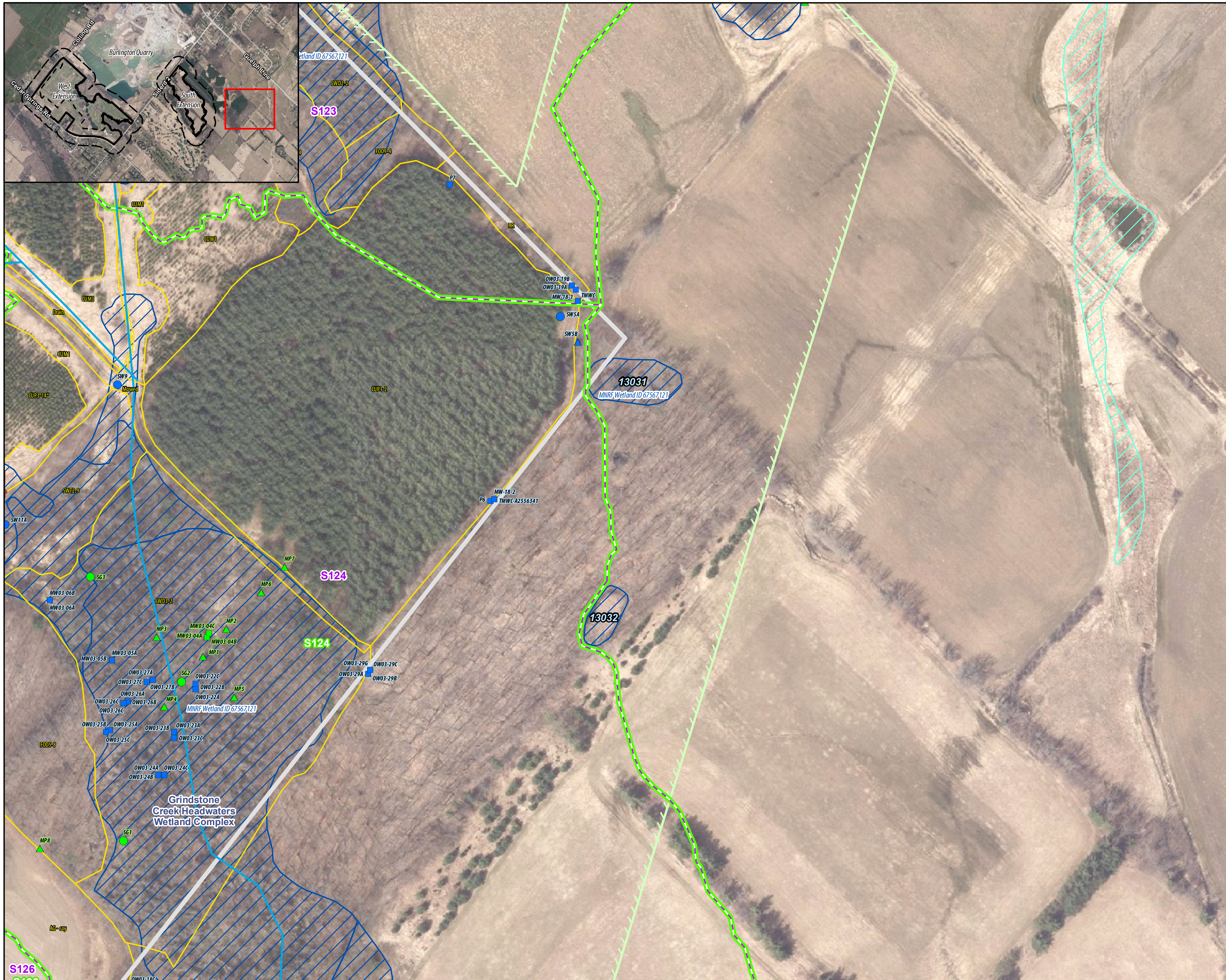

Groundwater Hydrograph
Wetland 13031
285
280
275
Jan-01-04
Jan-01-06
Jan-01-08
Jan-01-10
Jan-01-12
Jan-01-14
Jan-01-16
Jan-01-18
Legend
Location: SW5B-MP Interval: SW5B Water Level - Logger (masl)
Location: OW03-19 Interval: OW03-19A Water Level - Logger (masl)
Location: OW03-19 Interval: OW03-19B Water Level - Logger (masl)
Location: OW03-19 Interval: OW03-19C Water Level - Logger (masl)
Location: OW03-19 Interval: OW03-19A Water Level (masl)
Location: OW03-19 Interval: OW03-19B Water Level (masl)
Location: OW03-19 Interval: OW03-19C Water Level (masl)

WETLAND 13031 - GRAPH 4



WETLAND 13032





Legend

- Subject Lands
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- Wetland - Not Evaluated per OWES (MNRF/LIO, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3-2, White Pine Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1-4, Gray Dogwood Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD5-8, Dry – Fresh Sugar Maple – White Ash Deciduous Forest
FOD9-4, Fresh – Moist Shagbark Hickory Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
SWD2-2, Green Ash Mineral Deciduous Swamp
SWD3-2, Silver Maple Mineral Deciduous Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 4
Wetland Characterization

Wetland 13031 and 13032 - South Extension

0 30 m
1:2,000
N

GEI Consultants
Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_mapbook.mxd Date S... ...ary 11, 2021

Wetland 13032

Wetland Characteristics	Description	Figure / Graph	Reference: Report	Reference: Section / Page
Wetland IDs:	MNRF – 67567121 (OGF ID 67567150) Earthfx – 19 Tatham – 13032 Savanta – 13032 Golder (Background) - 13032			
Wetland Area (ha):	LIO/MNRF - 0.04			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	N/A			
Catchment ID:	N/A			
Closed or Connected System:	Isolated Feature			
Condition:	Natural			
Bathymetry:	Bathymetry unavailable; off-site wetland without permission to survey.			
Outlet:	Isolated Feature			
Hydroperiod:	It is understood a permanent pool of water is maintained in Wetland 13032 year-round.			
Surface Water Monitoring:	MNRF Wetland 13032 was monitored in 2007 by the H Pond Staff Gauge (HPond SG). In addition to the staff gauge in the pond, two drive point mini-piezometers were installed near this pond in 2007. These drive points were always dry, indicating that the pond is perched above the water table.		HHIAR (Earthfx, April 2020)	158

Water Level Measurement Summary			
	Pond	DP1	DP2
Ref:	283.09	284.09	283.31
GS:	-	283.29	282.63
Date	Water Level Elevations		
17-May-07	283.40	N/A	N/A
11-Jul-07	283.21	282.25	281.83

Notes:
Ref: = reference point elevation
GS = ground surface elevation
DP1 is adjacent to the pond (north)
DP2 is about 20 m north (downslope) of the pond

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference: Report	Reference: Section / Page
Wetland Name & Provincial Significance Evaluation:	Grindstone Creek Headwaters Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Unknown – outside of 120 m adjacent lands			
Regulated Habitat (MECP):	Yes – Jefferson Salamander (not field verified during 2019 field program; regulated based on historical data) Hydroperiod sensitive species; water presence necessary until end of June		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	Unknown – outside of 120 m adjacent lands			
Fish Habitat:	None			
Habitat of Endangered and Threatened Species:	Unknown – outside of 120 m adjacent lands			

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2" colspan="6">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td colspan="6">Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td colspan="6">Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td colspan="6">The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland receives no significant groundwater inflow, and is isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Background Shallow Groundwater (Mini-piezometer) Monitoring:</td><td>Mini-piezometer ID</td><td>Ground Elevation</td><td>Bottom Elevation</td><td>Average WL</td><td>Logger</td><td>Manual Meas.</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>DP1</td><td>283.29</td><td>282.25</td><td>Dry</td><td>-</td><td>2007.00</td></tr>
<tr><td>DP2</td><td>282.63</td><td>281.83</td><td>Dry</td><td>-</td><td>2007.00</td></tr>
<tr><td rowspan="5">Groundwater Monitoring (Monitoring Wells):</td><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td><td rowspan="5">Graph 1</td><td rowspan="5"></td><td rowspan="5"></td></tr>
<tr><td>OW03-29A</td><td>126 (W)</td><td>Bedrock</td><td>277.06</td><td>256.46 - 248.92</td><td>274.84</td></tr>
<tr><td>OW03-29B</td><td>126 (W)</td><td>Bedrock</td><td>277.05</td><td>273.93 - 266.83</td><td>275.47</td></tr>
<tr><td>OW03-29C</td><td>126 (W)</td><td>Overburden</td><td>277.02</td><td>276.72 - 275.12</td><td>275.79</td></tr>
<tr><td>OW03-29G</td><td>126 (W)</td><td>Overburden</td><td>277.02</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">Water Budget Results:</td><td colspan="6">A detailed average water budget, as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.27, p. 188). The baseline water budget is reproduced in Figure 1a. The wetland is a net provider of groundwater and never receives groundwater inflow. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) are discussed in Section 7 of the main report.</td><td rowspan="3">Figure 1a</td><td rowspan="3">HHIAR (Earthfx, April 2020)</td><td rowspan="3">165 - 190</td></tr>
<tr><td>Wetland 13032</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td colspan="3"></td></tr>
<tr><td>Baseline (Existing)</td><td>19.82</td><td>0.00</td><td colspan="3"></td></tr>
<tr><td>Integrated Model Calibration:</td><td colspan="6">Earthfx Figures 6.35 and 6.36 (p.159) in the Main Report shows data for the H Pond staff gauge along with hydrographs of simulated shallow water levels. The results are reproduced in Graph 2. A discussion of Wetland 19 is contained in Earthfx Section 6.11.6.3 (p. 158).</td><td>Graph 2</td><td></td><td></td></tr>
</table>

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.34, p. 223); and P3456 (Figure 8.66, p. 250). The water budget results for Scenario P12 are reproduced in Figure 1b. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.	Figure 1b	HHIAR (Earthfx, April 2020)	191 - 303
Change on Soil Moisture Conditions:	The Water Budget figures indicate that there is no groundwater seepage entering the wetland under baseline conditions, so there will be no change under P12 conditions.			
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13032	GW Outflow (%)	GW Inflow (%)	Change in GW	Change in GW
Baseline (Existing)	19.82	0.00	-	-
Operations Ph 1 & 2	19.35	0.00	-0.47	0.00

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.34, p. 223); and P3456 (Figure 8.66, p. 250). The water budget results for Scenario P3456 are reproduced in Figure 1c. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.	Figure 1c	HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13032	GW Outflow (%)	GW Inflow (%)	Change in GW	Change in GW
Baseline (Existing)	19.82	0.00	-	-
Operations Ph 3 - 6	19.79	0.00	-0.03	0.00

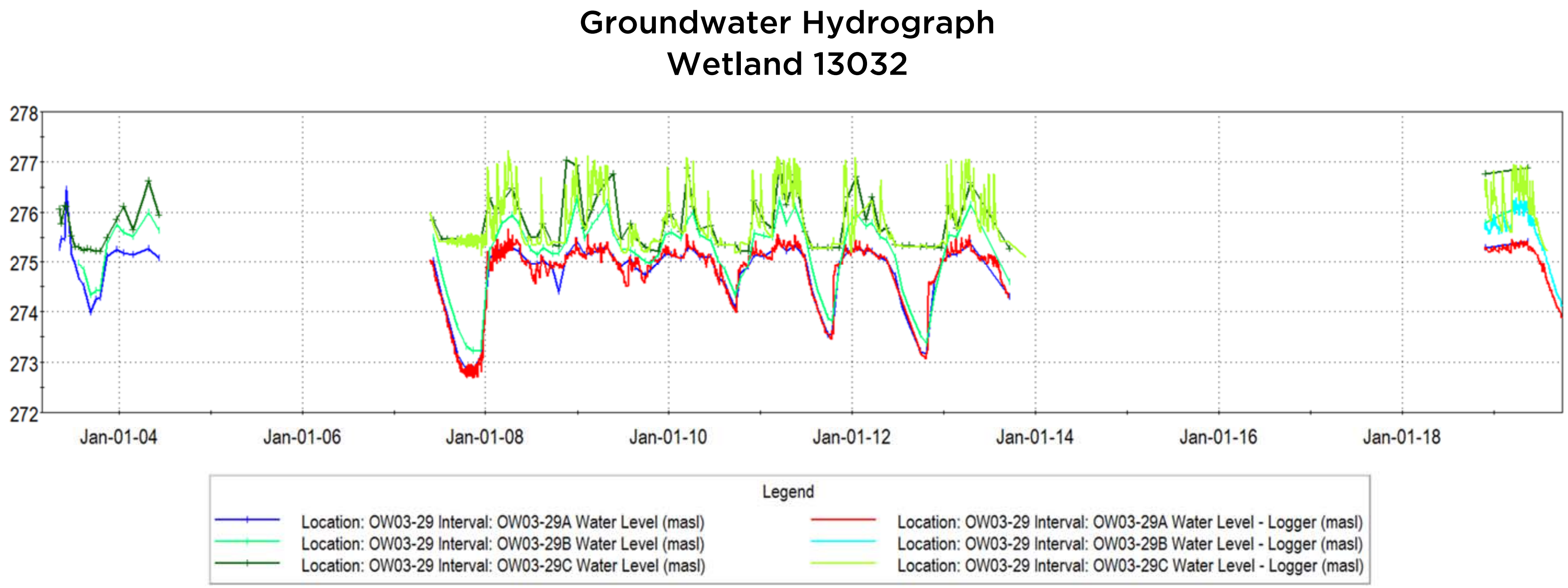
Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	5.4.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	5.4.1 & Drawing DP-3
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	5.4.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.34, p. 223); and P3456 (Figure 8.66, p. 250). The water budget results for Scenario RHB1 and RHB2 are reproduced in Figures 1d and 1e. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for each scenario are discussed in Section 8 of the main report.	Figure 1d and 1e	HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13027	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	19.82	0.00	-	-
Rehab Scenario 1	20.94	0.00	1.12	0.00
Rehab Scenario 2	20.30	0.00	0.48	0.00

Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

WETLAND 13032 - GRAPH 1



WETLAND 13032

FIGURE 1A

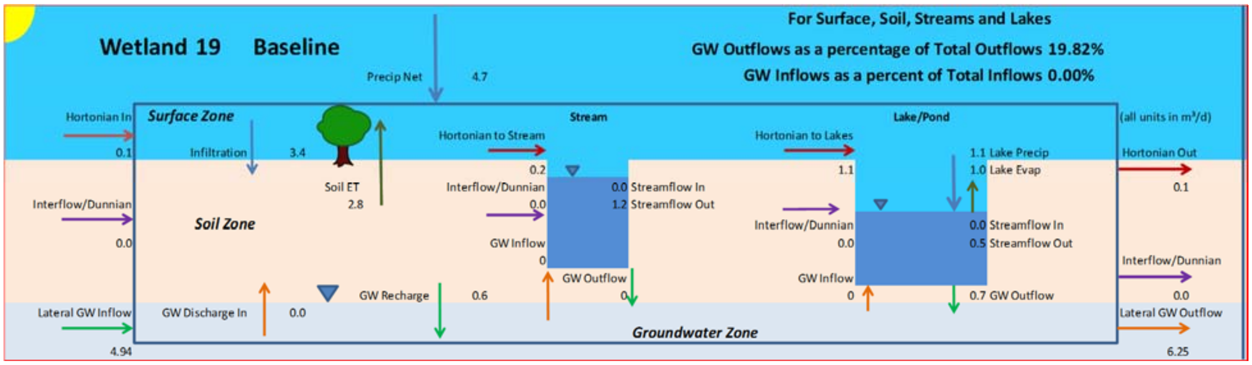


FIGURE 1B

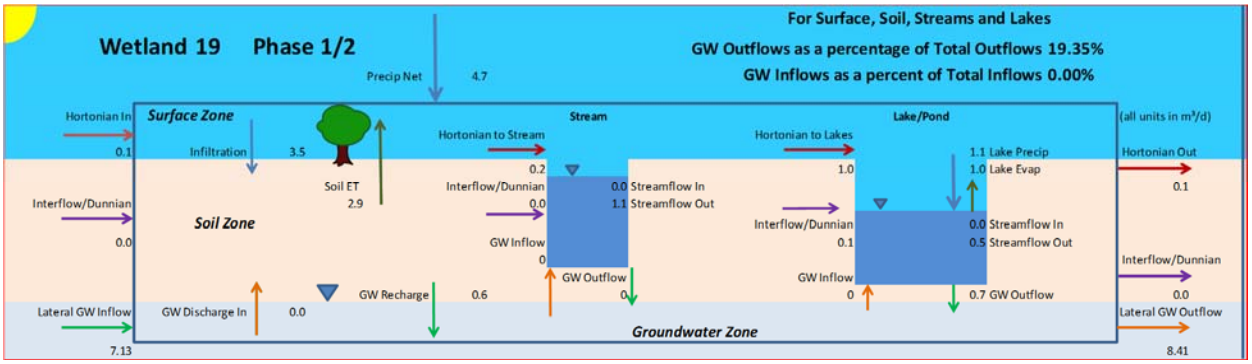


FIGURE 1C

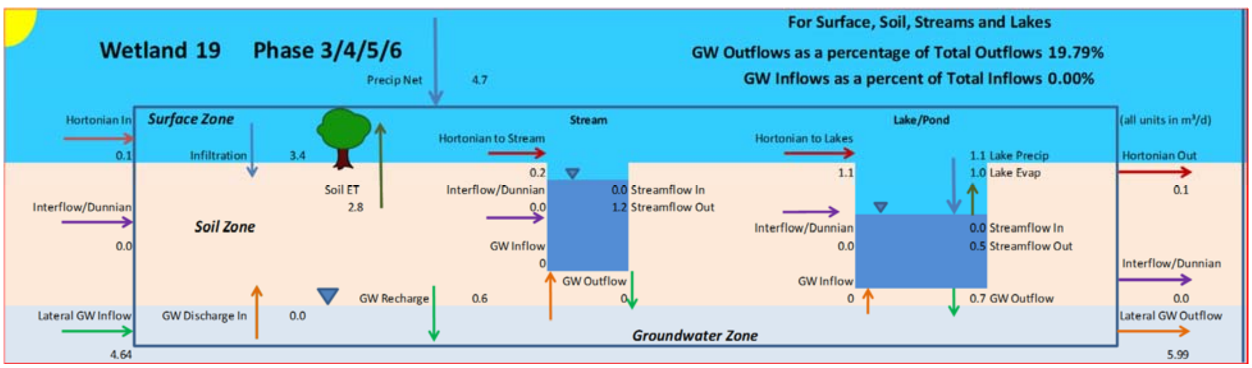


FIGURE 1D

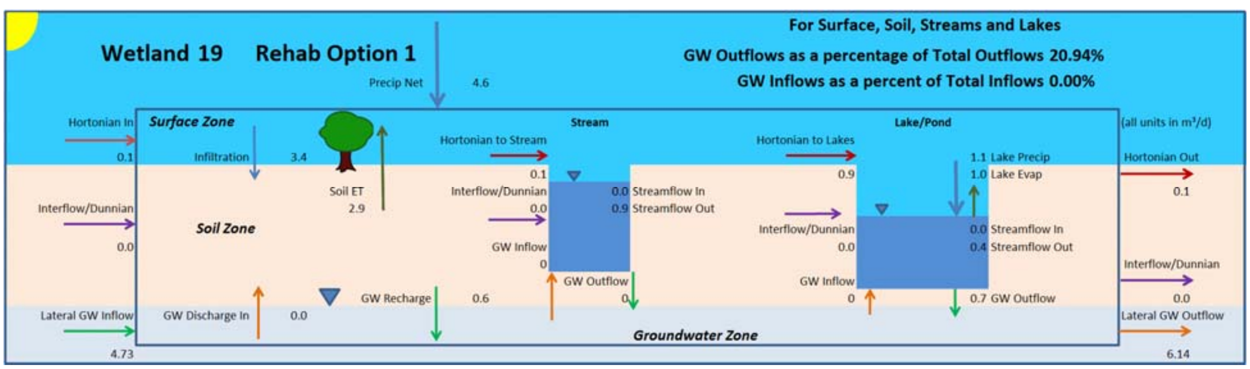
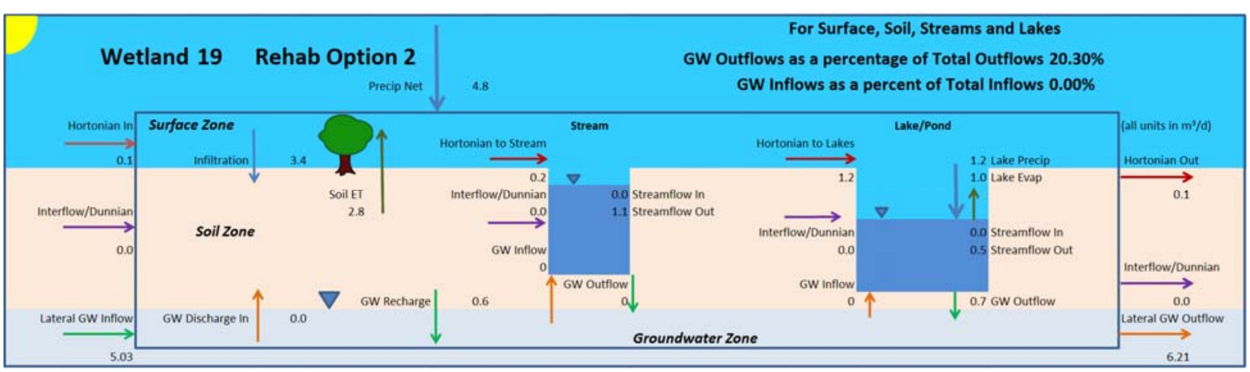
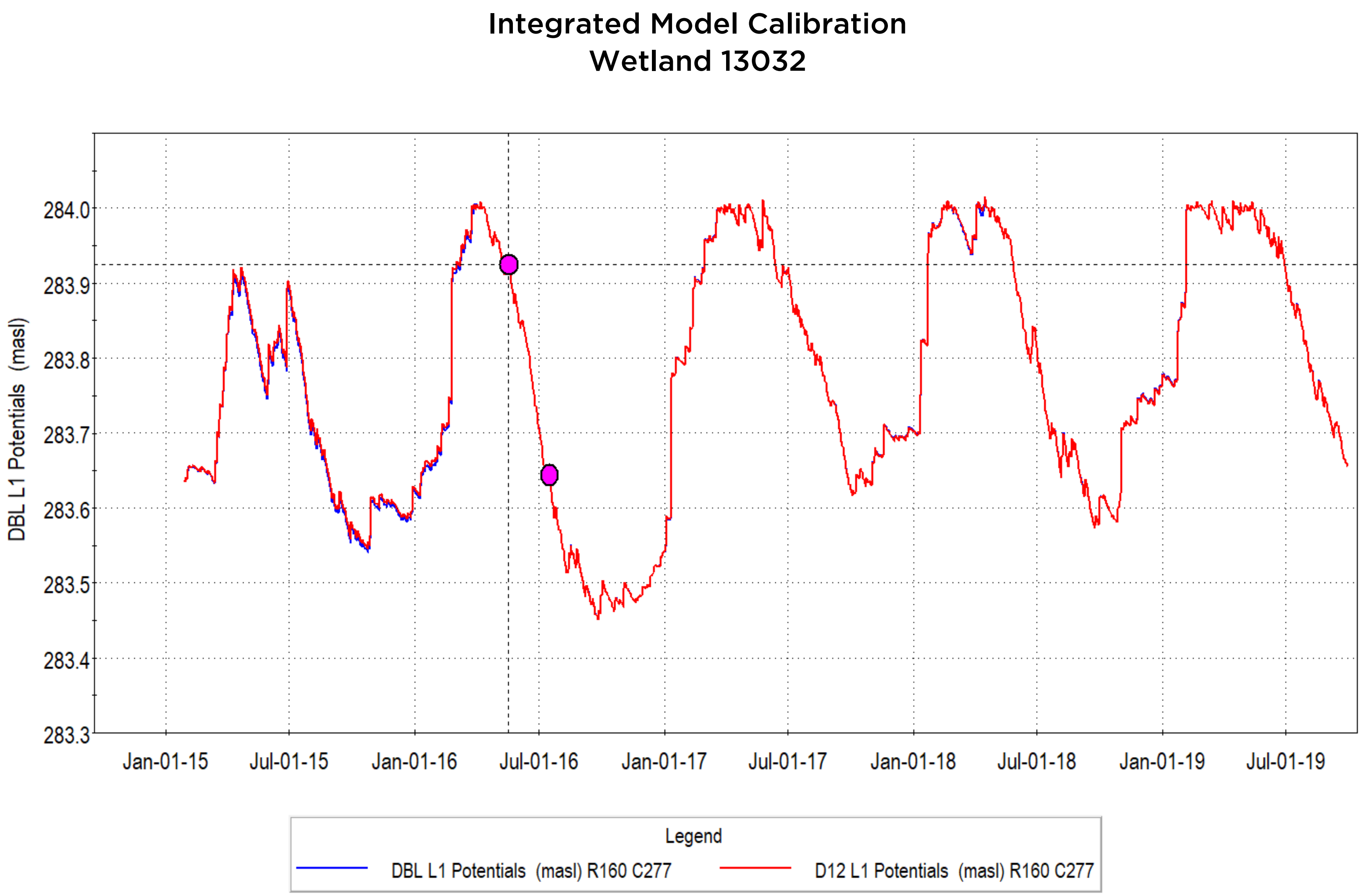


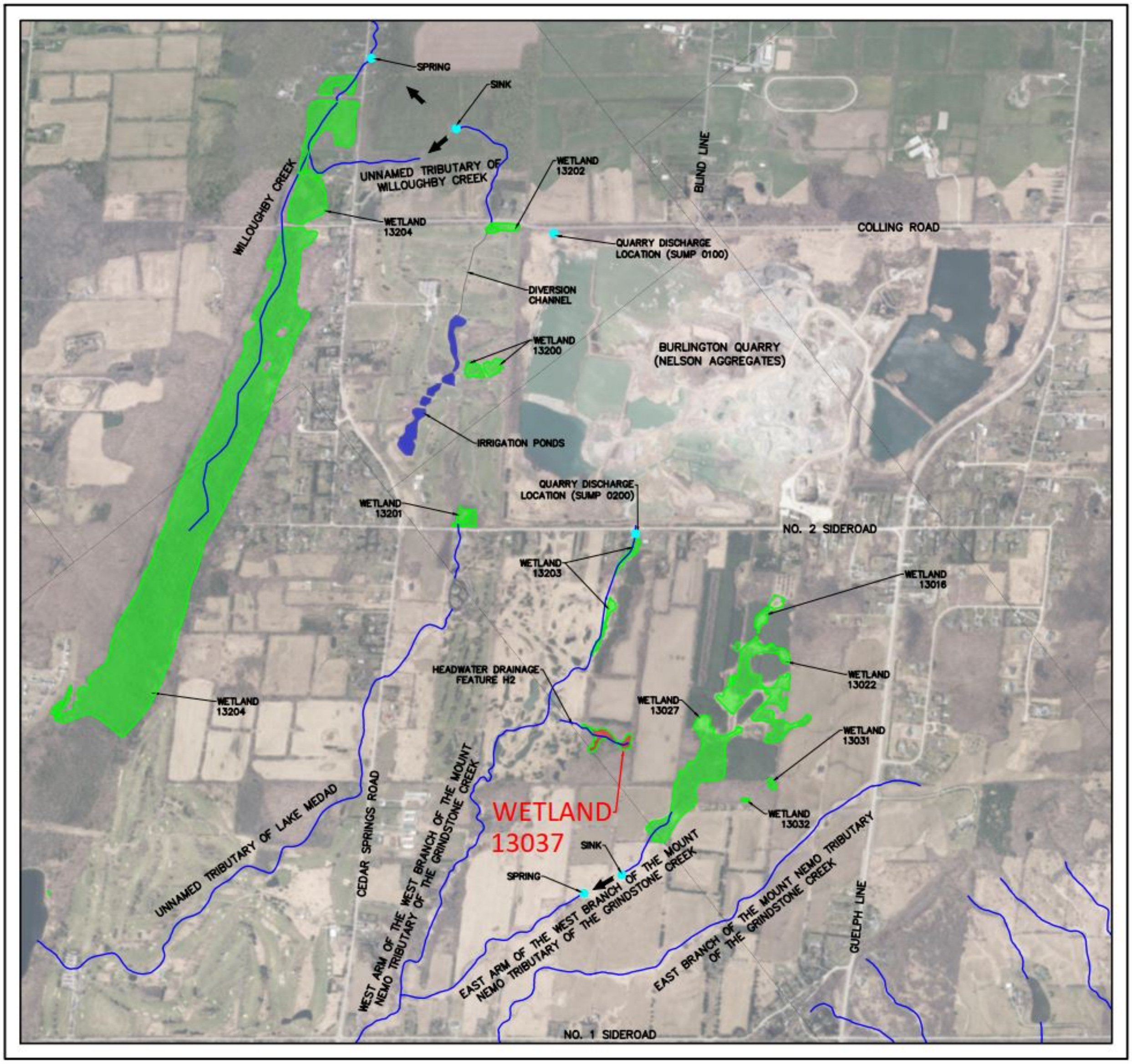
FIGURE 1E

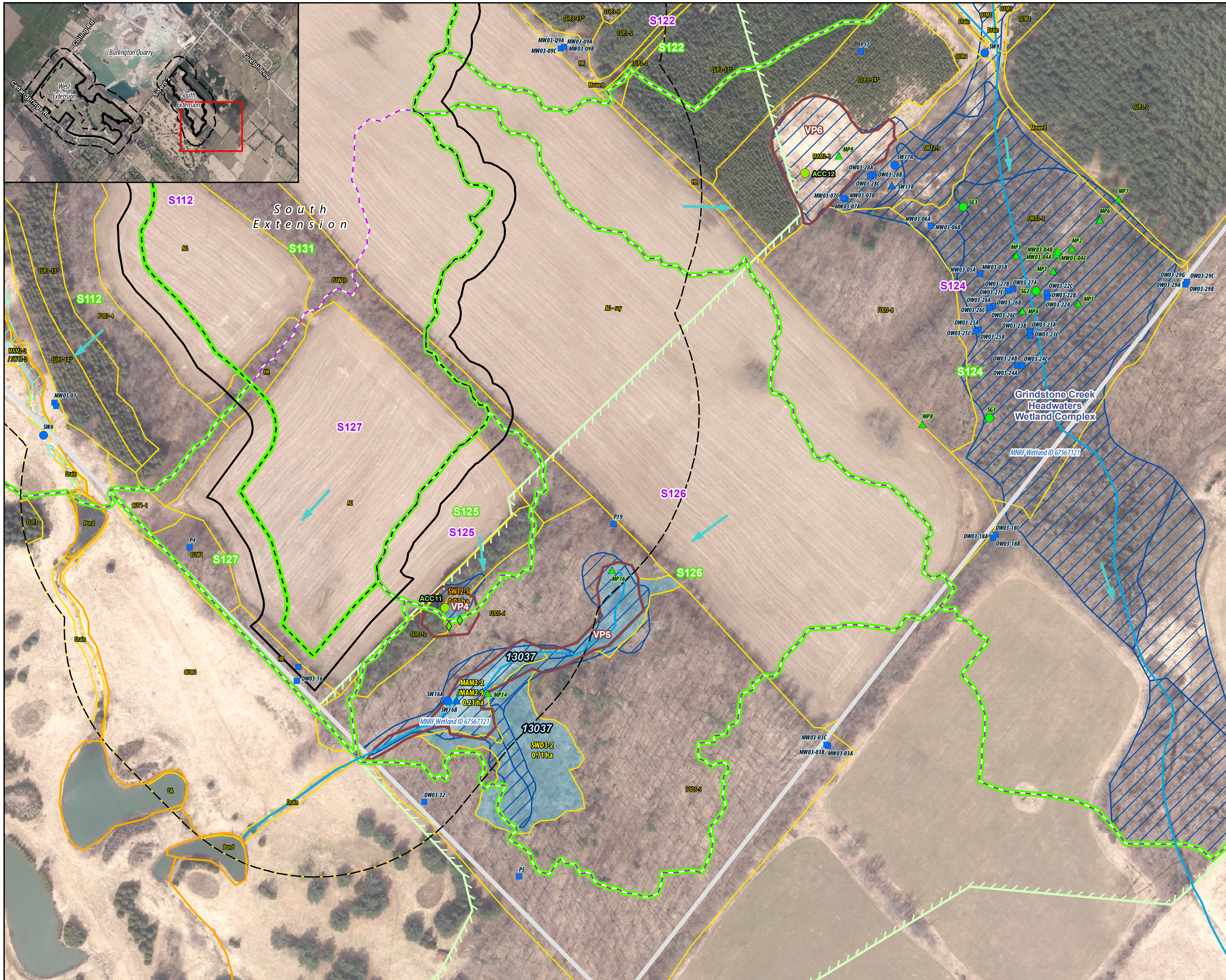


WETLAND 13032 - GRAPH 2



WETLAND 13037





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Amphibian Call Count Station (2019)
- Salamander Trap (2019)
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Direct Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Provincially Significant Wetland (LIO/MNRF, 2020)
- Wetland - Not Evaluated per OWES (MNRF/LIO, 2020)
- MECP Jefferson Salamander Regulated Habitat

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3, Coniferous Plantation
CUP3-2, White Pine Coniferous Plantation
CUP3-6, European Larch Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1-1, Sumac Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD5-5, Dry – Fresh Sugar Maple – Hickory Deciduous Forest
FOD5-6, Dry- Fresh Sugar Maple-Basswood Deciduous Forest
FOD5-8, Dry – Fresh Sugar Maple – White Ash Deciduous Forest
FOD7-4, Fresh – Moist Black Walnut Lowland Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
MAM2-9, Jewelweed Mineral Meadow Marsh
OA, Open Aquatic
SWD3-2, Silver Maple Mineral Deciduous Swamp
SWT2-2, Willow Mineral Thicket Swamp
SWT2-5, Red-osier Dogwood Mineral Thicket Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 5
Wetland Characterization

Wetland 13037 - South Extension

0 40 m
1:2,500

N

GEI Consultants
Savanta Division

Wetland 13037

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – 67567121 (OGF ID 67567139, 67567128, 67567138, 67567132) Earthfx - 20 Tatham – 13036, 13037 Savanta - 13037 Golder (Background) – 13036, 13037, 13038, 13039			
Wetland Area (ha):	LIO/MNRF - 1.05 Savanta - 0.95			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	10.05		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S125, S126		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream watercourse)			
Condition:	Natural			
Bathymetry:	A bathymetry survey of Wetland 13037 was completed by Tatham Engineering Limited and incorporated into the integrated model (see Earthfx Section 18.3, p.381). Wetland lakes were assigned to Layer 1 of the integrated model by adjusting the base of Layer 1 to correspond with the interpolated bottom elevation. Care was taken to ensure that the lowest elevation observed in the wetland was honored in the assigned elevations.	Figure 1	HHIAR (Earthfx, April 2020)	18.3 (page 381)
Outlet:	Headwater Drainage Feature H2			
Hydroperiod:	Spring Hydroperiod (date wetland dries out) – May 25th – August 26th Fall Hydroperiod (start of hydroperiod) – September 6th – December 25th	Graph 1	SWA (Tatham, April 2020)	2.2.5, 3 and Appendix F
Surface Water Monitoring:	ID: SW16A (Tatham) Installation Date: October 23, 2018 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 590888.61, Northing 4804899.887	Graph 1	SWA (Tatham, April 2020)	2.2.5, 3 and Appendix F

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Grindstone Creek Headwaters Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Dogwood Mineral Swamp Thicket: SWT2-5 Reed-canary grass / Jewelweed Mineral Meadow Marsh: MAM2-2/MAM2-9 Silver Maple Mineral Deciduous Swamp: SWD3-2		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	Yes – Jefferson Salamander (none observed despite survey effort) Hydroperiod sensitive species; water presence necessary until end of June		NETR (Savanta, April 2020)	6.1.2
Significant Wildlife Habitat:	None confirmed for amphibian breeding, despite survey effort through salamander habitat assessments, salamander trapping and call count surveys.		NETR (Savanta, April 2020)	4.2.2; 4.2.3; 4.2.5; 5.2.2; 5.2.3; 5.2.5; 6.4; Table 19
Fish Habitat:	Indirect		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	No species at risk salamanders observed, despite survey effort including salamander habitat assessment, salamander trapping and egg mass surveys.		NETR (Savanta, April 2020)	4.2.2; 4.2.3; 5.2.2; 5.2.3; 6.7

Groundwater Interaction	Description						Figure / Graph	Reference	
								Report	Section / Page
Lithology:	Halton Till								
Hydraulic Conductivity:	Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till. Wetland Water Balance (Tatham) – 1.2×10^{-10} m/s.								
Surface Water/Groundwater Interaction:	The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland receives some groundwater inflow but is relatively isolated from changes in the water table due to quarry development.								
Shallow Groundwater (Mini-piezometer) Monitoring:	ID: SW16B (Tatham) Installation Date: October 23, 2018 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 590888.61, Northing 4804899.887						Graph 2	SWA (Tatham, April 2020)	2.3 and Appendix G
Background Shallow Groundwater (Mini-piezometer) Monitoring:	Mini-piezometer ID	Ground Elevation	Bottom Elevation	Average WL	Logger	Manual Meas.	Graph 3		
	Golder MP14	274.57	273.37	270.93	-	2007-2013			
	Golder MP16	276.37	275.17	273.45	2007-2013	2007-2013			
Groundwater Monitoring (Monitoring Wells):	Monitoring Well ID	Distance (Dir.)	Geologic Unit	Ground Elevation	Monitoring Elev	Average WL	Graph 3		
	OW03-32A	78 (SSW)	Bedrock	278.00	265.0 - 254.4	268.62			
	OW03-32B	78 (SSW)	Bedrock	271.00	269.1 – 261.3	268.64			
	OW03-16A	114 (W)	Bedrock	272.20	254.4 – 246.6	268.28			
	OW03-16B	114 (W)	Bedrock	272.20	269.3 – 262.2	270.22			
	OW03-16C	112 (W)	Bedrock	272.30	270.0 – 268.4	270.55			
	MW03-03A	212 (E)	Bedrock	274.80	255.6 – 251.6	273.33			
	MW03-03B	212 (E)	Bedrock	274.80	264.7 – 260.8	273.69			
	MW03-03C	212 (E)	Overburden	274.70	274.1 – 272.1	272.93			
Water Budget Results:	A detailed average water budget, as simulated by the integrated model, was not presented in the Main report but is provided in Figure 2a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13016 (Earthfx Wetland 11) for baseline conditions is discussed in Section 7 of the main report.						Figure 2a	HHIAR (Earthfx, April 2020)	165 - 190
	Wetland 13037	GW Outflow (%)	GW Inflow (%)						
	Baseline (Existing)	12.84	1.76						
Integrated Model Calibration:	Two mini-piezometers in Wetland 20 provide multiple years of monitoring in the soil zone and upper weathered Halton Till. These monitors correspond to the PRMS soil zone and upper-most part of Layer 1 of the GSFLOW model. A comparison of the mini-piezometer data to the simulated soil moisture conditions (see Graphs 4 and 5) demonstrates that the model is closely matching both the soil moisture and hydroperiod of the shallow subsurface at this wetland. Based on recent measurements at SW16B, it appears that the historic data at MP14 may have an elevation offset. The timing of the simulated response does, however, match the recorded data.						Graphs 4 & 5		
	Earthfx Figure 6.29 (p.154) and Figure 19.44 (p.444) in the Main Report shows a hydrograph for Golder MP16 along with simulated shallow water levels. The figure is reproduced in Graphs 4 and 5. Note that the total range in observed water level fluctuation is less than 40 cm. A brief discussion of the Wetland 20 is contained in Earthfx Section 6.11.4 (p. 152). A more detailed discussion is provided in Appendix E, Section 19.6 (p. 443).						Graph 6	HHIAR (Earthfx, April 2020)	154, 443 - 444

<table>
<tr><th rowspan="2">Impact Assessment (Operations Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change. Wetland located greater than 120 m from licensed boundary.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. Subcatchment area protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1 & Drawing DP-2</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.</td><td></td><td>SWA (Tatham, April 2020)</td><td>4.2.1</td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.35, p. 223); P3456 (Figure 8.67, p. 250); RHB1 (Figure 8.102, p. 279), and RHB2 (Figure 8.129, p. 300). The water budget results for Scenario P12 are reproduced in Figure 2b. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13037 (Earthfx Wetland 20) for each scenario are discussed in Section 8 of the main report.

<table>
<tr><td>Wetland 13037</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>12.84</td><td>1.76</td><td>-</td><td>-</td></tr>
<tr><td>Operations Ph 1 & 2</td><td>15.90</td><td>0.00</td><td>3.45</td><td>-1.76</td></tr>
</table></td><td>Figure 2b</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Change on Soil Moisture Conditions:</td><td>The soil moisture under Baseline and P12 conditions, as well as Baseline surface discharge (seepage), are shown in Graph 7. The small reduction in soil moisture under P12 conditions is due to the loss of groundwater seepage (due to the drawdown in groundwater levels near the excavation). Under baseline conditions, groundwater seepage occurs as water levels rise in the late spring in response to snowmelt. Seepage fluctuates significantly, however, due to natural inter-annual climate variability. During a dry year (2015-2016) groundwater levels are naturally low, there is limited groundwater seepage, and a very minor difference in soil moisture between Baseline and P12. During an average year (2017-2018) there is small change in the late summer soil moisture conditions due to the loss of groundwater discharge during P12 development. During a wet year there is a modest loss of soil moisture in the May-September time frame. Additional surface water and ground water interaction occurs through the bottom of the ponded water portions of Wetland 20. Pond leakage to the groundwater system is shown in Graph 8. Negative seepage indicates groundwater is upwelling into the pond. Under Baseline conditions, the ponds leak water to the groundwater system for most of the year, and only receive upwelling (negative leakage or seepage) for short periods during the wetter years when the water table is higher. Under P12 conditions (red line), the ponds leak water to the groundwater system at varying rates throughout the year; generally higher in the spring and declining through the summer.</td><td>Graphs 7 & 8</td><td></td><td></td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Operational Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	4.2.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	4.2.1 & Drawing DP-2
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	4.2.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.35, p. 223); P3456 (Figure 8.67, p. 250); RHB1 (Figure 8.102, p. 279), and RHB2 (Figure 8.129, p. 300). The water budget results for Scenario P3456 are reproduced in Figure 2c. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13037 (Earthfx Wetland 20) for each scenario are discussed in Section 8 of the main report.	Figure 2c	HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

Wetland 13037	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	12.84	1.76	-	-
Operations Ph 3 - 6	16.29	0.00	3.45	-1.76

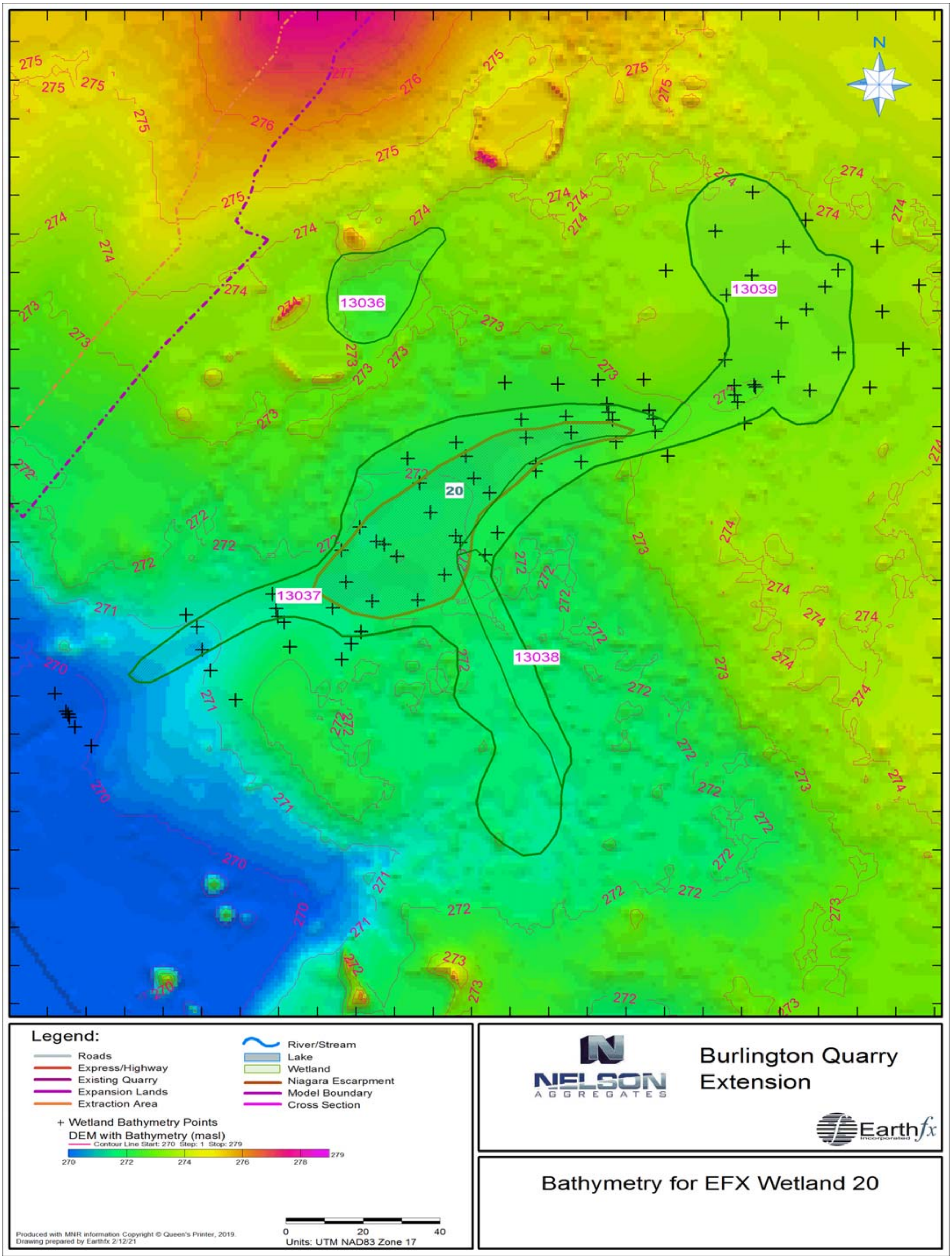
Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.		SWA (Tatham, April 2020)	5.4.1
Change in Wetland Catchment Area (ha):	No change. Subcatchment area protected.		SWA (Tatham, April 2020)	5.4.1 & Drawing DP-3
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area being protected.		SWA (Tatham, April 2020)	5.4.1
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.28, p. 188); Scenario P12 (Figure 8.35, p. 223); P3456 (Figure 8.67, p. 250); RHB1 (Figure 8.102, p. 279), and RHB2 (Figure 8.129, p. 300). The water budget results for Scenarios RHB1 and RHB2 are reproduced in Figures 2d and 2e. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13037 (Earthfx Wetland 20) for each scenario are discussed in Section 8 of the main report.	Figure 2d and 2e	HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .			

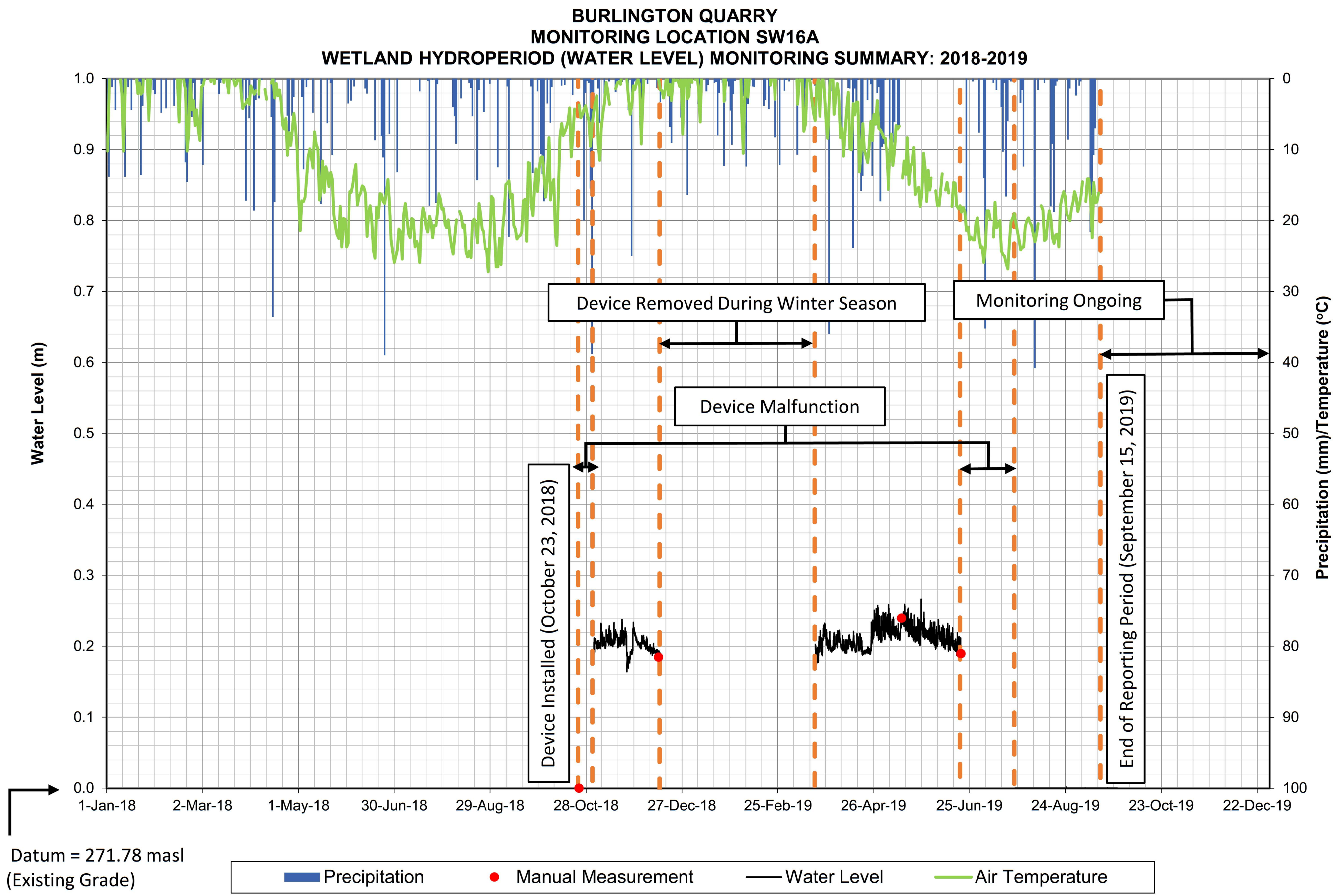
Wetland 13037	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	12.84	1.76	-	-
Rehab Scenario 1	15.85	0.17	3.01	-1.59
Rehab Scenario 2	14.91	0.22	2.07	-1.54

Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

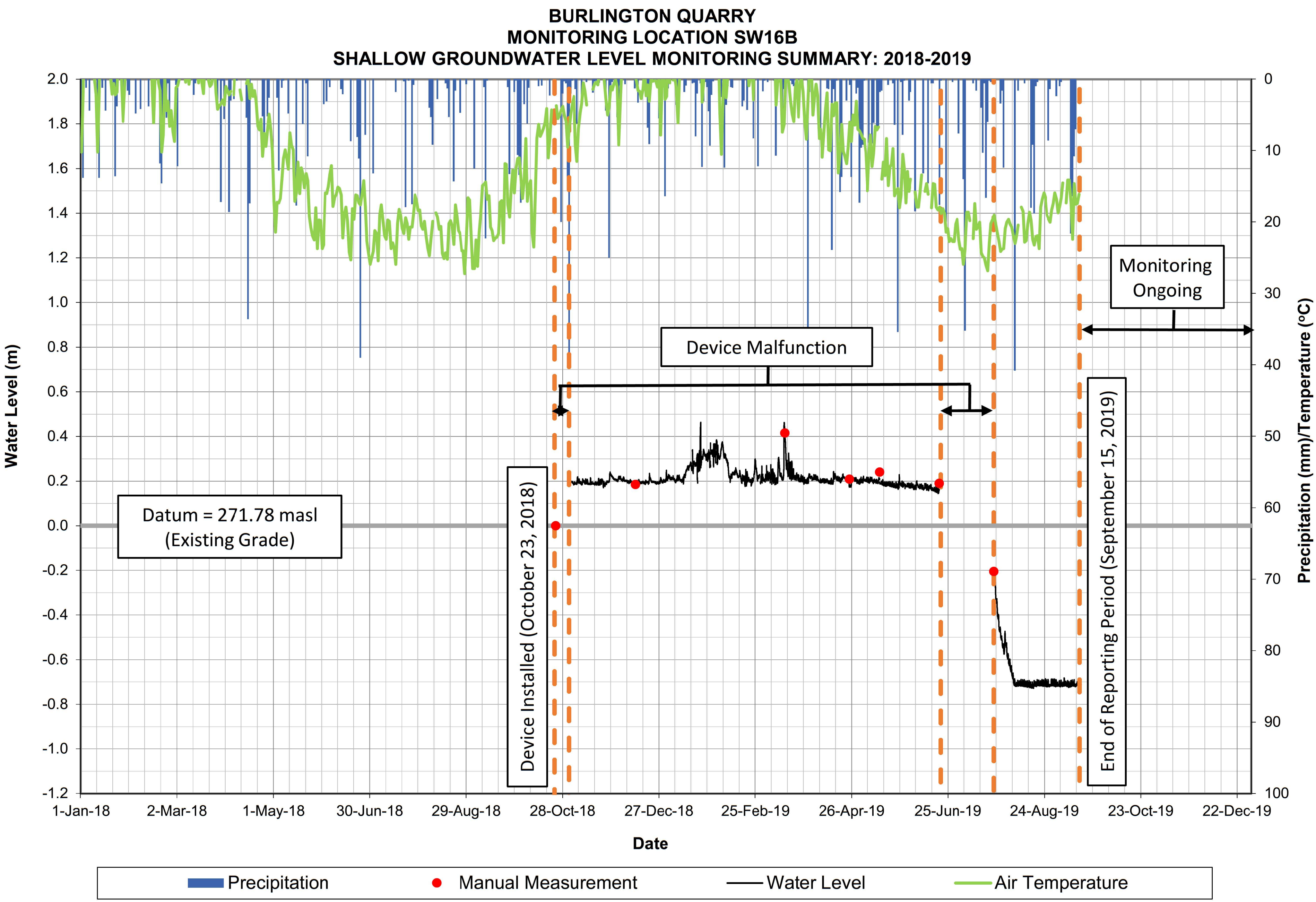
WETLAND 13037 - FIGURE 1



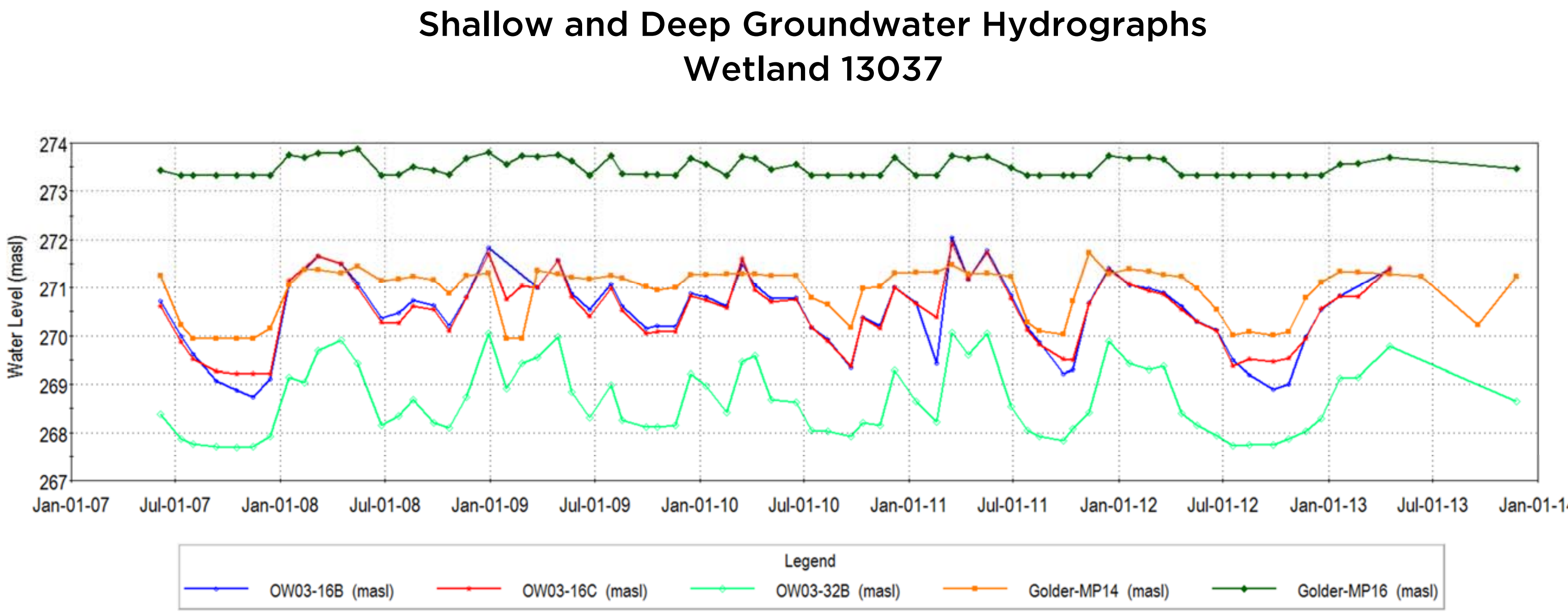
WETLAND 13037 - GRAPH 1



WETLAND 13037 - GRAPH 2



WETLAND 13037 - GRAPH 3



WETLAND 13037

FIGURE 2A

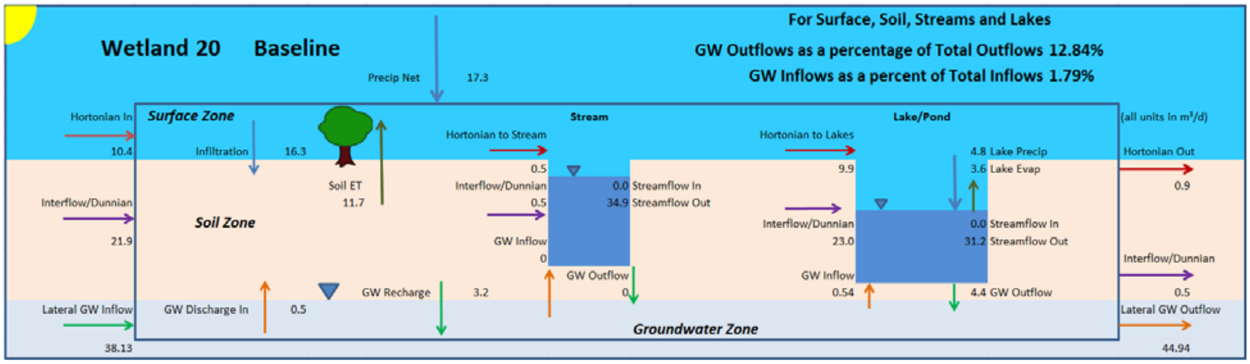


FIGURE 2B

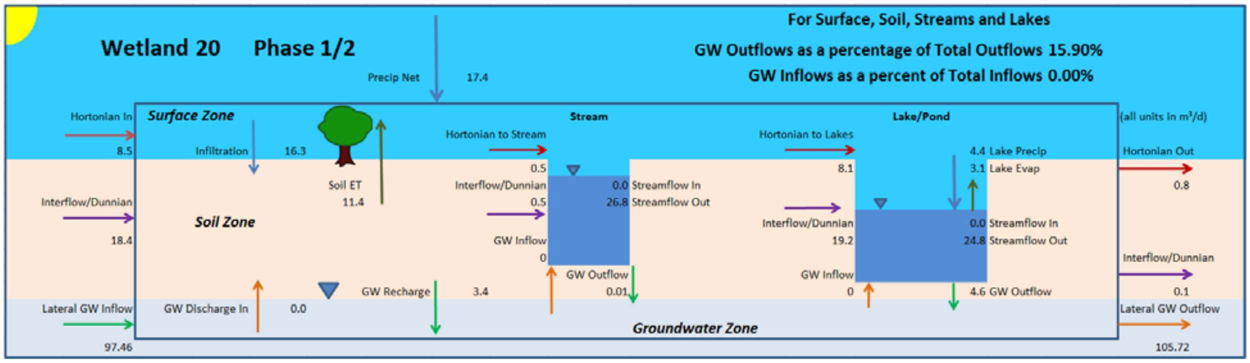


FIGURE 2C

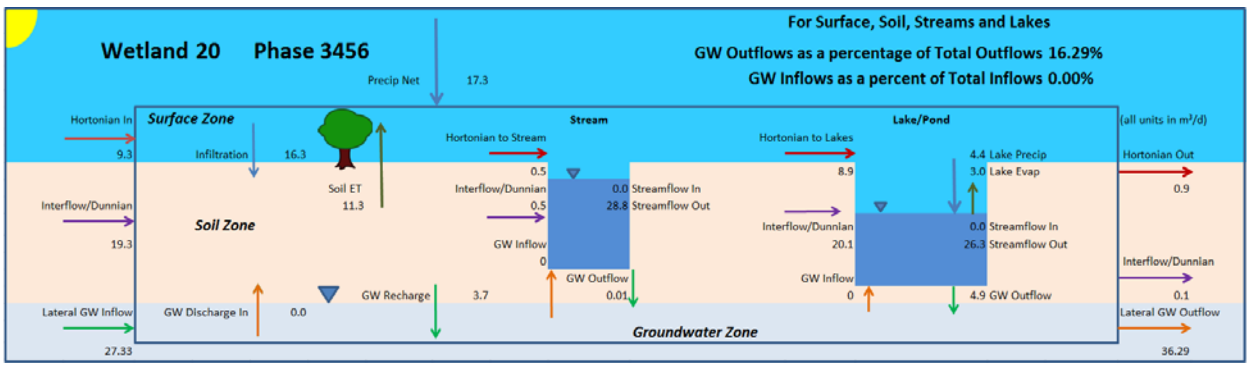


FIGURE 2D

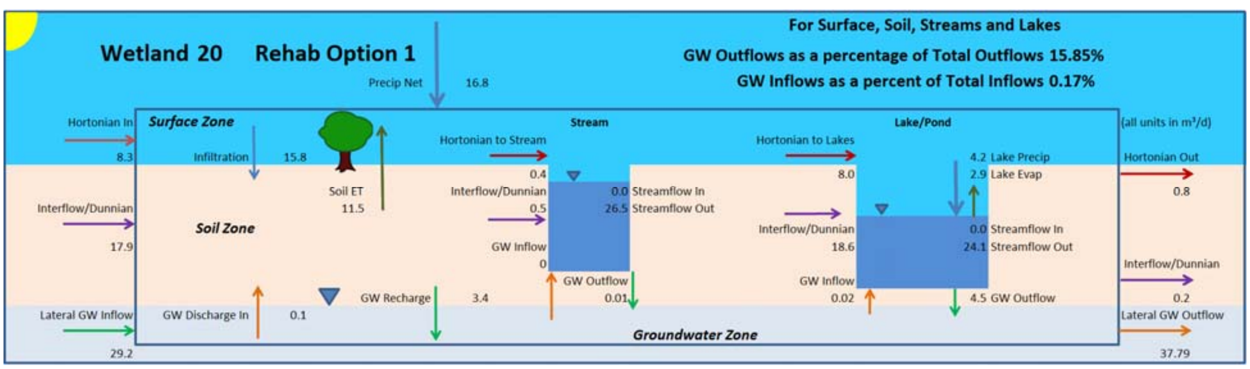
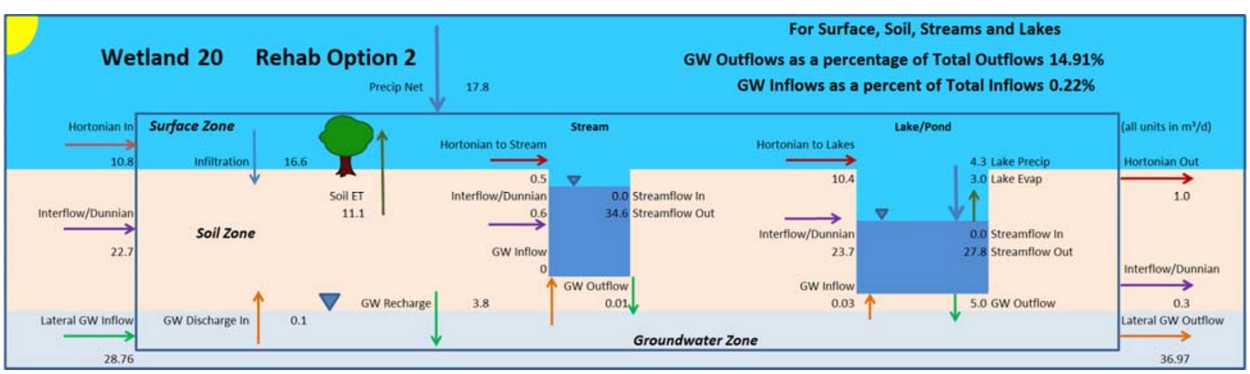
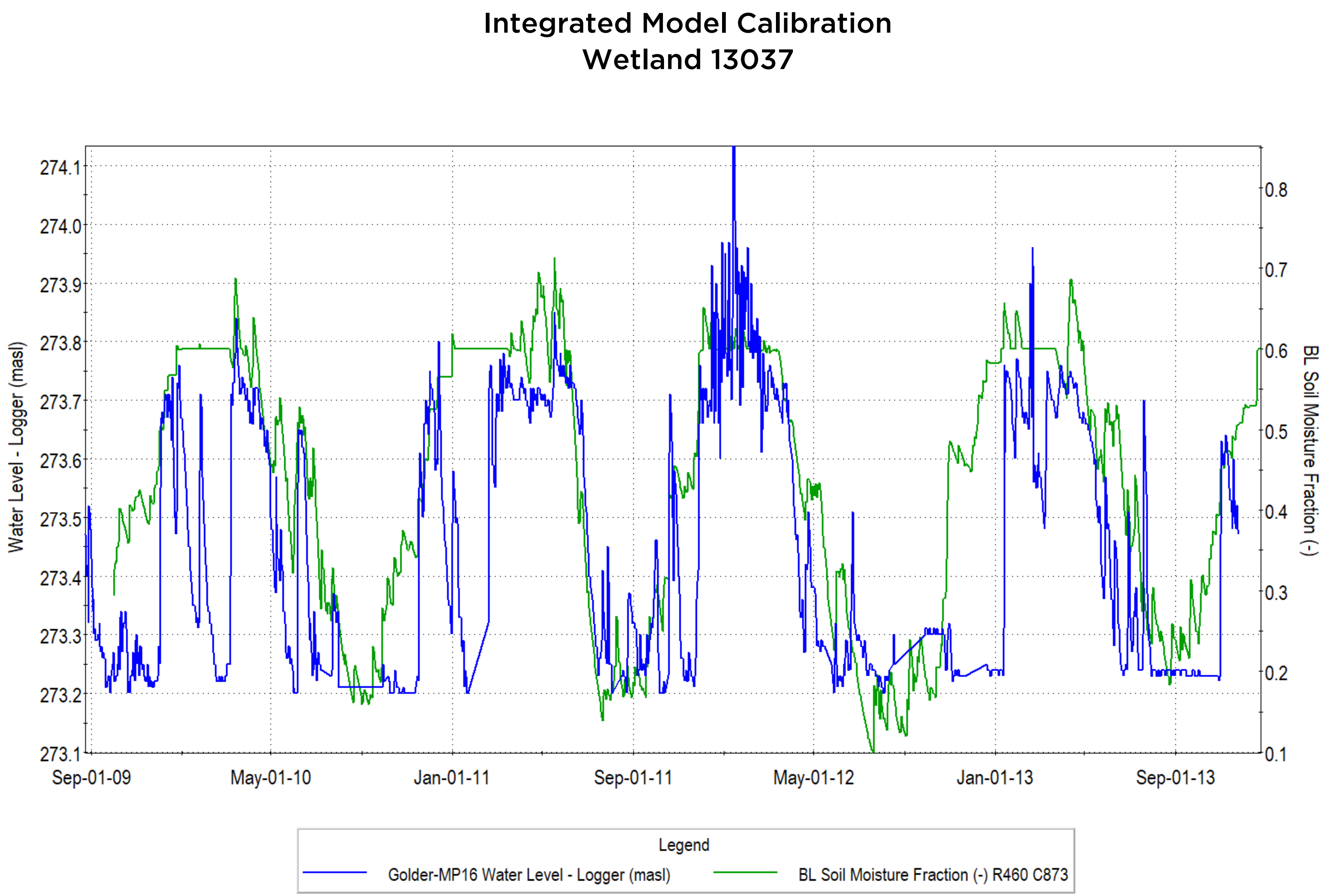


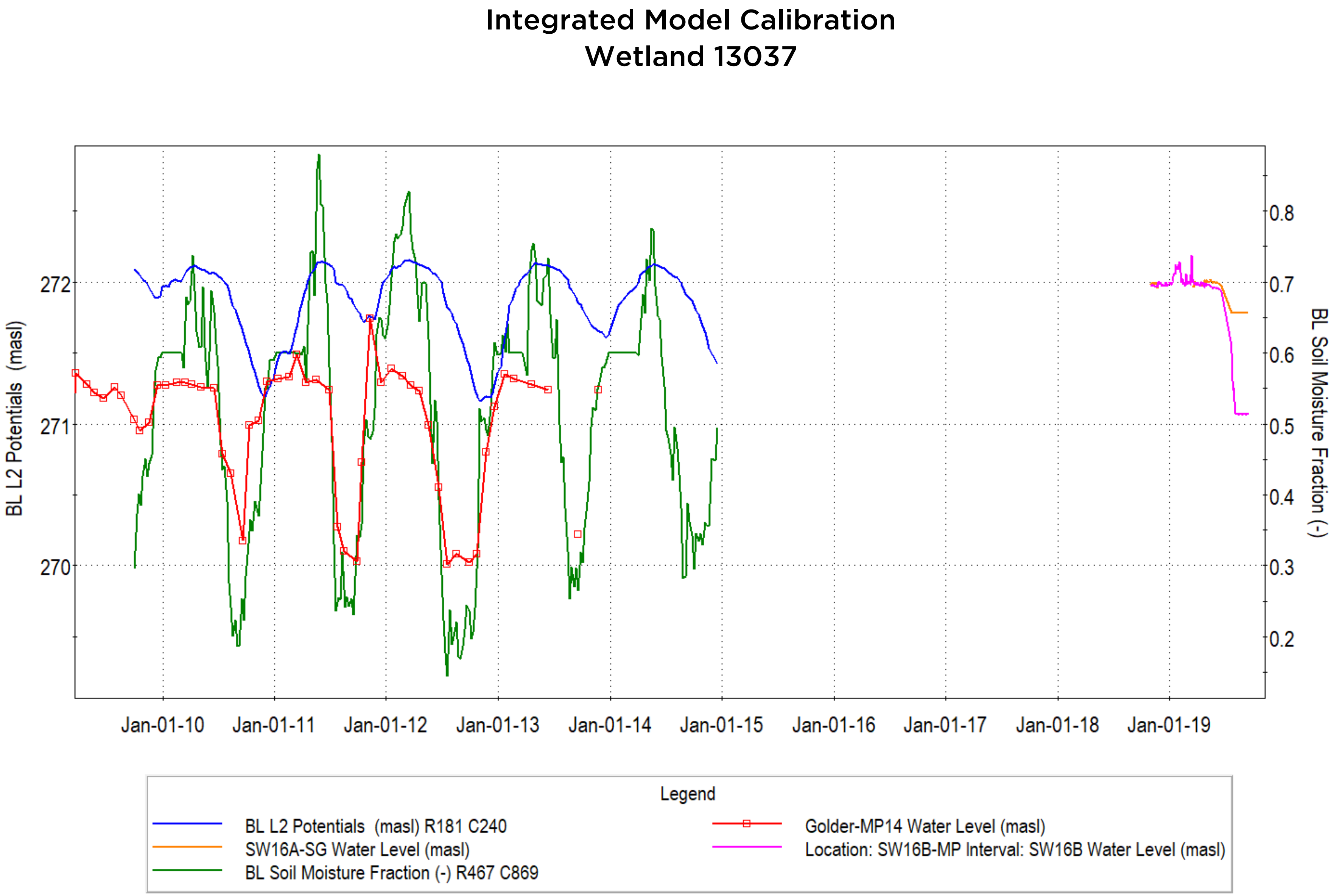
FIGURE 2E



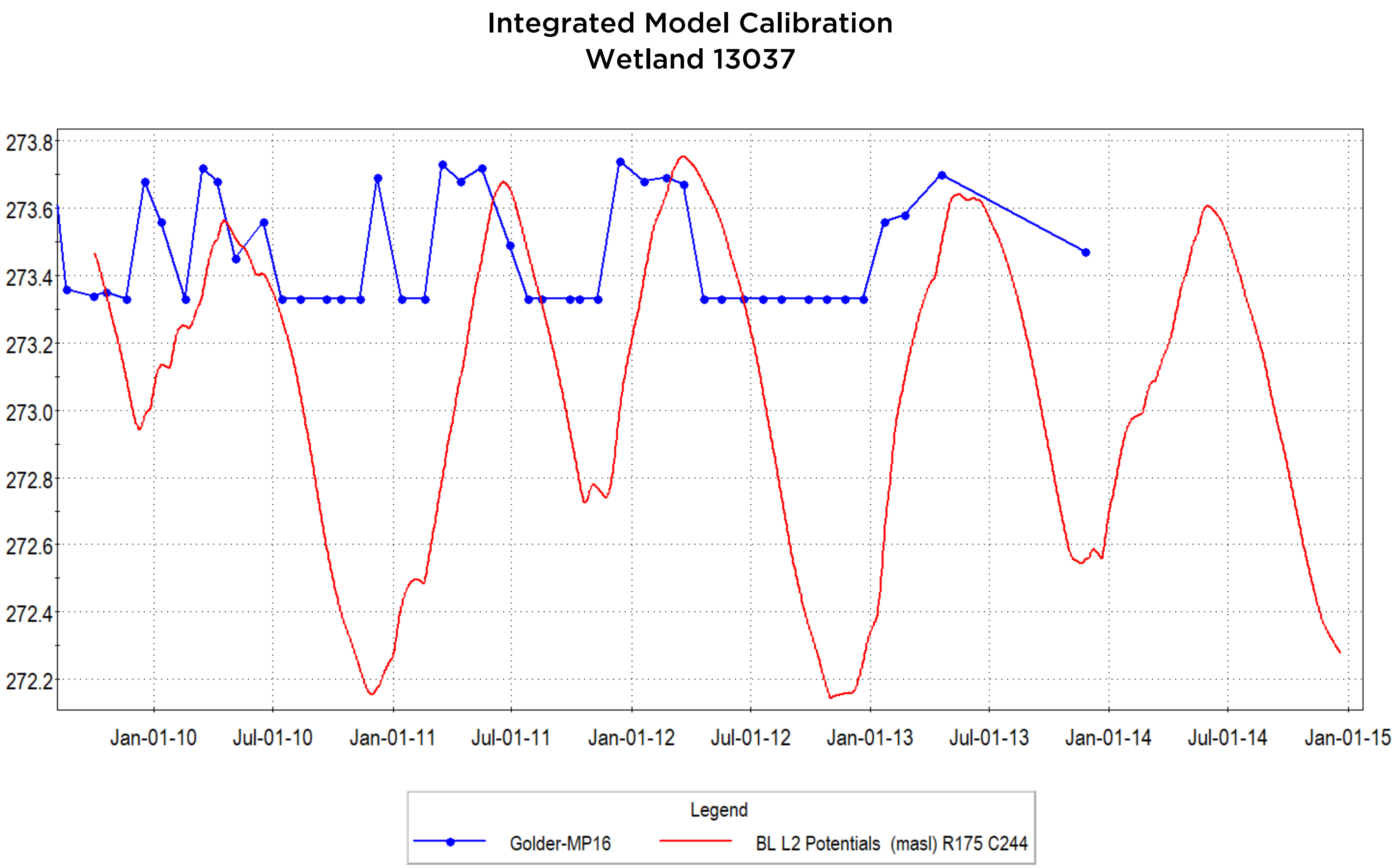
WETLAND 13037 - GRAPH 4



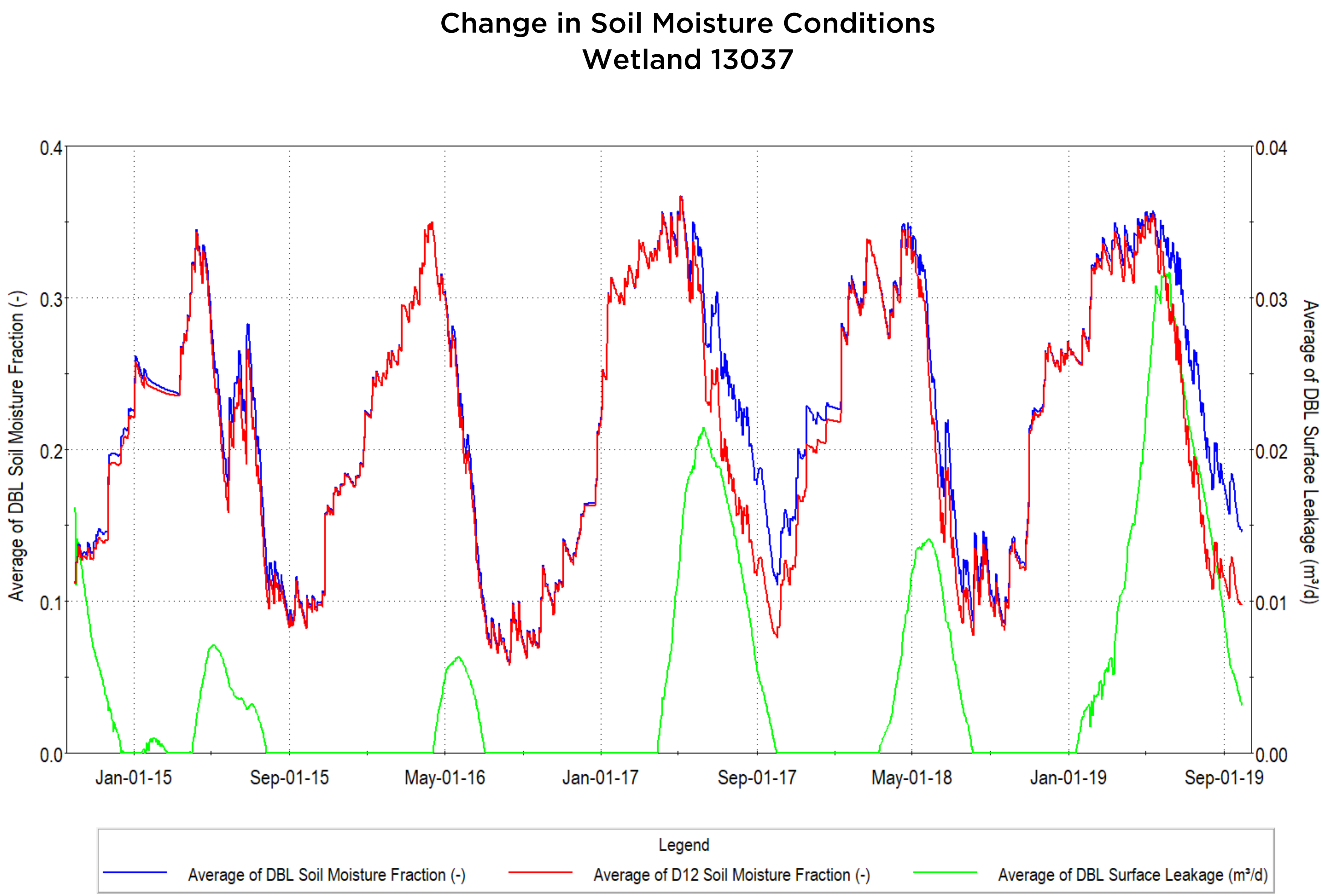
WETLAND 13037 - GRAPH 5

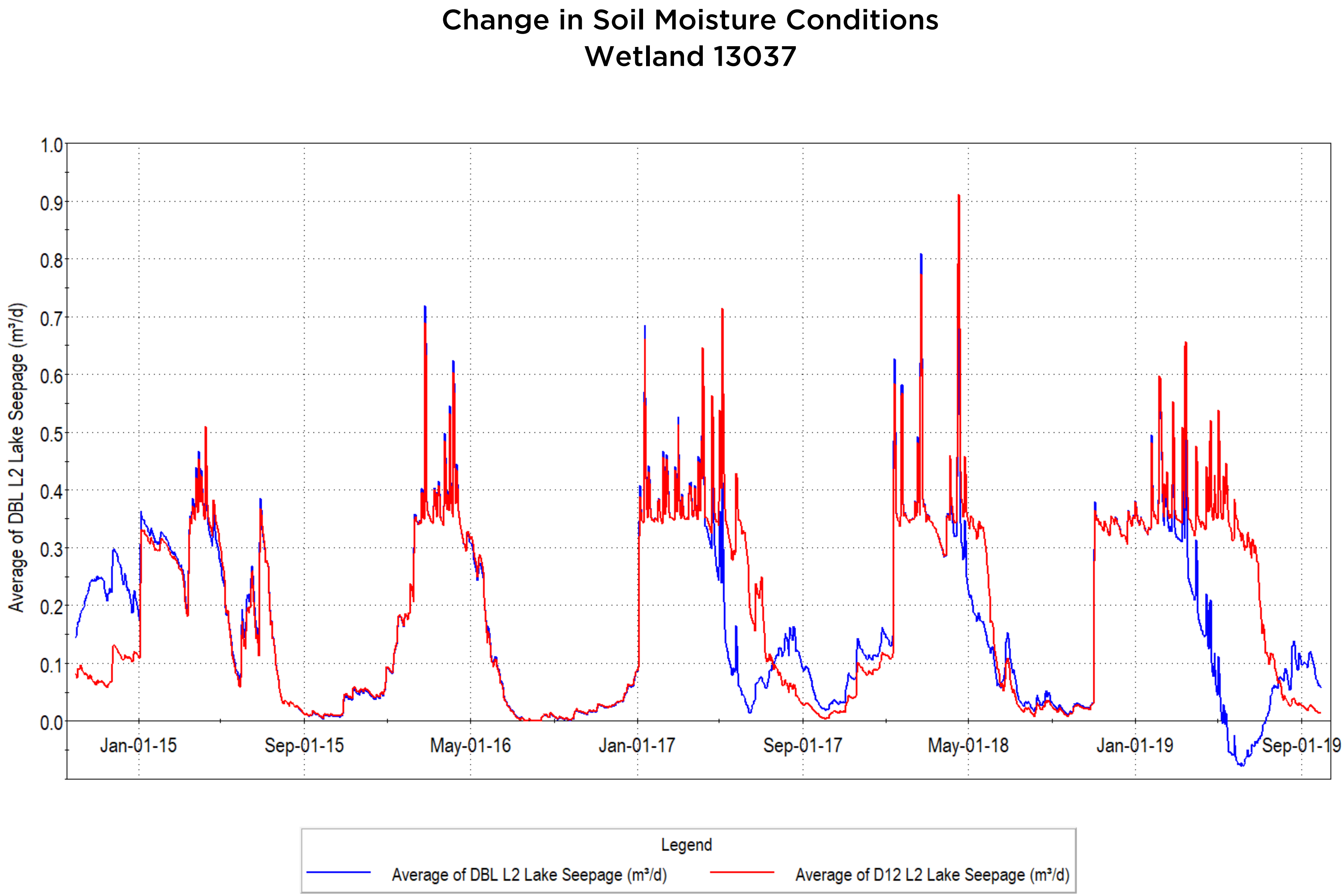


WETLAND 13037 - GRAPH 6

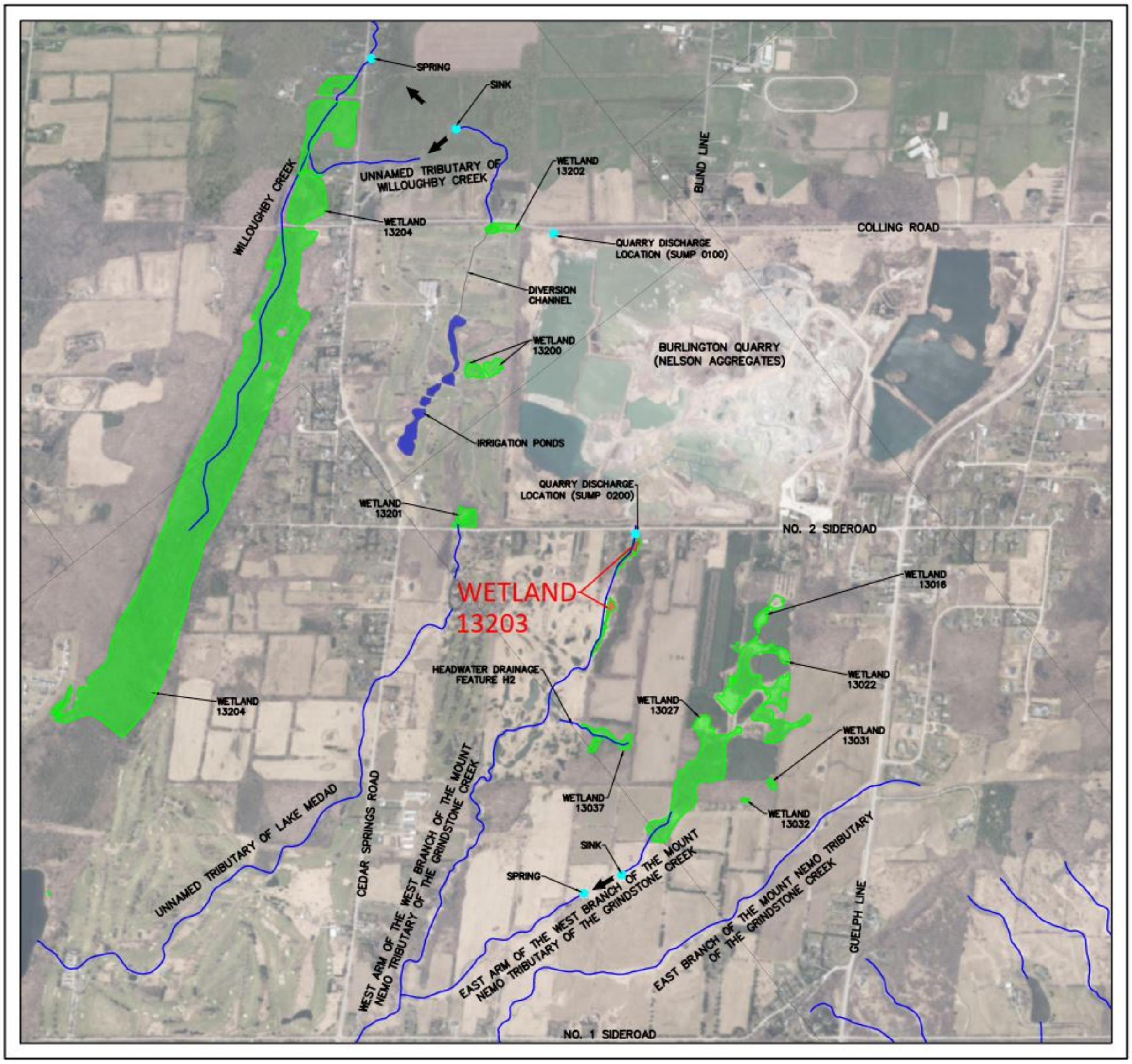


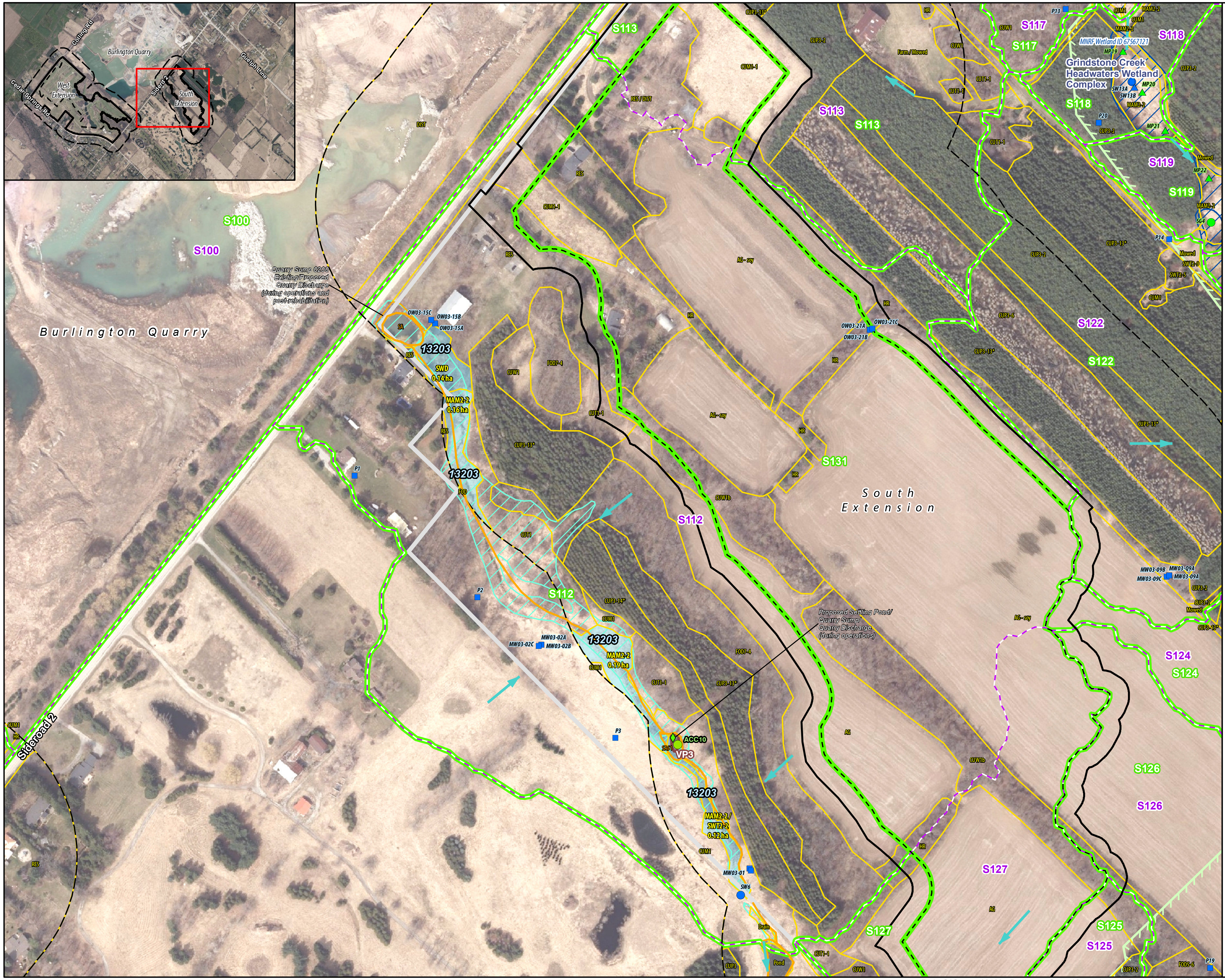
WETLAND 13037 - GRAPH 7




Change in Soil Moisture Conditions
Wetland 13037
Average of DBL L2 Lake Seepage (m³/d)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan-01-15
Sep-01-15
May-01-16
Jan-01-17
Sep-01-17
May-01-18
Jan-01-19
Sep-01-19
Legend
Average of DBL L2 Lake Seepage (m³/d)
Average of D12 L2 Lake Seepage (m³/d)

WETLAND 13203





Legend

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Previous Instrumentation

- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUM1-1, Dry Moist Old Field Meadow
CUP3, Coniferous Plantation
CUP3-2, White Pine Coniferous Plantation
CUP3-6, European Larch Coniferous Plantation
CUP3-13*, White Spruce Coniferous Plantation
CUP3-14*, White Cedar Coniferous Plantation
CUT1, Mineral Cultural Thicket
CUT1-1, Sumac Cultural Thicket
CUW1, Mineral Cultural Woodland
DIST, Disturbed
FOD, Deciduous Forest
FOD5-6, Dry- Fresh Sugar Maple-Basswood Deciduous Forest
FOD7-4, Fresh – Moist Black Walnut Lowland Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
RES, Residential
SA, Shallow Aquatic
SAS1, Submerged Shallow Aquatic
SWD, Deciduous Swamp
SWT2-2, Willow Mineral Thicket Swamp
SWT2-5, Red-osier Dogwood Mineral Thicket Swamp
SWT2-9, Gray Dogwood Mineral Thicket Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 6
Wetland Characterization

Wetland 13203 - South Extension

0 50 m
1:3,000
N

GEI Consultants
Savanta Division

Wetland 13203

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – N/A (OGF ID 67196365, 67196392, 67196289) Earthfx - 18 Tatham - 13203 Savanta - 13203 Golder (Background) - N/A			
Wetland Area (ha):	LIO/MNRF – 1.84 (includes wetland area outside 120 m adjacent lands) Savanta – 0.61 (excludes wetland area outside 120 m adjacent lands)			
Watershed:	Grindstone Creek Watershed			
Sub-Watershed:	West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	26.2 + quarry discharge (Sump 0200)		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S112		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream watercourse)			
Condition:	Modified			
Bathymetry:	A bathymetric survey of Wetland 13202 has not been completed.			
Outlet:	West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek			
Hydroperiod:	Water level in Wetland 13203 maintained by quarry discharge. When quarry discharge ceases, flow through West Arm ceases.		SWA (Tatham, April 2020)	2.1.2, 3 and Appendix C
Surface Water Monitoring:	ID: SW6 (Tatham) Installation Date: September 19, 2014 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Coordinates of Monitoring Station: Easting 590629.123, Northing 4805071.124	Graph 1	SWA (Tatham, April 2020)	2.1.2 and Appendix C

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Wetland 13203 – Other (as determined by MNRF and it is completely dependent on pumping from the existing quarry; however it has been designed to demonstrate no negative impacts.)		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Shallow Aquatic: SA Submerged Shallow Aquatic: SAS1 Deciduous Swamp: SWD Reed-canary Grass Mineral Meadow Marsh: MAM2-2 Reed-canary Grass Mineral Meadow Marsh / Willow Mineral Thicket Swamp: MAM2-2 / SWT2-2		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	No		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	Confirmed for amphibian breeding (woodland) – SAS1. Salamander species absent, despite survey effort including salamander habitat assessment, salamander trapping and egg mass surveys.		NETR (Savanta, April 2020)	4.2.2; 4.2.3; 4.2.5; 5.2.2; 5.2.3; 5.2.5; 6.4; Table 19
Fish Habitat:	Indirect		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	No species at risk salamanders observed, despite survey effort including salamander habitat assessment, salamander trapping and egg mass surveys.		NETR (Savanta, April 2020)	4.2.2; 4.2.3; 5.2.2; 5.2.3; 6.7

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td>Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td>Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td>The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland receives some groundwater inflow but is generally isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td>Groundwater Monitoring (Monitoring Wells):</td><td><table>
<tr><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td></tr>
<tr><td>MW03-01A</td><td>227 (SW)</td><td>Bedrock</td><td>270.94</td><td>251.9 – 247.7</td><td>269.33</td></tr>
<tr><td>MW03-01B</td><td>227 (SW)</td><td>Bedrock</td><td>270.94</td><td>261.8 – 256.8</td><td>269.37</td></tr>
<tr><td>MW03-01C</td><td>227 (SW)</td><td>Bedrock</td><td>270.97</td><td>270.4 - 269.5</td><td>270.13</td></tr>
<tr><td>MW03-02A</td><td>36 (E)</td><td>Bedrock</td><td>272.48</td><td>251.8 – 247.8</td><td>259.76</td></tr>
<tr><td>MW03-02B</td><td>36 (E)</td><td>Bedrock</td><td>272.48</td><td>260.9 – 256.6</td><td>262.02</td></tr>
<tr><td>MW03-02C</td><td>36 (E)</td><td>Bedrock</td><td>272.54</td><td>270.0 – 268.4</td><td>269.89</td></tr>
<tr><td>OW03-15A</td><td>226 (NNE)</td><td>Bedrock</td><td>275.12</td><td>256.8 – 250.0</td><td>259.11</td></tr>
<tr><td>OW03-15B</td><td>226 (NNE)</td><td>Bedrock</td><td>275.12</td><td>269.2 – 264.9</td><td>268.97</td></tr>
<tr><td>OW03-15B</td><td>226 (NNE)</td><td>Bedrock</td><td>275.13</td><td>273.2 – 271.6</td><td>272.93</td></tr>
</table></td><td>Graphs 2, 3 & 4</td><td></td><td></td></tr>
<tr><td>Water Budget Results:</td><td>A detailed average water budget, as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.26, p. 187). The baseline water budget is reproduced in Figure 1a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 18 for baseline conditions are discussed in Section 7 of the main report.<table>
<tr><td>Wetland 13203</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>5.98</td><td>2.42</td></tr>
</table></td><td>Figure 1a</td><td>HHIAR (Earthfx, April 2020)</td><td>165 - 190</td></tr>
<tr><td>Integrated Model Calibration:</td><td>No mini-piezometers for calibration. The model is replicating the dewatering effects of the existing quarry at the north end of the wetland (see Graph 5). Water level calibration at the south end of wetland is reasonable (see Graph 6). There is some uncertainty in the calibration because records and operations of south quarry discharge are intermittent. Wetland 13203 is not discussed in the Main Report. Other nearby wetlands are discussed in Appendix E, Section 19.6.</td><td>Graphs 5 & 6</td><td></td><td></td></tr>
</table>

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 1 and 2 the catchment area will be reduced to 14.5 ha (reduction of 11.7 ha)		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	No change in hydroperiod expected as quarry discharge maintains wetland water levels.			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.26, p. 187); Scenario P12 (Figure 8.33, p. 222); P3456 (Figure 8.65, p. 249); RHB1 (Figure 8.101, p. 278), and RHB2 (Figure 8.126, p. 300). The water budget results for Scenario P12 are reproduced in Figure 1b. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13203 (Earthfx Wetland 18) for each scenario are discussed in Section 8 of the main report.	Figure 1b	HHIAR (Earthfx, April 2020)	191 - 303
Change on Soil Moisture Conditions:	The soil moisture and surface discharge patterns in Wetland 18 are shown in Graph 7. There will only be a minimal change in soil moisture conditions under P12 conditions. Note that the Baseline groundwater inflow as a percentage of total inflows is only 2.42% (the right-hand scale range is very small).	Graph 7		
Potential Impact to Form and Function of Feature:	Both the pond and the wetland will remain in place. There will be no encroachment from the project into the wetlands. Proposed limit of extraction is >30 m from the wetland boundary. The extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Wetland 13203	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	5.98	2.42	-	-
Operations Ph 1 & 2	9.95	0.00	3.97	-2.42

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	The wetland is supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur at the same location at the upstream end of the tributary and in the same manner as existing pumping.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 1 and 2 the catchment area will be reduced to 14.5 ha (reduction of 11.7 ha). This reduction in drainage area will remain long-term.		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	No change in hydroperiod expected as quarry discharge maintains wetland water levels.			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.26, p. 187); Scenario P12 (Figure 8.33, p. 222); P3456 (Figure 8.65, p. 249); RHB1 (Figure 8.101, p. 278), and RHB2 (Figure 8.126, p. 300). The water budget results for Scenario P3456 are reproduced in Figure 1c. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13203 (Earthfx Wetland 18) for each scenario are discussed in Section 8 of the main report.	Figure 1c	HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	Both the pond and the wetland will remain in place. There will be no encroachment from the project into the wetlands. Proposed limit of extraction is >30 m from the wetland boundary. The extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

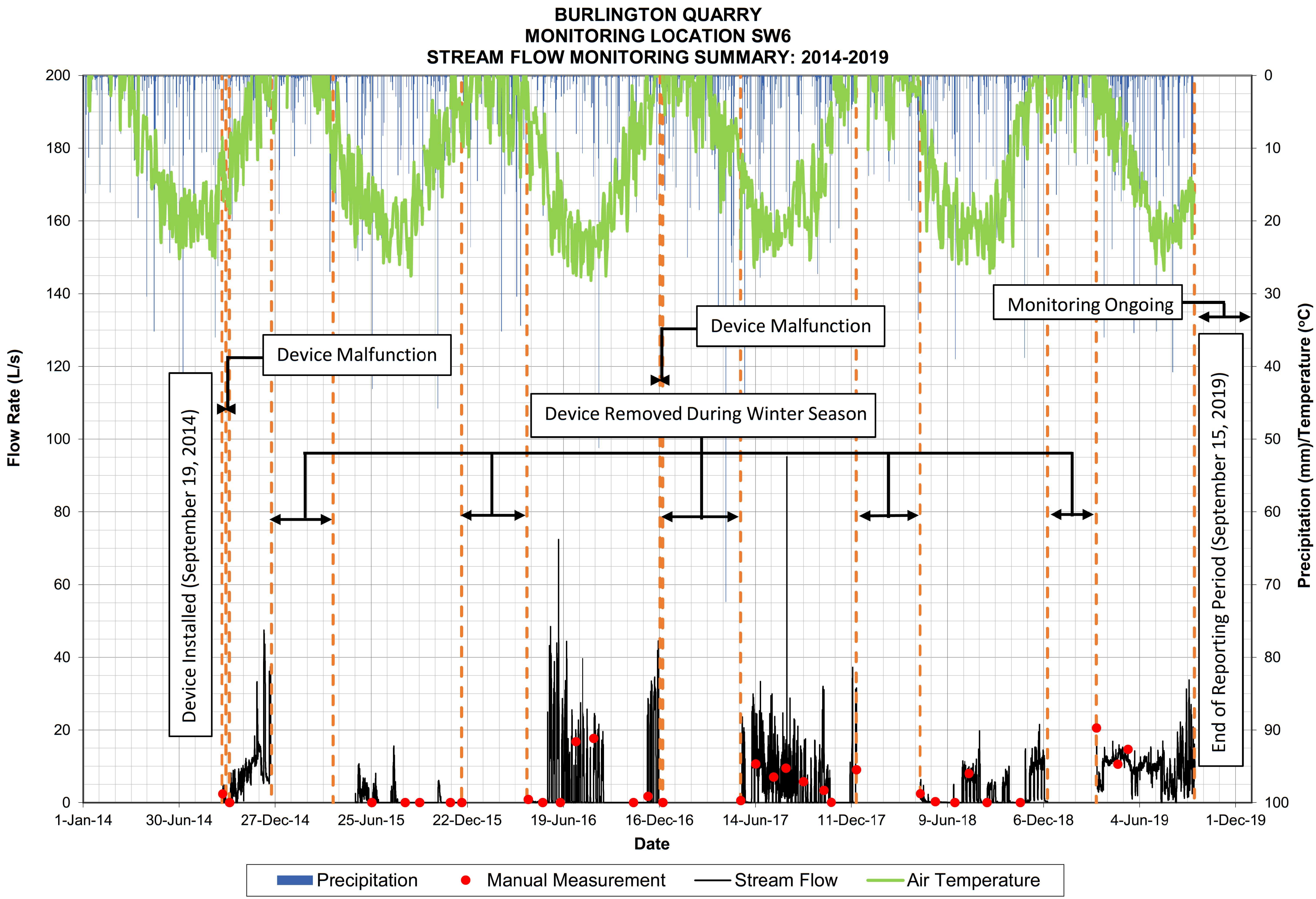
Wetland 13203	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	5.98	2.42	-	-
Operations Ph 3 - 6	7.11	0.04	1.13	-2.38

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	The wetland is supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur at the same location at the upstream end of the tributary and in the same manner as existing pumping.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

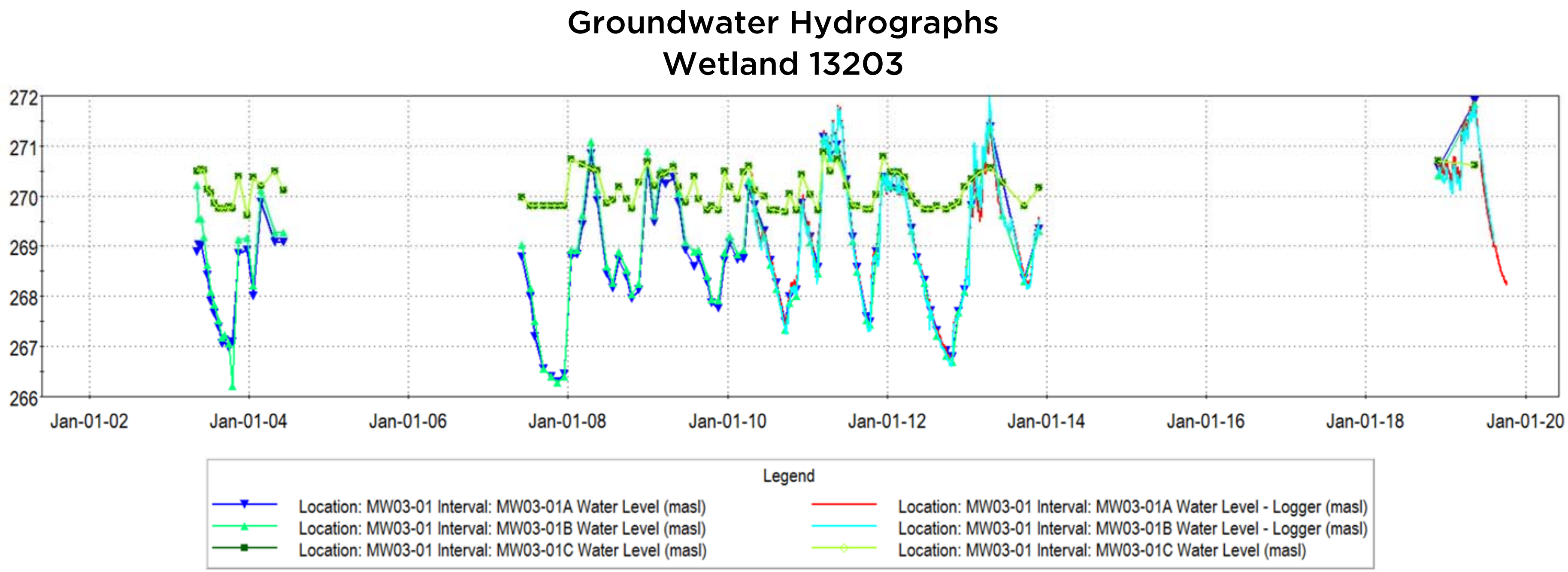
<table>
<tr><th rowspan="2">Impact Assessment (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>Reduction in catchment area. During operations in Phases 1 and 2 the catchment area will be reduced to 14.5 ha (reduction of 11.7 ha). This reduction in drainage area will remain long-term.</td><td></td><td>SWA (Tatham, April 2020)</td><td>Drawing DP-3</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No change in hydroperiod expected as quarry discharge maintains wetland water levels.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.26, p. 187); Scenario P12 (Figure 8.33, p. 222); P3456 (Figure 8.65, p. 249); RHB1 (Figure 8.101, p. 278), and RHB2 (Figure 8.126, p. 300). The water budget results for Scenario RHB1 and RHB2 are reproduced below. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13203 (Earthfx Wetland 18) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13203</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>5.98</td><td>2.42</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>5.19</td><td>1.36</td><td>-0.79</td><td>-1.06</td></tr>
<tr><td>Rehab Scenario 2</td><td>6.68</td><td>3.53</td><td>0.70</td><td>1.11</td></tr>
</table></td><td>Figure 1d and 1e</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>Both the pond and the wetland will remain in place. There will be no encroachment from the project into the wetlands. Proposed limit of extraction is >30 m from the wetland boundary. The extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project .</td><td></td><td>NETR (Savanta, April 2020)</td><td>7.2.1; 7.1.1; 7.1.2</td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>The wetland is supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur at the same location at the upstream end of the tributary and in the same manner as existing pumping.</td><td></td><td>NETR (Savanta, April 2020)</td><td>7.2.1; 7.1.1; 7.1.2</td></tr>
</table>

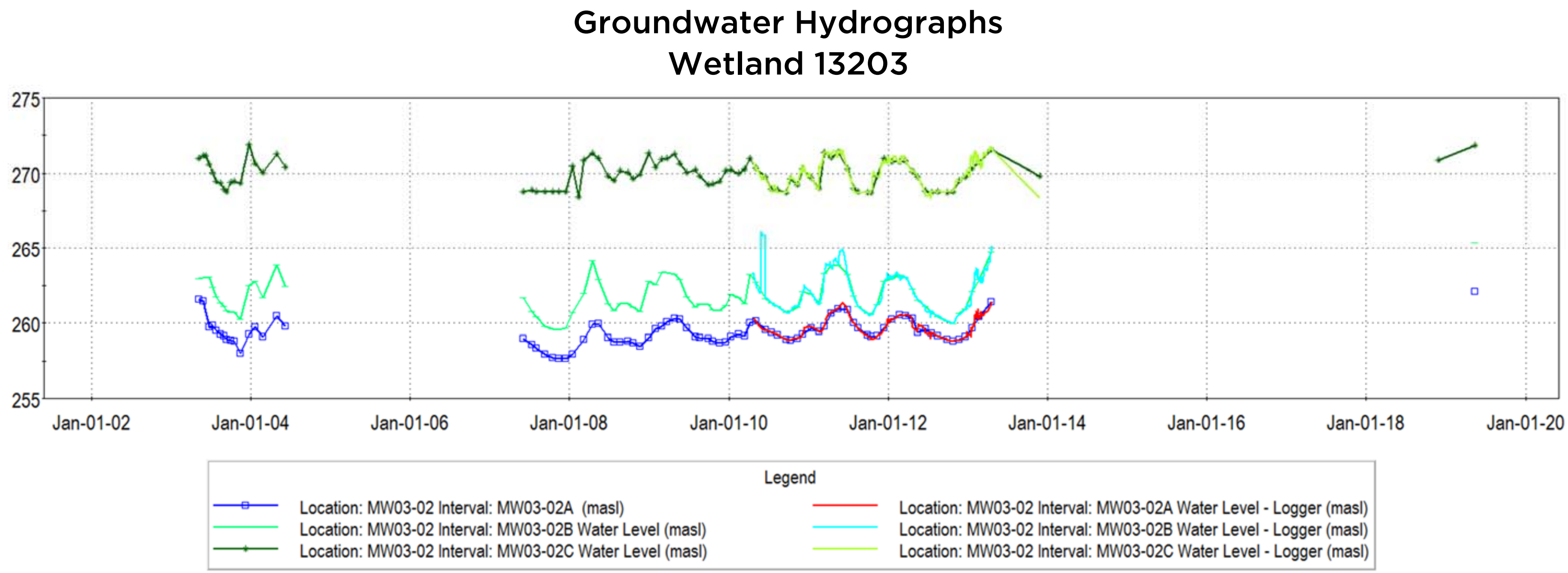
WETLAND 13203 - GRAPH 1



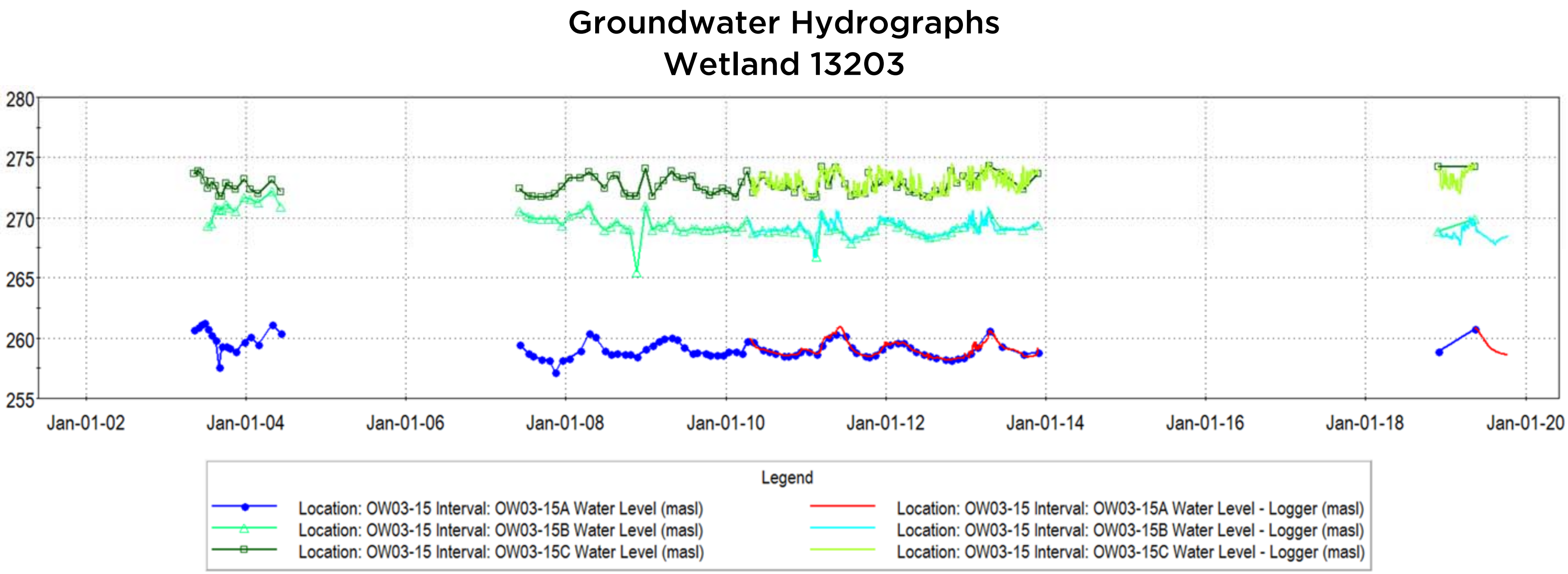
WETLAND 13203 - GRAPH 2



WETLAND 13203 - GRAPH 3



WETLAND 13203 - GRAPH 4



WETLAND 13203

FIGURE 1A

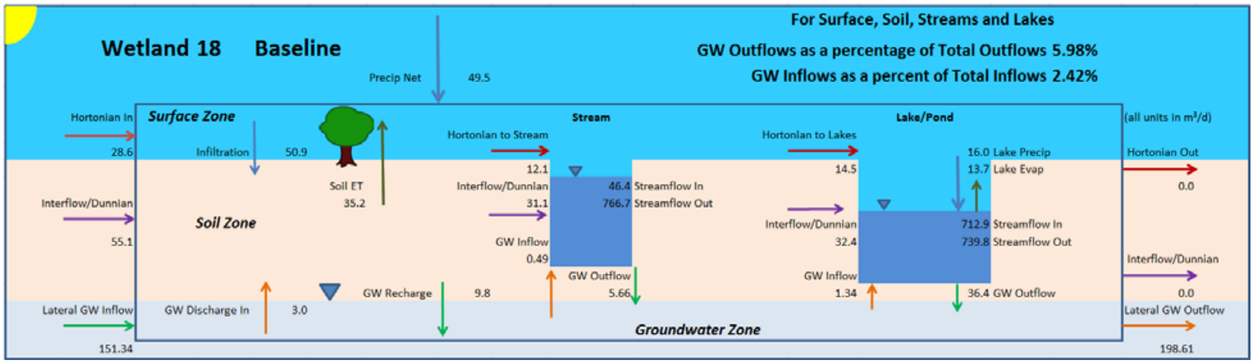


FIGURE 1B

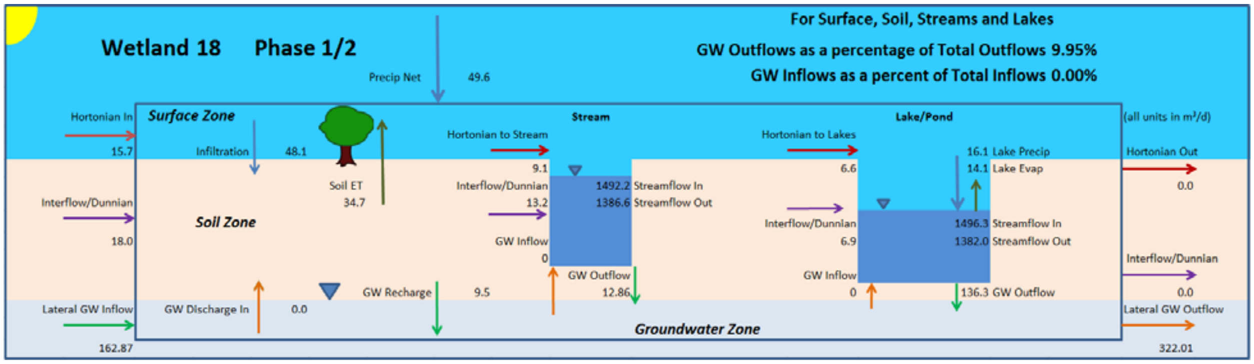


FIGURE 1C

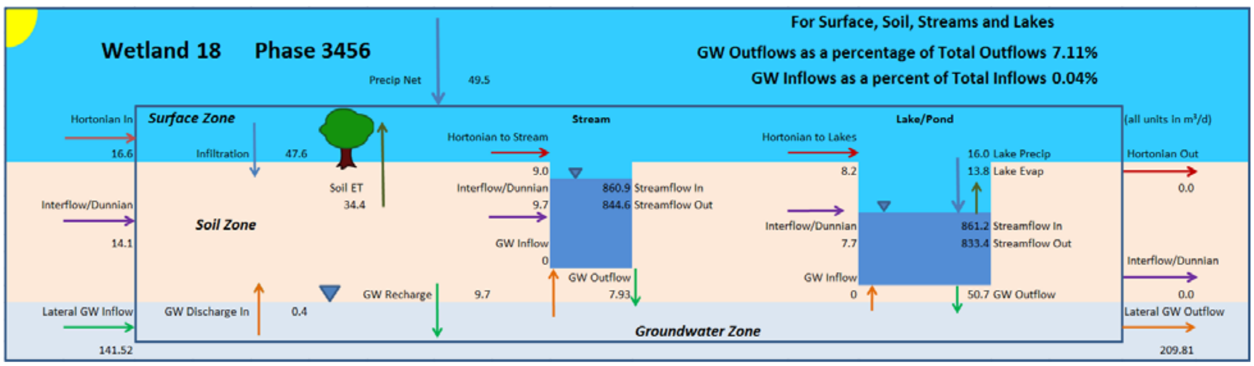


FIGURE 1D

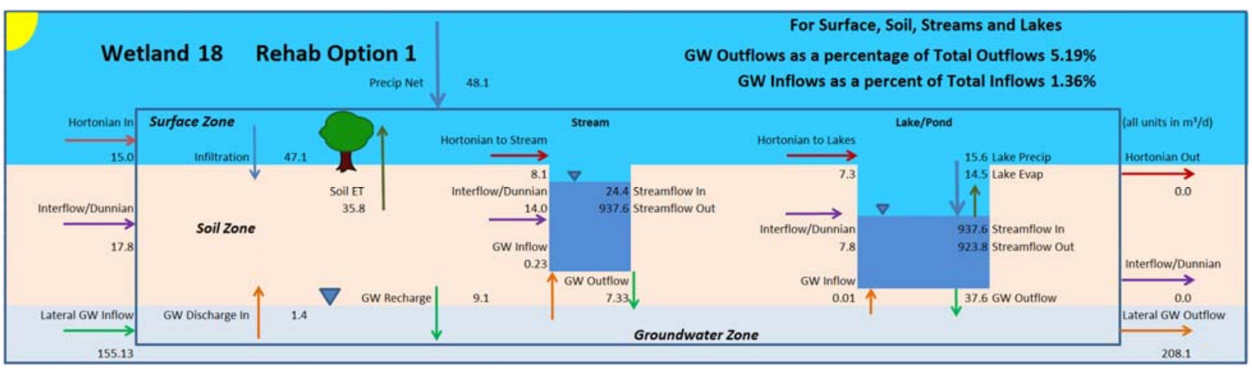
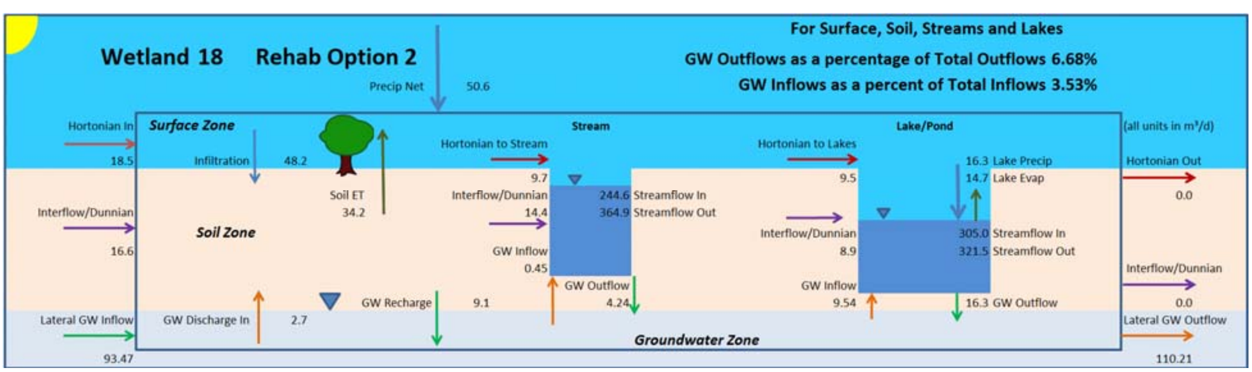
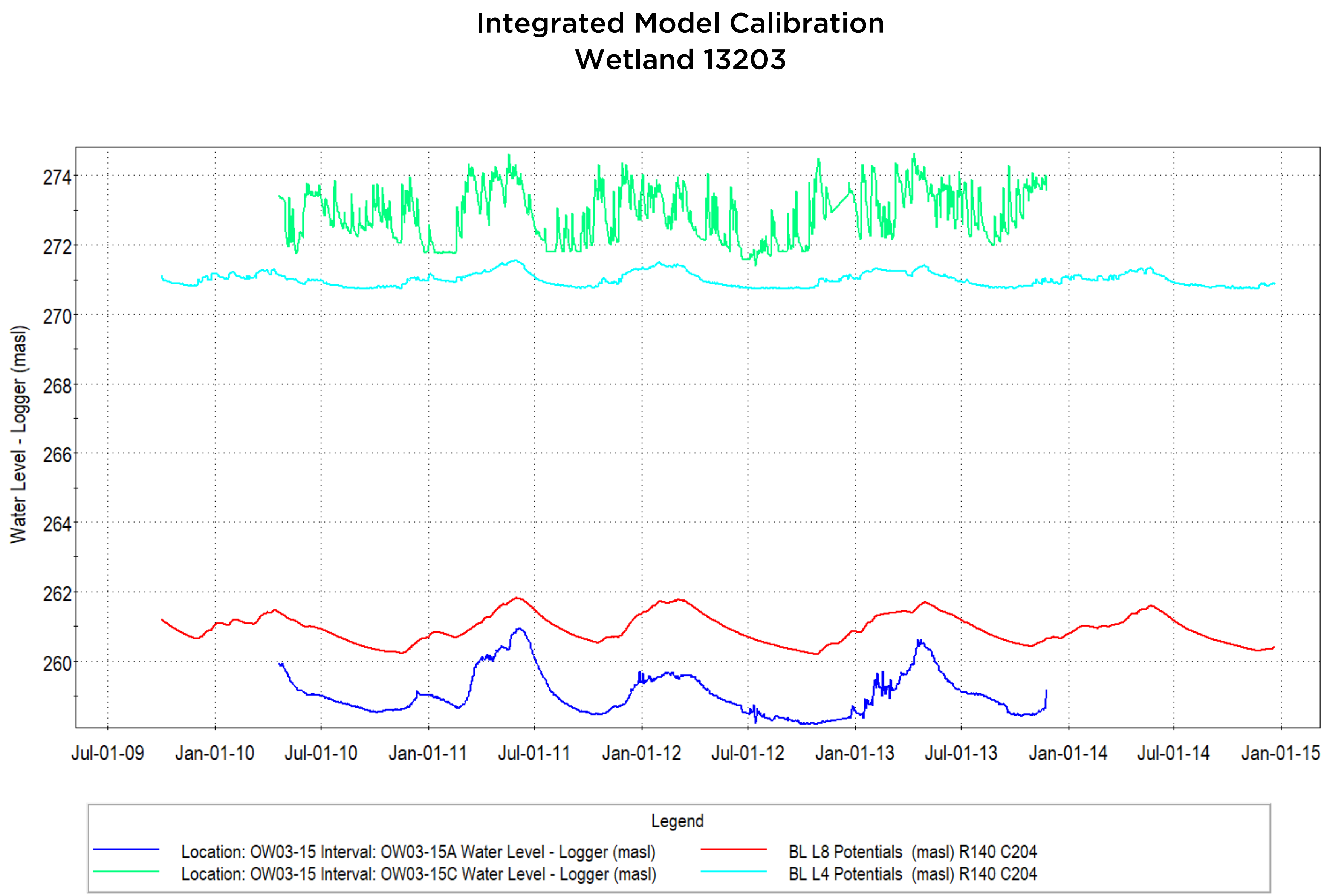
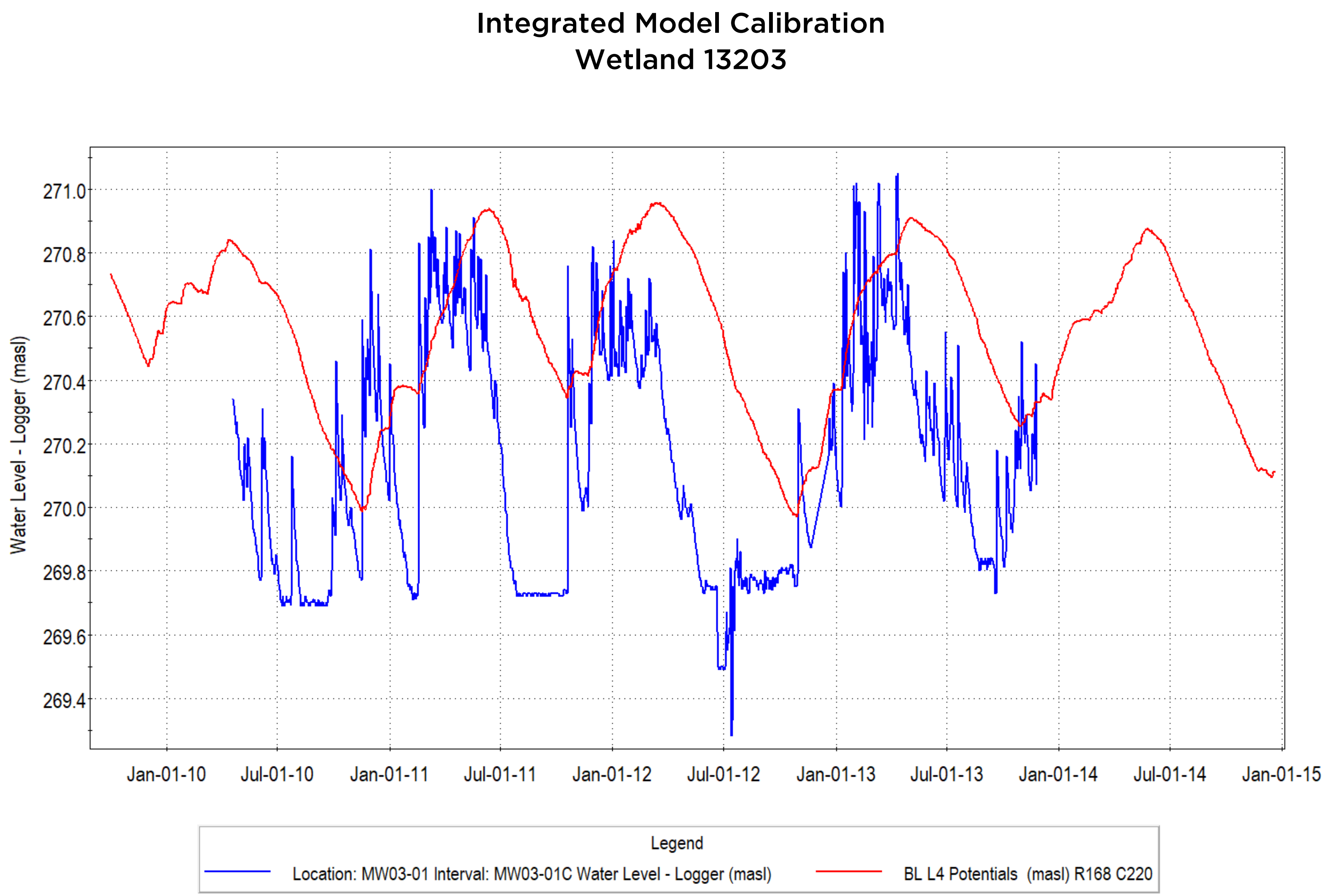


FIGURE 1E

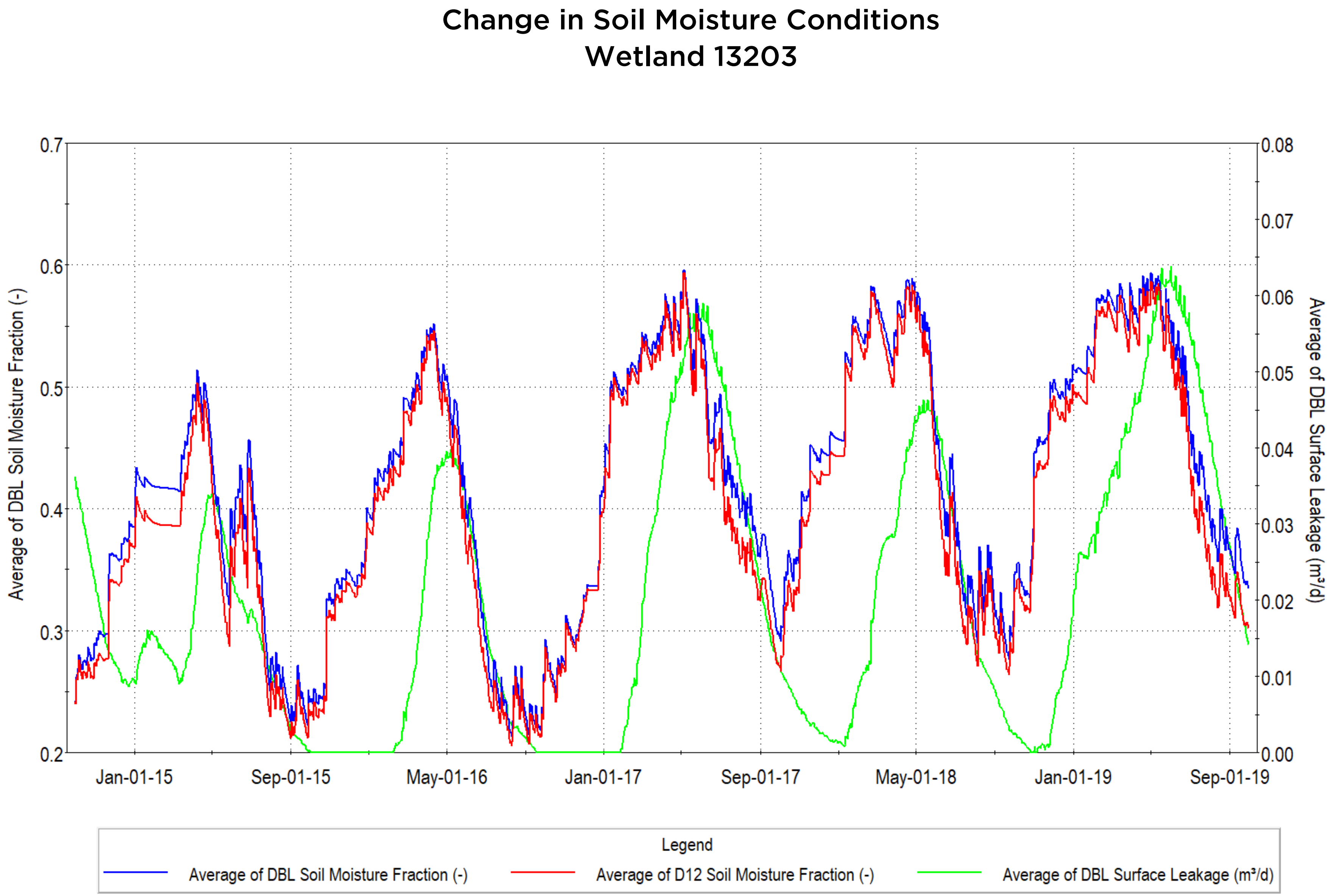



Integrated Model Calibration
Wetland 13203
Water Level - Logger (masl)
274
272
270
268
266
264
262
260
Jul-01-09
Jan-01-10
Jul-01-10
Jan-01-11
Jul-01-11
Jan-01-12
Jul-01-12
Jan-01-13
Jul-01-13
Jan-01-14
Jul-01-14
Jan-01-15
Legend
Location: OW03-15 Interval: OW03-15A Water Level - Logger (masl)
Location: OW03-15 Interval: OW03-15C Water Level - Logger (masl)
BL L8 Potentials (masl) R140 C204
BL L4 Potentials (masl) R140 C204

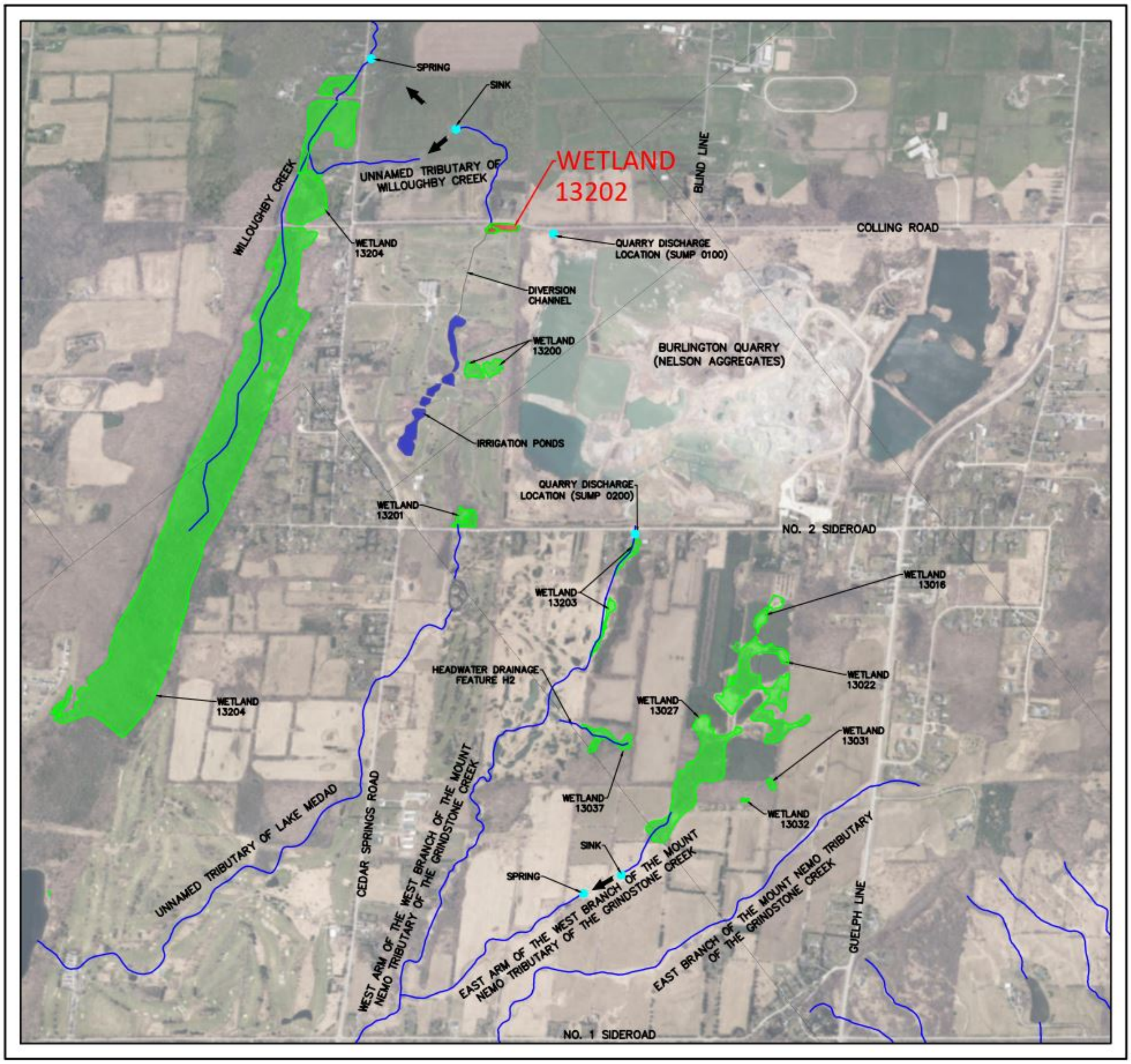
WETLAND 13203 - GRAPH 6

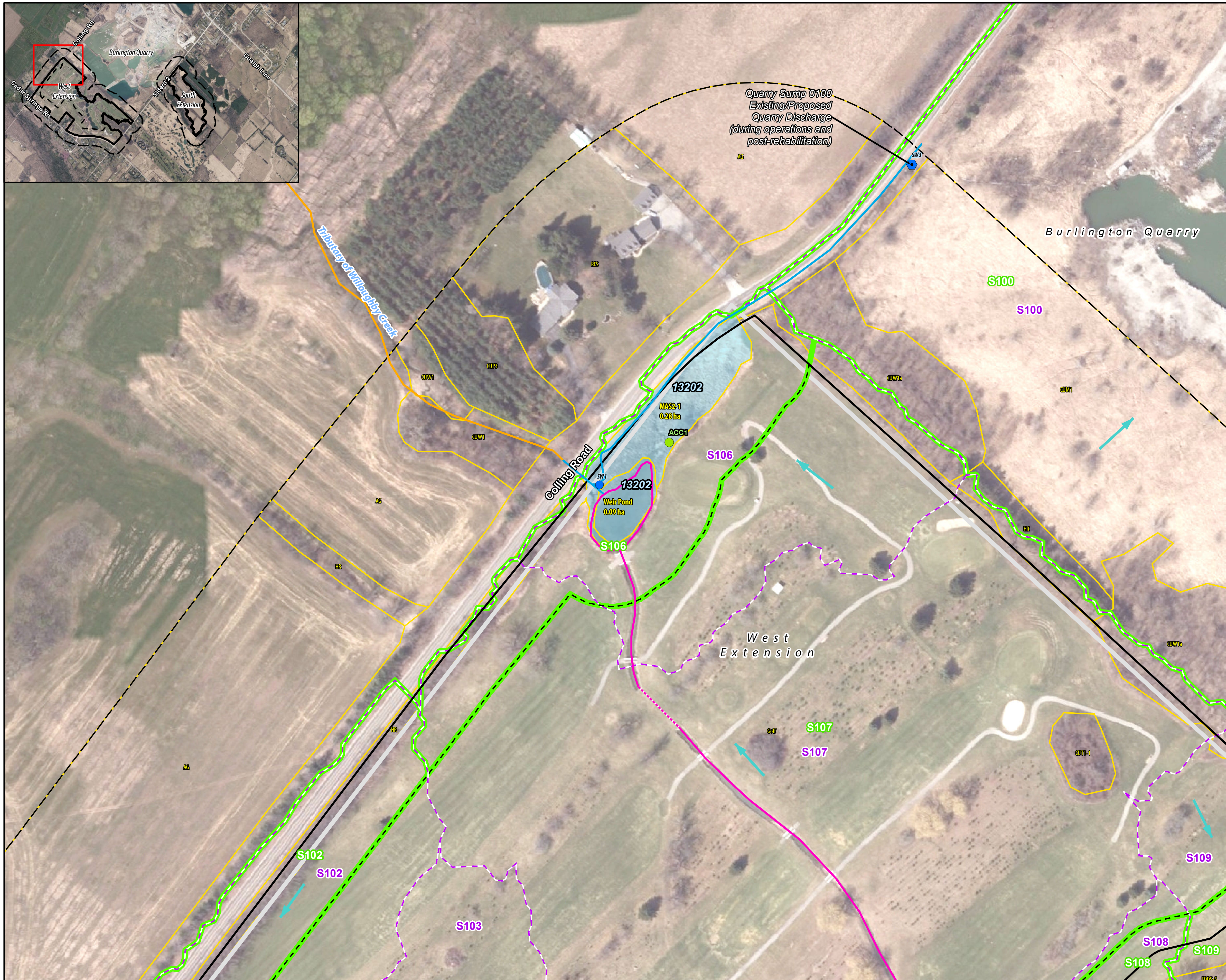


WETLAND 13203 - GRAPH 7



WETLAND 13202





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Amphibian Call Count Station (2019)
- Golf Course Irrigation Ponds and Channel
- Indirect Fish Habitat
- Direct Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)

Current Instrumentation

- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUP3, Coniferous Plantation
CUT1-1, Sumac Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD5-5, Dry – Fresh Sugar Maple – Hickory Deciduous Forest
HR, Hedgerow
MAS2-1, Cattail Mineral Shallow Marsh
RES, Residential

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 7
Wetland Characterization
Wetland 13202 - West Extension

0 30 m
1:2,000

N

GEI Consultants
Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_mapbook.mxd Date: ...uary 11, 2021

Wetland 13202

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF -N/A Earthfx - N/A Tatham - 13202 Savanta - 13202 Golder (Background) - N/A			
Wetland Area (ha):	Savanta - 0.37			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	Yes			
Catchment Area (ha):	2.32 + quarry discharge (Sump 0100)		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S106		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	On-line (connected to downstream watercourse)			
Condition:	Modified			
Bathymetry:	A bathymetric survey of Wetland 13202 has not been completed.			
Outlet:	Tributary of Willoughby Creek			
Hydroperiod:	Water level in Wetland 13202 and the weir pond maintained by quarry discharge. Water levels in Wetland 13202 and the weir pond are also manipulated by a weir structure operated by the Burlington Springs Golf and Country Club for irrigation of the golf course and to maintain water levels in the on-site irrigation/hazard ponds.		SWA (Tatham, April 2020)	2.1.1, 3 and Appendix B
Surface Water Monitoring:	ID: SW1 (Tatham) Installation Date: July 17, 2015 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Coordinates of Monitoring Station: Easting 589015.325, Northing 4805832.639	Graph 1	SWA (Tatham, April 2020)	2.1.1 and Appendix B

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Wetland 13202 – Other (it is completely dependent on pumping from the existing quarry; however it has been designed to demonstrate no negative impacts.)		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Pond: Weir Pond Cattail Mineral Shallow Marsh: MAS2-1		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	No		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	None confirmed for amphibian breeding, despite survey effort through habitat assessments and call count surveys. Confirmed for species of conservation concern – Unicorn Clubtail.		NETR (Savanta, April 2020)	4.2.2; 4.2.5; 5.2.2; 5.2.5; 6.4; Table 19
Fish Habitat:	Weir Pond – part of the golf course irrigation ponds and channel MAS2-1 – Indirect fish habitat		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	No species at risk salamanders observed, despite survey effort including habitat assessment.		NETR (Savanta, April 2020)	5.2.2

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Lithology:	Halton Till			
Hydraulic Conductivity:	Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.			
Surface Water/Groundwater Interaction:	The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. None of the wetlands receive significant groundwater inflow and are thus isolated from any changes in the water table due to quarry development.			
Water Budget Results:	No detailed water budget was produced for this wetland. The wetland is close to Wetland 13032 (Earthfx Wetland 19) and similar in size. The water budget for this wetland should be similar. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13032 (Earthfx Wetland 19) for baseline conditions is discussed in Section 7 of the main report			
Integrated Model Calibration:	The calibration of this wetland is not discussed in the Earthfx Report.			

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	No change. No extraction proposed in West Extension as part of Phases 1 and 2 of extraction.		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	No Change.			
Change in Water Budget:	Detailed water budgets were not prepared for this feature. Changes in streamflow at SW1 were discussed in Section 8.7.6. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of the wetland are discussed in Section 8 of the main report for each scenario a.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	No potential impacts to Wetland 13202 and the weir pond under Phases 1 and 2 of operations.			

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	No mitigation required under Phase 1 and 2 of operations. Existing quarry discharge to be maintained.			

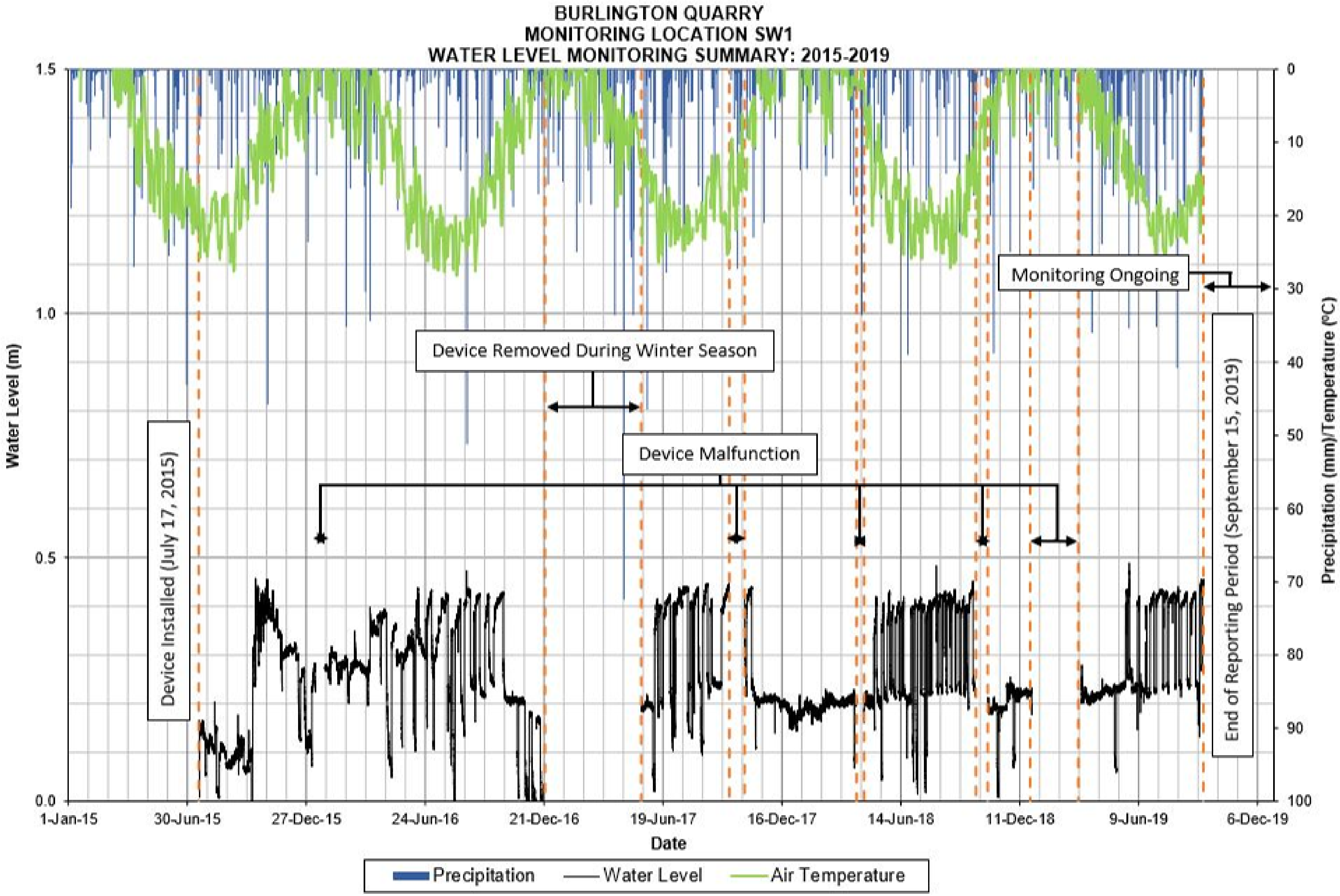
Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced to 1.6 ha (reduction of 0.72 ha)		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	No change in hydroperiod expected as quarry discharge maintains wetland and weir pond water levels.			
Change in Water Budget:	Detailed water budgets were not prepared for this feature. Changes in streamflow at SW1 were discussed in Section 8.7.6. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of the wetland are discussed in Section 8 of the main report for each scenario.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	Both the pond and the wetland will remain in place. There will be no encroachment from the project into the wetlands. Proposed limit of extraction is ≥30 m from the wetland boundary. A proposed berm will be constructed within the 30 m setback. The closest point of the berm will be 14 m from the wetland boundary. The extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The berm will be vegetated with common, native species (as approved by Conservation Halton) to ensure soil stability and prevention of erosion. The Weir Pond and the MAS2-1 are supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur at the same location at the upstream end of the tributary and in the same manner as existing pumping.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	The Weir Pond and the MAS2-1 are supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur at the same location at the upstream end of the tributary and in the same manner as existing pumping.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

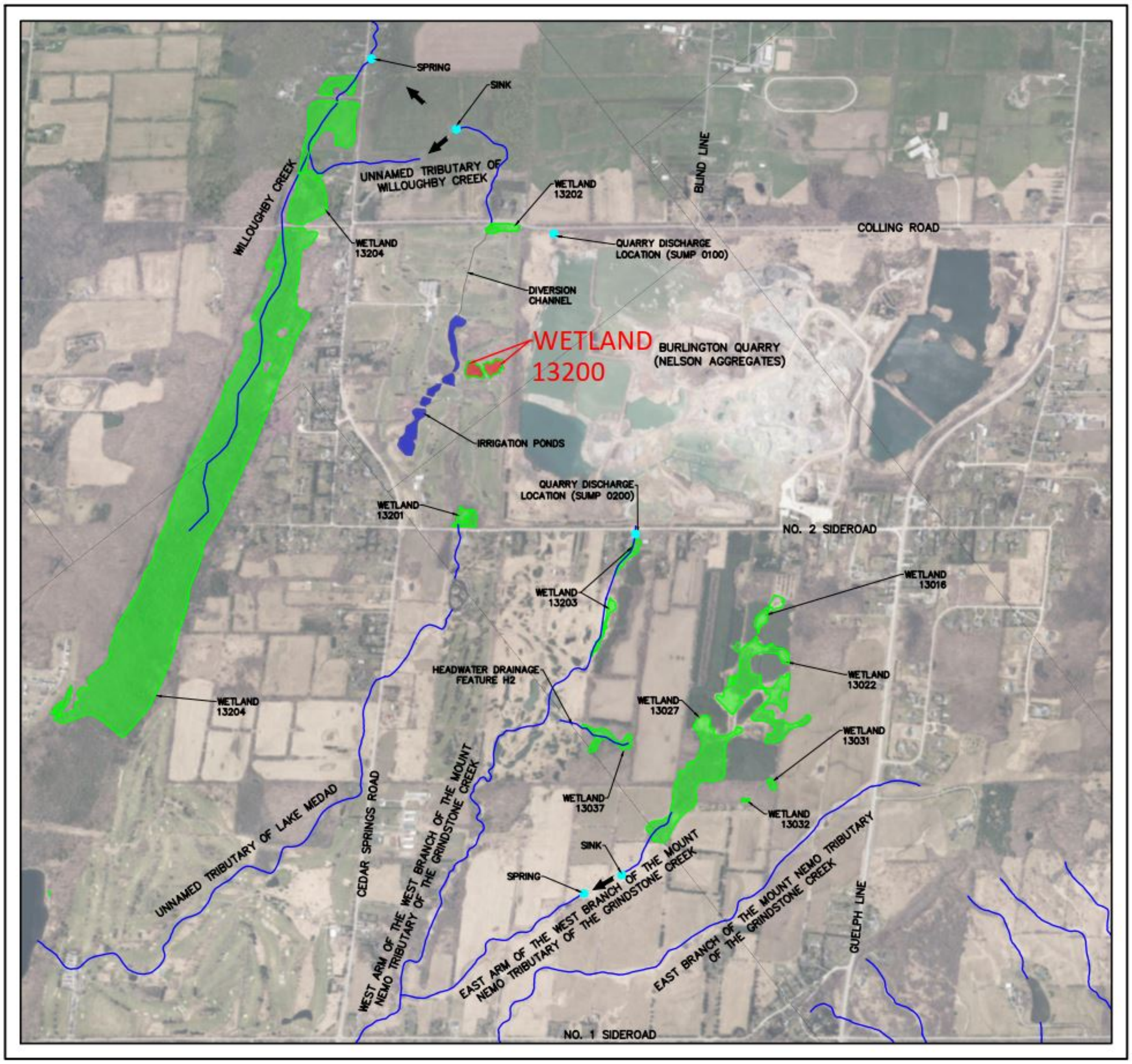
Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced to 1.6 ha (reduction of 0.72 ha). Drainage area to remain 1.6 ha post rehabilitation.		SWA (Tatham, April 2020)	Drawing DP-3
Change in Hydroperiod:	Currently approved plan for Burlington Quarry is to cease discharge following operations creating a pit lake. Ceasing discharge from the quarry will adversely impact Wetland 13202 and the Tributary of Willoughby Creek. No change in hydroperiod expected if quarry discharge is maintained.			
Change in Water Budget:	Detailed water budgets were not prepared for this feature. Changes in streamflow at SW1 were discussed in Section 8.7.6. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of the wetland are discussed in Section 8 of the main report for each scenario.		HHIAR (Earthfx, April 2020)	191 - 303
Potential Impact to Form and Function of Feature:	Both the pond and the wetland will remain in place. There will be no encroachment from the project into the wetlands. Proposed limit of extraction is ≥30 m from the wetland boundary. A proposed berm will be constructed within the 30 m setback. The closest point of the berm will be 14 m from the wetland boundary. The extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The berm will be vegetated with common, native species (as approved by Conservation Halton) to ensure soil stability and prevention of erosion. The Weir Pond and the MAS2-1 are supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur long-term at the same location at the upstream end of the tributary and in the same manner as existing pumping.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	The Weir Pond and the MAS2-1 are supplied with water by pumping from the existing adjacent quarry. The proposed quarry Extension is not anticipated to have any impact on pumping or water quality related to discharge from the existing quarry. Pumping and discharge are recommended to occur long-term at the same location at the upstream end of the tributary and in the same manner as existing pumping. The cessation of quarry discharge will adversely impact Wetland 13202 and the Unnamed Tributary of Willoughby Creek.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

WETLAND 13202 - GRAPH 1



WETLAND 13200



Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Amphibian Call Count Station (2019)
- Golf Course Irrigation Ponds and Channel
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Proposed Subcatchment Boundary - Operations (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Post-Rehabilitation (Tatham Engineering, 2020)
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)
- Ecological Land Classification (Savanta, 2020)

Current Instrumentation

- Mini Piezometer (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)

ELC Legend

CUM1, Mineral Cultural Meadow
CUT1, Mineral Cultural Thicket
CUT1-1, Sumac Cultural Thicket
CUW1, Mineral Cultural Woodland
DIST, Disturbed
FOD5-1, Dry- Fresh Sugar Maple Deciduous Forest
FOD5-2, Dry- Fresh Sugar Maple-Beech Deciduous Forest
FOD5-5, Dry – Fresh Sugar Maple – Hickory Deciduous Forest
FOD7-2, Fresh-Moist Ash Lowland Deciduous Forest
HR, Hedgerow
OA, Open Aquatic
RES, Residential
SWD3-2, Silver Maple Mineral Deciduous Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 8
Wetland Characterization

Wetland 13200 - West Extension

0 30 m
1:2,000
N

GEI Consultants
Savanta Division

Wetland 13200

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF -N/A Earthfx - 22 Tatham - 13200 Savanta - 13200 Golder (Background) - N/A			
Wetland Area (ha):	Savanta - 0.73			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	7.38		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S109		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	Isolated Feature			
Condition:	Natural			
Bathymetry:	A bathymetric survey of Wetland 13200 has not been completed.			
Outlet:	None			
Hydroperiod:	Monitoring station established April 22, 2020. Hydroperiod to be determined.			
Surface Water Monitoring:	ID: SW37 (Tatham) Installation Date: April 22, 2020 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 589429.71, Northing 4805390.25			

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Wetland 13200 – Other (considered not significant due to lack of amphibian breeding habitat, isolated and not connected to a PSW; however it has been designed to demonstrate no negative impacts.)		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Silver Maple Mineral Deciduous Swamp: SWD3-2a		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	No		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	None confirmed for amphibian breeding, despite survey effort through habitat assessments. Salamander trapping and call count surveys were not completed due to absence of water.		NETR (Savanta, April 2020)	4.2.2; 5.2.2; Table 19
Fish Habitat:	None		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	No species at risk salamanders observed, despite survey effort including habitat assessment.		NETR (Savanta, April 2020)	5.2.2

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2" colspan="6">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Lithology:</td><td colspan="6">Halton Till</td><td></td><td></td><td></td></tr>
<tr><td>Hydraulic Conductivity:</td><td colspan="6">Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water/Groundwater Interaction:</td><td colspan="6">The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland does not receive significant groundwater inflow and is isolated from any changes in the water table due to quarry development.</td><td></td><td></td><td></td></tr>
<tr><td>Shallow Groundwater (Mini-piezometer) Monitoring:</td><td colspan="6">ID: SW37 (Tatham)
Installation Date: April 22, 2020
Data Collection: Continuous water level and temperature and manual monthly water level measurements
Coordinates of Monitoring Station: Easting 589429.71, Northing 4805390.25</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Groundwater Monitoring (Monitoring Wells):</td><td>Monitoring Well ID</td><td>Distance (Dir.)</td><td>Geologic Unit</td><td>Ground Elevation</td><td>Monitoring Elev</td><td>Average WL</td><td rowspan="4">Graph 1</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>BS-03A</td><td>131 (SSW)</td><td>Bedrock</td><td>271.73</td><td>-</td><td>264.53</td></tr>
<tr><td>BS-03B</td><td>131 (SSW)</td><td>Bedrock</td><td>271.73</td><td>-</td><td>264.57</td></tr>
<tr><td>BS-03</td><td>131 (SSW)</td><td>Bedrock</td><td>271.73</td><td>-</td><td>266.05</td></tr>
<tr><td rowspan="3">Water Budget Results:</td><td colspan="6">A detailed average water budget, as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.30, p. 189). The baseline water budget is reproduced in Figure 1a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13200 (Earthfx Wetland 22) for baseline conditions are discussed in Section 7 of the main report.</td><td rowspan="3">Figure 1a</td><td rowspan="3">HHIAR (Earthfx, April 2020)</td><td rowspan="3">165 - 190</td></tr>
<tr><td>Wetland 13200</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>Baseline (Existing)</td><td>26.31</td><td>0.00</td></tr>
<tr><td>Integrated Model Calibration:</td><td colspan="6">No mini-piezometers for calibration. The model calibration to the new groundwater monitoring well 100 m south west show a good calibration to the available monitoring record (see Graph 2). Wetland 22 is not discussed in the Main Report. Other nearby wetlands are discussed in Appendix E, Section 19.6.</td><td>Graph 2</td><td></td><td></td></tr>
</table>

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	No change. No extraction proposed in West Extension as part of Phases 1 and 2 of extraction.		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	No Change			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.30, p. 189); Scenario P12 (Figure 8.37, p. 224); P3456 (Figure 8.69, p. 251 Wetland 22); RHB1 (Figure 8.103, p. 279), and RHB2 (Figure 8.130, p. 301). The water budget results for Scenario P12 are reproduced in Figure 1b. Wetland 13200 (Earthfx Wetland 22) is located between the P3456 extraction area and the existing quarry. This wetland had no change in the water budget compared to baseline conditions during Phase 1 and 2 operations because it is perched year-round and there was no change in the contributing area. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13200 (Earthfx Wetland 22) for each scenario are discussed in Section 8 of the main report.	Figure 1b	HHIAR (Earthfx, April 2020)	191 - 303

Wetland 13200	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	26.31	0.00	-	-
Operations Ph 1 & 2	25.24	0.00	-1.07	0.00

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Report	Section / Page
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be maintained. There will be no encroachment from the project into the wetland.			

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced to 5.40 ha (reduction of 1.98 ha)		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	Reduction due to reduction in catchment area. Change in hydroperiod to be determined (to be mitigated).			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.30, p. 189); Scenario P12 (Figure 8.37, p. 224); P3456 (Figure 8.69, p. 251 Wetland 22); RHB1 (Figure 8.103, p. 279), and RHB2 (Figure 8.130, p. 301). The water budget results for Scenario P3456 are reproduced in Figure 1c. Wetland 13200 (Earthfx Wetland 22) is located between the P3456 extraction area and the existing quarry. This wetland had a minor change in the water budget compared to baseline conditions due to changes to the contributing drainage area. However the wetland remained perched. This wetland will be monitored and receive supplemental inflows as required to maintain its hydroperiod, as described in the Tatham, 2020 report. The planned supplementation has not been represented in the model, so the Wetland 13201 (Earthfx Wetland 21) water budget is not fully representative of future conditions. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13200 (Earthfx Wetland 13200) for each scenario are discussed in Section 8 of the main report	Figure 1c	HHIAR (Earthfx, April 2020)	191 - 303

Wetland 13200	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	26.31	0.00	-	-
Operations Ph 3 - 6	26.31	0.00	0.00	0.00

Change on Soil Moisture Conditions:	The Water Budget figures indicate that there is no groundwater seepage entering the wetland under baseline conditions, so there will be no change under P3456 conditions.			
Potential Impact to Form and Function of Feature:	Both wetlands will remain in place. There will be no encroachment from the project into the wetlands. The proposed limit of extraction is >30 m from the wetland boundary. The licensed boundary/extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The drainage area to these wetland units will be reduced during operations, which has the potential to adversely impact the hydroperiods.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	To mitigate this potential impact, flow to the wetlands will be supplemented by pumping from Quarry Sump 0100 directly into the wetland at specified rates and volumes to maintain the wetland hydroperiod. Wetland hydroperiod and shallow groundwater monitoring stations were installed in spring 2020. This data will be used to establish existing thresholds so existing conditions can be maintained throughout extraction operations.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

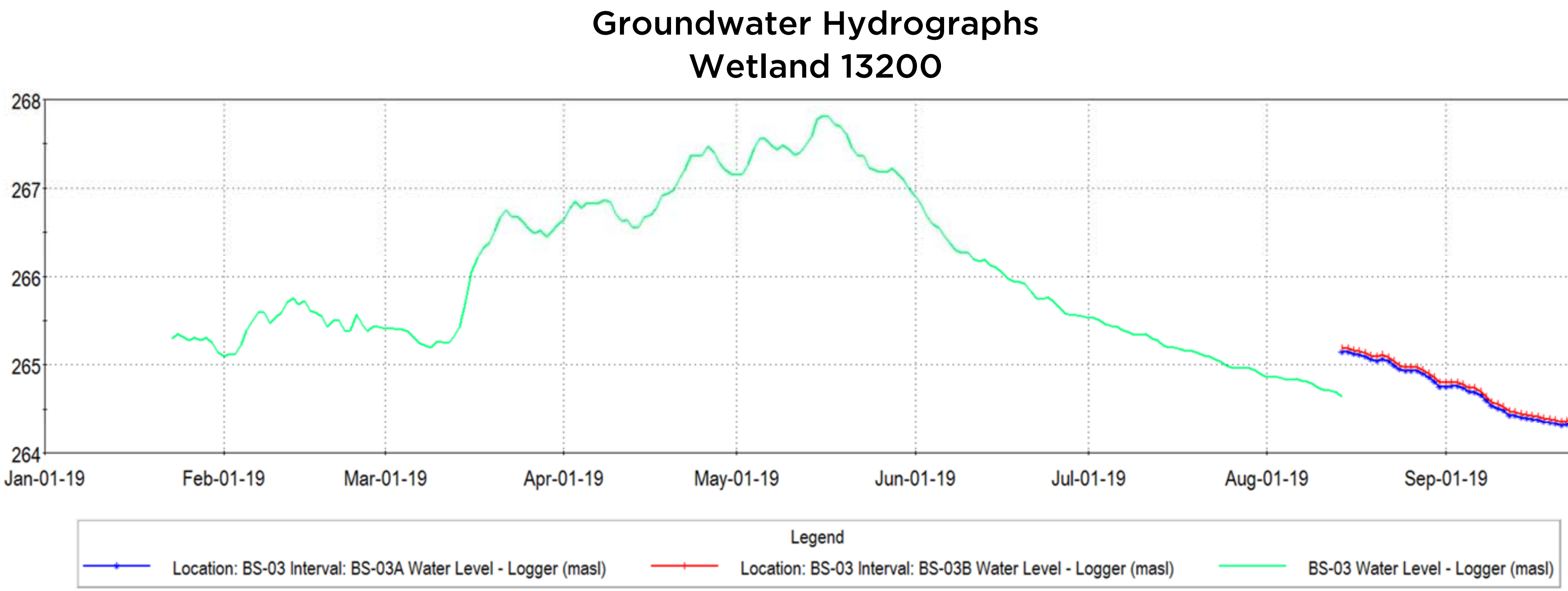
Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	No change. Subcatchment area will be reinstated as part of rehabilitation.		SWA (Tatham, April 2020)	Drawing DP-3
Change in Hydroperiod:	No Change. Wetland is perched and isolated from the groundwater system. Subcatchment area will be reinstated as part of rehabilitation.			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.30, p. 189); Scenario P12 (Figure 8.37, p. 224); P3456 (Figure 8.69, p. 251 Wetland 22); RHB1 (Figure 8.103, p. 279), and RHB2 (Figure 8.130, p. 301). The water budget results for Scenarios RHB1 and RHB2 are presented in Figures 1d and 1e. Wetland 13200 (Earthfx Wetland 22) is located between the P3456 extraction area and the existing quarry. This wetland had no significant change in the water budget compared to baseline conditions because it is perched year-round and the catchment area will be reinstated as part of rehabilitation of the site. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13200 (Earthfx Wetland 13200) for each scenario are discussed in Section 8 of the main report	Figure 1d and 1e	HHIAR (Earthfx, April 2020)	191 - 303

Wetland 13200	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	26.31	0.00	-	-
Rehab Scenario 1	24.14	0.00	-2.17	0.00
Rehab Scenario 2	28.47	0.00	2.16	0.00

Potential Impact to Form and Function of Feature:	Both wetlands will remain in place. There will be no encroachment from the project into the wetlands. The proposed limit of extraction is >30 m from the wetland boundary. The licensed boundary/extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The drainage area to these wetland units will be reduced during operations, which has the potential to adversely impact the hydroperiods.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	Once operations are complete and the rehabilitation is implemented, the grade around the wetlands will be returned to existing conditions reinstating the catchment area to the wetland. Wetland hydroperiods and shallow groundwater monitoring stations were installed in spring 2020. This data will be used to establish existing thresholds so existing conditions can be maintained throughout extraction operations and replicated in post-operation / rehabilitated conditions.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

WETLAND 13200 - GRAPH 1



WETLAND 13200

FIGURE 1A

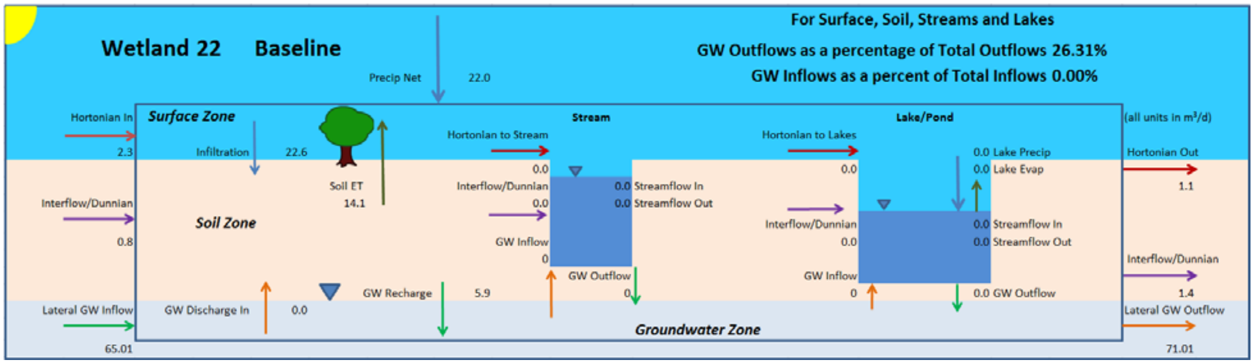


FIGURE 1B

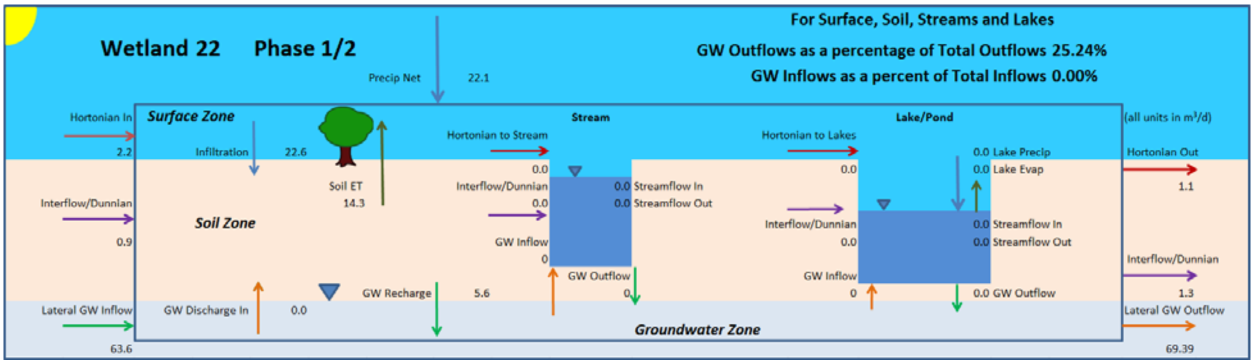


FIGURE 1C

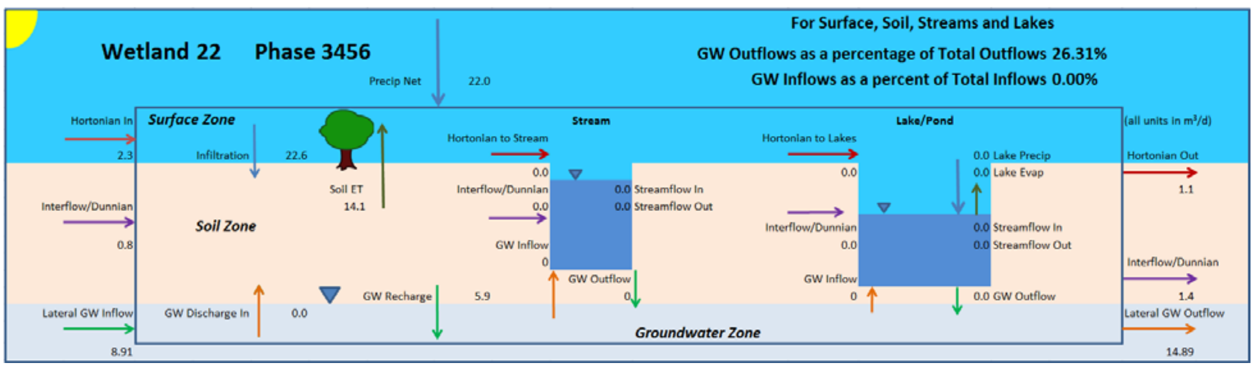


FIGURE 1D

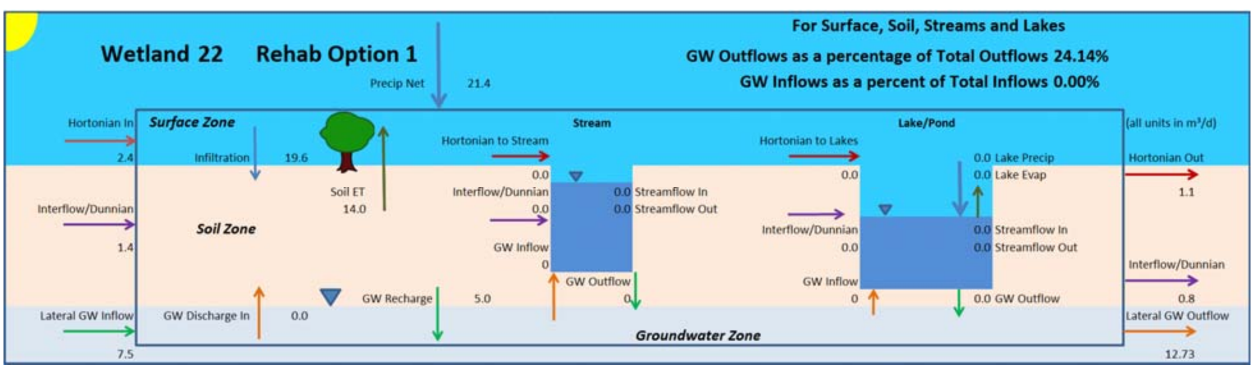
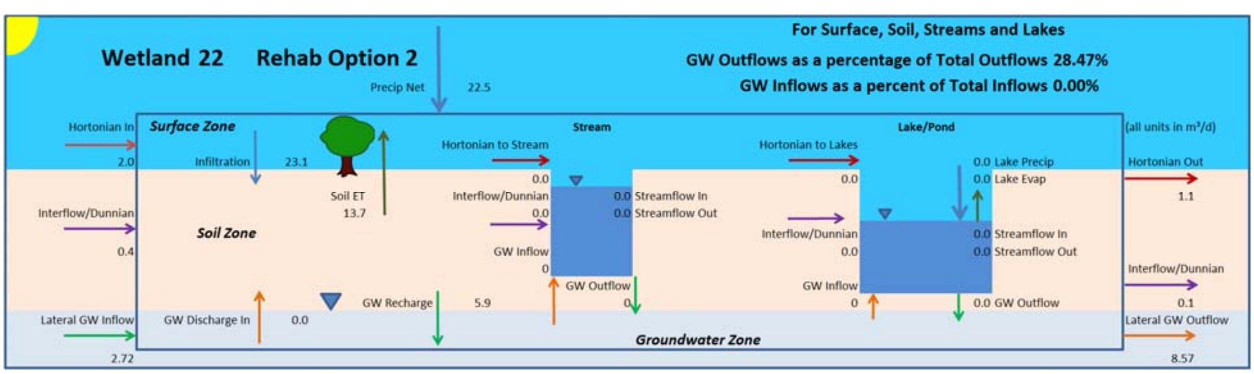
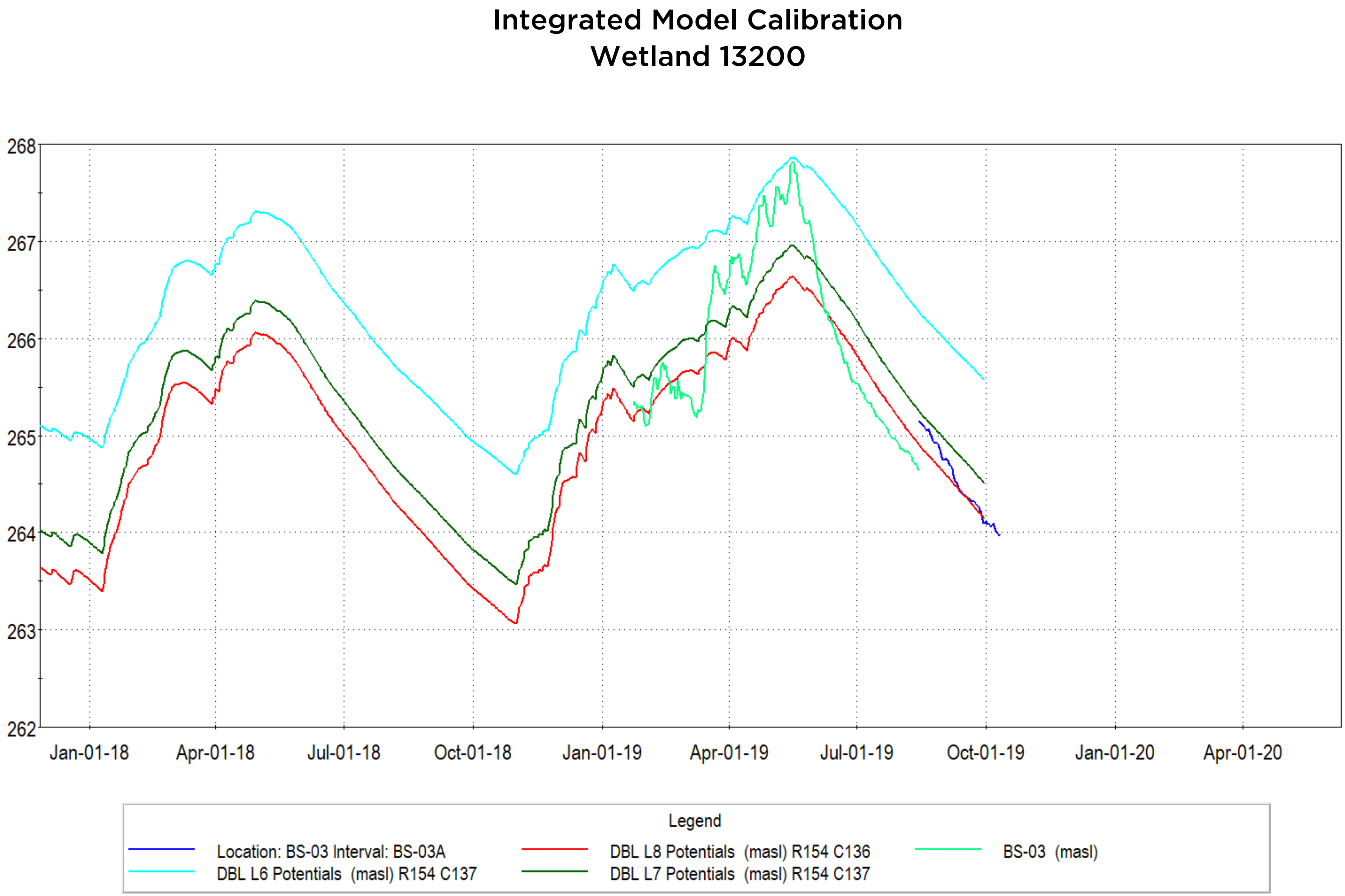
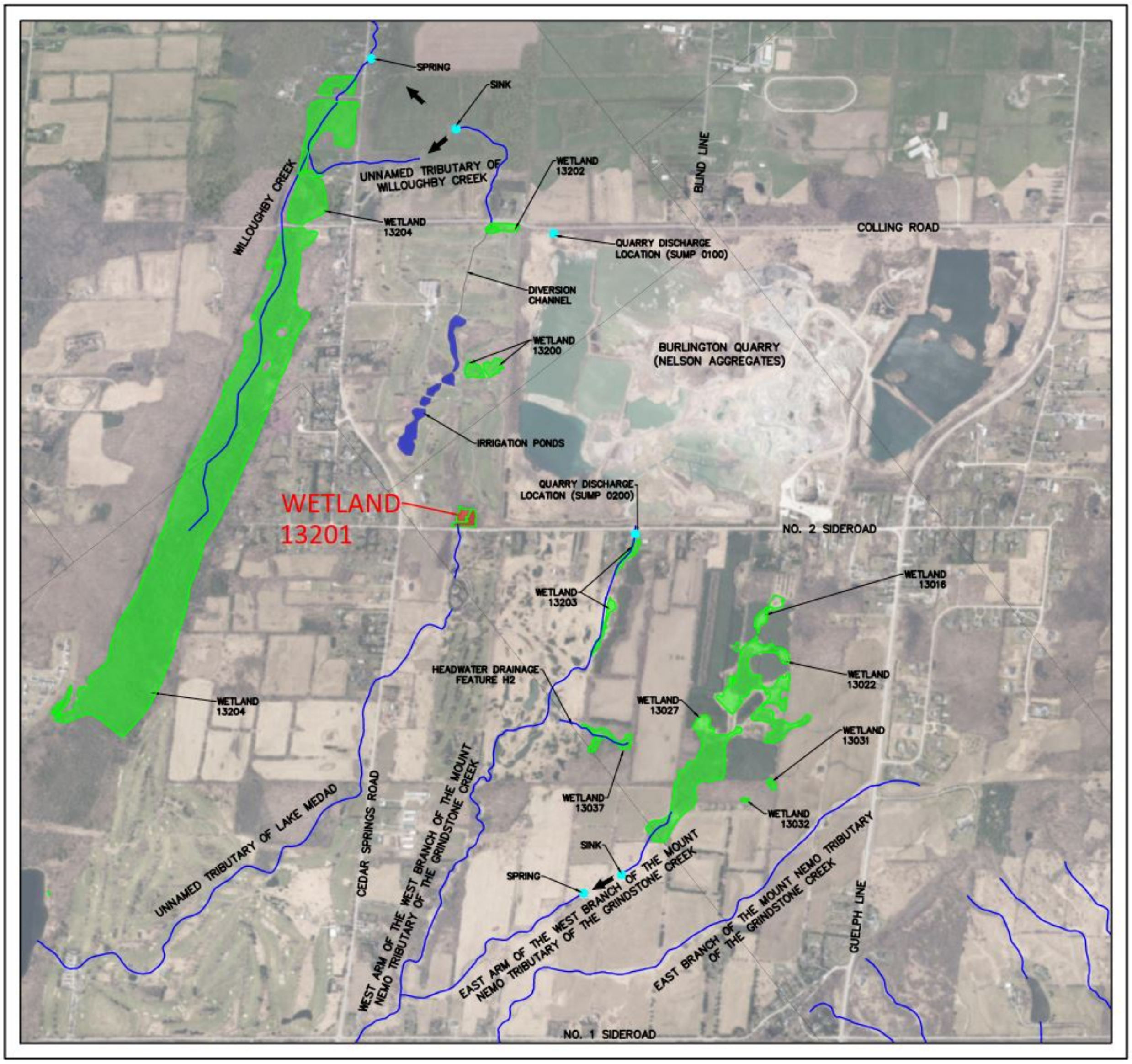


FIGURE 1E




Integrated Model Calibration
Wetland 13200
268
267
266
265
264
263
262
Jan-01-18
Apr-01-18
Jul-01-18
Oct-01-18
Jan-01-19
Apr-01-19
Jul-01-19
Oct-01-19
Jan-01-20
Apr-01-20
Legend
Location: BS-03 Interval: BS-03A
DBL L6 Potentials (masl) R154 C137
DBL L8 Potentials (masl) R154 C136
DBL L7 Potentials (masl) R154 C137
BS-03 (masl)

WETLAND 13201



Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Amphibian Call Count Station (2019)
- Salamander Trap (2019)
- Salamander Habitat Assessment (2019)
- Indirect Fish Habitat
- Direct Fish Habitat
- Existing Subcatchment Boundary (Tatham Engineering, 2020)
- Proposed Subcatchment Boundary - Operations and Post-Rehabilitation (Tatham Engineering, 2020
- Wetland (Savanta, 2020)
- Ecological Land Classification (Savanta, 2019 & 2020)

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

ELC Legend

AG, Agriculture
CUM1, Mineral Cultural Meadow
CUT1, Mineral Cultural Thicket
CUW1, Mineral Cultural Woodland
FOD, Deciduous Forest
FOD7-2, Fresh-Moist Ash Lowland Deciduous Forest
FOD7-4, Fresh – Moist Black Walnut Lowland Deciduous Forest
HR, Hedgerow
MAM2-2, Reed-canary Grass Mineral Meadow Marsh
RES, Residential
SWD, Deciduous Swamp
SWD3-2, Silver Maple Mineral Deciduous Swamp

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 9
Wetland Characterization

Wetland 13201 - West Extension

0 30 m
1:2,000
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Savanta Division

Wetland 13201

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF -N/A Earthfx - 21 Tatham - 13201 Savanta - 13201 Golder (Background) - N/A			
Wetland Area (ha):	Savanta - 0.92			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	14.85		SWA (Tatham, April 2020)	Drawing DP-1
Catchment ID:	S111		SWA (Tatham, April 2020)	Drawing DP-1
Closed or Connected System:	Isolated Feature (culvert under No. 2 Sideroad plugged and there is no evidence of a culvert or channel connection to the Unnamed Tributary of Lake Medad).			
Condition:	Modified			
Bathymetry:	A bathymetric survey of Wetland 13201 has not been completed.			
Outlet:	None			
Hydroperiod:	Monitoring station established April 22, 2020. Hydroperiod to be determined.			
Surface Water Monitoring:	ID: SW36 (Tatham) Installation Date: April 22, 2020 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 589880.52, Northing 4804990.81			

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Wetland 13201 – Other (considered not significant due to lack of amphibian breeding habitat, isolated and not connected to a PSW; however it has been designed to demonstrate no negative impacts.)		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Reed-canary Grass Mineral Meadow Marsh: MAM2-2 Silver Maple Mineral Deciduous Swamp: SWD3-2b		NETR (Savanta, April 2020)	Table 2
Regulated Habitat (MECP):	No		NETR (Savanta, April 2020)	6.7
Significant Wildlife Habitat:	None confirmed for amphibian breeding, despite survey effort through salamander habitat assessments, salamander trapping and call count surveys.		NETR (Savanta, April 2020)	4.2.2; 5.2.2; Table 19
Fish Habitat:	None		NETR (Savanta, April 2020)	6.6
Habitat of Endangered and Threatened Species:	No species at risk salamanders observed, despite survey effort including salamander habitat assessment and salamander trapping.		NETR (Savanta, April 2020)	5.2.2

Groundwater Interaction	Description						Figure / Graph	Reference	
								Report	Section / Page
Lithology:	Halton Till								
Hydraulic Conductivity:	Integrated Model (Earthfx) - The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.								
Surface Water/Groundwater Interaction:	The low permeability of the Halton Till underlying the wetland is the dominant control on surface and groundwater interaction. The wetlands and streams are generally perched above the water table and isolated from the groundwater system by the low permeability till. This wetland receives some groundwater inflow but is relatively isolated from any changes in the water table due to quarry development.								
Shallow Groundwater (Mini-piezometer) Monitoring:	ID: SW36 (Tatham) Installation Date: April 22, 2020 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 589880.52, Northing 4804990.81								
Background Shallow Groundwater (Mini-piezometer) Monitoring:	Mini-piezometer ID	Ground Elevation	Bottom Elevation	Average WL	Logger	Manual Meas.			
	Golder MP34	273.66	273.15	173.26	2010 - 2013	2010 - 2013			
Groundwater Monitoring (Monitoring Wells):	Monitoring Well ID	Distance (Dir.)	Geologic Unit	Ground Elevation	Monitoring Elev	Average WL	Graphs 1 & 2		
	BS-04A	144 (SW)	Bedrock	284.87	-	264.34			
	BS-04B	144 (SW)	Bedrock	284.87	-	264.69			
	BS-04C	144 (SW)	Bedrock	284.98	-	264.70			
Water Budget Results:	A detailed average water budget, as simulated by the integrated model, is provided in the main report for Baseline Conditions (Earthfx Figure 7.29, p. 189). The baseline water budget is reproduced in Figure 1a. The wetland is a net provider of groundwater. Simulated groundwater levels, groundwater discharge to riparian areas, and streamflow in the vicinity of Wetland 13201 (Earthfx Wetland 21) for baseline conditions are discussed in Section 7 of the main report.						Figure 1a	HHIAR (Earthfx, April 2020)	165 - 190
	Wetland 13201	GW Outflow (%)	GW Inflow (%)						
	Baseline (Existing)	29.78	2.98						
Integrated Model Calibration:	The model calibration to Well BS02 shows a good calibration to the available monitoring record (see Graph 3). Wetland 22 is not discussed in the Main Report. Other nearby wetlands are discussed in Appendix E, Section 19.6.						Graph 3		

<table>
<tr><th rowspan="2">Impact Assessment (Operations Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>No change. No extraction proposed in West Extension as part of Phases 1 and 2 of extraction.</td><td></td><td>SWA (Tatham, April 2020)</td><td>Drawing DP-2</td></tr>
<tr><td>Change in Hydroperiod:</td><td>No Change</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.29, p. 189); Scenario P12 (Figure 8.36, p. 224); P3456 (Figure 8.68, p. 251 Wetland 22). The water budget results for Scenario P12 are reproduced in Figure 1b. Wetland 13201 (Earthfx Wetland 21) is located at the south edge of the West Extension area. This wetland will be monitored and receive supplemental inflows as required to maintain its hydroperiod, as described in the Tatham, 2020 report. The planned supplementation has not been represented in the model, so the Wetland 13201 (Earthfx Wetland 21) water budget is not fully representative of future conditions. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13201 (Earthfx Wetland 21) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13201</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>29.78</td><td>2.98</td><td>-</td><td>-</td></tr>
<tr><td>Operations Ph 1 & 2</td><td>30.38</td><td>1.76</td><td>-0.60</td><td>-1.22</td></tr>
</table></td><td>Figure 1b</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>No wetlands will be removed and the wetlands subcatchment will be maintained. There will be no encroachment from the project into the wetland.</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Operational Phases 1 & 2)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>None required.</td><td></td><td></td><td></td></tr>
</table>

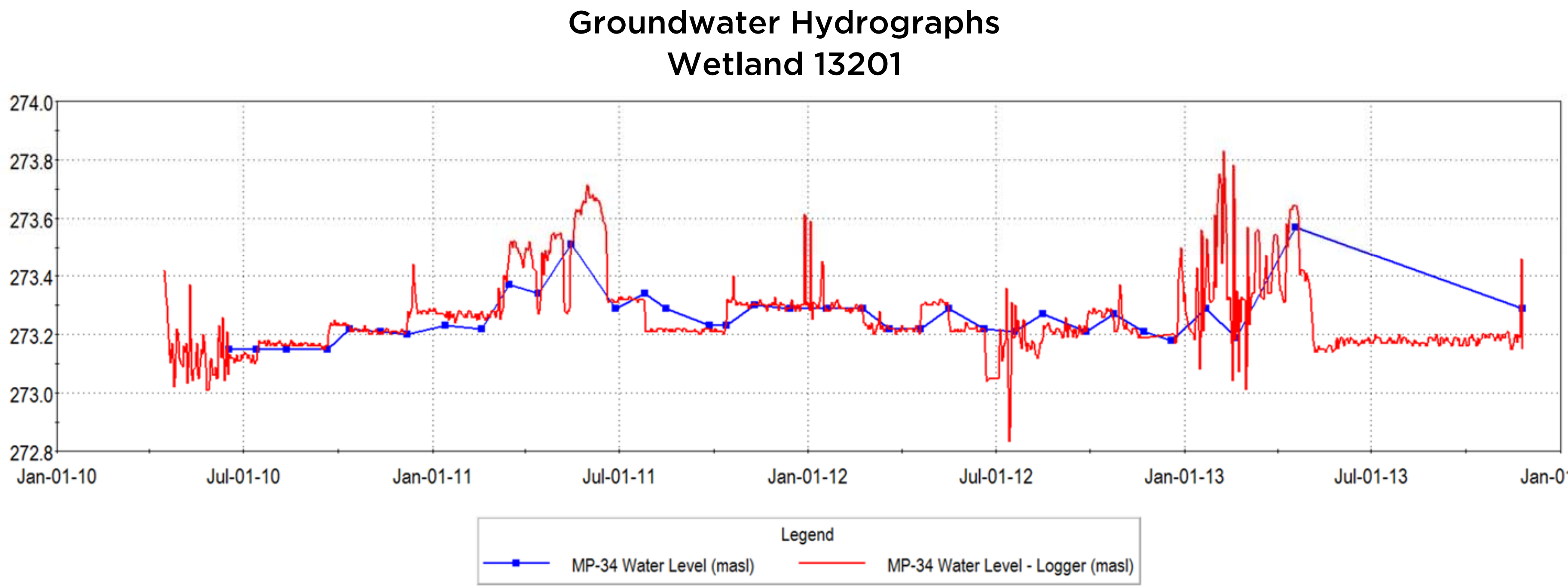
Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced to 7.6 ha (reduction of 7.25 ha)		SWA (Tatham, April 2020)	Drawing DP-2
Change in Hydroperiod:	Reduction due to reduction in catchment area. Change in hydroperiod to be determined (to be mitigated).			
Change in Water Budget:	A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.29, p. 189); Scenario P12 (Figure 8.36, p. 224); P3456 (Figure 8.68, p. 251 Wetland 22). The water budget results for Scenario P3456 are reproduced in Figure 1c. Wetland 13201 (Earthfx Wetland 21) is located at the south edge of the West Extension area. This wetland will be monitored and receive supplemental inflows as required to maintain its hydroperiod, as described in the Tatham, 2020 report. The planned supplementation has not been represented in the model, so the Wetland 13201 (Earthfx Wetland 21) water budget is not fully representative of future conditions. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13201 (Earthfx Wetland 21) for each scenario are discussed in Section 8 of the main report.	Figure 1c	HHIAR (Earthfx, April 2020)	191 - 303
Change on Soil Moisture Conditions:	The predicted soil moisture and surface discharge patterns in Wetland 21 are shown in Graph 4. The pond leakage for Wetland 21 is shown in Graph 5. The change in soil moisture and pond seepage is somewhat more complex in Wetland 21 than the other wetlands because the headwater catchment area will be reduced by the development of P3456. Under Baseline conditions, the wetland receives runoff and interflow from a larger catchment resulting in higher average soil moisture conditions. Under P3456 conditions the change in catchment area reduces the soil moisture and groundwater seepage. These changes (due to lower water availability and the drop in the water table) cause higher pond leakage in the spring, and lower leakage in the fall (Graph 5). It is important to note that groundwater inflow as a percentage of total inflows is only 2.98% under baseline conditions.	Graph 4 & 5		
Potential Impact to Form and Function of Feature:	Both wetlands will remain in place. There will be no encroachment from the project into the wetlands. The proposed limit of extraction is >30 m from the wetland boundary. The licensed boundary/extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The drainage area to these wetland units will be reduced during operations, which has the potential to adversely impact the hydroperiods.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

Wetland 13201	GW Outflow (%)	GW Inflow (%)	Δ in Outflow (%)	Δ in Inflow (%)
Baseline (Existing)	29.78	2.98	-	-
Operations Ph 3 - 6	51.69	0.01	21.91	-2.97

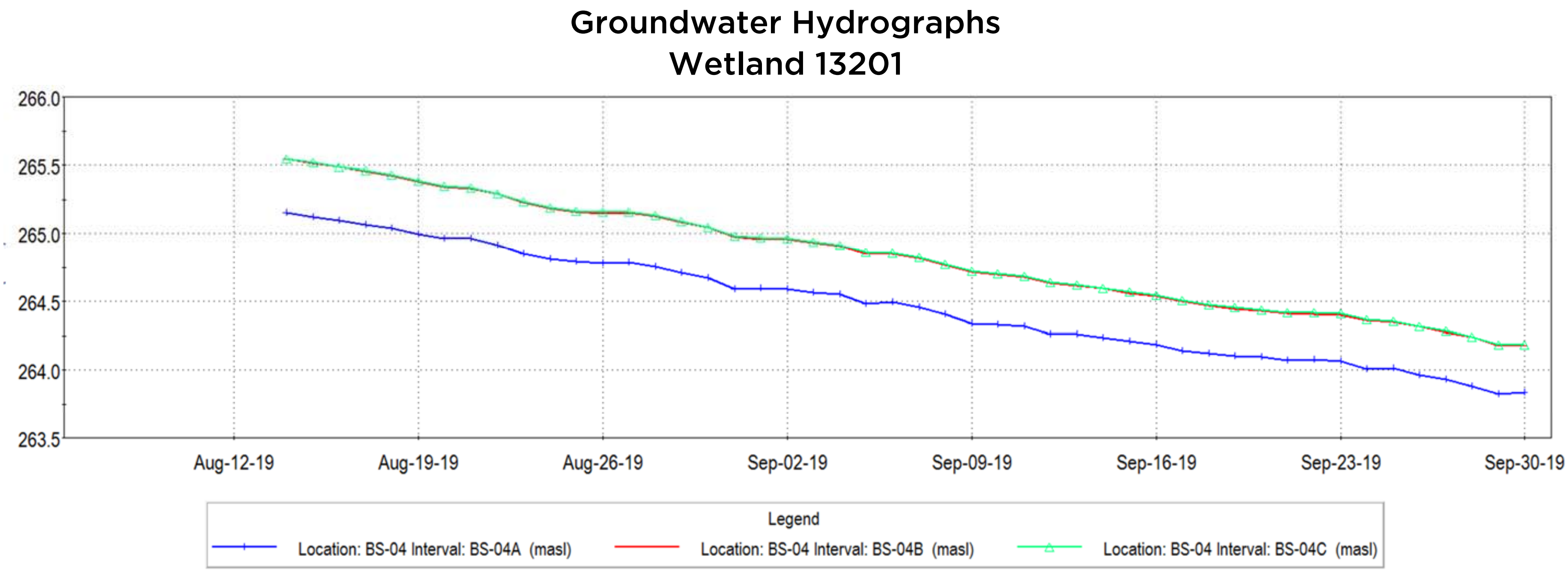
Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	To mitigate this potential impact, flow to the wetlands will be supplemented by a bottom draw outlet constructed in the southeast corner of the proposed infiltration pond and an outlet pipe with a control valve will be installed to discharge water into the roadside ditch along No. 2 Sideroad, feeding the wetland. The bottom draw outlet, outlet pipe and control valve will remain post extraction as part of the rehabilitation of the site. Wetland hydroperiod and shallow groundwater monitoring stations were installed in spring 2020. This data will be used to establish existing thresholds so existing conditions can be maintained throughout extraction operations and replicated in post-operation / rehabilitated conditions.		NETR (Savanta, April 2020)	7.2.1; 7.1.1; 7.1.2

<table>
<tr><th rowspan="2">Impact Assessment (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Change in Wetland Area (ha):</td><td>No change.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Wetland Catchment Area (ha):</td><td>Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced to 7.6 ha (reduction of 7.25 ha)</td><td></td><td>SWA (Tatham, April 2020)</td><td>Drawing DP-3</td></tr>
<tr><td>Change in Hydroperiod:</td><td>Reduction due to reduction in catchment area. Change in hydroperiod to be determined (to be mitigated).</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Budget:</td><td>A detailed average water budget as simulated by the integrated model is provided in the Earthfx report for Baseline Conditions (Figure 7.29, p. 189); Scenario P12 (Figure 8.36, p. 224); P3456 (Figure 8.68, p. 251 Wetland 22). The water budget results for Scenario RHB1 and RHB2 are reproduced in Figures 1d and 1e. Wetland 13201 (Earthfx Wetland 21) is located at the south edge of the West Extension area. This wetland will be monitored and receive supplemental inflows as required to maintain its hydroperiod, as described in the Tatham, 2020 report. The planned supplementation has not been represented in the model, so the Wetland 13201 (Earthfx Wetland 21) water budget is not fully representative of future conditions. Simulated change in groundwater levels (drawdowns), groundwater discharge to riparian areas, and change in streamflow in the vicinity of Wetland 13201 (Earthfx Wetland 21) for each scenario are discussed in Section 8 of the main report.
<table>
<tr><td>Wetland 13201</td><td>GW Outflow (%)</td><td>GW Inflow (%)</td><td>Δ in Outflow (%)</td><td>Δ in Inflow (%)</td></tr>
<tr><td>Baseline (Existing)</td><td>26.31</td><td>0.00</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>49.00</td><td>0.23</td><td>19.22</td><td>-2.75</td></tr>
<tr><td>Rehab Scenario 2</td><td>2.21</td><td>15.67</td><td>-27.57</td><td>12.69</td></tr>
</table></td><td>Figure 1d and 1e</td><td>HHIAR (Earthfx, April 2020)</td><td>191 - 303</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>Both wetlands will remain in place. There will be no encroachment from the project into the wetlands. The proposed limit of extraction is >30 m from the wetland boundary. The licensed boundary/extraction limit will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project . The drainage area to these wetland units will be reduced during operations, which has the potential to adversely impact the hydroperiods.</td><td></td><td>NETR (Savanta, April 2020)</td><td>7.2.1; 7.1.1; 7.1.2</td></tr>
</table>

<table>
<tr><th rowspan="2">Mitigation (Rehabilitation)</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Proposed Mitigation Measures:</td><td>To mitigate this potential impact, flow to the wetlands will be supplemented by a bottom draw outlet constructed in the southeast corner of the proposed infiltration pond and an outlet pipe with a control valve will be installed to discharge water into the roadside ditch along No. 2 Sideroad, feeding the wetland. The bottom draw outlet, outlet pipe and control valve will remain post extraction as part of the rehabilitation of the site. Wetland hydroperiods and shallow groundwater monitoring stations were installed in spring 2020. This data will be used to establish existing thresholds so existing conditions can be maintained throughout extraction operations and replicated in post-operation / rehabilitated conditions.</td><td></td><td>NETR (Savanta, April 2020)</td><td>7.2.1; 7.1.1; 7.1.2</td></tr>
</table>


Groundwater Hydrographs
Wetland 13201
274.0
273.8
273.6
273.4
273.2
273.0
272.8
Jan-01-10
Jul-01-10
Jan-01-11
Jul-01-11
Jan-01-12
Jul-01-12
Jan-01-13
Jul-01-13
Legend
MP-34 Water Level (masl)
MP-34 Water Level - Logger (masl)

WETLAND 13201 - GRAPH 2



WETLAND 13201

FIGURE 1A

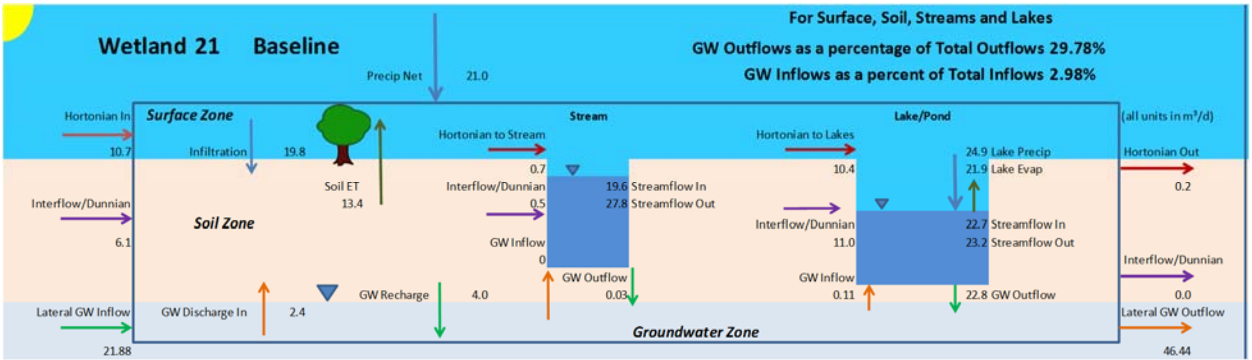


FIGURE 1B

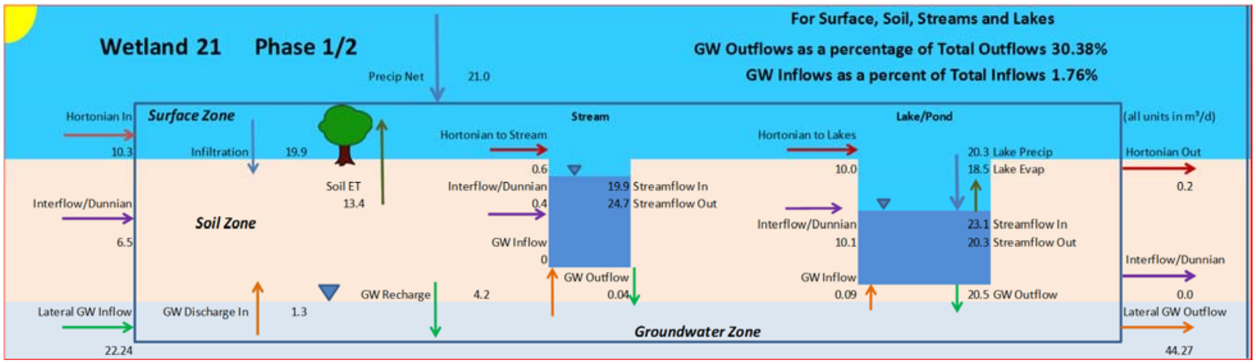


FIGURE 1C

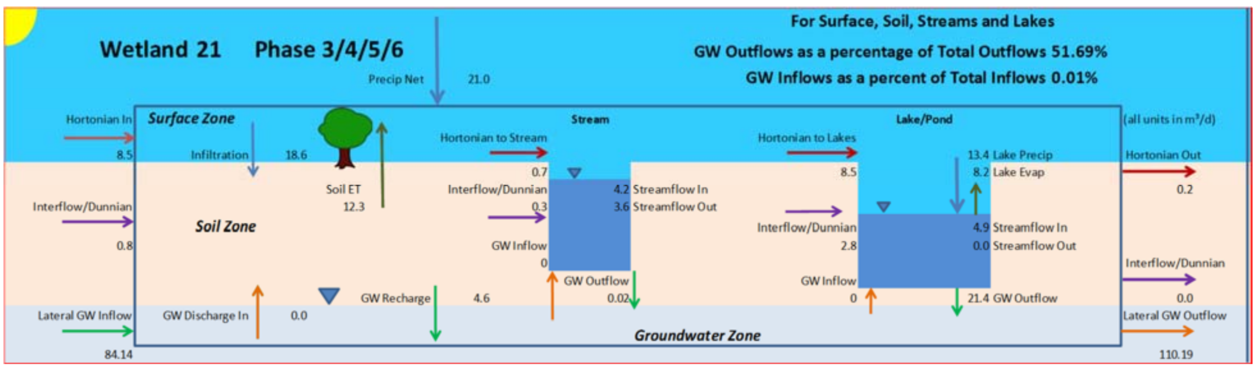


FIGURE 1D

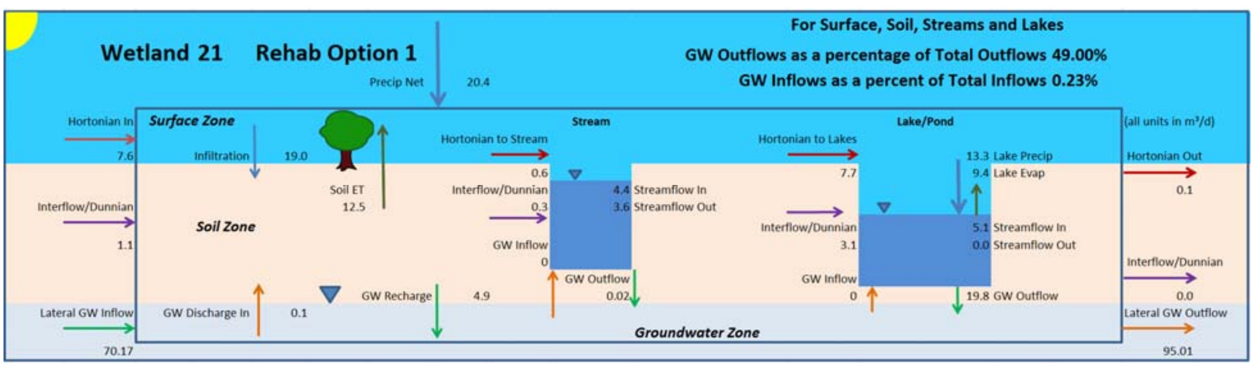
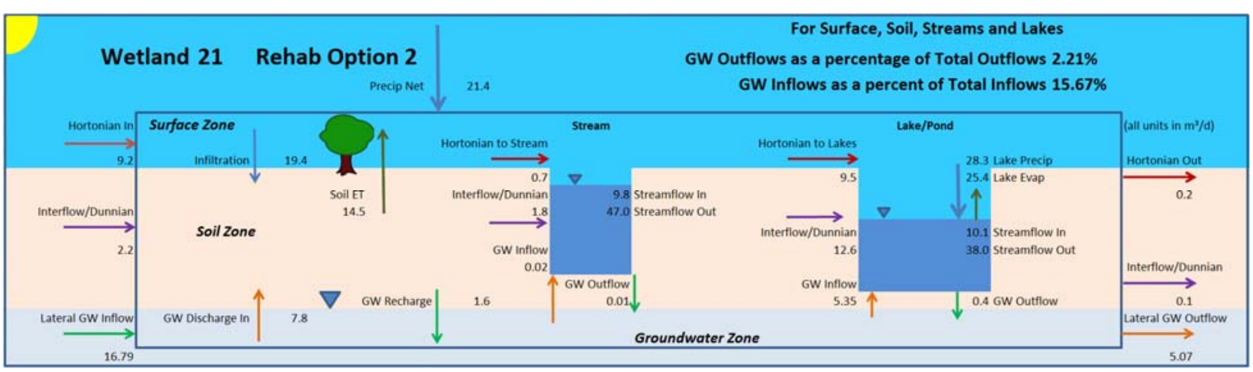
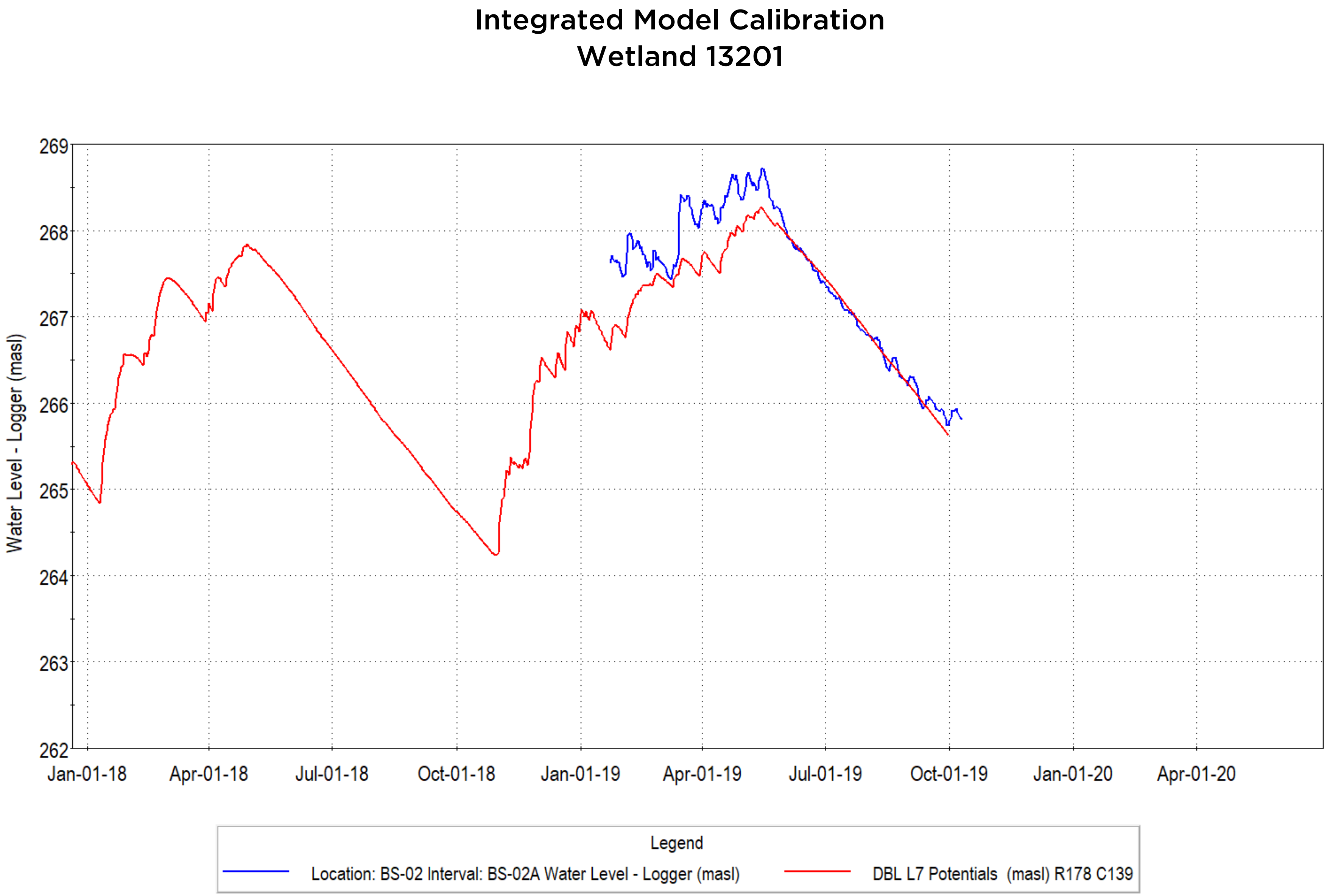


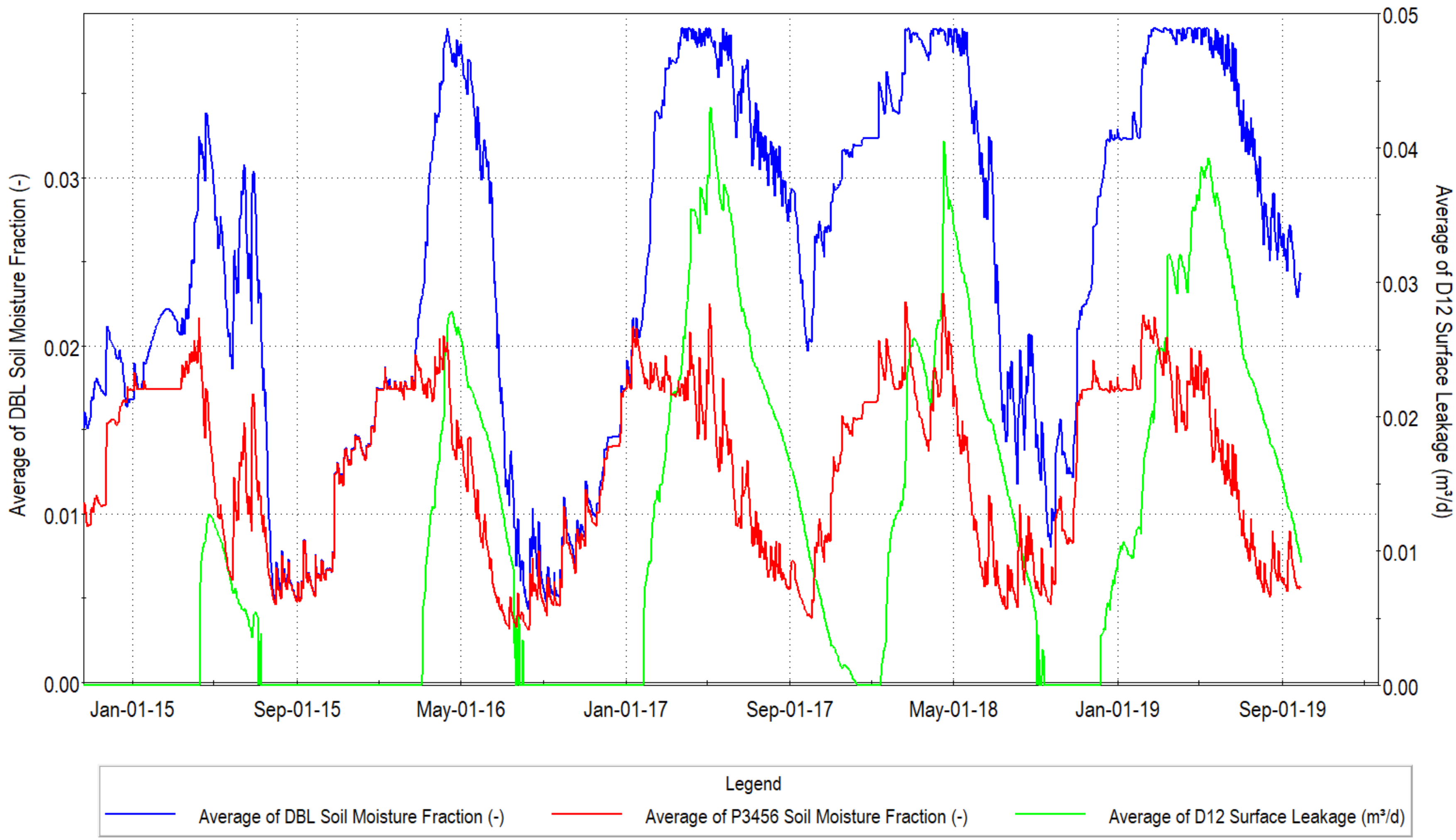
FIGURE 1E



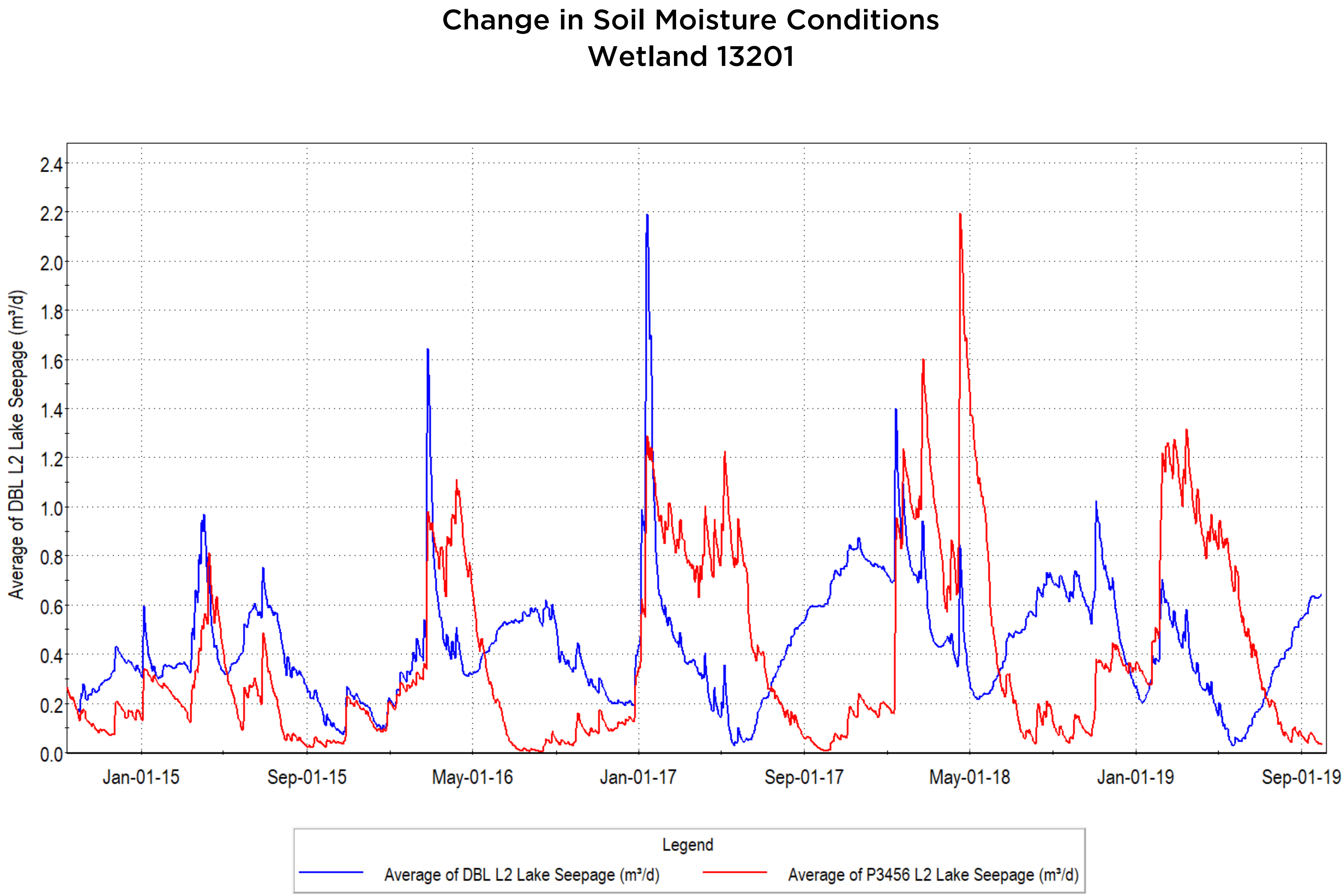

Integrated Model Calibration
Wetland 13201
Water Level - Logger (masl)
269
268
267
266
265
264
263
262
Jan-01-18
Apr-01-18
Jul-01-18
Oct-01-18
Jan-01-19
Apr-01-19
Jul-01-19
Oct-01-19
Jan-01-20
Apr-01-20
Legend
Location: BS-02 Interval: BS-02A Water Level - Logger (masl)
DBL L7 Potentials (masl) R178 C139

WETLAND 13201 - GRAPH 4

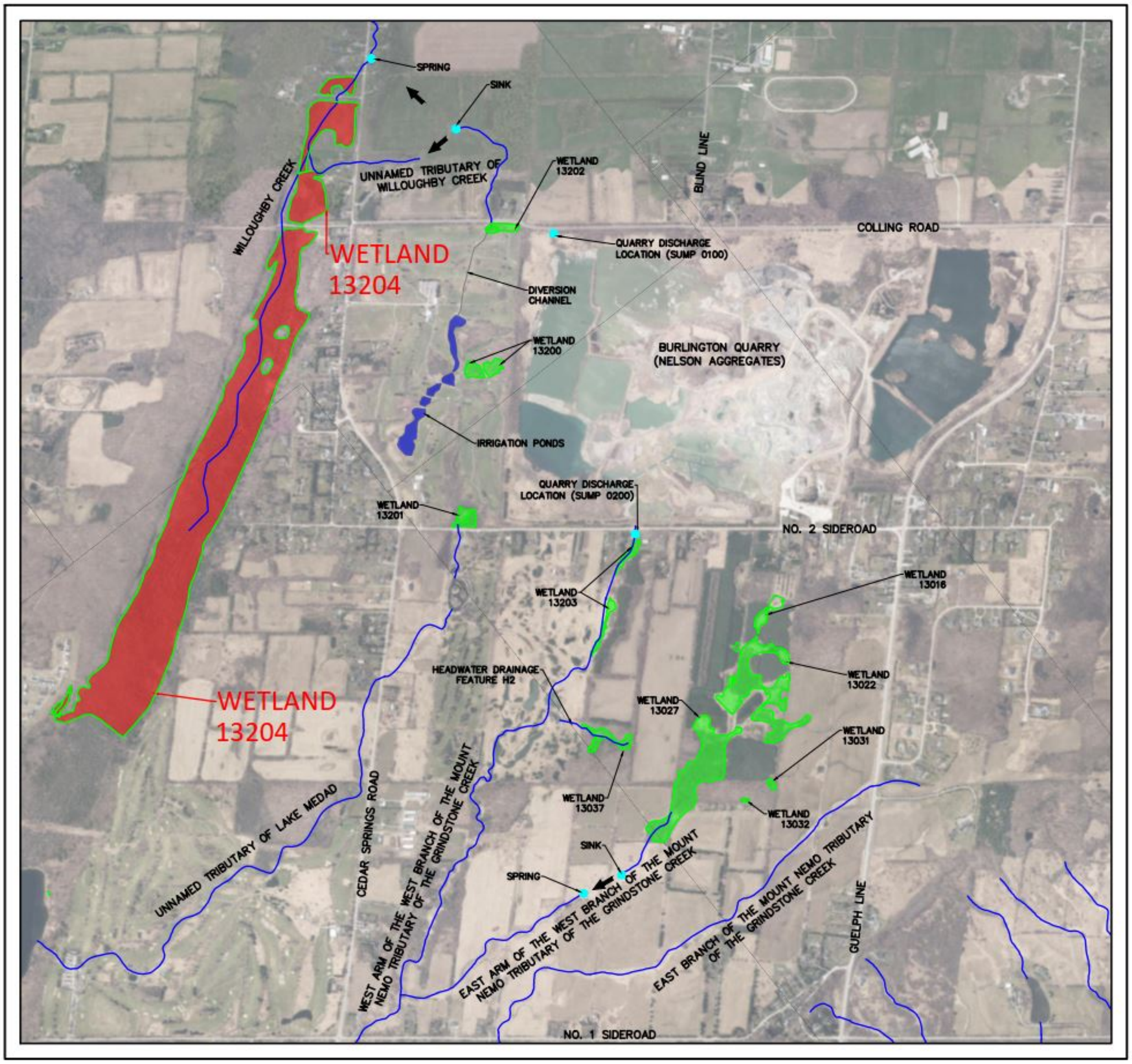
Change in Soil Moisture Conditions
Wetland 13201

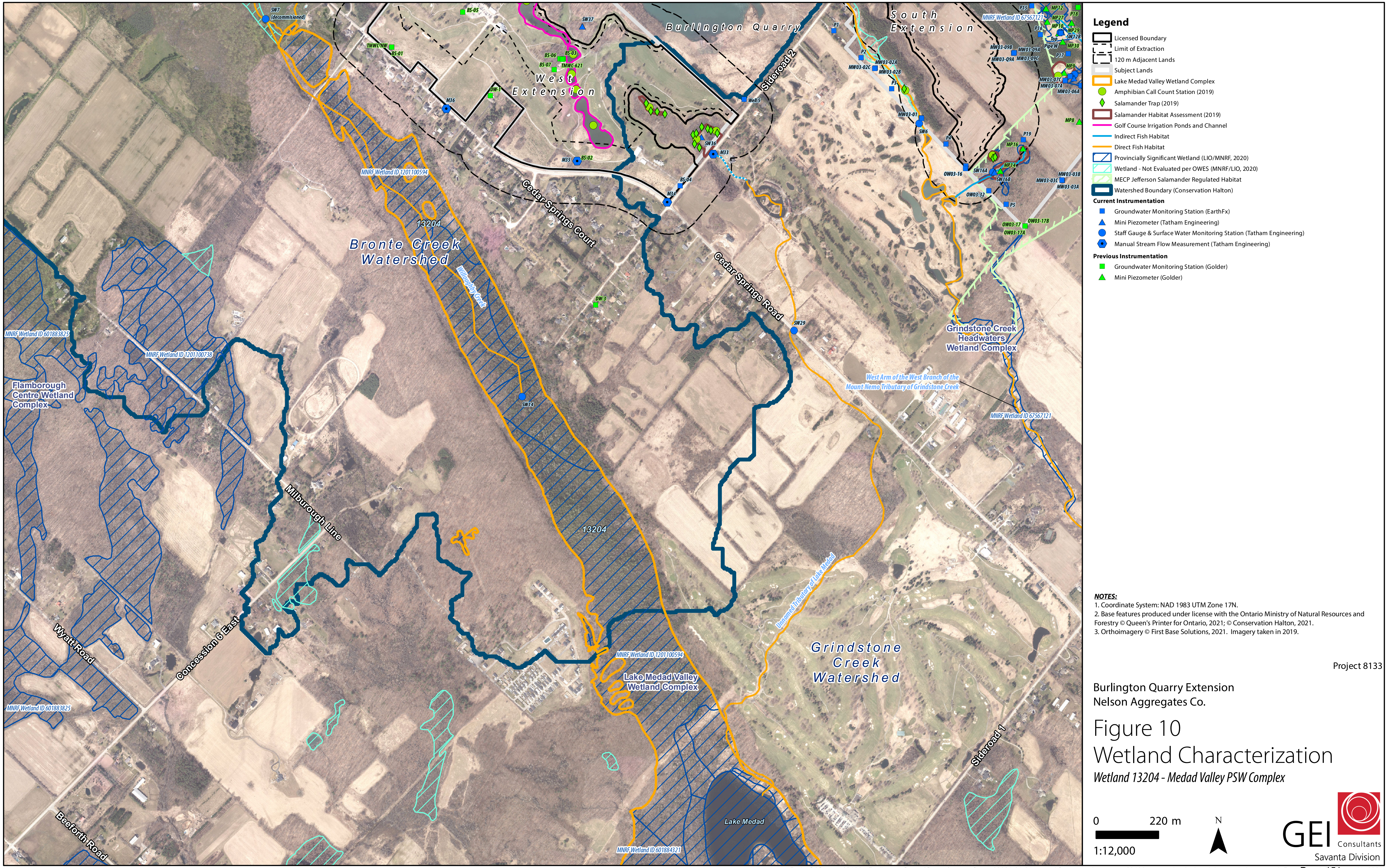


WETLAND 13201 - GRAPH 5



WETLAND 13204





NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021; © Conservation Halton, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 10
Wetland Characterization
Wetland 13204 - Medad Valley PSW Complex

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Savanta Division

Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_wetland_char_lake_medad_psw.mxd Date: ...uary 11, 2021

Wetland 13204

Wetland Characteristics	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland IDs:	MNRF – 1201100594 (OGF 1200821993, 1200821992, 1200821982, 1200821988, 67340473, 1200821978, 67196301, Earthfx - Medad Valley Tatham - 13204 Savanta - Lake Medad Wetland Golder (Background) - N/A			
Wetland Area (ha):	LIO/MNRF - 48.5			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	844 + quarry discharge (Sump 0100)			
Catchment ID:	N/A			
Closed or Connected System:	On-line (connected to downstream watercourse)			
Condition:	Natural			
Bathymetry:	No bathymetric data available for the Lake Medad PSW.			
Outlet:	Willoughby Creek			
Hydroperiod:	Seasonal			
Surface Water Monitoring:	ID: SW14 (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature and manual monthly water level measurements Coordinates of Monitoring Station: Easting 589226.754, Northing 4804106.857	Graph 1	SWA (Tatham, April 2020)	2.1.1, 3 and Appendix B

Natural Heritage and Habitat Features	Description	Figure / Graph	Reference	
			Report	Section / Page
Wetland Name & Provincial Significance Evaluation:	Lake Medad Valley Wetland Complex – Provincially Significant		NETR (Savanta, April 2020)	6.1.2
ELC Unit(s):	Unknown – outside of 120 m adjacent lands			
Regulated Habitat (MECP):	No			
Significant Wildlife Habitat:	Unknown – outside of 120 m adjacent lands			
Fish Habitat:	Unknown – outside of 120 m adjacent lands			
Habitat of Endangered and Threatened Species:	Unknown – outside of 120 m adjacent lands			

Groundwater Interaction	Description	Figure / Graph	Reference	
			Report	Section / Page
Lithology:	The Medad Valley is a partly-buried gorge that carried meltwater from the receding ice for a period of time (Karrow, 1987). The infill deposits are likely coarse-grained glaciofluvial deposits overlain by organic deposits. While there is limited borehole information in the Medad Valley, there is some evidence that the sand deposits are thicker in the valley to the north and south of the site.			
Hydraulic Conductivity:	Integrated Model (Earthfx) - Model values for the horizontal hydraulic conductivity of the MIS sands were 5.0×10^{-5} m/s and 2.5×10^{-5} m/s for vertical hydraulic conductivity.			
Surface Water/Groundwater Interaction:	The Medad Valley is a local groundwater discharge zone. Flow is supplemented by groundwater discharge to springs on the flanks of the valley. The GSFLOW model indicated that groundwater discharge exceeds groundwater recharge in this area. The model also indicated that lowering the water table in the quarry vicinity has limited effect on the major areas of groundwater discharge, such as the Medad Valley, which are already at a lower elevation than the quarry. The model also indicated that, while the Medad Valley is generally a groundwater discharge area, there are reaches of the main stream in the centerline of the valley that lose water to the groundwater system (see figure 7.21 in Earthfx report, reproduced below). This demonstrates that the incised Medad wetlands and streams are isolated from and behave differently than the streams and wetlands of the upland plateau (where the quarry is located). Despite these losing conditions, there is still a net gain of water in the stream between gauges SW14 and SW07.	Figure 1		
Water Budget Results:	A detailed Baseline water budget (to stream gauge SW7) was produced for this wetland and it is discussed in the Watercourse Characterization Table for Willoughby Creek.	Figure 2a		
Integrated Model Calibration:	Model calibration focused on matching observed streamflow. The calibration to streamflow is presented in Earthfx Section 19.4. The figure shows the calibration to SW2.	Graph 2	HHIAR (Earthfx, April 2020)	19.4

Impact Assessment (Operations Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.			
Change in Wetland Catchment Area (ha):	No Change as a result of extraction in Phase 1. Catchment area remains unaltered.			
Change in Hydroperiod:	No Change. Subcatchment area remains unaltered.			
Change in Water Budget:	A detailed Baseline water budget (to stream gauge SW7) was produced for this wetland and it is discussed in the Watercourse Characterization Table for Willoughby Creek.	Figure 2b		
Potential Impact to Form and Function of Feature:	No wetlands will be removed and the wetlands subcatchment will be protected. There will be no encroachment from the project into the wetland. The proposed limit of extraction is >120 m from the wetland boundary. Licensed boundary will be demarcated and fenced to ensure site construction and operations do not extend beyond the proposed limits of the project.			

Mitigation (Operational Phases 1 & 2)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	None required.			

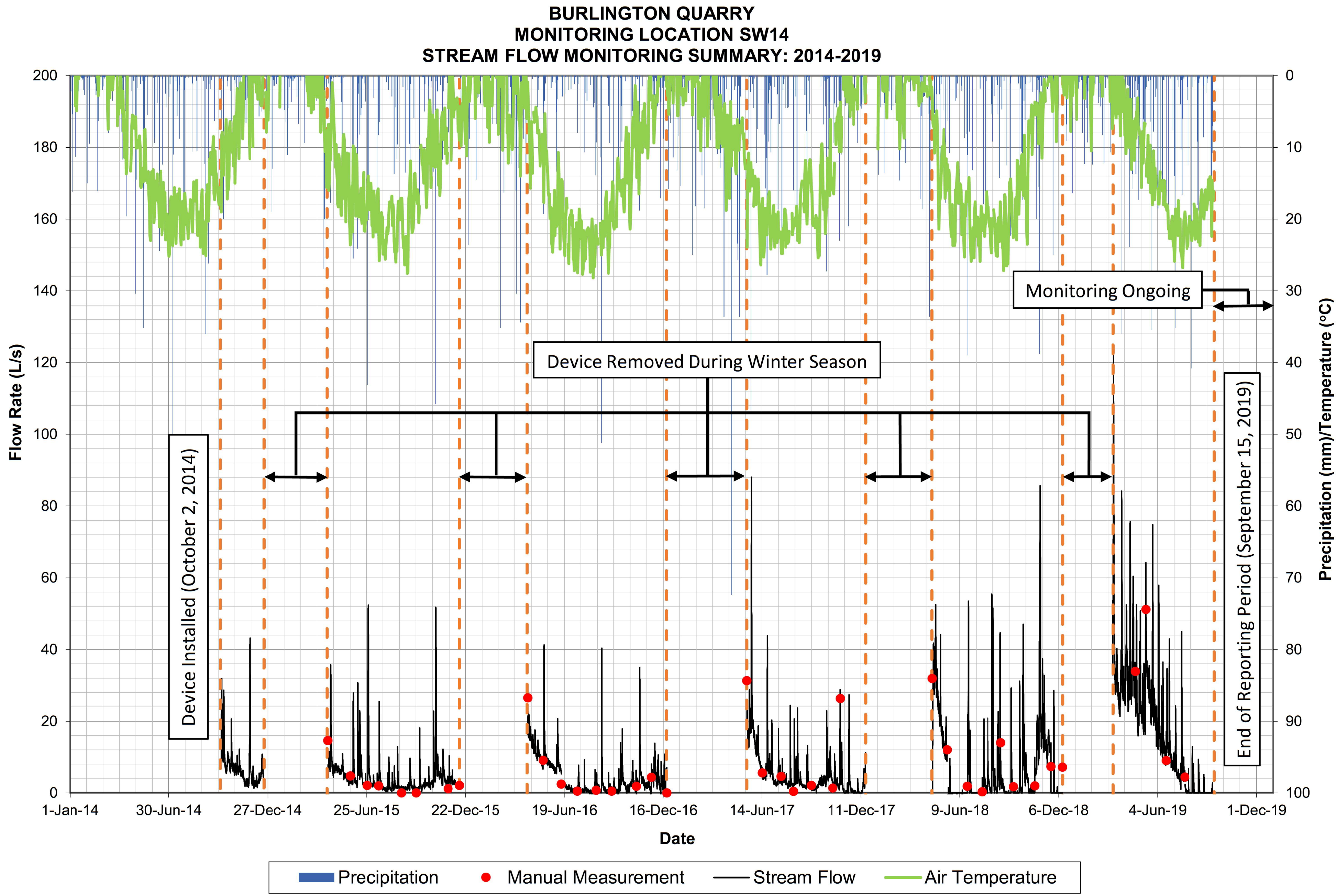
Impact Assessment (Operations Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced by 18.6 ha (reduction of 2%).			
Change in Hydroperiod:	Insignificant reduction due to reduction in catchment area. Potential reduction due to groundwater drawdown to be mitigated through construction of infiltration pond.			
Change in Water Budget:	A detailed Baseline water budget (to stream gauge SW7) was produced for this wetland and it is discussed in the Watercourse Characterization Table for Willoughby Creek. Changes in streamflow at SW7 in the Medad Valley were generally small. Figures 8.11 (p. 203) and Figure 8.49 (p. 237) compare streamflow under Phase 12 and Phase 3456, respectively, to baseline flows. The figures are reproduced in Graphs 3 and 4. The small changes indicate that changes to the Medad wetland are also likely to be small.	Figure 2c and Graphs 3 & 4		
Change on Soil Moisture Conditions:	The total change in surface leakage between Baseline and P3456 in catchment SW7 is shown in Graph 5. A small amount of groundwater seepage will be intercepted by P3456 and discharged to the Medad Valley just downstream of SW7. This change in seepage is relatively uniform over time and will not be observable because it is highly diffuse.	Graph 5		
Potential Impact to Form and Function of Feature:	Potential adverse impacts to wetland hydroperiod due to reduction in catchment area and groundwater drawdown to be mitigated.			

Mitigation (Operational Phases 3 - 6)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	Construction of infiltration pond is intended to maintain seepage to GW in the vicinity West Extension to maintain GW levels and GW discharge to the Medad Valley.			

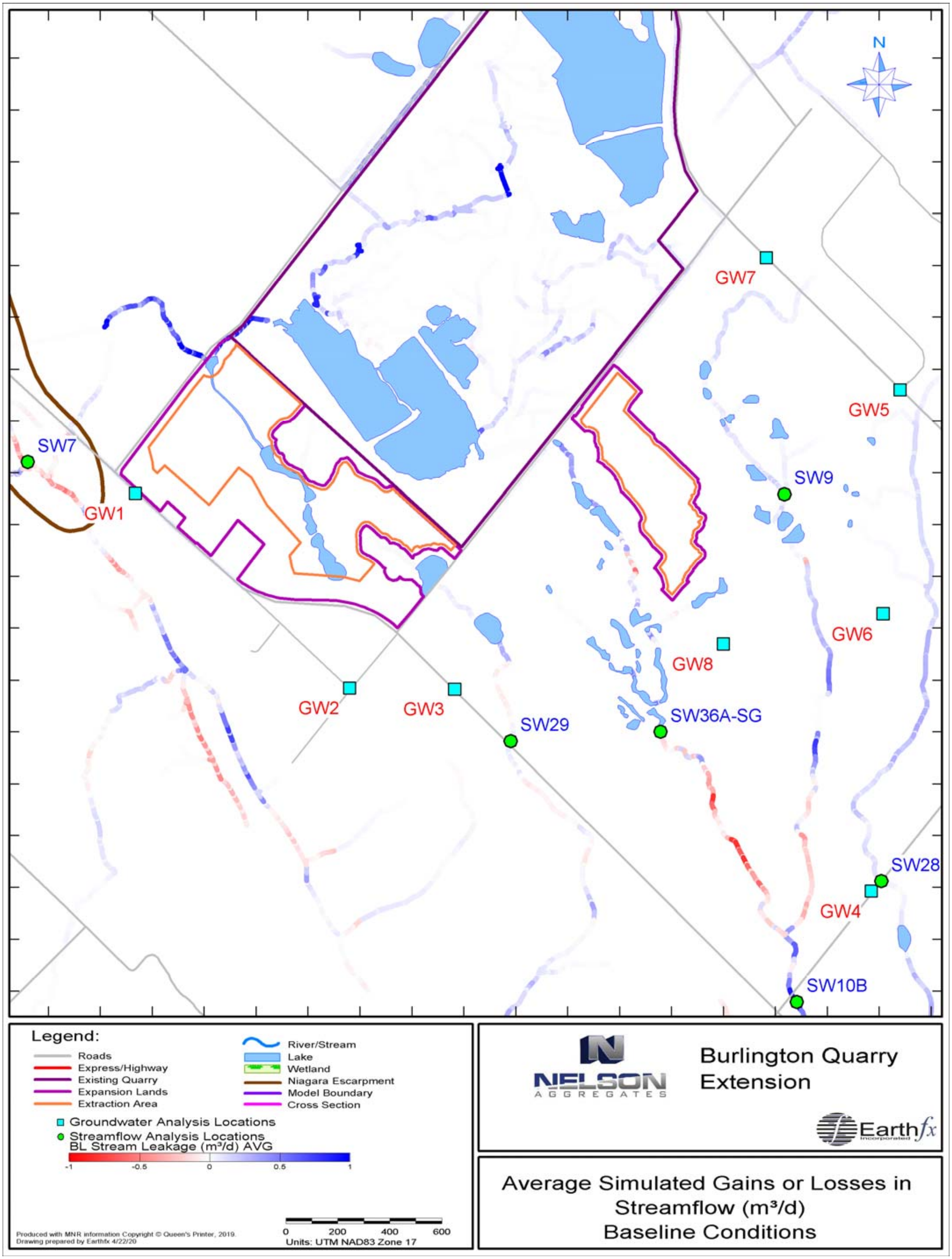
Impact Assessment (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Change in Wetland Area (ha):	No change. Wetland located greater than 120 m from licensed boundary.			
Change in Wetland Catchment Area (ha):	Reduction in catchment area. During operations in Phases 3 through 6 the catchment area will be reduced by 18.6 ha (reduction of 2%).			
Change in Hydroperiod:	Insignificant reduction due to reduction in catchment area. Potential reduction due to groundwater drawdown to be mitigated through construction of infiltration pond.			
Change in Water Budget:	See Change in Water Budget described under Impact Assessment (Phases 3 through 6).			
Potential Impact to Form and Function of Feature:	Potential adverse impacts to wetland hydroperiod due to reduction in catchment area and groundwater drawdown to be mitigated.			

Mitigation (Rehabilitation)	Description	Figure / Graph	Reference	
			Report	Section / Page
Proposed Mitigation Measures:	Construction of infiltration pond is intended to maintain seepage to GW in the vicinity West Extension to maintain GW levels and GW discharge to the Medad Valley.			

WETLAND 13204 - GRAPH 1



WETLAND 13204 - FIGURE 1



WETLAND 13204

FIGURE 2A

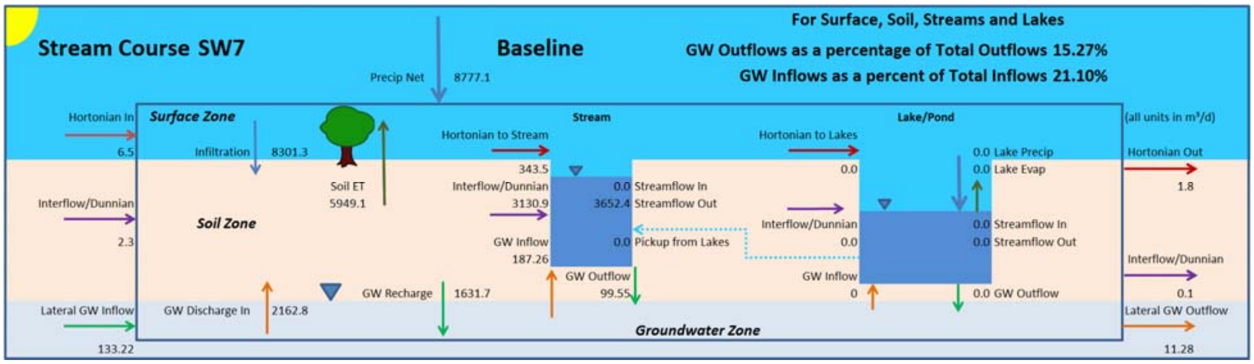


FIGURE 2B

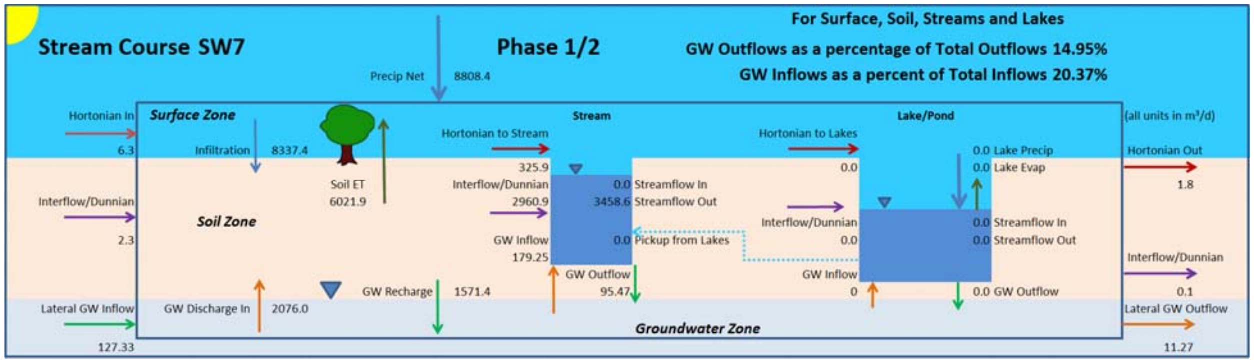


FIGURE 2C

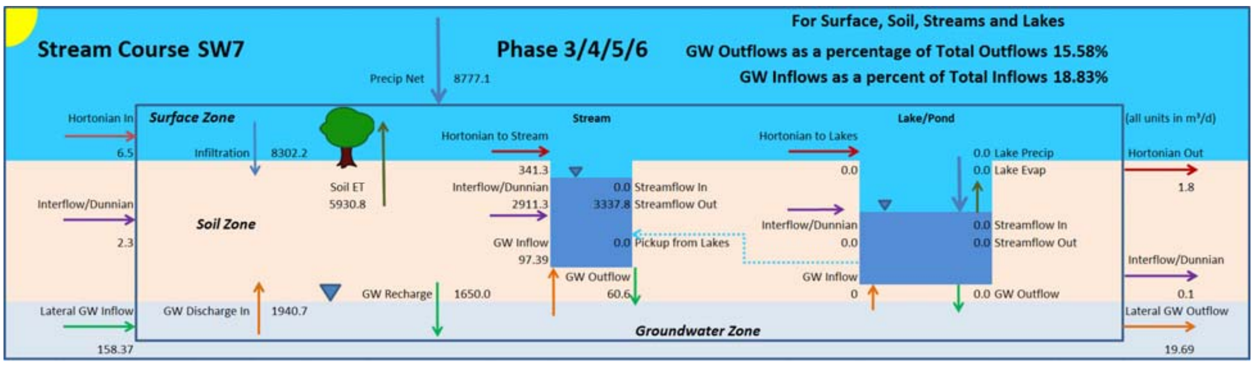


FIGURE 2D

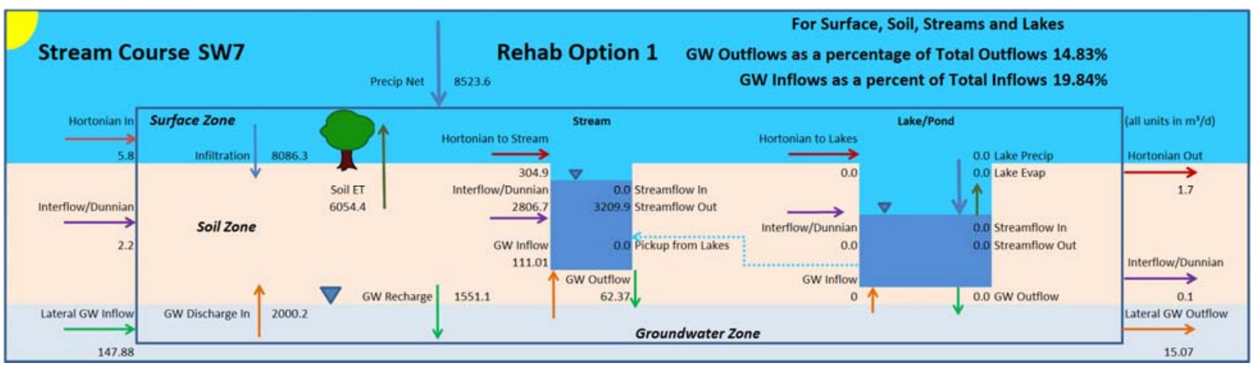
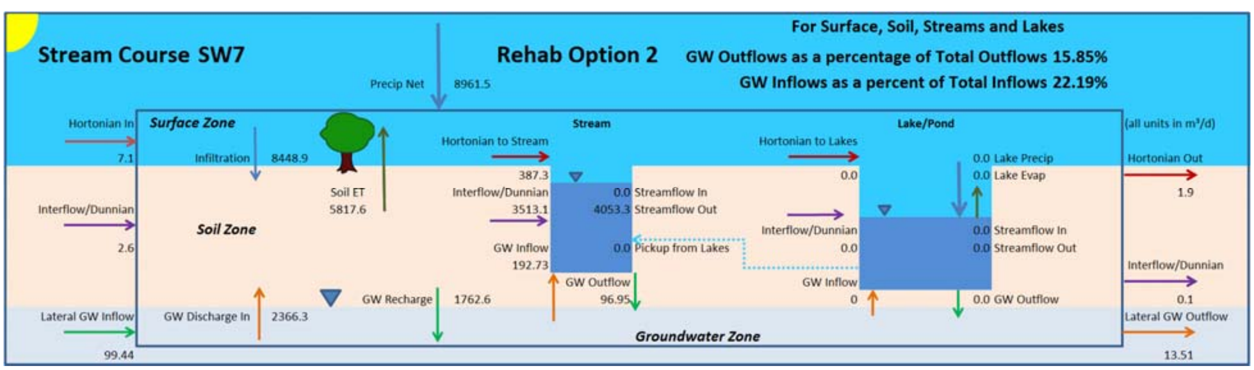
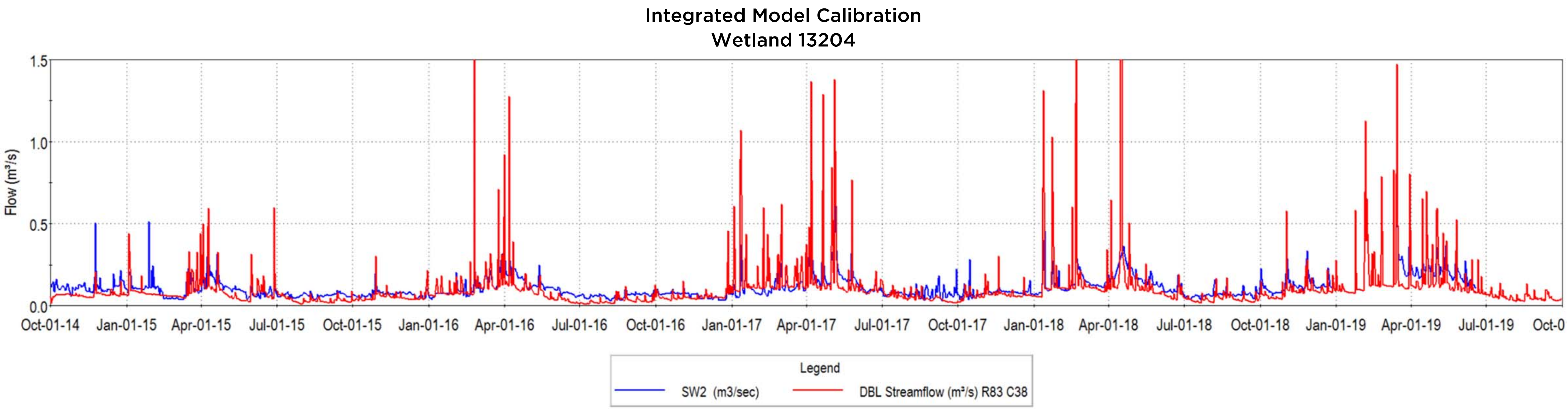


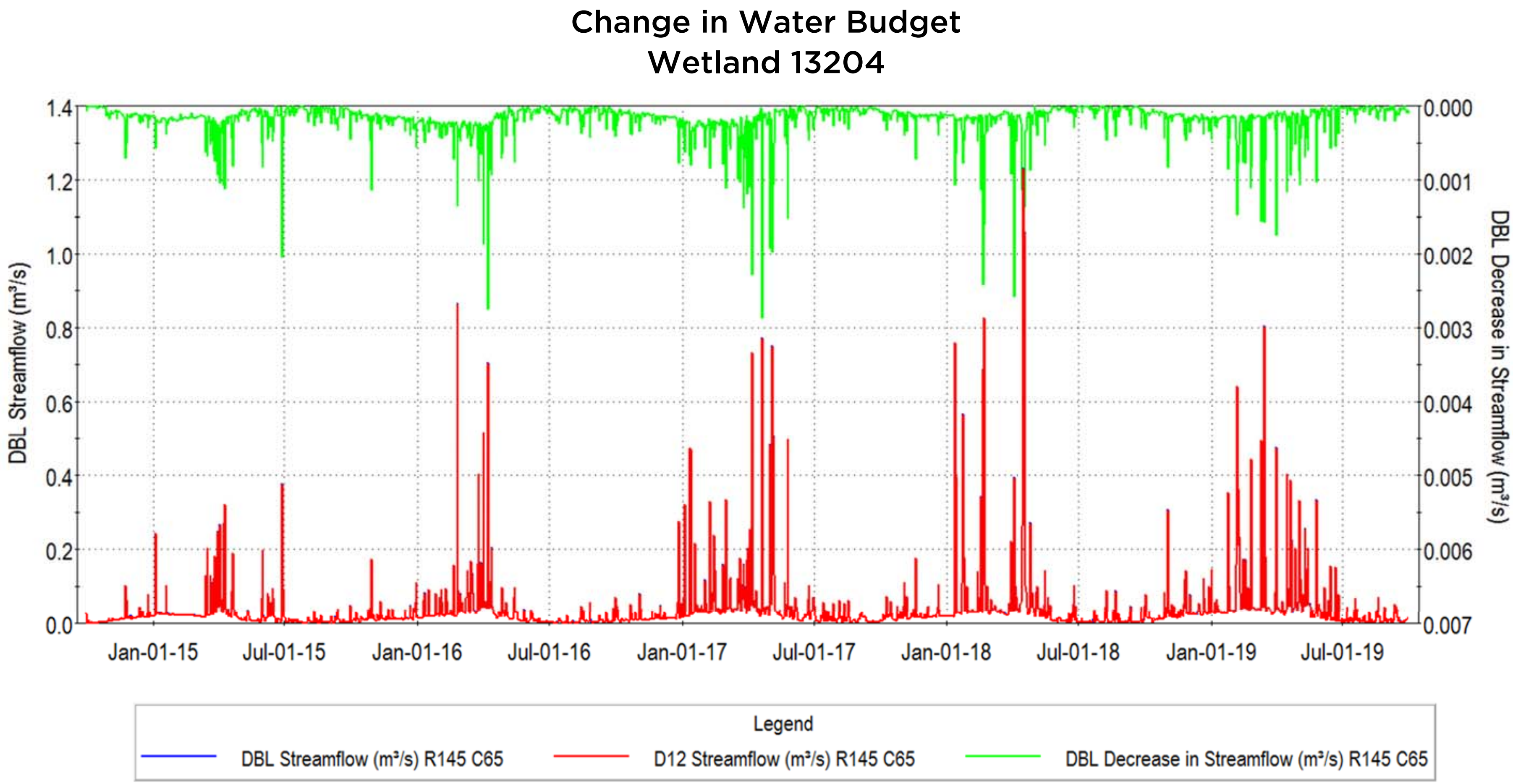
FIGURE 2E



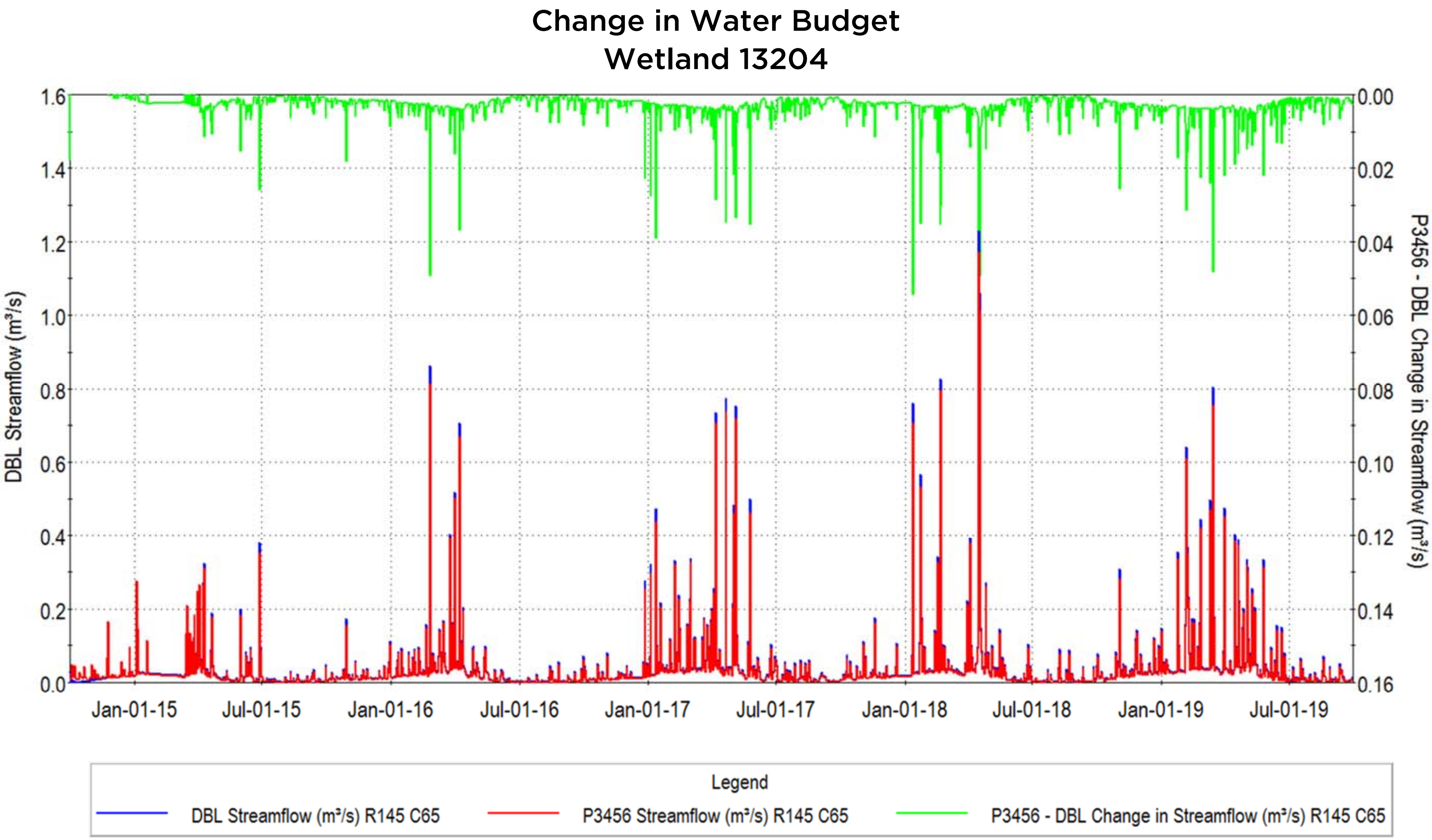
WETLAND 13204 - GRAPH 2



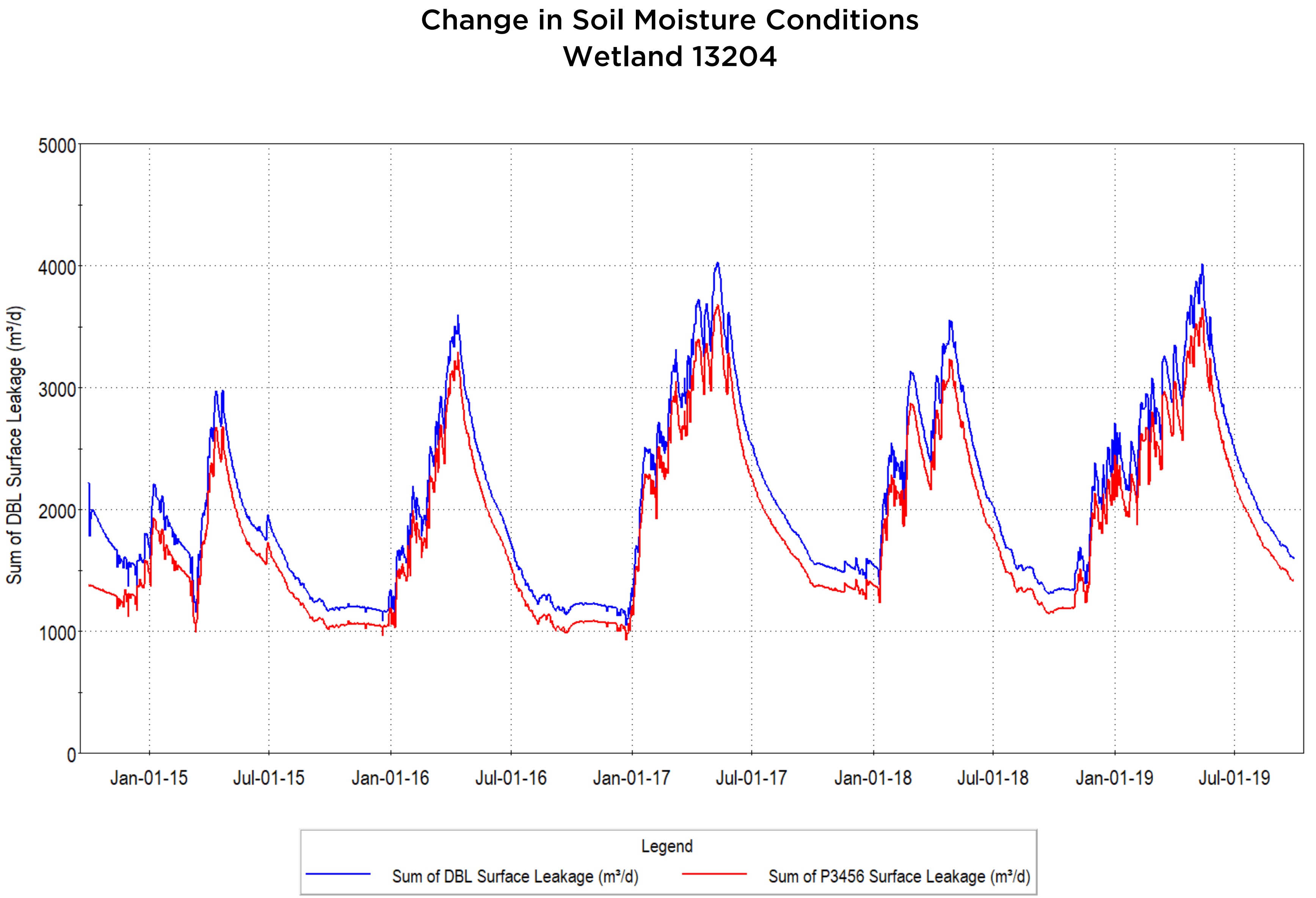
WETLAND 13204 - GRAPH 3



WETLAND 13204 - GRAPH 4



WETLAND 13204 - GRAPH 5



Attachment 2 – Watercourse Characterization

Watercourse Characterization Summaries Proposed Burlington Quarry Extension, Nelson Aggregates Co.

Prepared for:

NELSON AGGREGATES

April 2021
Version 1.0

April 2021

Nelson Aggregate Co.
2433 No. 2 Sideroad
Burlington, Ontario
L7P 0G8

Attention: Mr. Quinn Moyer, President

RE: Burlington Quarry Watercourse Characterization Summaries

Dear Mr. Moyer,

Earthfx Incorporated, Savanta Inc. and Tatham Engineering Limited are pleased to provide Nelson Aggregates Co. with the enclosed watercourse characterization summaries in support of the Proposed Burlington Quarry Extension. The watercourse characterization summaries have been prepared in response to comments received by the Ministry of Natural Resources and Forestry.

The watercourse characterization summaries have been prepared to summarize the watercourse information provided in the Level 1 and Level 2 Hydrogeological Impact Assessment, Level 1 and Level 2 Natural Environment Technical Report, and Surface Water Assessment. The hope is the watercourse characterization summaries will aid in the review of the reports and expedite the review process.

Regards,

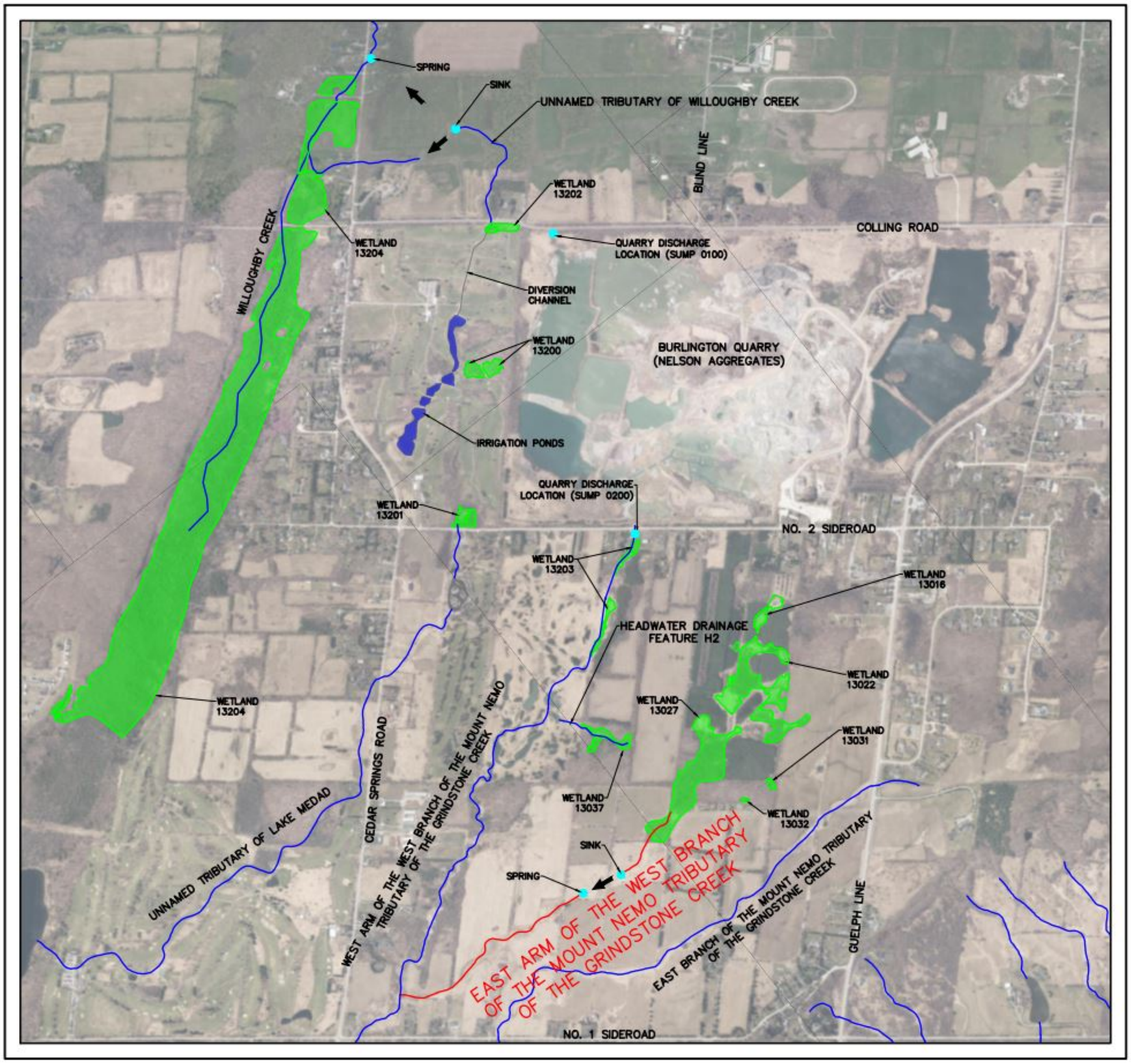
Dirk Kassenaar, M.Sc., P.Eng.
President, Eartfx Incorporated

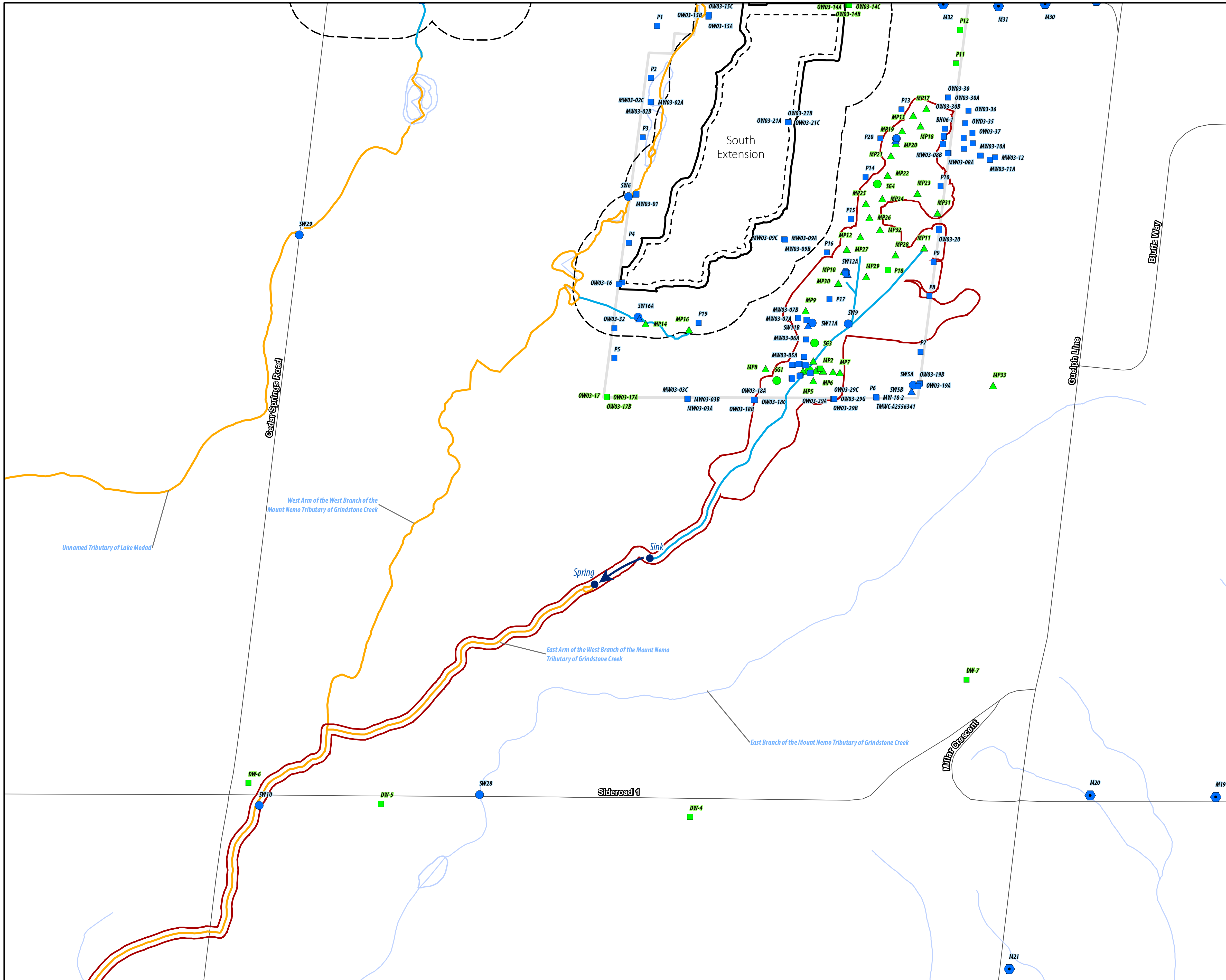
Shannon Catton, MSc.
Branch Manager & Senior Ecologist, Savanta Inc.

Daniel Twigger, B.Sc.Eng., P.Eng.
Senior Engineer, Group Leader, Tatham Engineering Limited

Table of Contents

EAST ARM OF THE WEST BRANCH





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
- Road
- Indirect Fish Habitat
- Direct Fish Habitat
- Watercourse
- Waterbody
- Wetland (Savanta, 2020)

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Mini Piezometer (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 16
Watercourse Characterization

East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

0 180 m

1:10,000

East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2" colspan="5">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Watercourse Name:</td><td colspan="5">East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Watershed:</td><td colspan="5">Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Sub-Watershed:</td><td colspan="5">Mount Nemo Tributary of Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed Limit of Extraction:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed License Boundary:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Catchment Area (ha):</td><td colspan="5">85 ha (at confluence with West Arm)</td><td></td><td></td><td></td></tr>
<tr><td>Catchment ID:</td><td colspan="5">N/A</td><td></td><td></td><td></td></tr>
<tr><td>Primary Source(s) of Flow:</td><td colspan="5">Surface runoff</td><td></td><td></td><td></td></tr>
<tr><td>Discharge from Quarry / PTTW:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Conditions of PTTW:</td><td colspan="5">Not Applicable</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water Monitoring:</td><td colspan="5">ID: SW9 (Tatham)
Installation Date: October 2, 2014
Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve)
Coordinates of Monitoring Station: Easting 591235.384, Northing 4805317.071</td><td>Graphs 1 & 2</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
<tr><td>Streamflow Conditions:</td><td colspan="5">Intermittent</td><td>Graphs 1 & 2</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
<tr><td rowspan="14">Average Daily Flow (SW9):</td><td colspan="4">Average Daily Streamflow (L/s)</td><td>Notes:</td><td rowspan="14">Graph 1</td><td rowspan="14">SWA (Tatham, April 2020)</td><td rowspan="14">2.1.2 and Appendix C</td></tr>
<tr><td>Month</td><td>Minimum</td><td>Average</td><td>Maximum</td><td rowspan="13">Minimum - lowest daily average streamflow recorded for period of record
Average - average daily streamflow recorded for period of record
Maximum - maximum daily average streamflow recorded for period of record
N/A - data not available as device removed from watercourse during winter months</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>1.2</td><td>9.1</td><td>62.1</td></tr>
<tr><td>April</td><td>0.0</td><td>2.6</td><td>27.1</td></tr>
<tr><td>May</td><td>0.0</td><td>1.2</td><td>13.2</td></tr>
<tr><td>June</td><td>0.0</td><td>0.3</td><td>5.1</td></tr>
<tr><td>July</td><td>0.0</td><td>0.0</td><td>1.2</td></tr>
<tr><td>August</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>September</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>October</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>November</td><td>0.0</td><td>0.5</td><td>36.3</td></tr>
<tr><td>December</td><td>0.0</td><td>0.2</td><td>9.7</td></tr>
</table>

East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2" colspan="5">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td rowspan="14">Watercourse Thermal Regime (SW9):</td><td colspan="4">Average Daily Water Temperature (°C)</td><td>Notes:</td><td rowspan="14">Graph 2</td><td rowspan="14">SWA (Tatham, April 2020)</td><td rowspan="14">2.1.2 and Appendix C</td></tr>
<tr><td>Month</td><td>Minimum</td><td>Average</td><td>Maximum</td><td rowspan="13">Minimum - lowest daily average streamflow recorded for period of record

Average - average daily streamflow recorded for period of record

Maximum - maximum daily average streamflow recorded for period of record

N/A - data not available as device removed from watercourse during winter months</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>1.0</td><td>2.6</td><td>6.5</td></tr>
<tr><td>April</td><td>1.5</td><td>8.0</td><td>15.9</td></tr>
<tr><td>May</td><td>6.9</td><td>12.2</td><td>19.1</td></tr>
<tr><td>June</td><td>11.5</td><td>15.6</td><td>19.6</td></tr>
<tr><td>July</td><td>16.8</td><td>17.1</td><td>17.7</td></tr>
<tr><td>August</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>September</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>October</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>November</td><td>2.4</td><td>4.5</td><td>10.1</td></tr>
<tr><td>December</td><td>3.5</td><td>4.6</td><td>5.9</td></tr>
</table>

<table>
<tr><th rowspan="2">Fish & Fish Habitat Features</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Fish Habitat (Direct/Indirect and Assumed/Confirmed):</td><td>1) The upstream reaches of the East Arm (from the headwaters to approximately 540 m downstream from the Subject Lands) are considered to be indirect fish habitat. These headwater areas are ephemeral to intermittent and have been observed to dry up completely in summer. Approximately 540 m downstream of the Subject Lands, the watercourse enters a karst sink, where it flows underground for approximately 162 m before discharging to a surface pond. No fish movement is expected to be possible through the 162 m long underground flow path, therefore, given that the upstream area is intermittent and dries out completely, and there is no upstream fish movement, fish are not present in the upper reaches. This upstream reach provides indirect contributing habitat functions to support the downstream fish community.

2) The remainder of the watercourse downstream from the karst outflow provides direct fish habitat. Fish have been previously captured by MNRF at the online pond at karst discharge and are assumed to be present through the watercourse downstream.</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
<tr><td>Fish Species Present:</td><td>Stantec (2010) previously reported that in 2006, MNRF captured several different age classes of Fathead Minnow, Bluntnose Minnow, Brook Stickleback and Green Sunfish in the pond at the karst discharge point.</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
<tr><td>Fish Community Thermal Regime:</td><td>Warm/Cool (based on fish species present)</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
<tr><td>Fish Habitat Types Present:</td><td>1) The headwater wetlands, swales and drainage ditches on the Subject Lands provide indirect habitat that supports the downstream direct fish community. Habitat functions of these areas include flow conveyance and regulation, water quality maintenance and organic allochthonous inputs and potentially seasonal benthic drift.

2) No investigations were completed in the downstream (off-site reaches) providing direct fish habitat.</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
<tr><td>Habitat Uses by Known Fish Community:</td><td>The local fish community likely uses the off-site habitat for the complete range of life history processes including spawning, nursery, foraging and overwintering.</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
<tr><td>Known Barriers to Fish Movement:</td><td>The karst inlet and associated 162 m long underground reach are assumed to provide a barrier to upstream fish movement.</td><td></td><td>NETR (Savanta, April 2020)</td><td>44 - 45 and Figure 9b</td></tr>
</table>

East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Underlying Deposits:</td><td>Halton Till. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water / Groundwater Interactions:</td><td>Seasonal groundwater contributions to watercourse. Groundwater seepage under baseline conditions during spring months equates to 0.1 L/s or less. Groundwater seepage is at its maximum during and immediately following the spring freshet.</td><td>Figures 1 & 2</td><td></td><td></td></tr>
<tr><td>Water Budget Results (SW9):</td><td>The baseline condition water budget results from the integrated model at monitoring location SW9 are presented in Figure 3a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>23.13%</td><td>0.15%</td></tr></table></td><td>Figure 3a</td><td></td><td></td></tr>
<tr><td>Water Budget Results (600m Downstream of SW9):</td><td>The baseline condition water budget results from the integrated model 600 m downstream of monitoring location SW9 are presented in Figure 4a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>22.18%</td><td>0.75%</td></tr></table></td><td>Figure 4a</td><td></td><td></td></tr>
<tr><td>Integrated Model Calibration:</td><td>SW9 monitors the flow through the wetland complex immediately to the east of the South extension. Simulated and observed streamflow at SW9 are presented in Earthfx (p. 414) for WY2017 to WY2019. Flow in the stream is intermittent and both the observed and simulated results are very flashy. The observed data also contain gaps. The match to the newly collected 2019 data is excellent (Earthfx, p.4141).</td><td>Graphs 3 & 4</td><td>HHIAR (Earthfx, April 2020)</td><td>411 - 414</td></tr>
</table>

East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Direct Alterations to Watercourse:</td><td>No direct alterations to this watercourse are proposed.</td><td></td><td>NETR (Savanta, April 2020)</td><td>75</td></tr>
<tr><td>Change in Primary Source of Flow:</td><td>Modeling predicted less than a 1% reduction in groundwater discharge to the existing headwater wetlands on the Subject Lands. This was predicted to result in an approximate reduction in surface water runoff volume to the watercourse of less than 1%.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Watercourse Catchment Area:</td><td>Catchment area to remain undisturbed, no change in catchment area.</td><td></td><td></td><td></td></tr>
<tr><td>Simulated Streamflow Change (Integrated Model Results):</td><td>The Earthfx report discusses changes in simulated streamflow under the different quarry expansion phases. The figure appended (GRaph 5) reproduces Figure 8.6 (p. 201) and presents simulated baseline(red) and Scenario P12 (blue) flows at location SW9. Decrease in flow (green) are plotted in reverse on the upper X axis with the scale shown on the right Y axis. Very small decreases in streamflow, primarily in winter and spring, are predicted Phase 12 area. A similar figure (Graph 6) is reproduced for Phase 3456 (Figure 8.44, p. 235) although the upper X axis shows the decrease in streamflow (with positive values indicating an decrease in flow relative to baseline). Spring flows are generally lower in the winter and spring but higher in the summer and fall periods.</td><td>Graphs 5, 6 & 7</td><td>HHIAR (Earthfx, April 2020)</td><td>198 - 203 and 230 - 237</td></tr>
<tr><td colspan="5">Water Budget Results at Monitoring Location SW9</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at monitoring location SW9 are presented in Figure 3b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>23.13%</td><td>0.15%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>22.51%</td><td>0.00%</td><td>-0.62%</td><td>-0.15%</td></tr>
</table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at monitoring location SW9 are presented in Figure 3c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>23.13%</td><td>0.15%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>23.27%</td><td>0.10%</td><td>0.14%</td><td>-0.05%</td></tr>
</table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at monitoring location SW9 are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>23.13%</td><td>0.15%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>22.39%</td><td>0.12%</td><td>-0.74%</td><td>-0.03%</td></tr>
</table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at monitoring location SW9 are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>23.13%</td><td>0.15%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>23.81%</td><td>0.28%</td><td>0.68%</td><td>0.13%</td></tr>
</table></td><td>Figure 3e</td><td></td><td></td></tr>
</table>

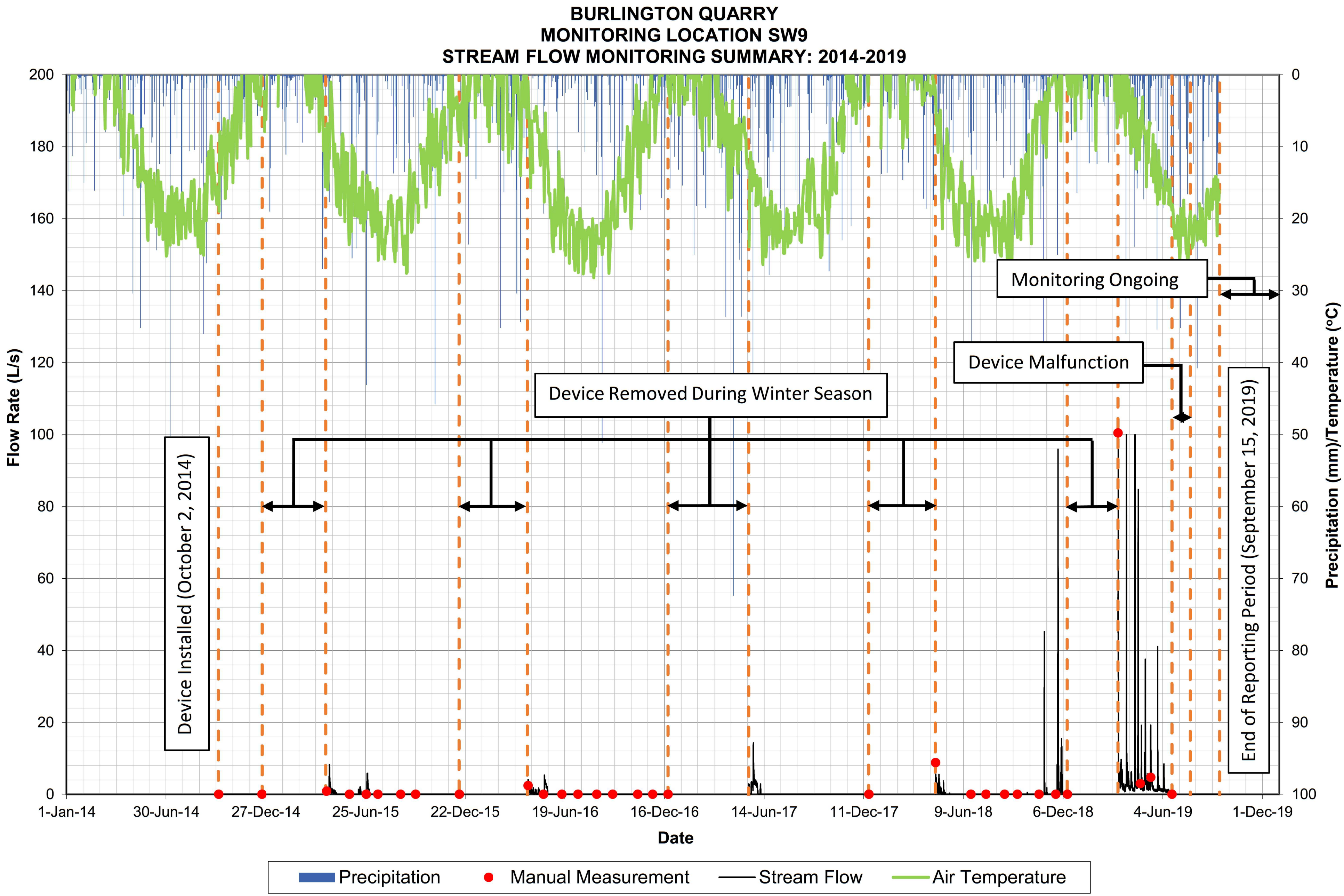
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td colspan="5">Water Budget Results 600 m Downstream of Monitoring Location SW9</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model 600 m downstream of monitoring location SW9 are presented in Figure 4b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>22.18%</td><td>0.75%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>22.32%</td><td>0.00%</td><td>0.14%</td><td>-0.75%</td></tr>
</table></td><td>Figure 4b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model 600 m downstream of monitoring location SW9 are presented in Figure 4c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>22.18%</td><td>0.75%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>22.67%</td><td>0.43%</td><td>0.49%</td><td>-0.32%</td></tr>
</table></td><td>Figure 4c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model 600 m downstream of monitoring location SW9 are presented in Figure 4d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>22.18%</td><td>0.75%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>21.68%</td><td>0.52%</td><td>0.50%</td><td>-0.23%</td></tr>
</table></td><td>Figure 4d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model 600 m downstream of monitoring location SW9 are presented in Figure 4e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>22.18%</td><td>0.75%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>23.16%</td><td>0.61%</td><td>0.98%</td><td>-0.14%</td></tr>
</table></td><td>Figure 4e</td><td></td><td></td></tr>
<tr><td>Change in Groundwater Contributions to Watercourse:</td><td>The Baseline groundwater seepage to the watercourse catchment (to SW9) is shown in Graph 8. Under P12 conditions this seepage is lost. The change in stream leakage between Baseline and P12 conditions is shown in Graph 9. There are short periods of time when leakage under Baseline conditions (blue line) is slightly higher than P12 conditions.</td><td>Graphs 8 and 9</td><td></td><td></td></tr>
<tr><td>Change in Watercourse Thermal Regime:</td><td>Negative changes on water temperature are not expected given that the wetlands and catchment area feeding the East Arm will remain undisturbed.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Quality:</td><td>Negative changes on water quality are not expected given that the wetlands and catchment area feeding the East Arm will remain undisturbed.</td><td></td><td></td><td></td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>A reduction of less than 1% in groundwater contributions to the headwaters will result in immeasurable changes to flows in the feature, but this reduction is not expected to negatively impact direct fish habitat given that the small change is within the range of natural fluctuation.</td><td></td><td></td><td></td></tr>
<tr><td>Potential Impact to Identified Species and Habitat:</td><td>A reduction of less than 1% in groundwater contributions to the headwaters will result in immeasurable changes to flows in the feature, but this reduction is not expected to negatively impact fish species in the watercourse given that the small change is within the range of natural fluctuation.</td><td></td><td></td><td></td></tr>
</table>

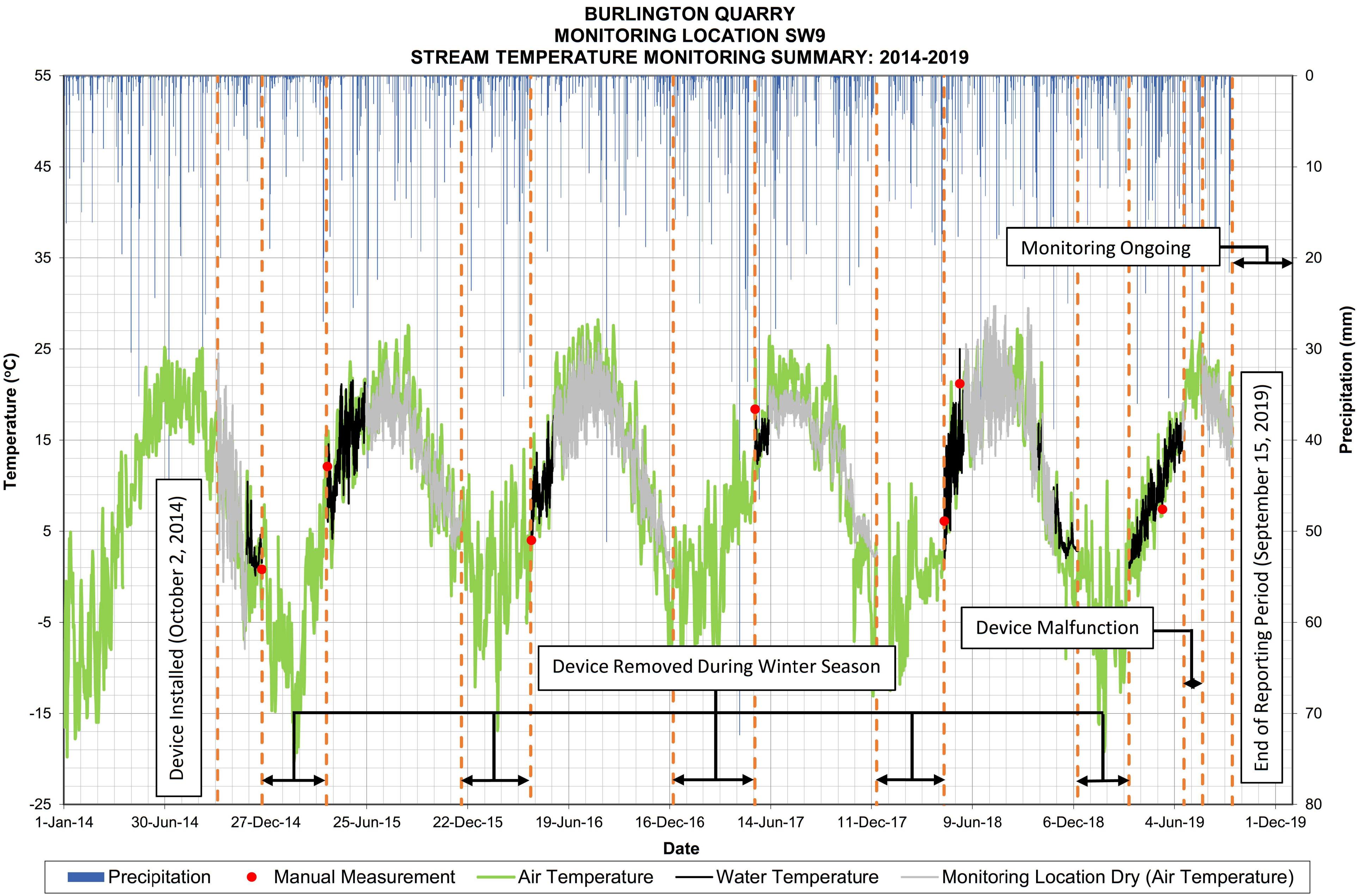
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

Mitigation	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	No direct alterations are proposed.		NETR (Savanta, April 2020)	75
Source Water Mitigation:	None required.			
Groundwater Contribution Mitigation:	None required.			
Erosion Mitigation:	None required.			
Thermal Mitigation:	None required.			
Water Quality Mitigation:	None required.			

EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 1

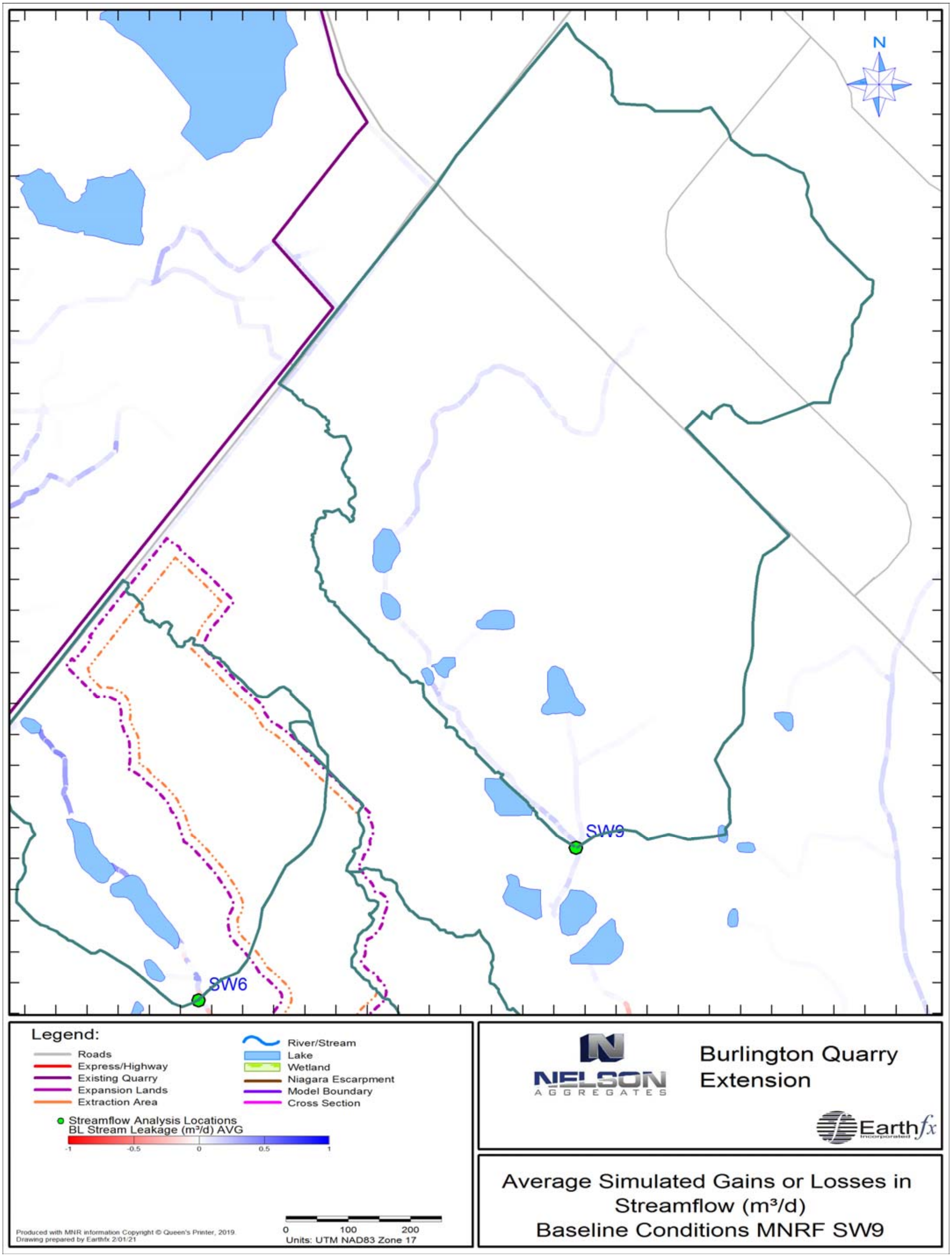


EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 2

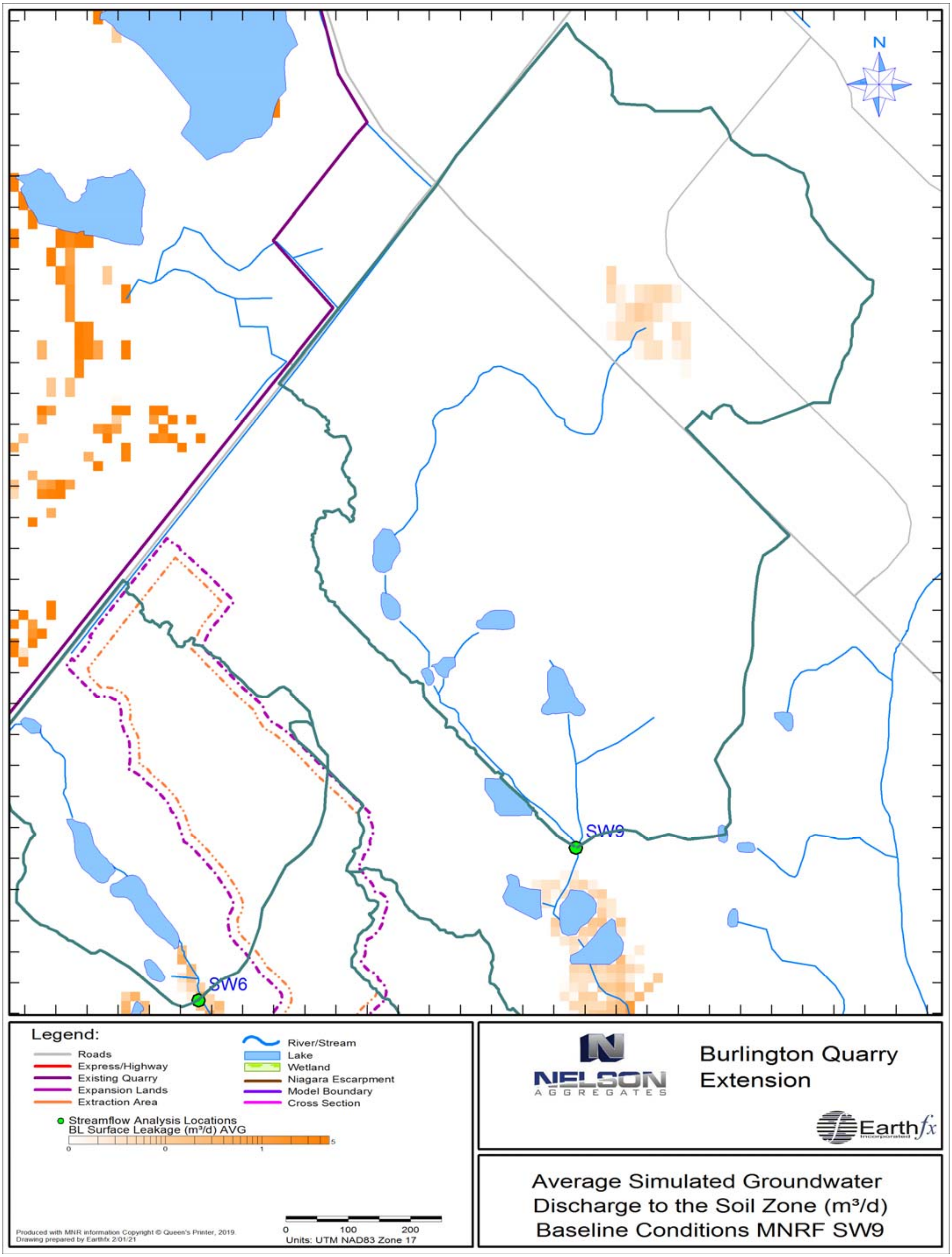


* Grey data indicates the monitoring location was dry and therefore the recorded values are respresentative of the air temperature.

EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - FIGURE 1



EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - FIGURE 2



EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK

FIGURE 3A

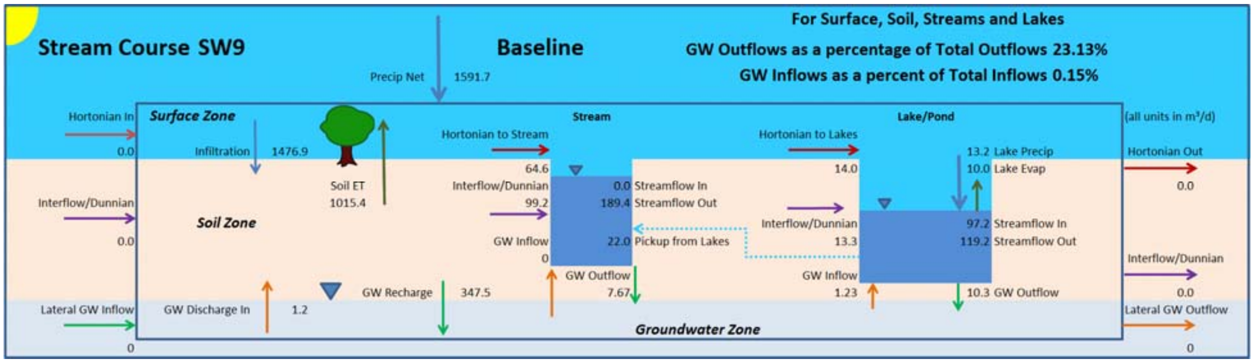


FIGURE 3B

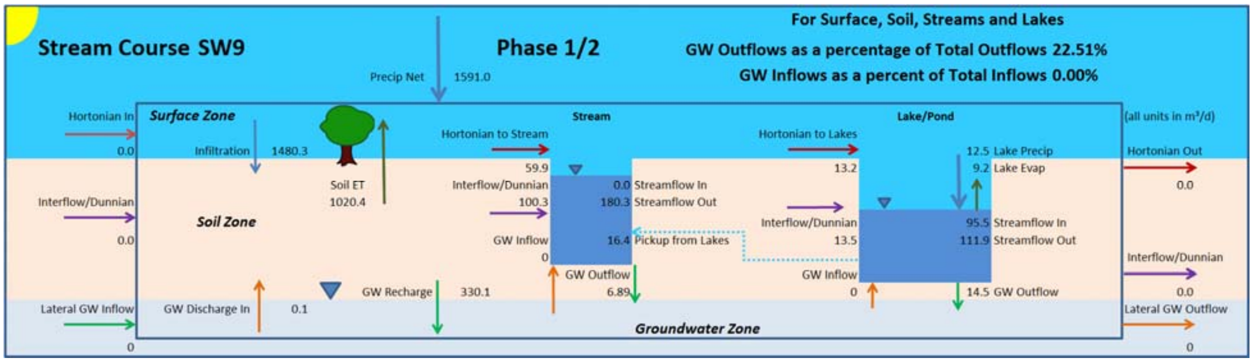


FIGURE 3C

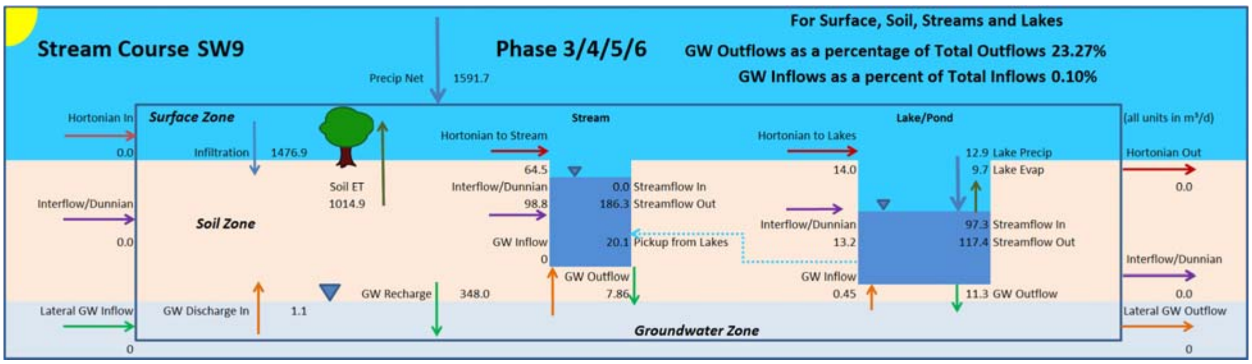


FIGURE 3D

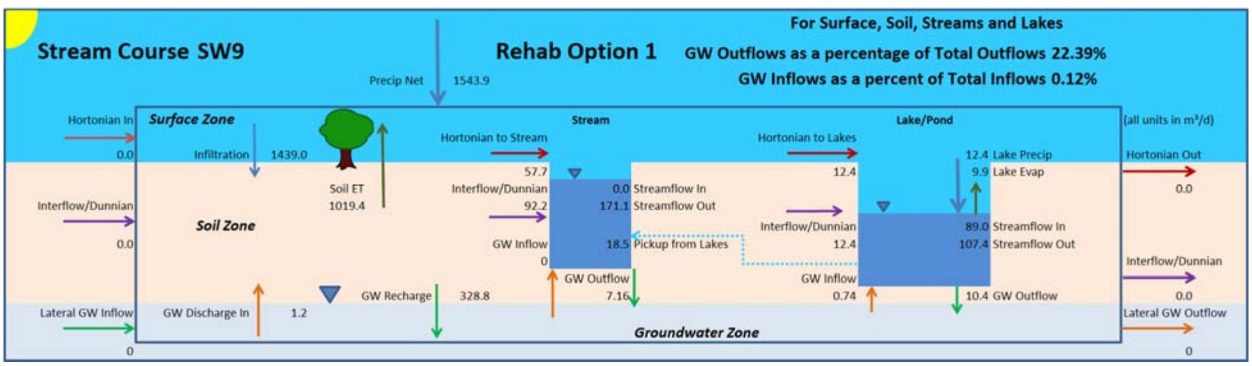
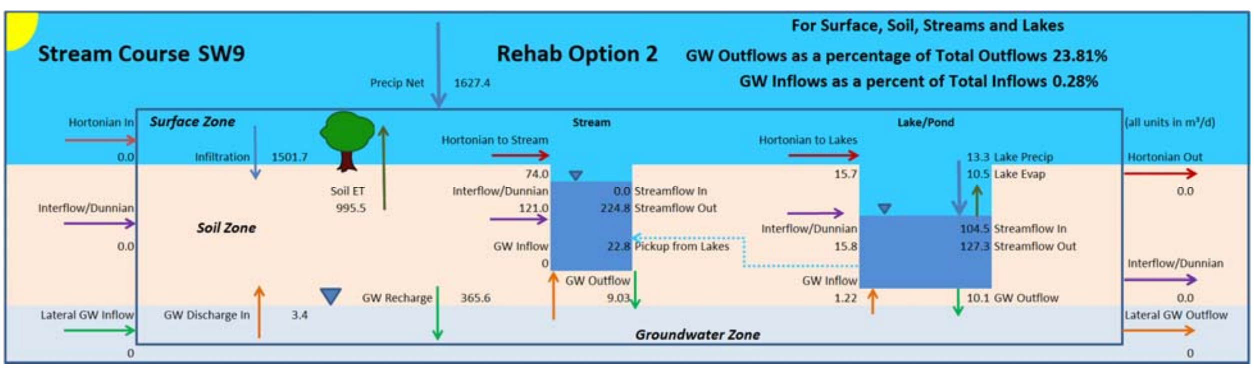


FIGURE 3E



EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK

FIGURE 4A

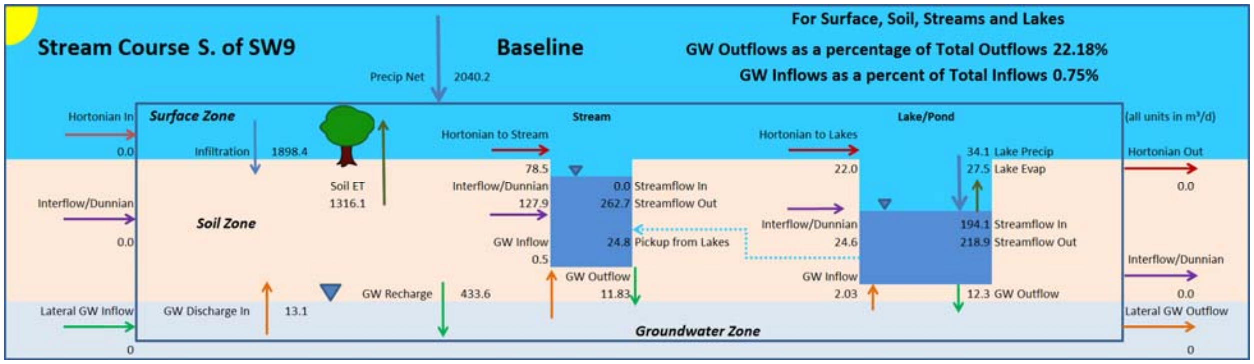


FIGURE 4B

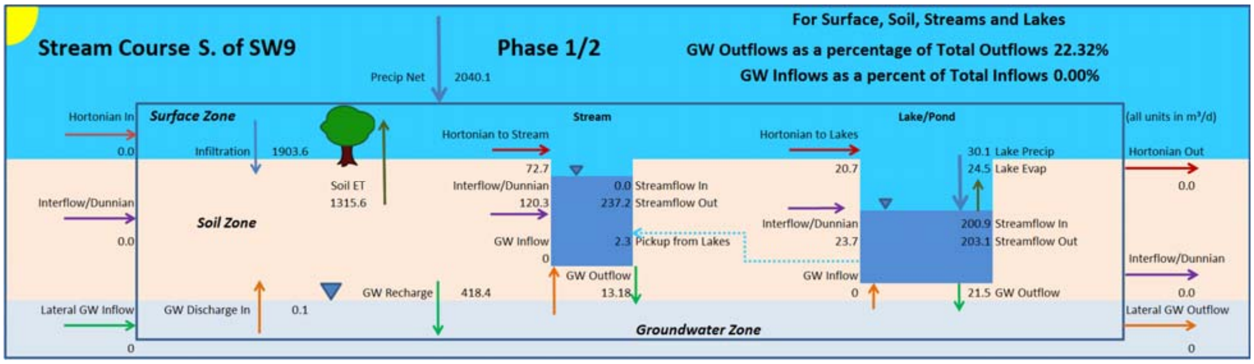


FIGURE 4C

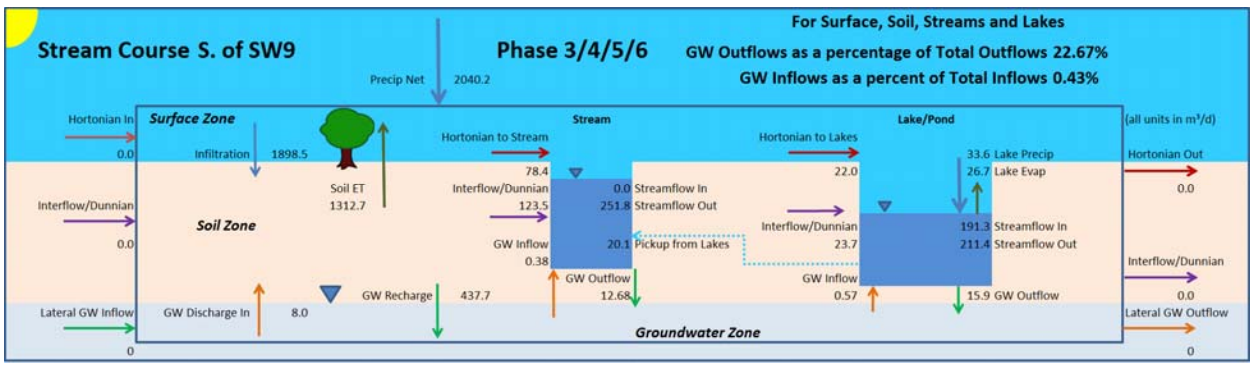


FIGURE 4D

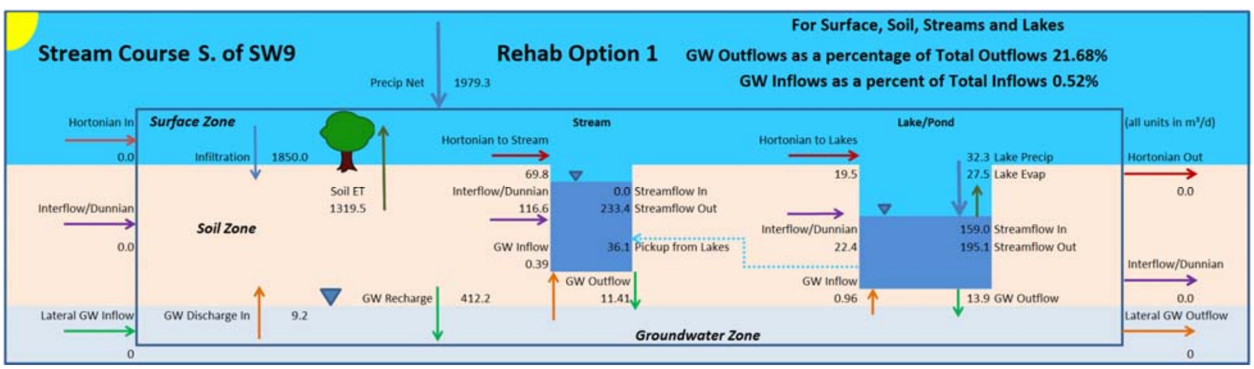
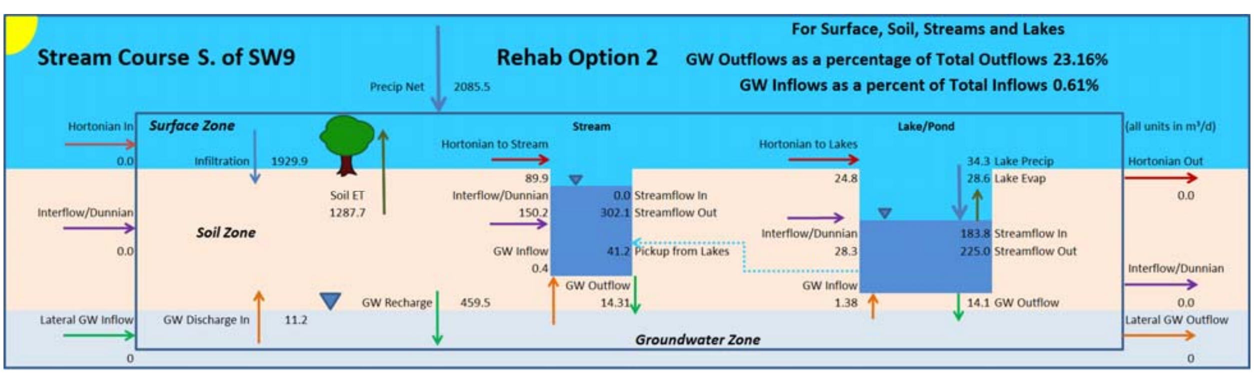
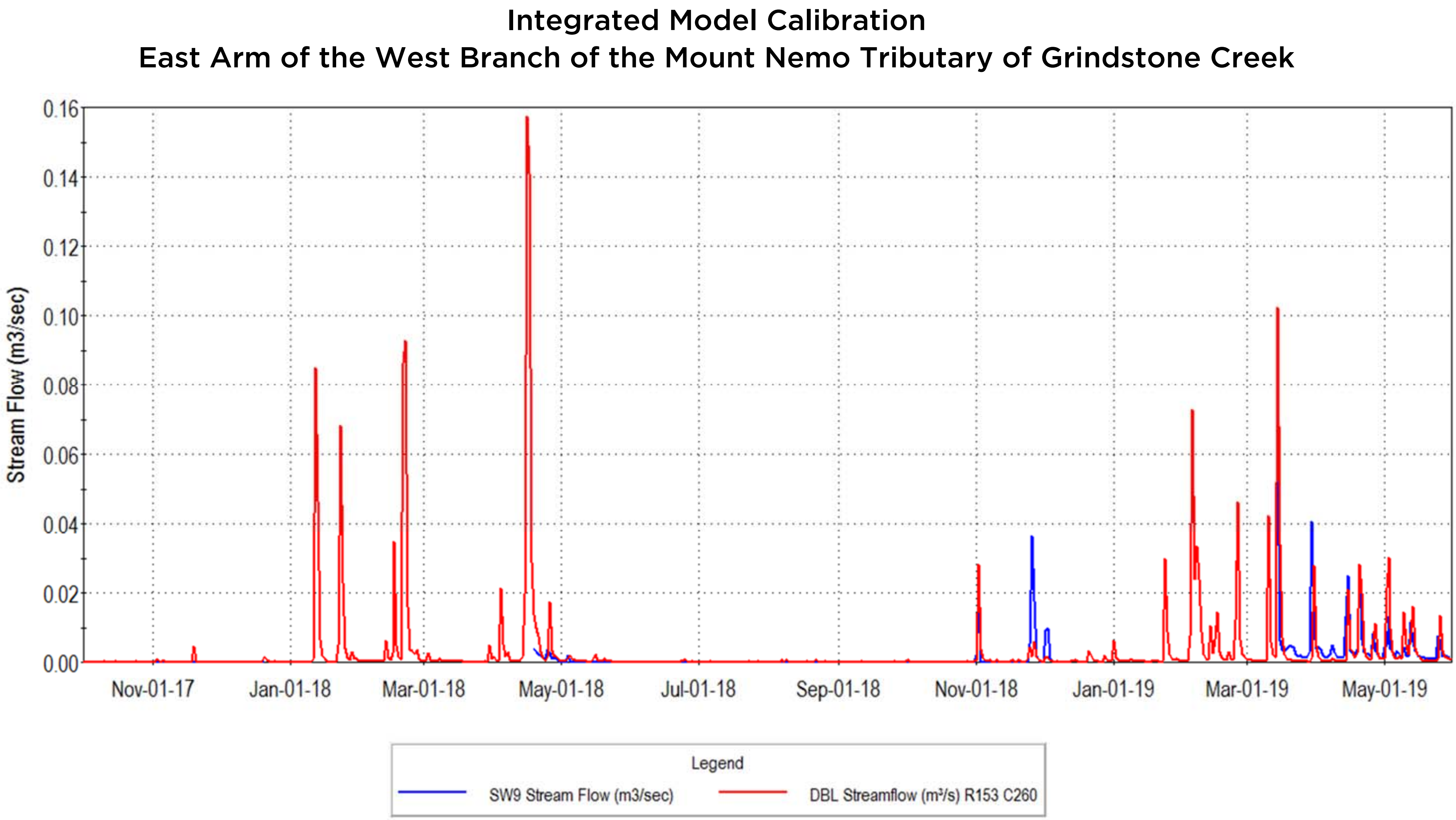
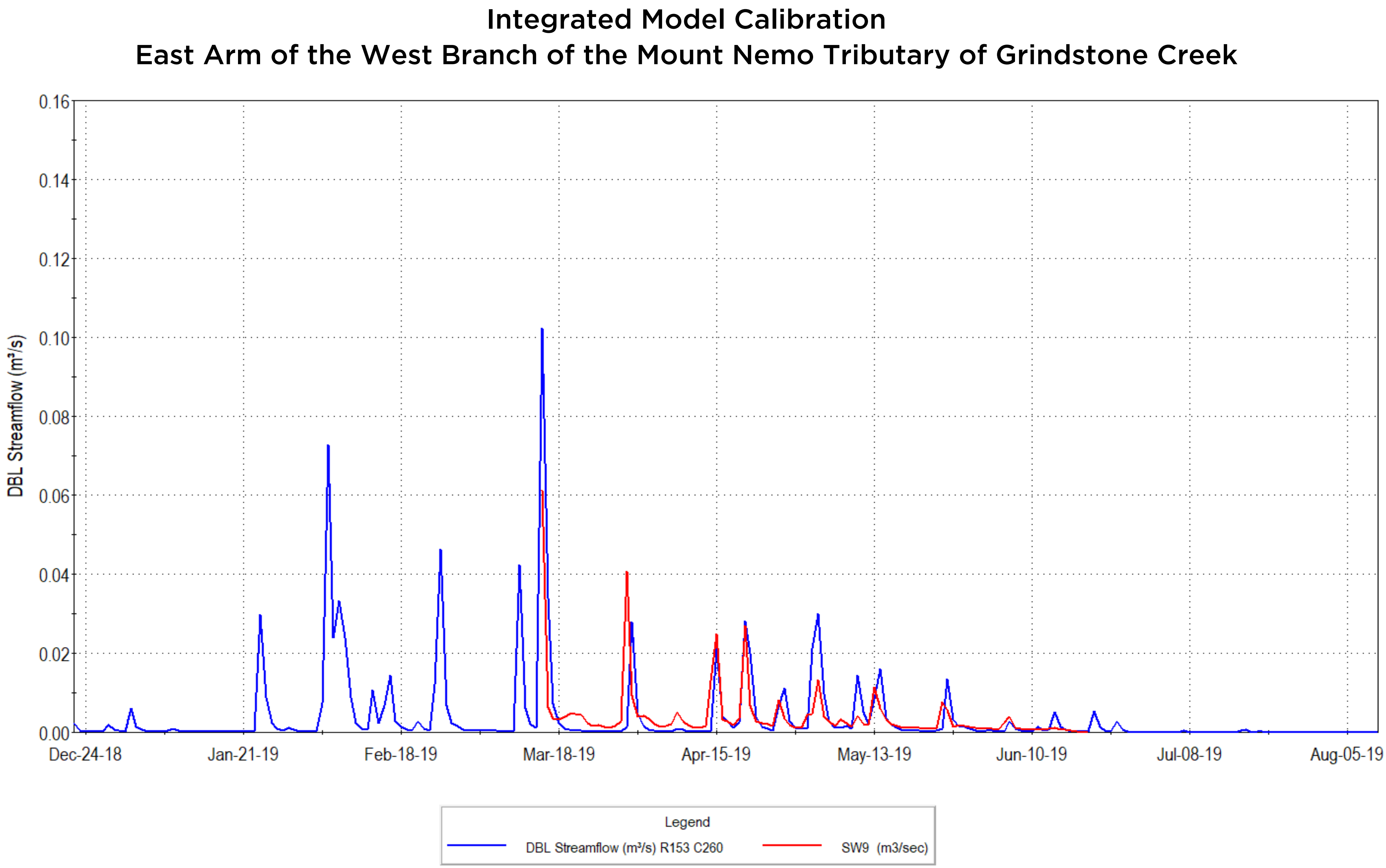


FIGURE 4E

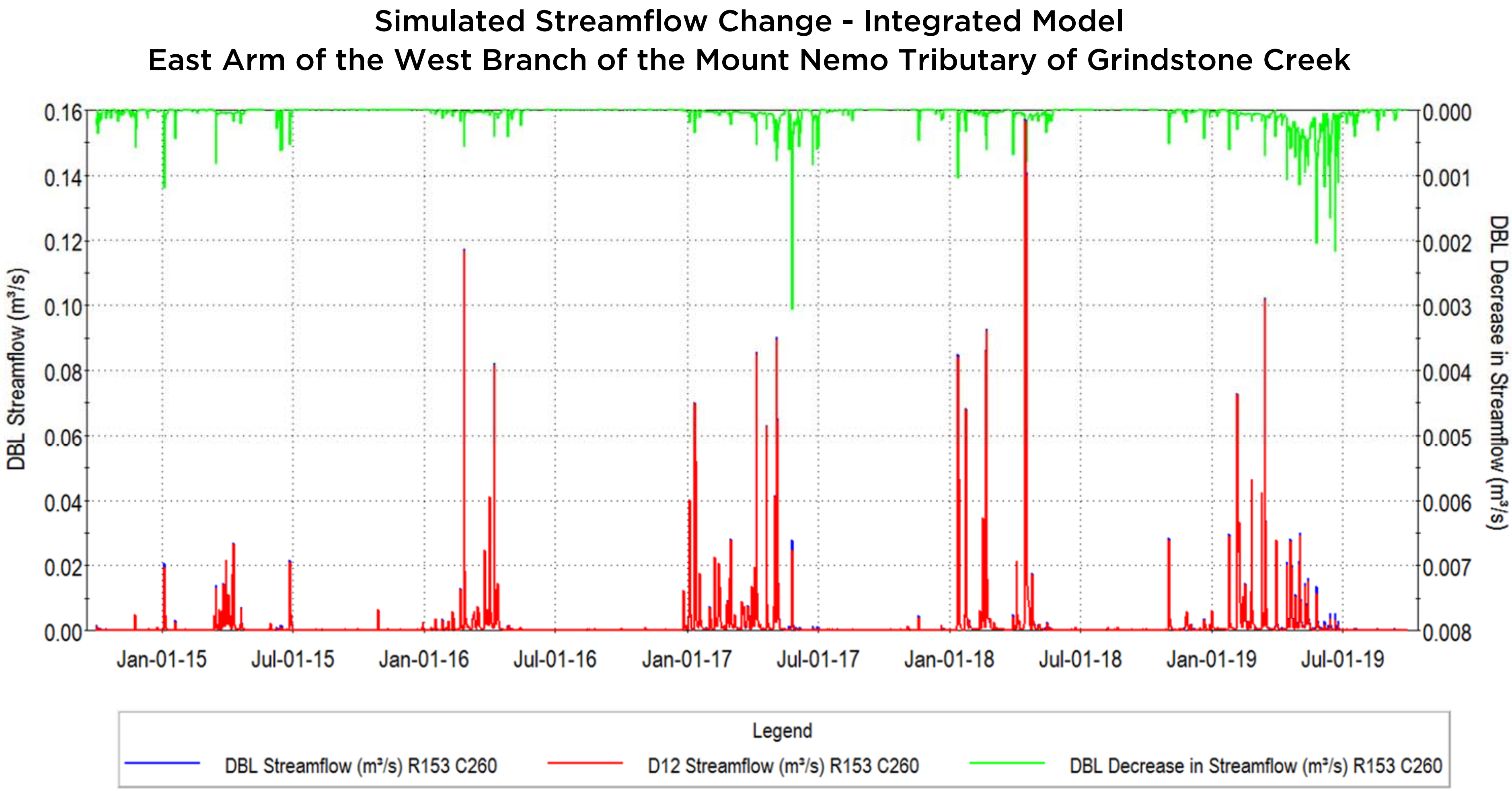


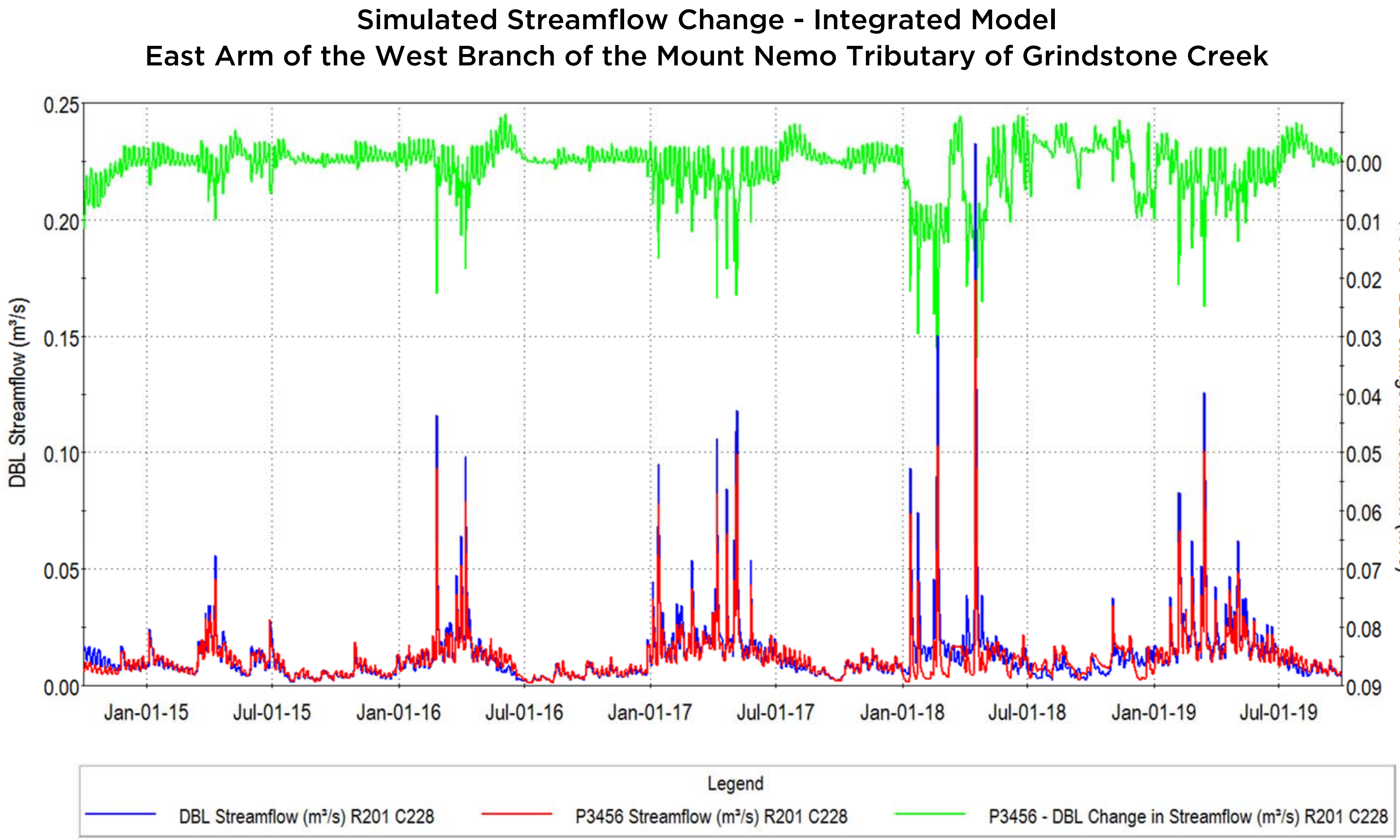
EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 3

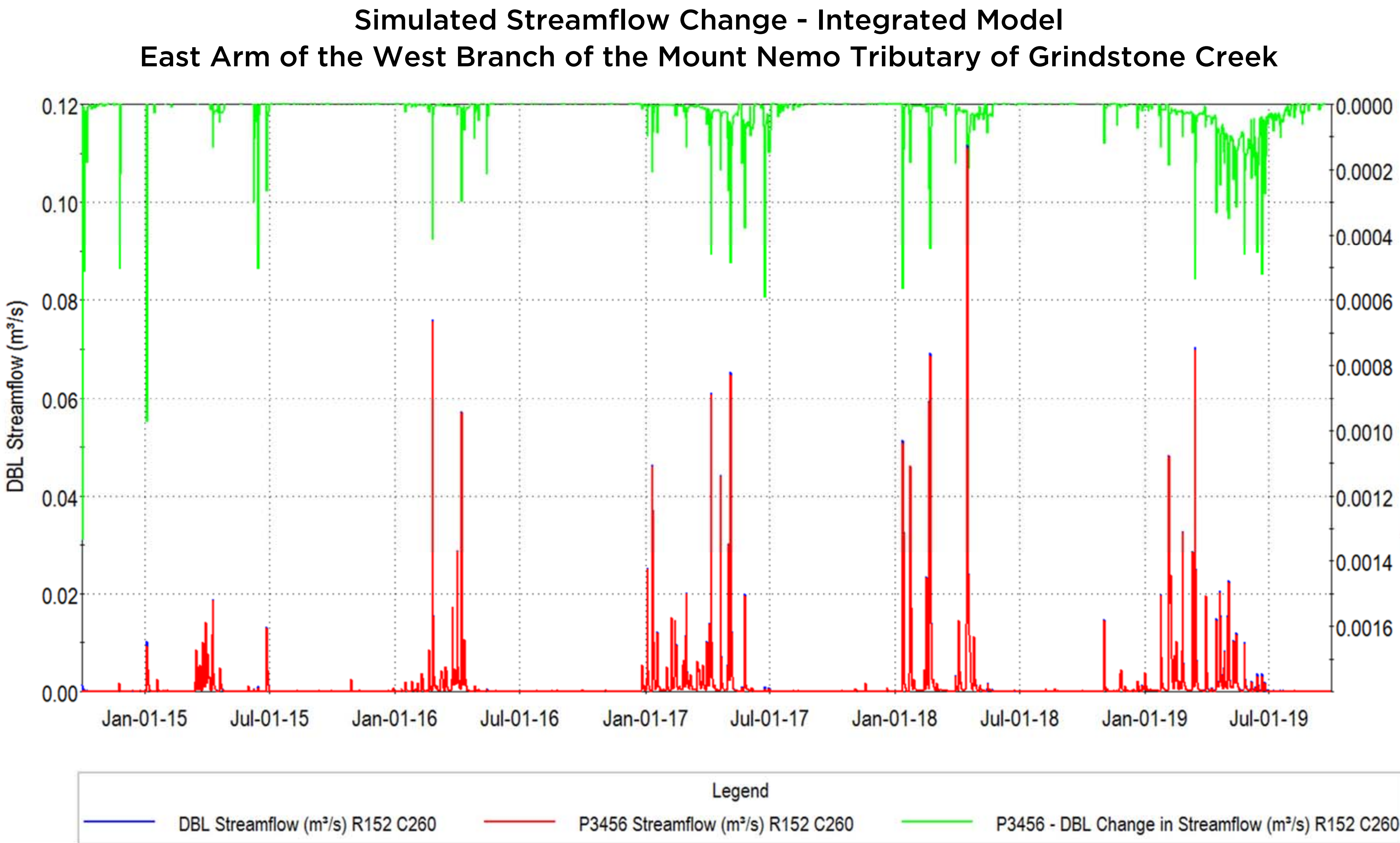



Integrated Model Calibration
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
DBL Streamflow (m³/s)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Dec-24-18
Jan-21-19
Feb-18-19
Mar-18-19
Apr-15-19
May-13-19
Jun-10-19
Jul-08-19
Aug-05-19
Legend
DBL Streamflow (m³/s) R153 C260
SW9 (m3/sec)

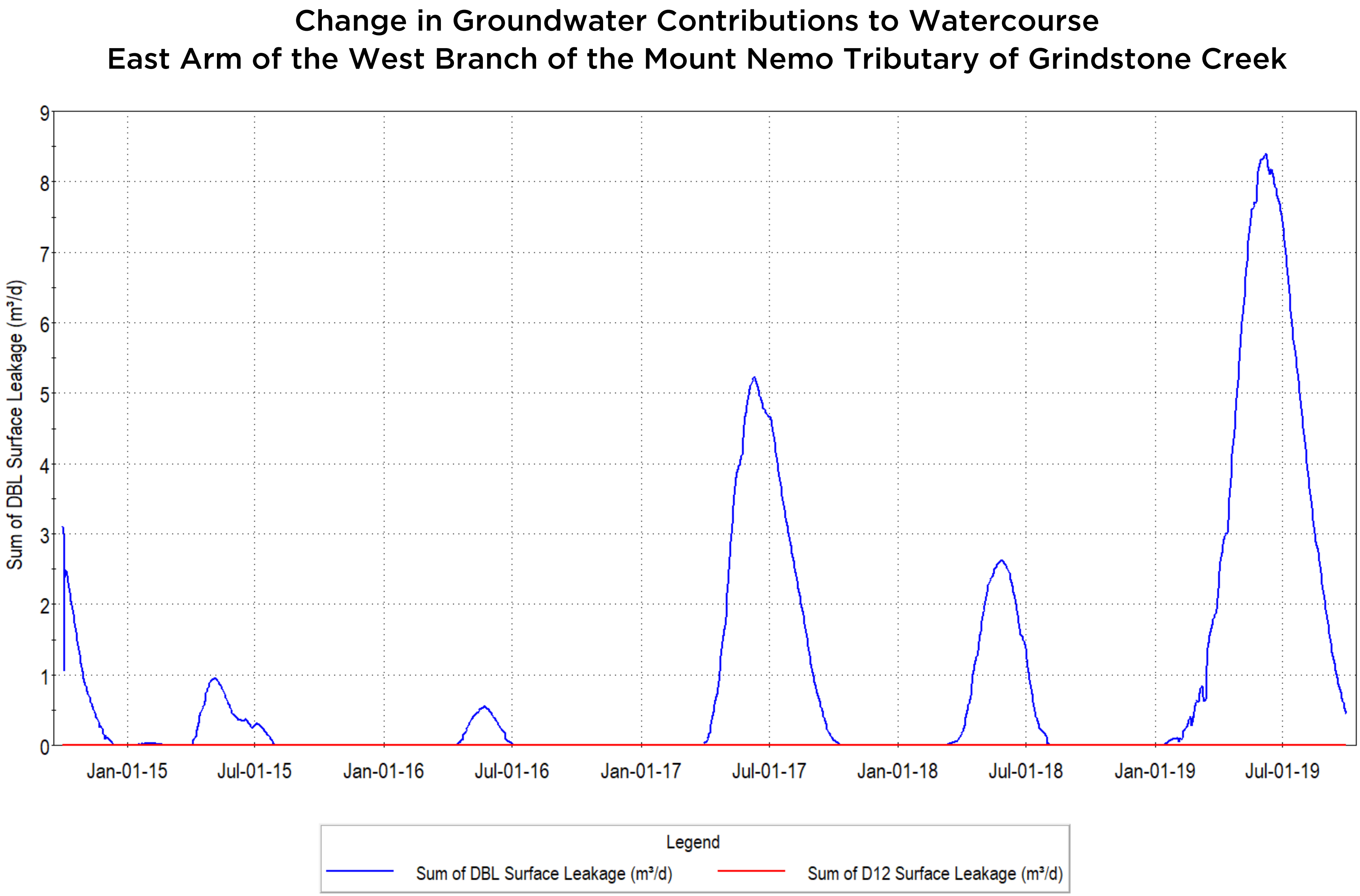
EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 5

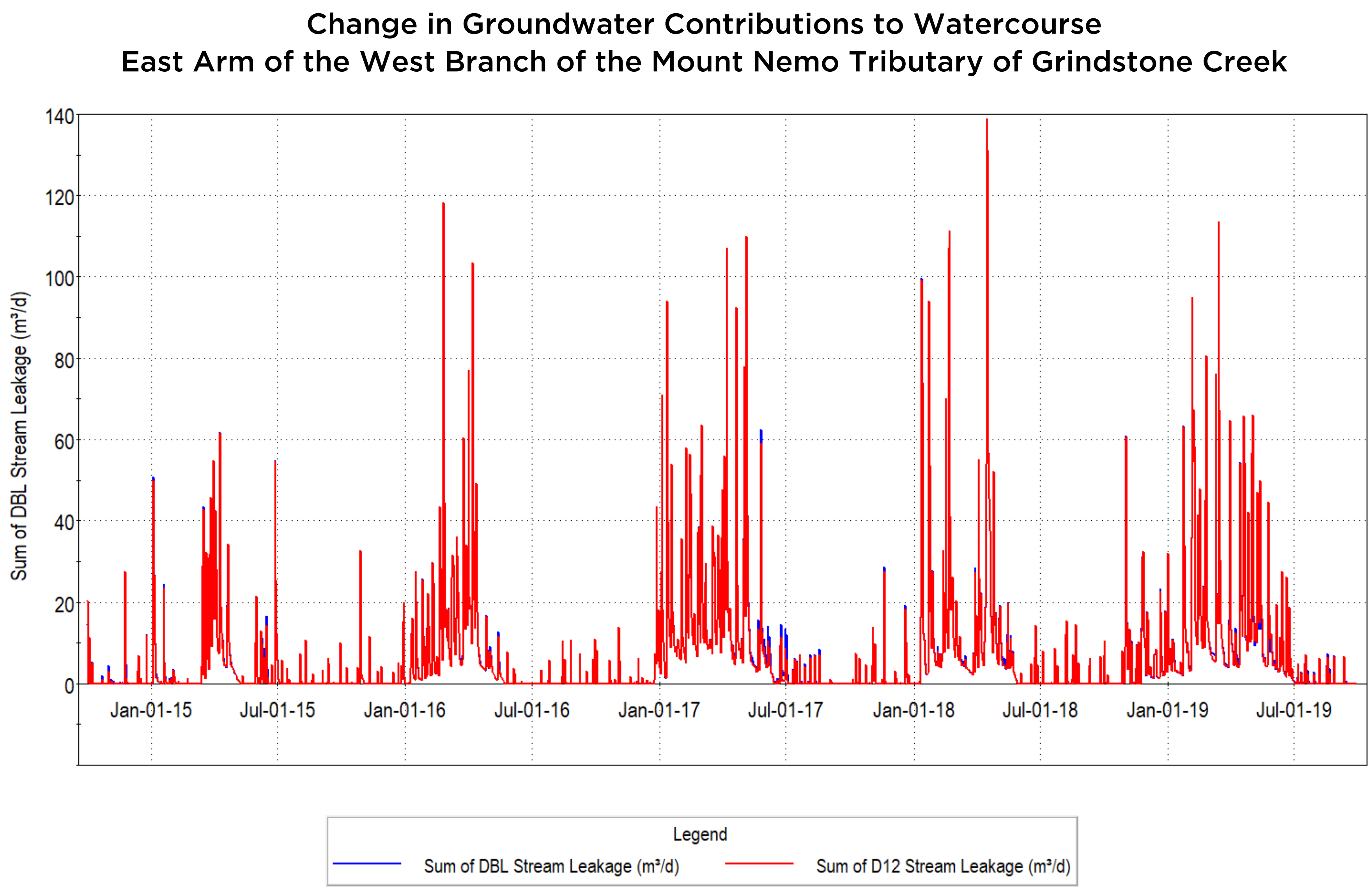



Simulated Streamflow Change - Integrated Model
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
DBL Streamflow (m³/s)
P3456 - DBL Change in Streamflow (m³/s)
0.25
0.20
0.15
0.10
0.05
0.00
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R201 C228
P3456 Streamflow (m³/s) R201 C228
P3456 - DBL Change in Streamflow (m³/s) R201 C228

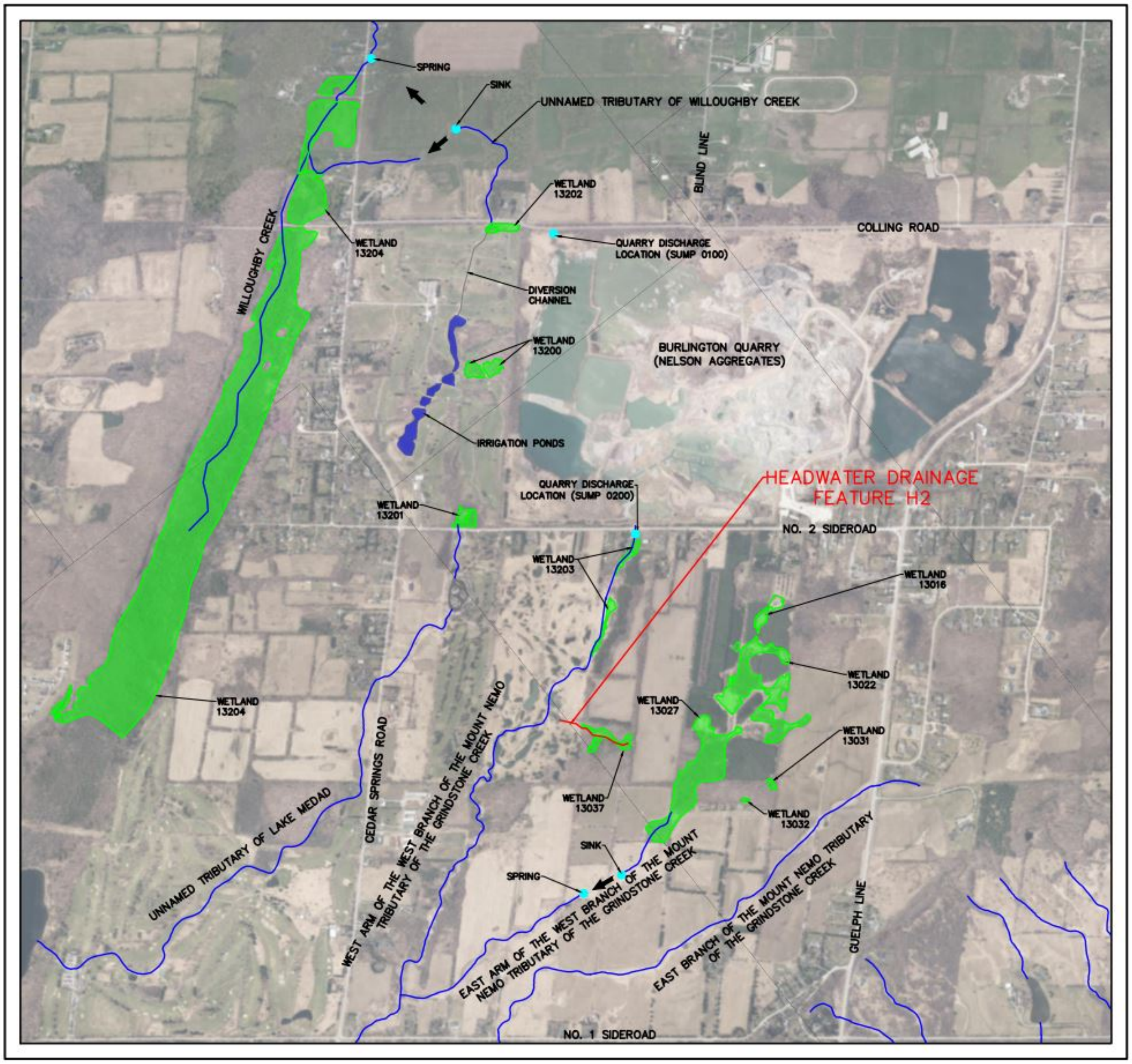

Simulated Streamflow Change - Integrated Model
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
DBL Streamflow (m³/s)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
P3456 - DBL Change in Streamflow (m³/s)
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
0.0014
0.0016
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R152 C260
P3456 Streamflow (m³/s) R152 C260
P3456 - DBL Change in Streamflow (m³/s) R152 C260

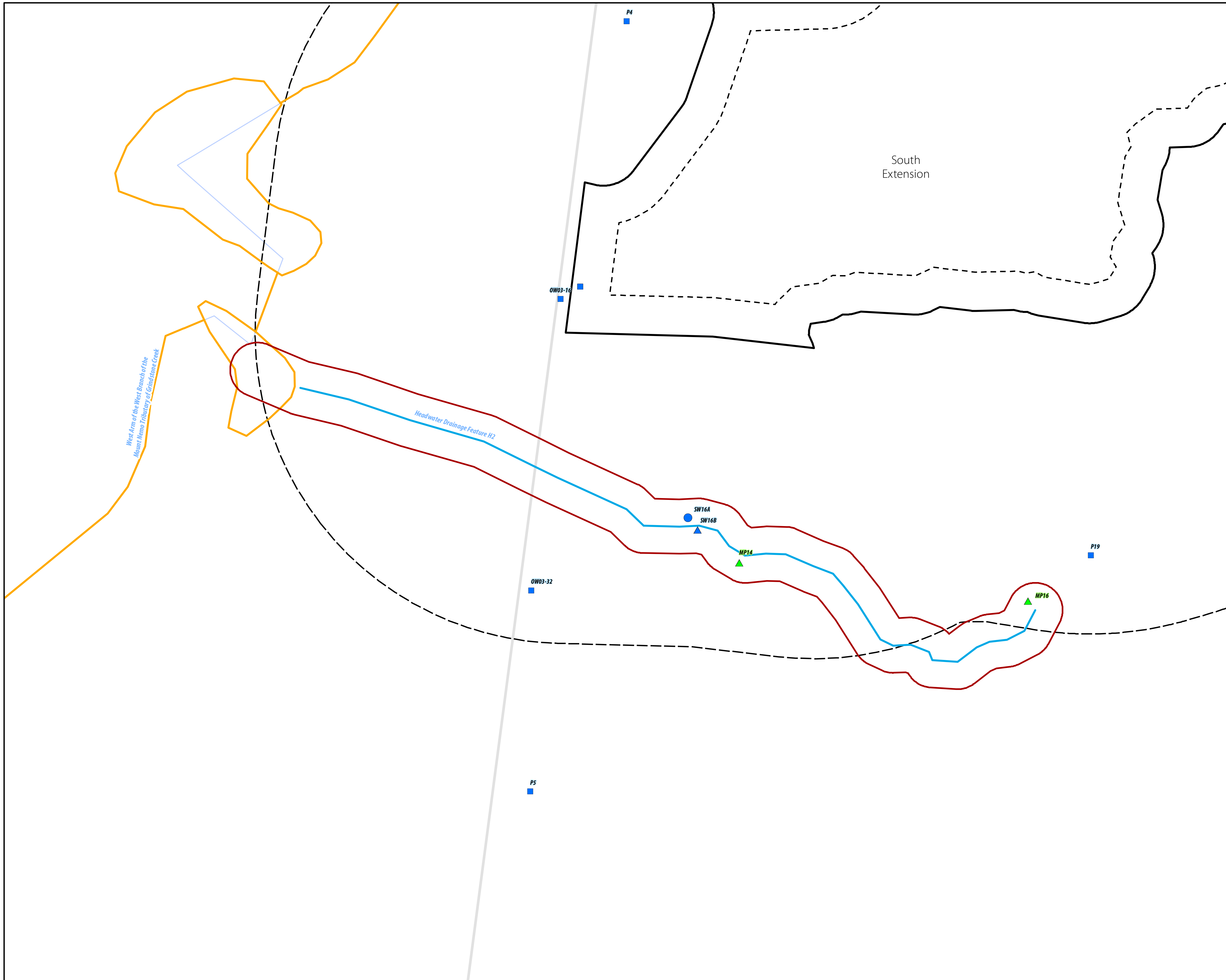
EAST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 8




Change in Groundwater Contributions to Watercourse
East Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
Sum of DBL Stream Leakage (m³/d)
140
120
100
80
60
40
20
0
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
Sum of DBL Stream Leakage (m³/d)
Sum of D12 Stream Leakage (m³/d)

HEADWATER DRAINAGE FEATURE H2





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Headwater Drainage Feature H2
- Indirect Fish Habitat
- Direct Fish Habitat
- Watercourse
- Wetland (Savanta, 2020)

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)

Previous Instrumentation

- Mini Piezometer (Golder)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 17
Watercourse Characterization

Headwater Drainage Feature H2

0 25 m

1:1,500

N

Headwater Drainage Feature H2

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2" colspan="5">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Watercourse Name:</td><td colspan="5">Headwater Drainage Feature H2</td><td></td><td></td><td></td></tr>
<tr><td>Watershed:</td><td colspan="5">Grindstone Creek Watershed</td><td></td><td></td><td></td></tr>
<tr><td>Sub-Watershed:</td><td colspan="5">West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed Limit of Extraction:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed License Boundary:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Catchment Area (ha):</td><td colspan="5">10 ha</td><td></td><td></td><td></td></tr>
<tr><td>Catchment ID:</td><td colspan="5">S125 and S126</td><td></td><td>SWA (Tatham, April 2020)</td><td>Drawing DP-1</td></tr>
<tr><td>Primary Source(s) of Flow:</td><td colspan="5">Surface runoff</td><td></td><td></td><td></td></tr>
<tr><td>Discharge from Quarry / PTTW:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Conditions of PTTW:</td><td colspan="5">Not applicable</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water Monitoring:</td><td colspan="5">ID: SW39 (Tatham)
Installation Date: March 25, 2021
Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve)
Coordinates of Monitoring Station: Easting 590856.53, Northing 590856.53</td><td></td><td></td><td></td></tr>
<tr><td>Streamflow Conditions:</td><td colspan="5">Intermittent</td><td></td><td></td><td></td></tr>
<tr><td>Average Daily Flow:</td><td colspan="5">To be determined. To date, water levels and temperatures have been collected in Wetland 13037 at the origin of the Headwater Drainage Feature H2. A streamflow monitoring gauge was installed in the spring of 2021 to monitor streamflow in this feature. Average daily flow will be established from the monitoring data collected moving forward. It is noted, Wetland 13037 dries out in the early summer, as early as May 25th, and has remained dry until as late as December 25th. Headwater Drainage Feature H2 runs dry consistent with the upstream wetland.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="14">Watercourse Thermal Regime (SW16A):</td><td colspan="4">Average Daily Water Temperature (°C)</td><td rowspan="14">Notes:
Minimum - lowest daily average streamflow recorded for period of record
Average - average daily streamflow recorded for period of record
Maximum - maximum daily average streamflow recorded for period of record
N/A - data not available as device removed from watercourse during winter months</td><td rowspan="14">Graph 1</td><td rowspan="14">SWA (Tatham, April 2020)</td><td rowspan="14">2.1.2 and Appendix C</td></tr>
<tr><td>Month</td><td>Minimum</td><td>Average</td><td>Maximum</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>-6.3</td><td>2.6</td><td>20.5</td></tr>
<tr><td>April</td><td>-5.9</td><td>6.8</td><td>24.4</td></tr>
<tr><td>May</td><td>0.7</td><td>12.0</td><td>31.7</td></tr>
<tr><td>June</td><td>8.2</td><td>16.5</td><td>30.3</td></tr>
<tr><td>July</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>August</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>September</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>October</td><td>Dry</td><td>Dry</td><td>Dry</td></tr>
<tr><td>November</td><td>-5.3</td><td>5.2</td><td>26.4</td></tr>
<tr><td>December</td><td>-1.5</td><td>2.7</td><td>5.5</td></tr>
</table>

Headwater Drainage Feature H2

Fish & Fish Habitat Features	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Fish Habitat (Direct/Indirect and Assumed/Confirmed):	1) The portion of the Headwater Drainage Feature H2 on the Subject Lands does not appear to provide direct fish habitat, based on the presence of a barrier to movement at the downstream end, intermittent nature (dries out in summer), and generally small size of the feature. No fish were observed in the feature during headwater drainage feature investigations in 2019. 2) The off-site (downstream) reach of this feature consists of an excavated, linear ditch on the adjacent golf course property. It runs for approximately 90 m before draining into an online golf course pond on the West Arm of the West Branch. There is a high probability that this pond contains fish, which could potentially have access to the channelized portion of this headwater drainage feature. However, based on low flows observed in 2019 and lack of suitable wetted width and depth to support fish, it has been assessed as providing indirect fish habitat.		NETR (Savanta, April 2020)	39 and 40
Fish Species Present:	Fish are assumed to not directly use the headwater drainage feature. No information on fish species in the online pond at the downstream end of the feature is known to exist. Pumpkinseed and Brook Stickleback are known to be present in upstream reaches of the West Arm of the West Branch.		NETR (Savanta, April 2020)	39 and 40
Fish Community Thermal Regime:	Fish are assumed to not directly use the headwater drainage feature.		NETR (Savanta, April 2020)	39 and 40
Fish Habitat Types Present:	The feature provides indirect fish habitat contributing to the downstream West Arm of the West Branch. On the Subject Lands, the feature consists of a headwater wetland and an approximately 50-m long, low flow channel running through a wooded area, before flowing into the off-site channelized reach on the adjacent property.		NETR (Savanta, April 2020)	39 and 40
Habitat Uses by Known Fish Community:	No direct use by fish is expected to occur. Indirect habitat functions provided by the feature include water storage and release (headwater wetlands), water quality maintenance, conveyance of flow, sediment transport and organic inputs.		NETR (Savanta, April 2020)	39 and 40
Known Barriers to Fish Movement:	There is a culvert at the Subject Lands property line that provides a barrier to upstream fish movement.		NETR (Savanta, April 2020)	39 and 40

Groundwater Interaction	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Underlying Deposits:	Halton Till. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.			
Surface Water / Groundwater Interactions:	Seasonal groundwater contributions to watercourse. Groundwater seepage under baseline conditions during spring months equates to 0.1 L/s or less. Groundwater seepage is at its maximum during and immediately following the spring freshet.	Figures 1 & 2		
Water Budget Results:	The baseline condition water budget results from the integrated model are presented in Figure 3a. Condition / GW Out / GW In Baseline (Existing) / 18.07% / 1.11%	Figure 3a		
Integrated Model Calibration:	This area was not discussed in the model calibration due to the lack of observations.			

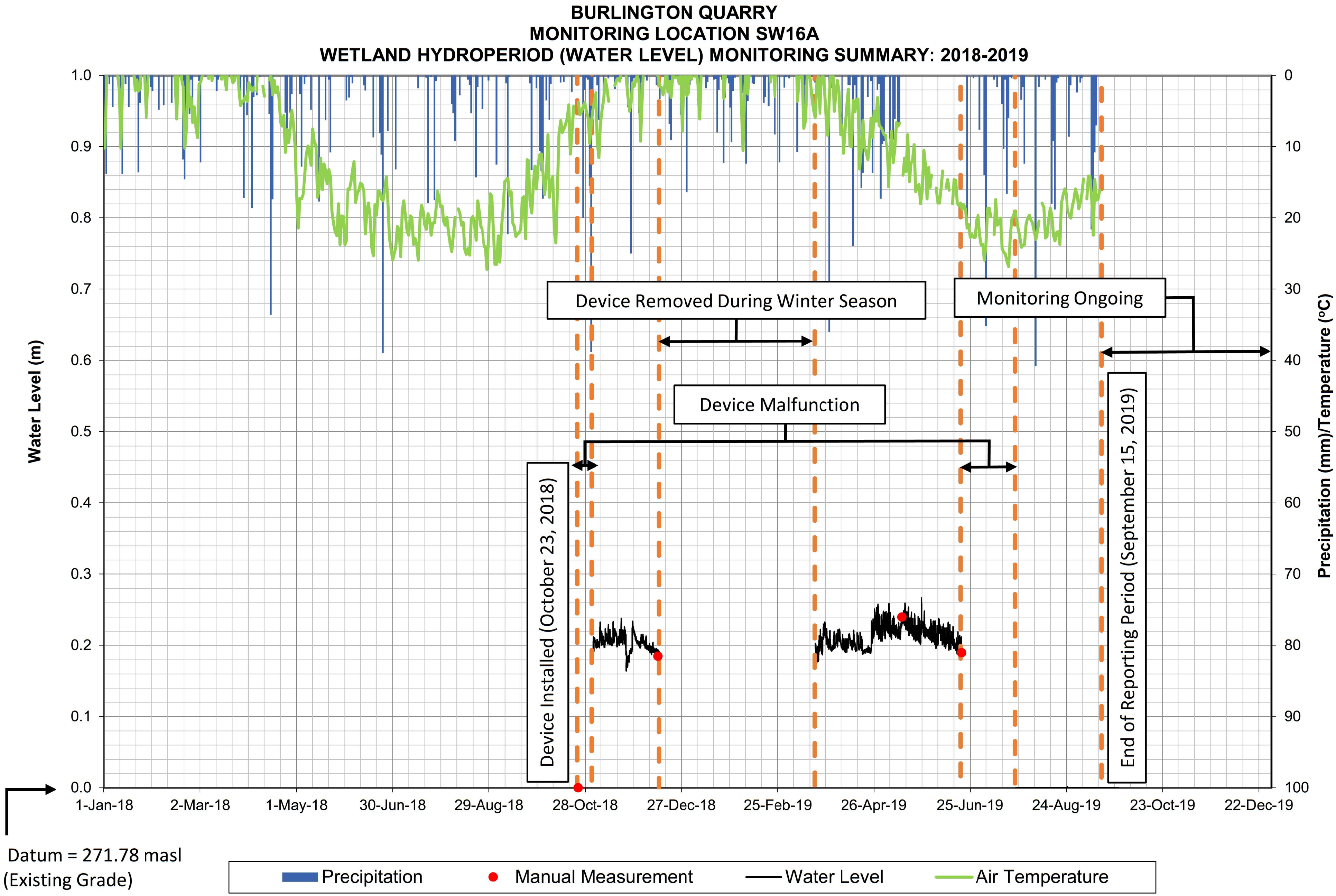
Headwater Drainage Feature H2

<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Direct Alterations to Watercourse:</td><td>No direct alterations to this headwater drainage feature are proposed.</td><td></td><td>NETR (Savanta, April 2020)</td><td>80</td></tr>
<tr><td>Change in Primary Source of Flow:</td><td>No change in surface water input as the catchment area of the Headwater Drainage Feature H2 will remain undisturbed. The headwater drainage feature is perched above the water table, generally losing rather than gaining flow from the groundwater system. The headwater drainage feature is primarily located in Halton Till, so the low permeability of the till limits GW/SW interactions</td><td></td><td></td><td></td></tr>
<tr><td>Change in Watercourse Catchment Area:</td><td>Catchment area to remain undisturbed, no change in catchment area.</td><td></td><td></td><td></td></tr>
<tr><td>Simulated Streamflow Change (Integrated Model Results):</td><td>The Earthfx report discusses changes in simulated streamflow under the different quarry expansion phases. This tributary was not discussed, but Graphs 2 and 3 show simulated baseline(red) and Scenario P12 (blue) flows. Decrease in flow (green) are plotted in reverse on the upper X axis with the scale shown on the right Y axis. Very small decreases in streamflow, primarily in winter and spring, are predicted.</td><td>Graphs 2 & 3</td><td>HHIAR (Earthfx, April 2020)</td><td>198 - 203 and 230 - 237</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model are presented in Figure 3b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>18.07%</td><td>1.11%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>18.57%</td><td>0.00%</td><td>0.50%</td><td>-1.11%</td></tr>
</table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model are presented in Figure 3c. Its noted the rehabilitation of the south extension is complete under this scenario.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>18.07%</td><td>1.11%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 though 6</td><td>19.18%</td><td>19.06%</td><td>1.11%</td><td>17.95%</td></tr>
</table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>18.07%</td><td>1.11%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>18.25%</td><td>18.43%</td><td>0.18%</td><td>17.32%</td></tr>
</table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model are presented in Figure 3e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>18.07%</td><td>1.11%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>19.04%</td><td>17.37%</td><td>0.97%</td><td>16.26%</td></tr>
</table></td><td>Figure 3e</td><td></td><td></td></tr>
<tr><td>Change in Groundwater Contributions to Watercourse:</td><td>Under Baseline conditions, the H2 catchment receives minimal amounts of groundwater seepage during drought years (more under wet years). Under P12 conditions, this seepage is lost due to the dewatering as shown in Graph 4. Leakage between the stream and groundwater system is shown in Graph 5 for Baseline and P12 conditions. The vast majority of the leakage is from the stream to the groundwater system. Under Baseline conditions there is a very minor amount of upwards leakage into the stream in the late spring (shown as negative leakage in blue).</td><td>Graphs 4 and 5</td><td></td><td></td></tr>
<tr><td>Change in Watercourse Thermal Regime:</td><td>Negative changes on water temperature are not expected given that the wetlands and catchment area feeding the Headwater Drainage Feature H2 will remain undisturbed.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Quality:</td><td>Negative changes on water quality are not expected given that the wetlands and catchment area feeding the Headwater Drainage Feature H2 will remain undisturbed.</td><td></td><td></td><td></td></tr>
</table>

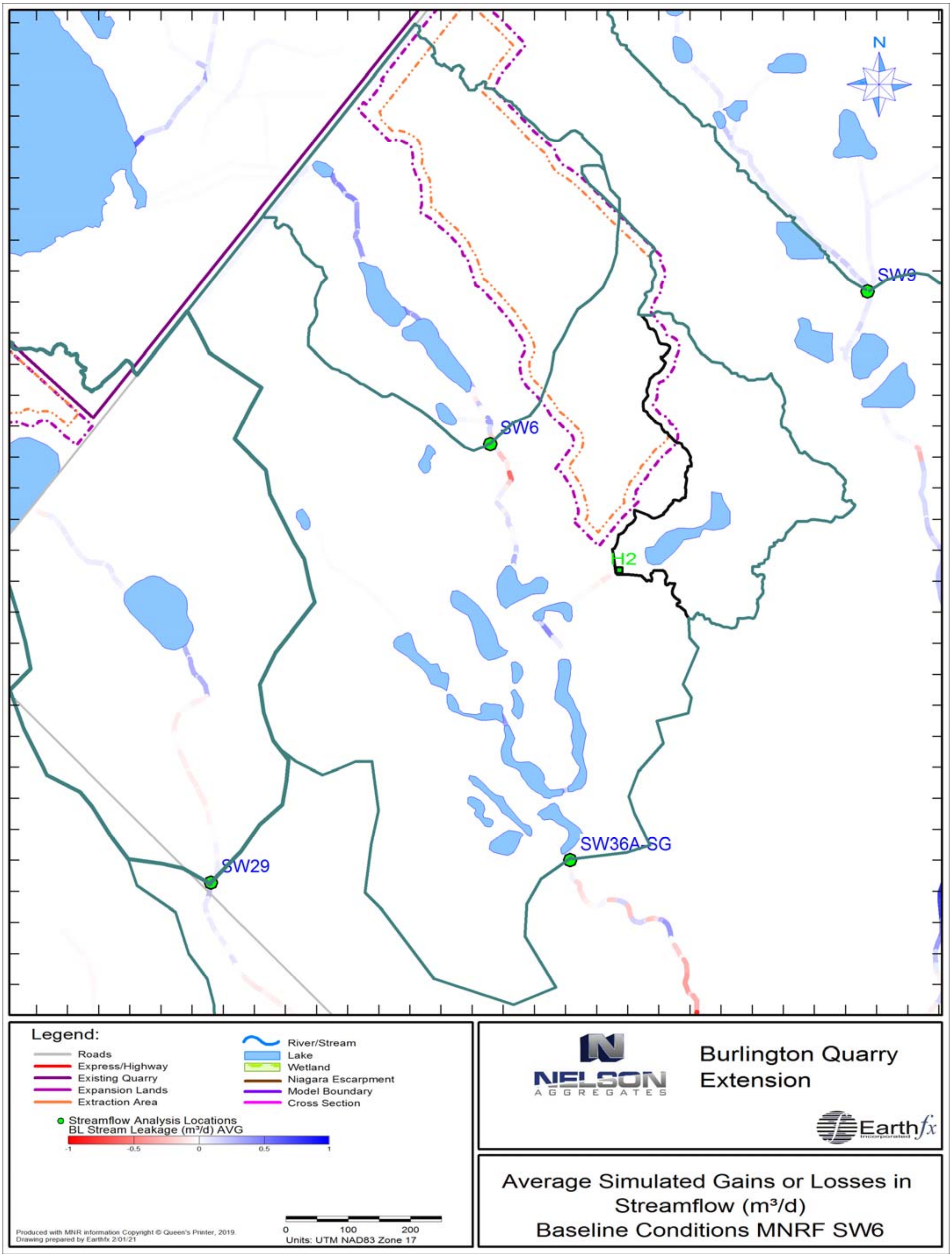
Headwater Drainage Feature H2

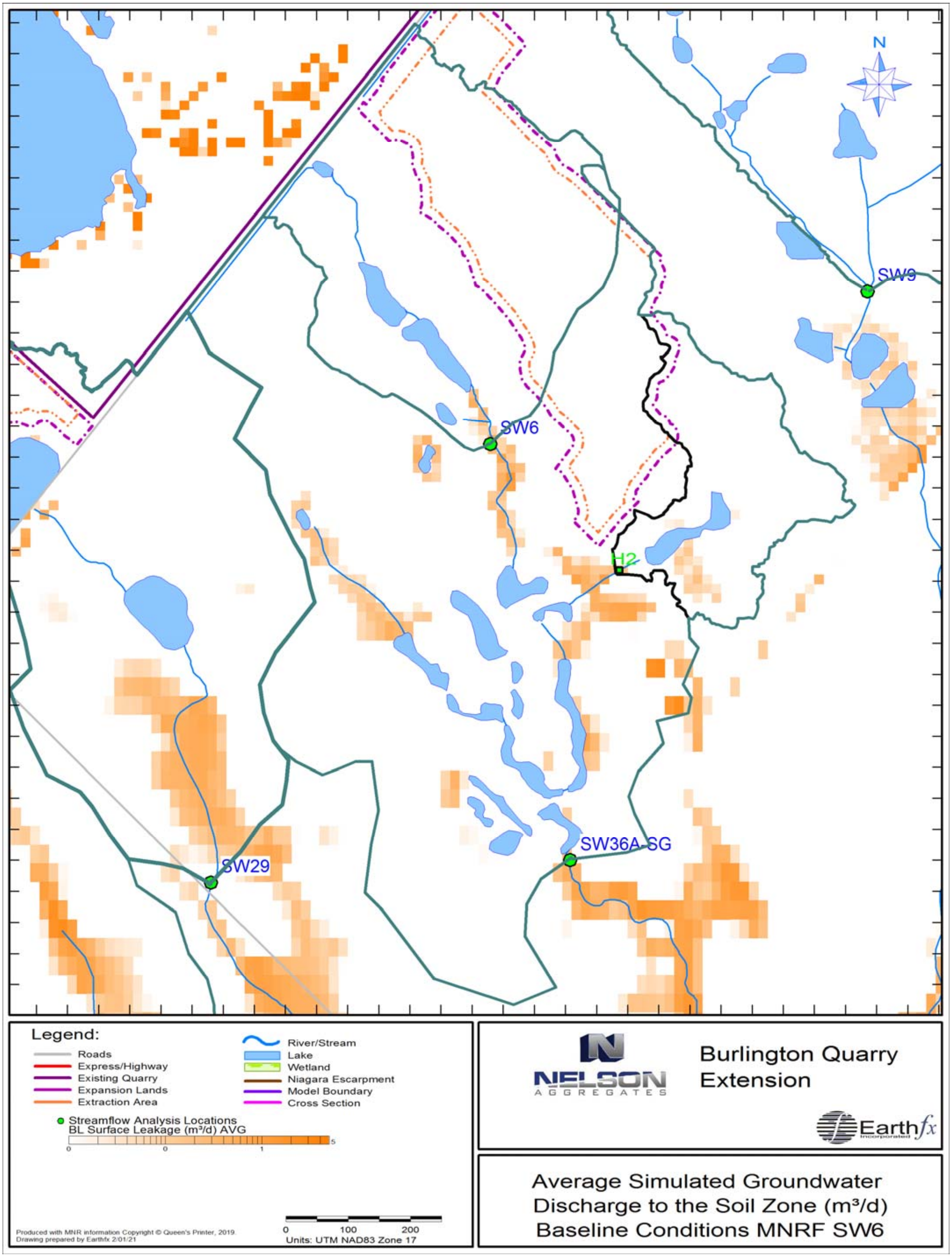
Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Potential Impact to Form and Function of Feature:	A 1% or 0.1 L/s reduction in groundwater discharge to the headwater wetland may have a corresponding 1% reduction in the volume of water conveyed downstream to the West Arm of the West Branch. The feature is predicted to continue to provide indirect fish habitat functions supporting the downstream watercourse as it will continue to convey flow downstream on a seasonal basis. The 0.1 L/s reduction in surface flow into the online pond on the West Arm of the West Branch (where Headwater Drainage Feature H2 drains) is not expected to have a measurable effect on direct fish habitat in the pond or watercourse.		NETR (Savanta, April 2020)	80
Potential Impact to Identified Species and Habitat:	No impacts to species or habitat in the downstream West Arm of the West Branch are predicted.		NETR (Savanta, April 2020)	80

Mitigation	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	No direct alterations are proposed; therefore, no mitigation is required.		NETR (Savanta, April 2020)	80
Source Water Mitigation:	No alterations to surface water catchment area; therefore, no mitigation is required.		NETR (Savanta, April 2020)	80
Groundwater Contribution Mitigation:	Given the minor nature of proposed changes in groundwater discharge to the wetland, no mitigation is proposed to supplement flows. However, the feature will continue to be monitored throughout the operations period, as specified in the AMP. If adverse effects on flow and/or wetland function are observed as a result of quarry extraction, mitigation (e.g., pumping from the quarry to the headwater wetland) could be implemented, if needed, to maintain ecological and biophysical functions of the feature.		NETR (Savanta, April 2020)	80
Erosion Mitigation:	None required.			
Thermal Mitigation:	None required.			
Water Quality Mitigation:	None required.			


BURLINGTON QUARRY
MONITORING LOCATION SW16A
WETLAND HYDROPERIOD (WATER LEVEL) MONITORING SUMMARY: 2018-2019
Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm)/Temperature (ºC)
0
10
20
30
40
50
60
70
80
90
100
1-Jan-18
2-Mar-18
1-May-18
30-Jun-18
29-Aug-18
28-Oct-18
27-Dec-18
25-Feb-19
26-Apr-19
25-Jun-19
24-Aug-19
23-Oct-19
22-Dec-19
Device Removed During Winter Season
Monitoring Ongoing
Device Malfunction
Device Installed (October 23, 2018)
End of Reporting Period (September 15, 2019)
Datum = 271.78 masl
(Existing Grade)
Precipitation
Manual Measurement
Water Level
Air Temperature

HEADWATER DRAINAGE FEATURE H2 - FIGURE 1




N
SW9
SW6
H2
SW36A-SG
SW29
Legend:
Roads
Express/Highway
Existing Quarry
Expansion Lands
Extraction Area
River/Stream
Lake
Wetland
Niagara Escarpment
Model Boundary
Cross Section
Streamflow Analysis Locations
BL Surface Leakage (m³/d) AVG
0
0
1
5
Produced with MNR information Copyright © Queen's Printer, 2019.
Drawing prepared by Earthfx 2/01/21
0
100
200
Units: UTM NAD83 Zone 17
NELSON
AGGREGATES
Burlington Quarry
Extension
Earthfx
Incorporated
Average Simulated Groundwater
Discharge to the Soil Zone (m³/d)
Baseline Conditions MNRF SW6

HEADWATER DRAINAGE FEATURE H2

FIGURE 3A

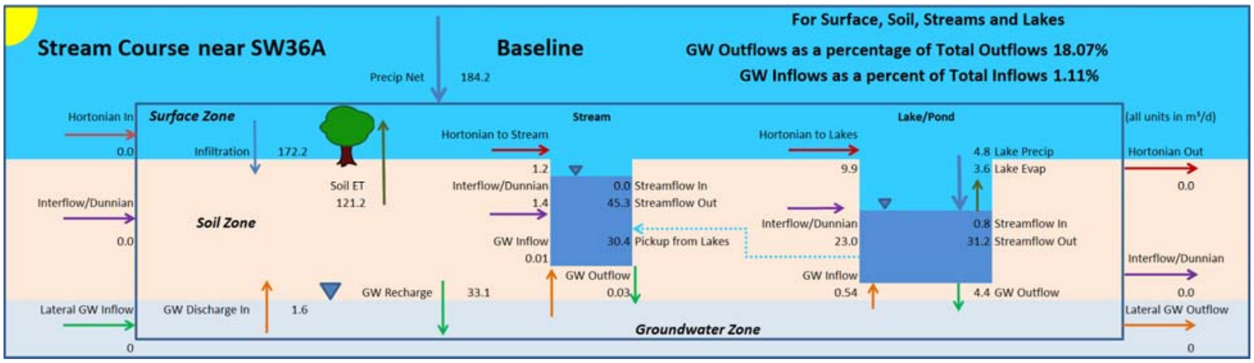


FIGURE 3B

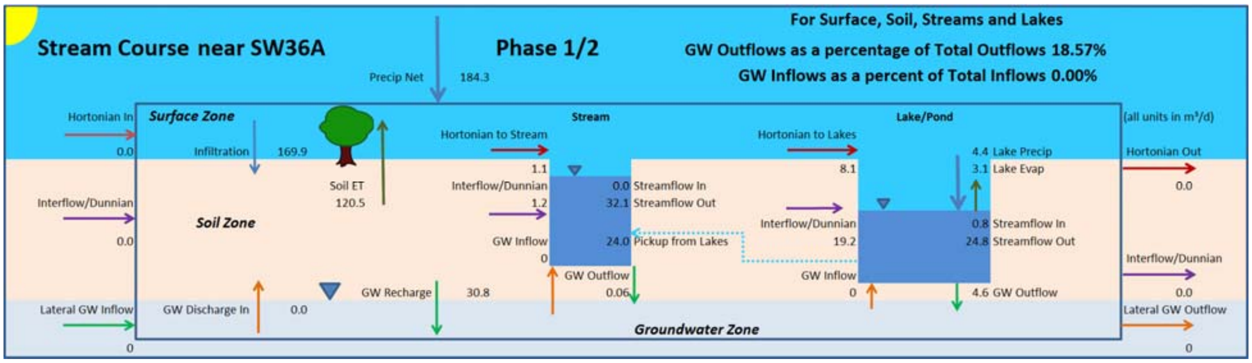


FIGURE 3C

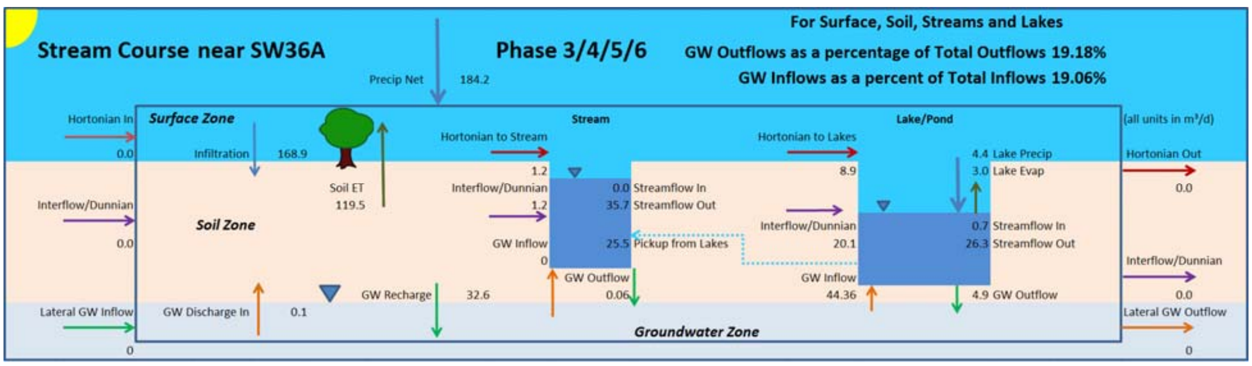


FIGURE 3D

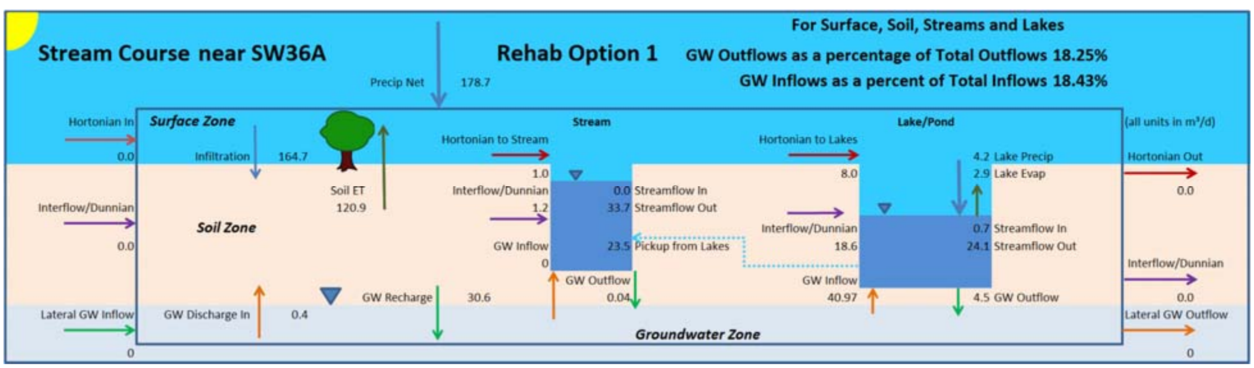
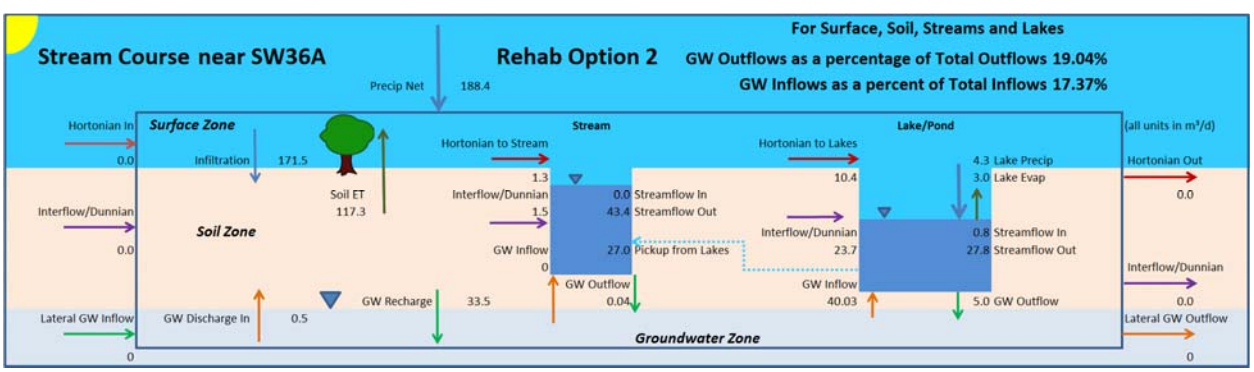
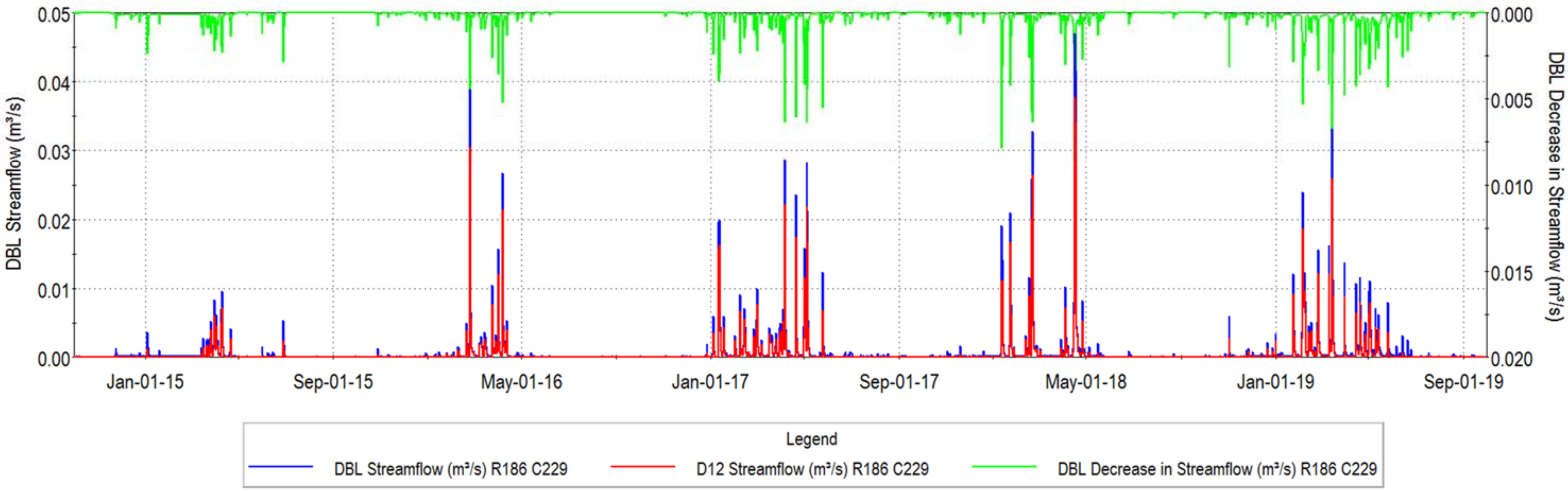


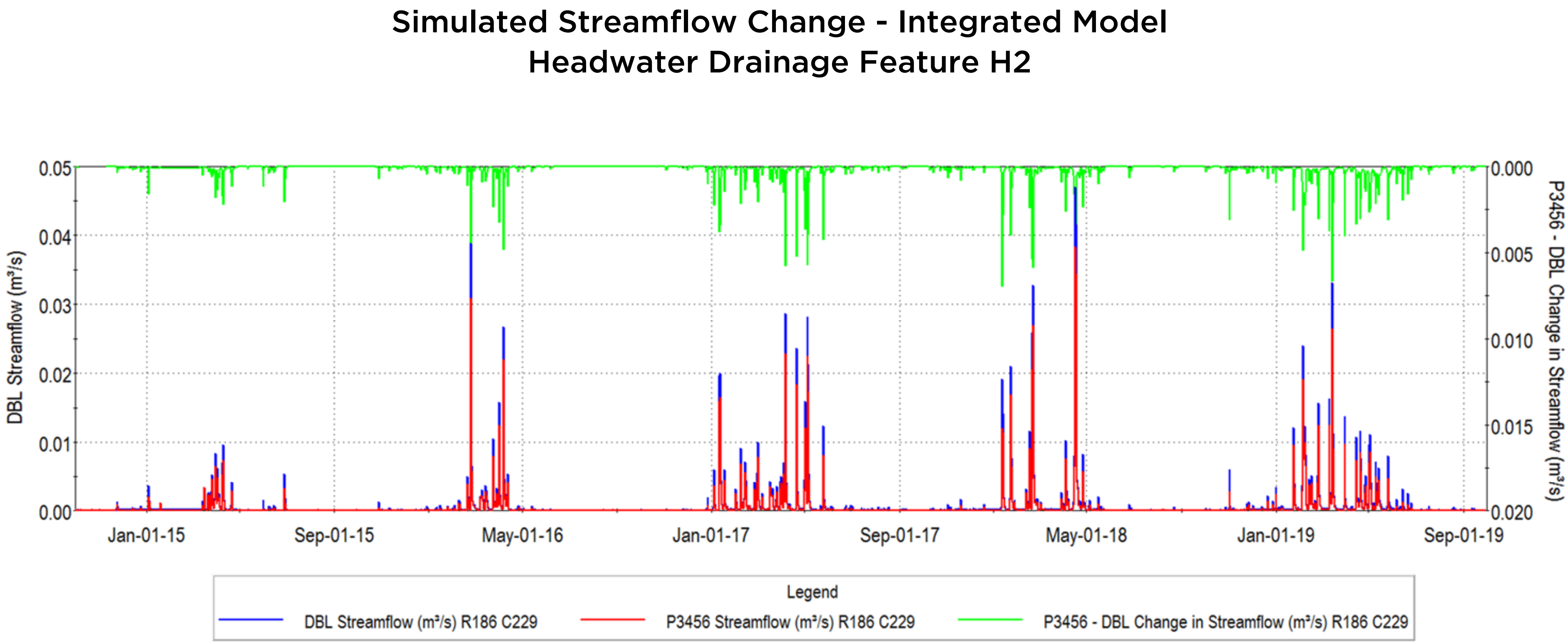
FIGURE 3E

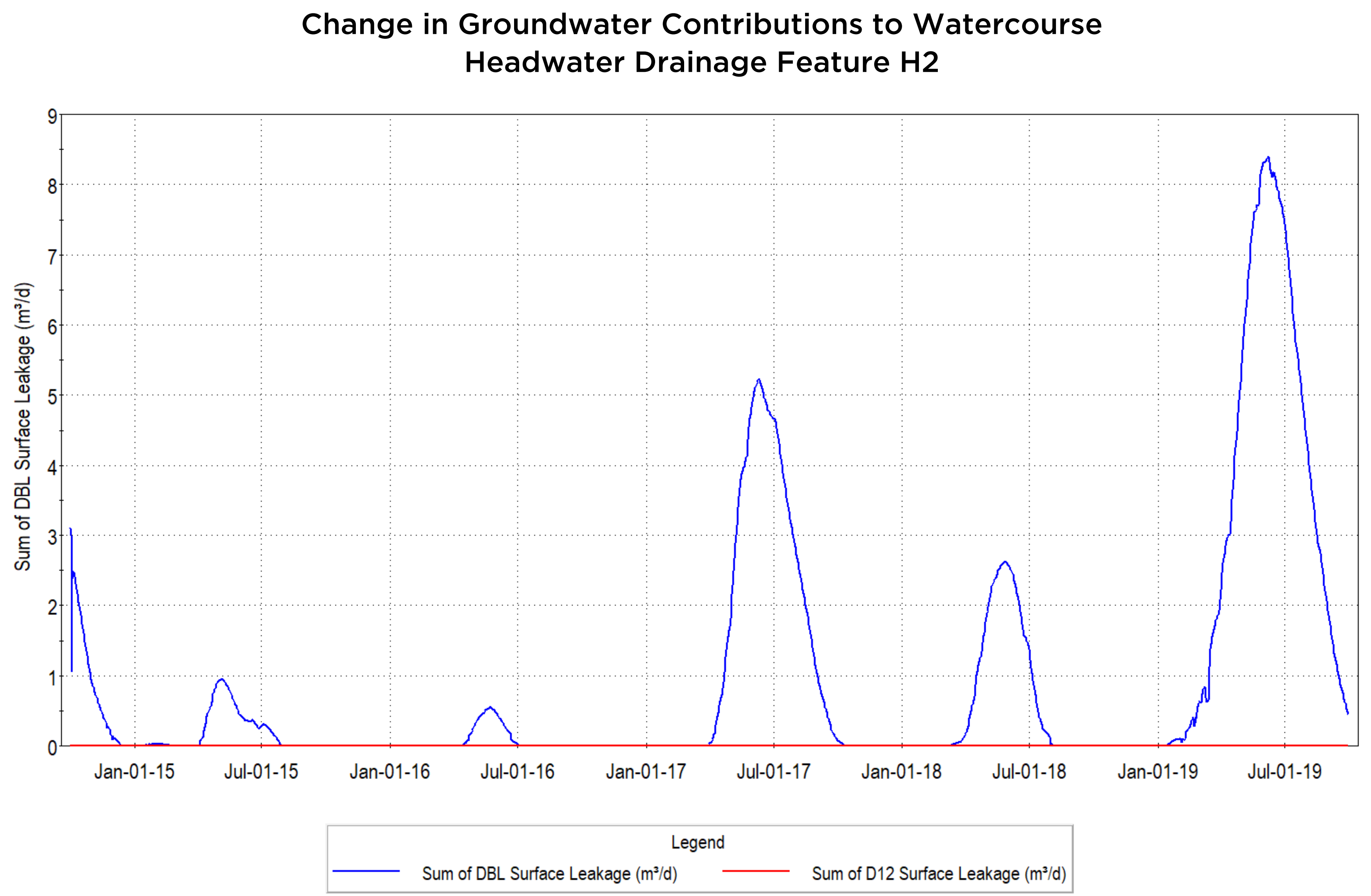


HEADWATER DRAINAGE FEATURE H2 - GRAPH 2

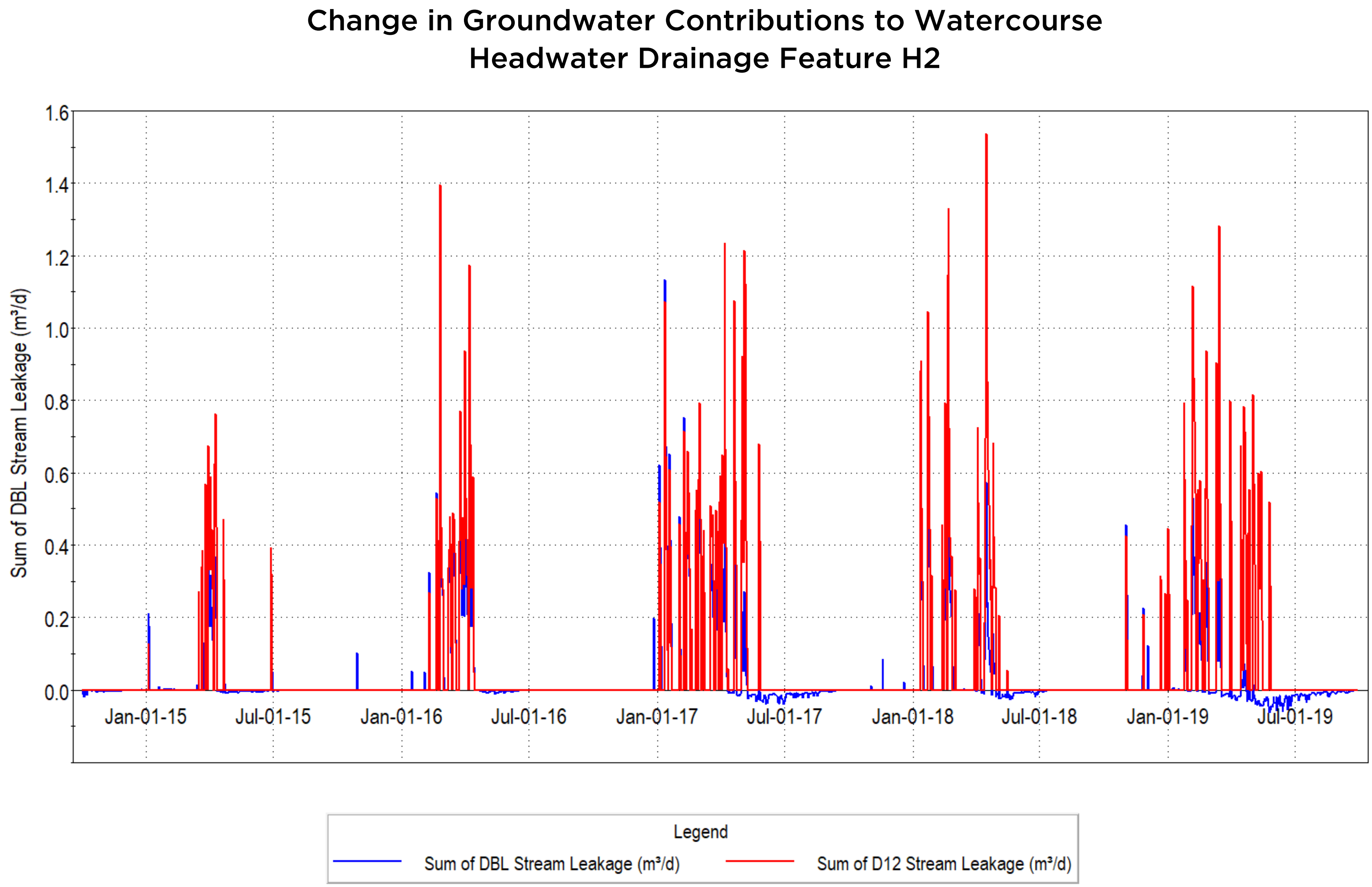
Simulated Streamflow Change - Integrated Model
Headwater Drainage Feature H2



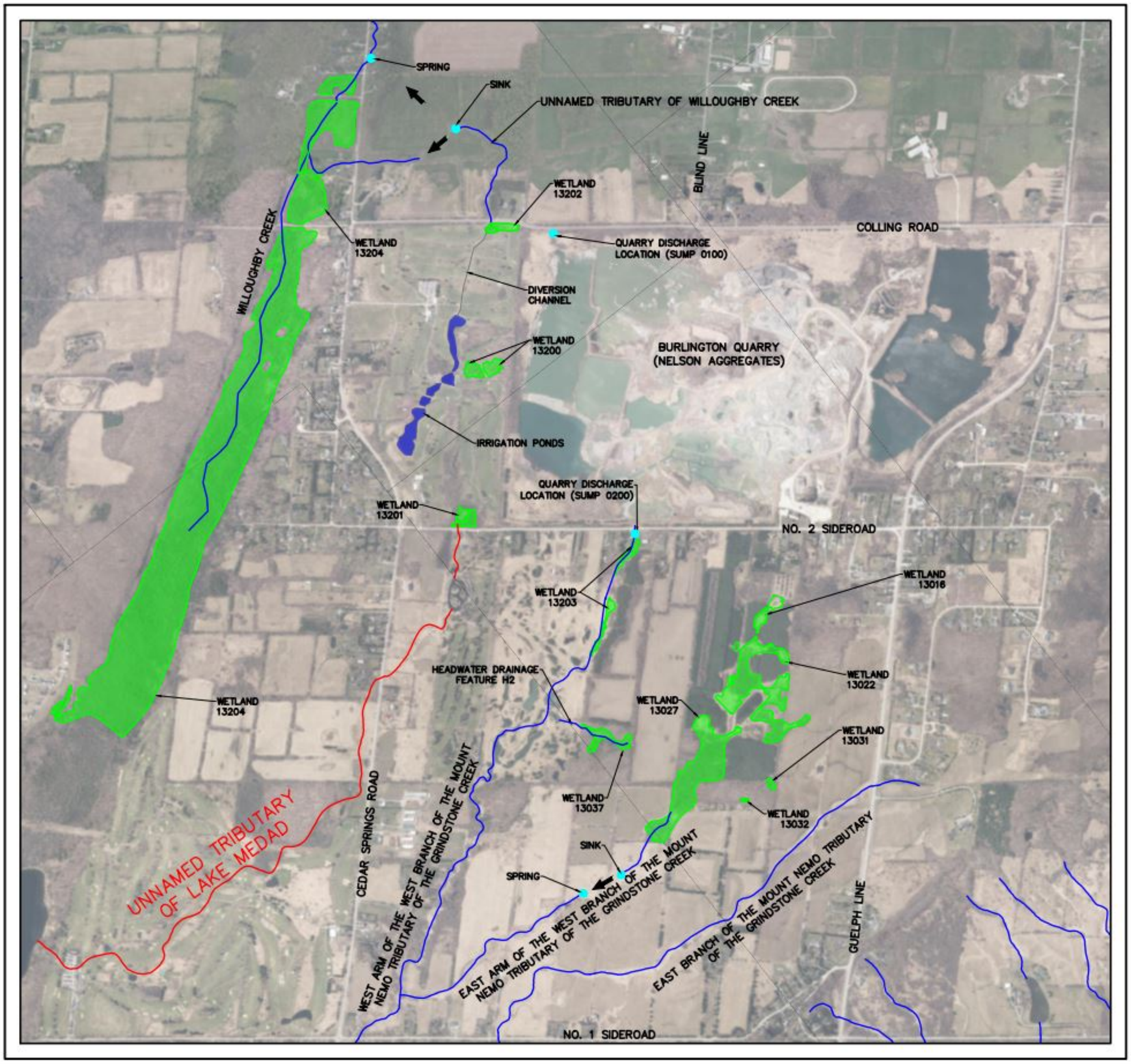

Simulated Streamflow Change - Integrated Model
Headwater Drainage Feature H2
DBL Streamflow (m³/s)
P3456 - DBL Change in Streamflow (m³/s)
0.05
0.04
0.03
0.02
0.01
0.00
0.000
0.005
0.010
0.015
0.020
Jan-01-15
Sep-01-15
May-01-16
Jan-01-17
Sep-01-17
May-01-18
Jan-01-19
Sep-01-19
Legend
DBL Streamflow (m³/s) R186 C229
P3456 Streamflow (m³/s) R186 C229
P3456 - DBL Change in Streamflow (m³/s) R186 C229

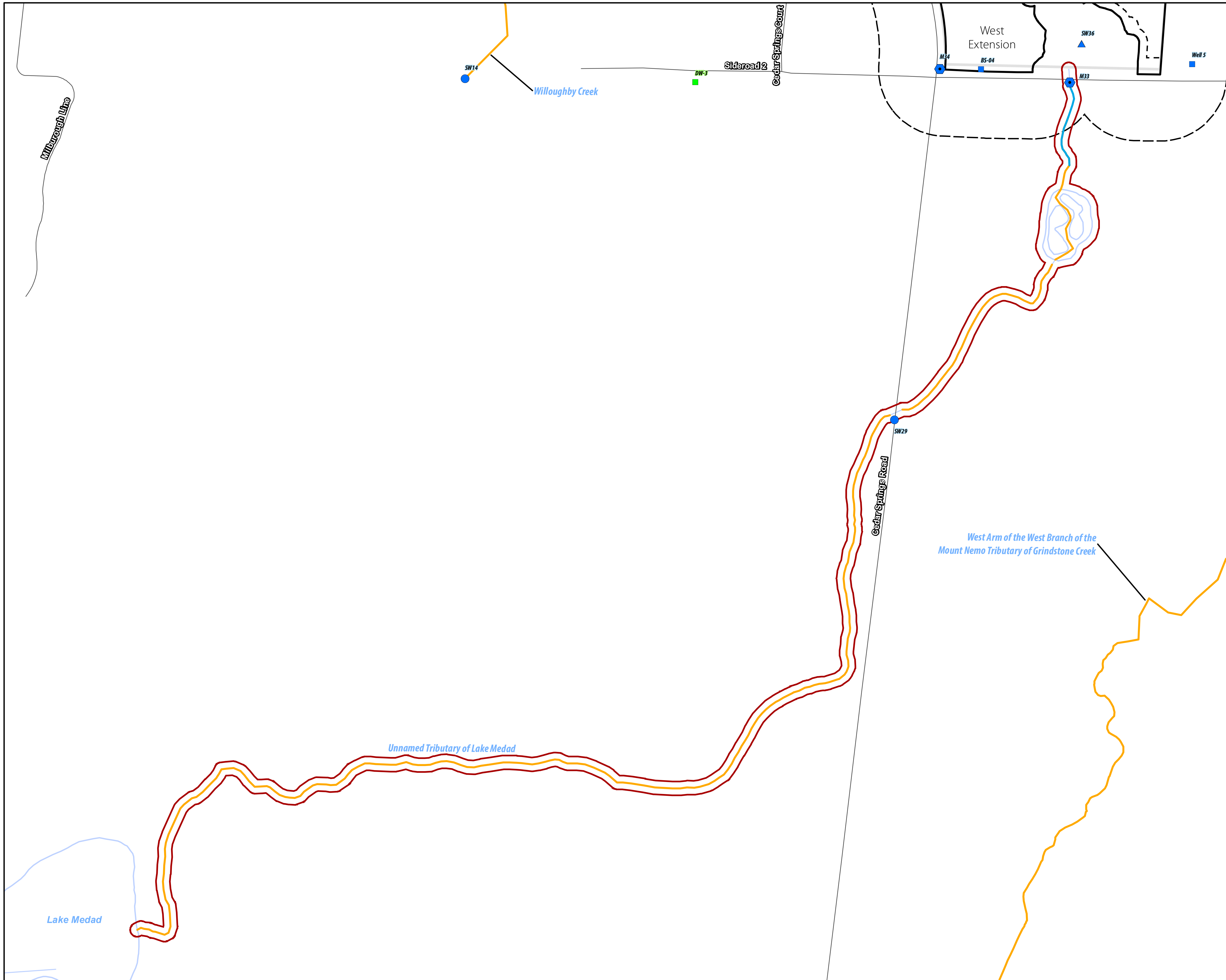

Change in Groundwater Contributions to Watercourse
Headwater Drainage Feature H2
Sum of DBL Surface Leakage (m³/d)
9
8
7
6
5
4
3
2
1
0
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
Sum of DBL Surface Leakage (m³/d)
Sum of D12 Surface Leakage (m³/d)

HEADWATER DRAINAGE FEATURE H2 - GRAPH 5



UNNAMED TRIBUTARY OF LAKE MEDAD





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Unnamed Tributary of Lake Medad
- Road
- Indirect Fish Habitat
- Direct Fish Habitat
- Watercourse
- Waterbody
- Wetland (Savanta, 2020)

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 14
Watercourse Characterization

Unnamed Tributary of Lake Medad

0 130 m

1:7,000

N

Unnamed Tributary of Lake Medad

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Watercourse Name:</td><td>Unnamed Tributary of Lake Medad</td><td></td><td></td><td></td></tr>
<tr><td>Watershed:</td><td>Grindstone Creek Watershed</td><td></td><td></td><td></td></tr>
<tr><td>Sub-Watershed:</td><td>Lake Medad</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed Limit of Extraction:</td><td>No</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed License Boundary:</td><td>No</td><td></td><td></td><td></td></tr>
<tr><td>Catchment Area (ha):</td><td>138 ha (at Lake Medad)</td><td></td><td></td><td></td></tr>
<tr><td>Catchment ID:</td><td>N/A</td><td></td><td></td><td></td></tr>
<tr><td>Primary Source(s) of Flow:</td><td>Surface runoff</td><td></td><td></td><td></td></tr>
<tr><td>Discharge from Quarry / PTTW:</td><td>No</td><td></td><td></td><td></td></tr>
<tr><td>Conditions of PTTW:</td><td>Not applicable</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water Monitoring:</td><td>ID: SW29 (Tatham)
Installation Date: October 25, 2018
Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve)
Coordinates of Monitoring Station: Easting 590180.497, Northing 4804363.89</td><td>Graphs 1 & 2 and Table 1</td><td>SWA (Tatham, April 2020)</td><td>2.1.2, Appendix C and Appendix H</td></tr>
<tr><td>Streamflow Conditions:</td><td>Intermittent</td><td>Graphs 1 & 2 and Table 1</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
<tr><td>Average Daily Flow (SW29):</td><td>
<table>
<tr><th colspan="4">Average Daily Streamflow (L/s)</th><th>Notes:</th></tr>
<tr><th>Month</th><th>Minimum</th><th>Average</th><th>Maximum</th><td rowspan="13">Minimum - lowest daily average streamflow recorded for period of record
Average - average daily streamflow recorded for period of record
Maximum - maximum daily average streamflow recorded for period of record
N/A - data not available as device removed from watercourse during winter months</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>3.3</td><td>7.3</td><td>21.1</td></tr>
<tr><td>April</td><td>1.9</td><td>4.6</td><td>8.6</td></tr>
<tr><td>May</td><td>1.0</td><td>2.8</td><td>5.8</td></tr>
<tr><td>June</td><td>0.0</td><td>0.6</td><td>2.2</td></tr>
<tr><td>July</td><td>0.0</td><td>0.0</td><td>0.2</td></tr>
<tr><td>August</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>September</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>October</td><td>0.0</td><td>0.0</td><td>0.0</td></tr>
<tr><td>November</td><td>0.2</td><td>0.9</td><td>4.4</td></tr>
<tr><td>December</td><td>0.4</td><td>0.8</td><td>2.2</td></tr>
</table>
</td><td>Graphs 1</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
</table>

Unnamed Tributary of Lake Medad

Surface Water Characteristics	Description					Figure / Graph / Table	Reference	
							Report	Section / Page
Watercourse Thermal Regime (SW29):	Average Daily Water Temperature (°C)				Notes:	Graph 2	SWA (Tatham, April 2020)	2.1.2 and Appendix C
	Month	Minimum	Average	Maximum	Minimum - lowest daily average streamflow recorded for period of record			
	January	N/A	N/A	N/A				
	February	N/A	N/A	N/A				
	March	-0.6	0.6	9.0	Average - average daily streamflow recorded for period of record			
	April	-0.1	6.2	14.8				
	May	4.9	11.4	18.6	Maximum - maximum daily average streamflow recorded for period of record			
	June	10.4	15.5	26.4				
	July	11.6	18.8	28.3				
	August	Dry	Dry	Dry	N/A - data not available as device removed from watercourse during winter months			
	September	Dry	Dry	Dry				
	October	Dry	Dry	Dry				
	November	-3.9	3.0	8.2				
	December	1.3	2.2	4.5				
Water Quality (SW29):	Water Quality Sample Results					Table 1	SWA (Tatham, April 2020)	2.4 and Appendix H
	Parameter	Units	Minimum	Average	Maximum			
	Turbidity	NTU	11.3	11.8	12.3			
	TDS	mg/L	437	469	500			
	TSS	mg/L	7.67	10.49	13.30			
	COD	mg/L	32	32	32			
	BOD5	mg/L	1.3	1.4	1.5			
	DOC	mg/L	8.1	9.8	11.4			
	pH		7.8	7.9	8			
	Alkalinity	mg/L	257	312	366			
	Conductivity	µS/cm	648	763	878			
	Phosphorus	ug/L	<50	77	104			
	Ammonia	mg/L	0.01	0.05	0.08			
	Hardness	mg/L	271	305	338			

Unnamed Tributary of Lake Medad

Fish & Fish Habitat Features	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Fish Habitat (Direct/Indirect and Assumed/Confirmed):	1) The uppermost reach of the watercourse (i.e., within 150 m downstream from the head of the watercourse at Sideroad No. 2) does not appear capable of providing direct fish habitat, based on aerial photo analysis, given a lack of a defined channel. Therefore, this portion of the watercourse is assumed to provide indirect fish habitat. 2) The remainder of the watercourse (i.e., beyond 150 m downstream from Sideroad No. 2) is assumed to provide direct fish habitat, although no fish community sampling is known to have been completed to confirm this assumption. There is a series of online ponds associated with the adjacent golf course approximately 150 m downstream from Sideroad No. 2 and there is a high probability that these ponds contain fish, as they appear to be permanent features.		NETR (Savanta, April 2020)	45 and Figure 9a
Fish Species Present:	No information on fish species present is known to exist.			
Fish Community Thermal Regime:	No information on fish community thermal regime is known to exist. Based on the presence of large, online ponds on the adjacent golf course, it is expected that a primarily warmwater fish community would be present.			
Fish Habitat Types Present:	No information on fish habitat types is known to be available for this watercourse.			
Habitat Uses by Known Fish Community:	The local fish community likely uses the off-site habitat for the complete range of life history processes including spawning, nursery, foraging and overwintering (in the online ponds or Lake Medad, given the intermittent nature of the watercourse).			
Known Barriers to Fish Movement:	There are no known barriers to fish movement in this watercourse.			

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Underlying Deposits:</td><td>Halton Till. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity was $1.6x10^{-7}$ m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water / Groundwater Interactions:</td><td>Seasonal groundwater contributions to watercourse. Groundwater seepage under baseline conditions during spring months equates to 1 L/s or less. Groundwater seepage is at its maximum during and immediately following the spring freshet.</td><td>Figures 1 & 2</td><td></td><td></td></tr>
<tr><td>Water Budget Results:</td><td>The baseline condition water budget results from the integrated model are presented in Figure 3a.
<table>
<tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr>
<tr><td>Baseline (Existing)</td><td>21.81%</td><td>5.06%</td></tr>
</table></td><td>Figure 3a</td><td></td><td></td></tr>
<tr><td>Integrated Model Calibration:</td><td>SW29 monitors the watershed west of the South extension. Both the model and the observations suggest an intermittent, flashy watershed response. Simulated and observed streamflow at SW29 are presented in Earthfx (p. 415) for WY2017 to WY2019. The model slightly underpredicts the baseflows and overpredicts the peak flows. Uncertainty regarding the diversions of streamflow to the golf course ponds and rates of irrigation may be contributing to the poorer match at this gauge. Comparisons at the other gauges showed a similar pattern with very good matches to the east and west of the quarry and poorer matches to the southwest.</td><td>Graph 3</td><td>HHIAR (Earthfx, April 2020)</td><td>19.4.2 (page 415)</td></tr>
</table>

Unnamed Tributary of Lake Medad

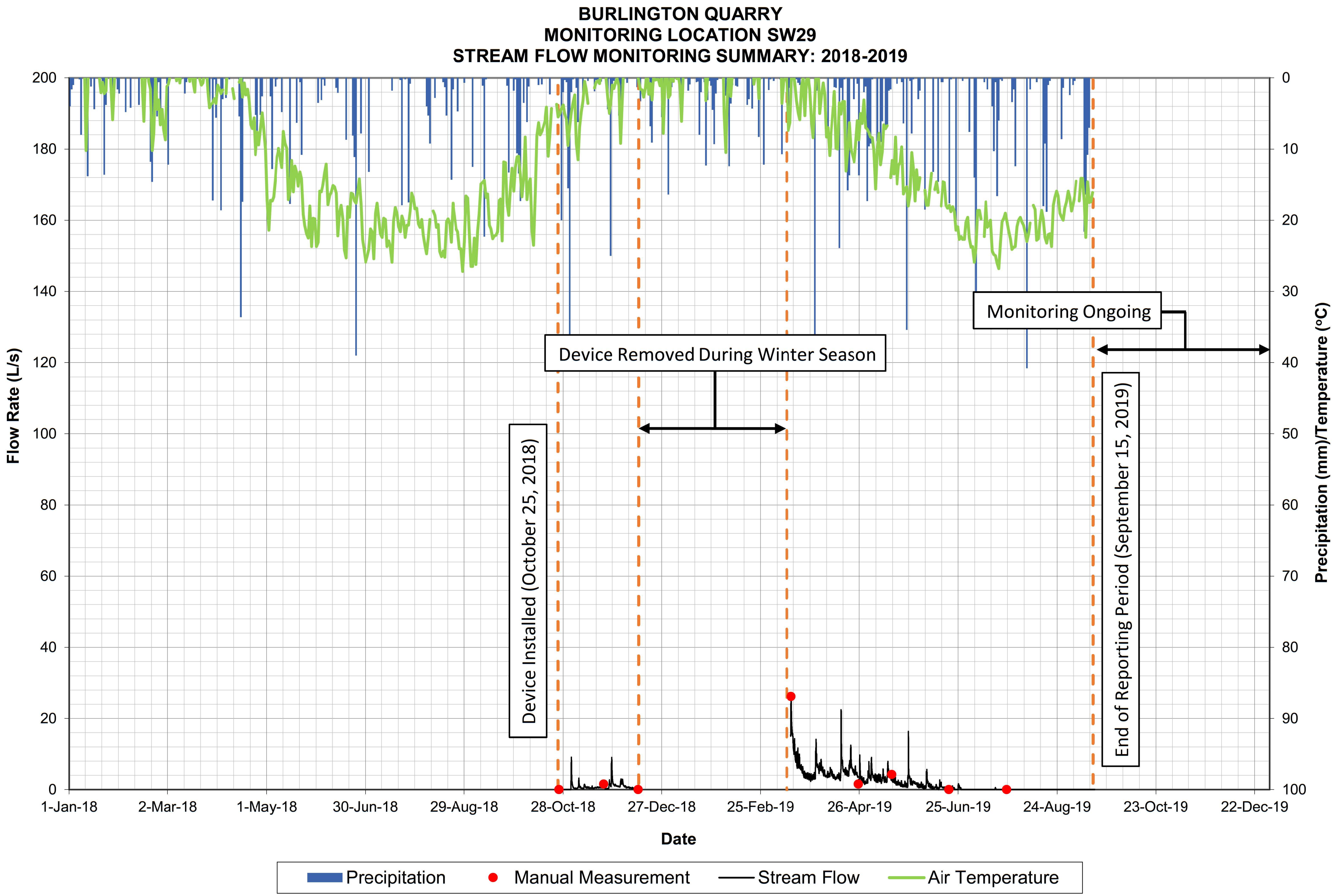
<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Direct Alterations to Watercourse:</td><td>No direct alterations to this watercourse are proposed.</td><td></td><td>NETR (Savanta, April 2020)</td><td>78</td></tr>
<tr><td>Change in Primary Source of Flow:</td><td>No change in surface water input as culvert under No. 2 Sideroad is plugged and there is no evidence of a connection between Wetland 13201 and the Unnamed Tributary of Lake Medad. Many streams are perched above the water table, they generally lose rather than gain flow from the groundwater system. The streams are primarily located in Halton Till, so the low permeability of the till limits GW/SW interactions.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Watercourse Catchment Area:</td><td>Culvert under No. 2 Sideroad is plugged and there is no evidence of a culvert or watercourse immediately downstream. As such, extraction in west extension will not alter the catchment area of the Unnamed Tributary of Lake Medad.</td><td></td><td></td><td></td></tr>
<tr><td>Simulated Streamflow Change (Integrated Model Results):</td><td>The Earthfx report discusses changes in simulated streamflow under the different quarry expansion phases. Graph 4 reproduces Figure 8.7 (p. 201) and presents simulated baseline(red) and Scenario P12 (blue) flows at location SW29. Decreases in flow (green) are plotted in reverse on the upper X axis with the scale shown on the right Y axis. Very small decreases in streamflow, primarily in winter and spring, are predicted Phase 12 area.</td><td>Graphs 4 & 5</td><td>HHIAR (Earthfx, April 2020)</td><td>198 - 230 and 230 - 237</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model are presented in Figure 3b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>21.81%</td><td>5.06%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>22.22%</td><td>2.30%</td><td>0.41%</td><td>-2.76%</td></tr>
</table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model are presented in Figure 3c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>21.81%</td><td>5.06%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>23.94%</td><td>1.91%</td><td>2.13%</td><td>-3.15%</td></tr>
</table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>21.81%</td><td>5.06%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>22.35%</td><td>3.34%</td><td>0.54%</td><td>-1.72%</td></tr>
</table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model are presented in Figure 3e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>21.81%</td><td>5.06%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>16.70%</td><td>10.90%</td><td>-4.21%</td><td>5.84%</td></tr>
</table></td><td>Figure 3e</td><td></td><td></td></tr>
<tr><td>Change in Groundwater Contributions to Watercourse:</td><td>The change in groundwater seepage in the SW29 stream catchment under Baseline conditions is shown in Graph 6. A reduction in seepage will occur under P3456 conditions due to a decline in groundwater levels due to the excavation. The change in stream leakage between Baseline and P3456 is shown in Graph 7. The changes reflect a lowering of the water table. Groundwater seepage under baseline conditions during spring months equates to 1 L/s or less.</td><td>Graphs 6 and 7</td><td></td><td></td></tr>
<tr><td>Change in Watercourse Thermal Regime:</td><td>No negative impacts on temperature expected.</td><td></td><td></td><td></td></tr>
<tr><td>Change in Water Quality:</td><td>No negative impacts on water quality expected.</td><td></td><td></td><td></td></tr>
</table>

Unnamed Tributary of Lake Medad

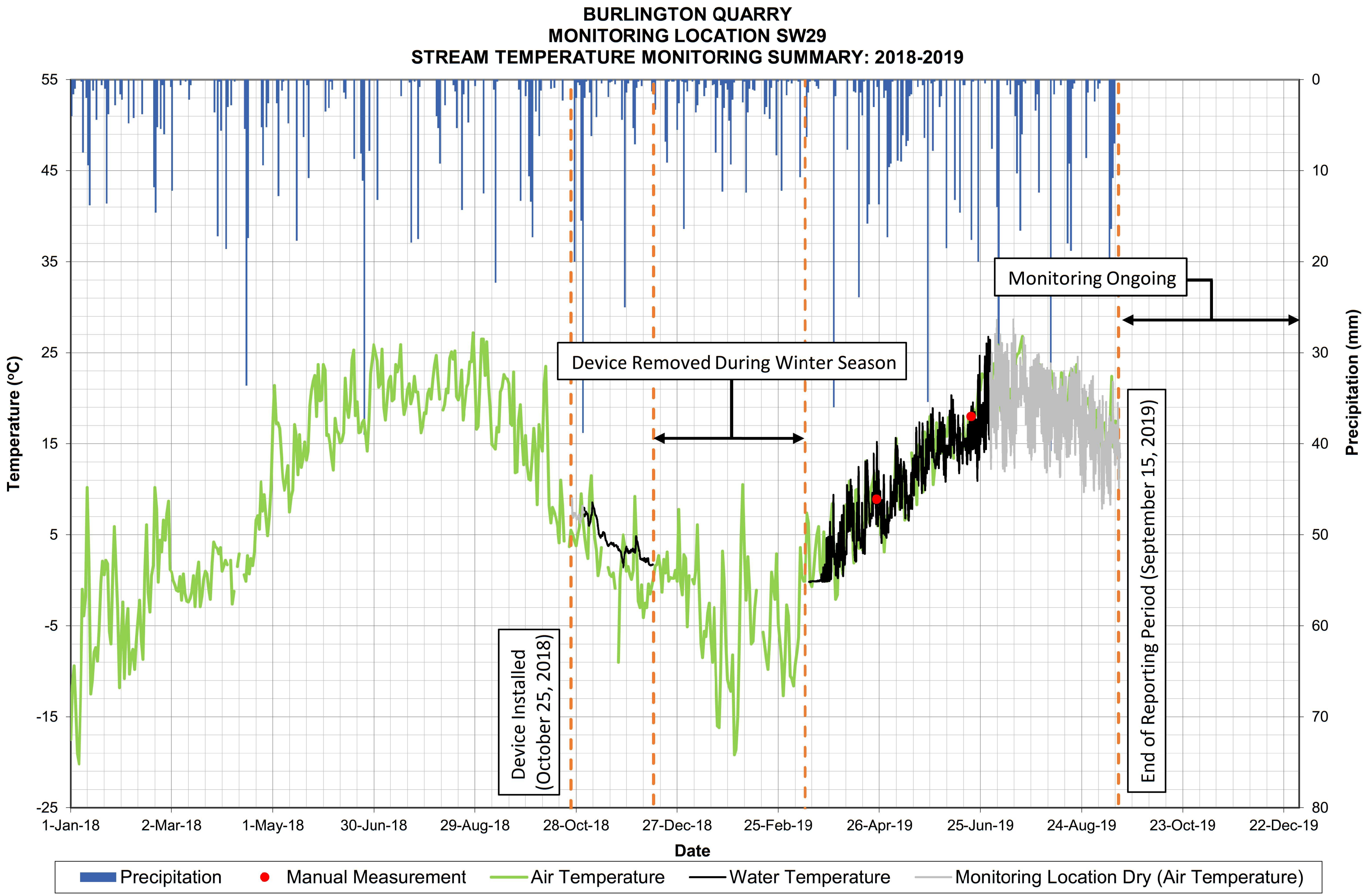
Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Potential Impact to Form and Function of Feature:	Unmitigated flow reductions could have negative impacts on habitat availability during low flow (baseflow) periods through reductions in wetted width and depth and limiting movements throughout the watercourse.		NETR (Savanta, April 2020)	78
Potential Impact to Identified Species and Habitat:	Unmitigated flow reductions could have negative impacts on fish species in the watercourse (e.g., lack of access to sufficient habitat, concentrating fish in residual features, increased competition for resources, increased vulnerability to predators).		NETR (Savanta, April 2020)	78

Mitigation	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	No direct alterations are proposed; therefore, no mitigation is required.		NETR (Savanta, April 2020)	75
Source Water Mitigation:	None required. Primary source of flow is surface runoff and catchment area will not be altered.			
Groundwater Contribution Mitigation:	None required. Groundwater contributions under baseline conditions equate to 1 L/s or less and overall percent change predicted at approximately 3%.			
Erosion Mitigation:	None required.			
Thermal Mitigation:	None required.			
Water Quality Mitigation:	None required.			

TRIBUTARY OF LAKE MEDAD - GRAPH 1



TRIBUTARY OF LAKE MEDAD - GRAPH 2



* Grey data indicates the monitoring location was dry and therefore the recorded values are respresentative of the air temperature.

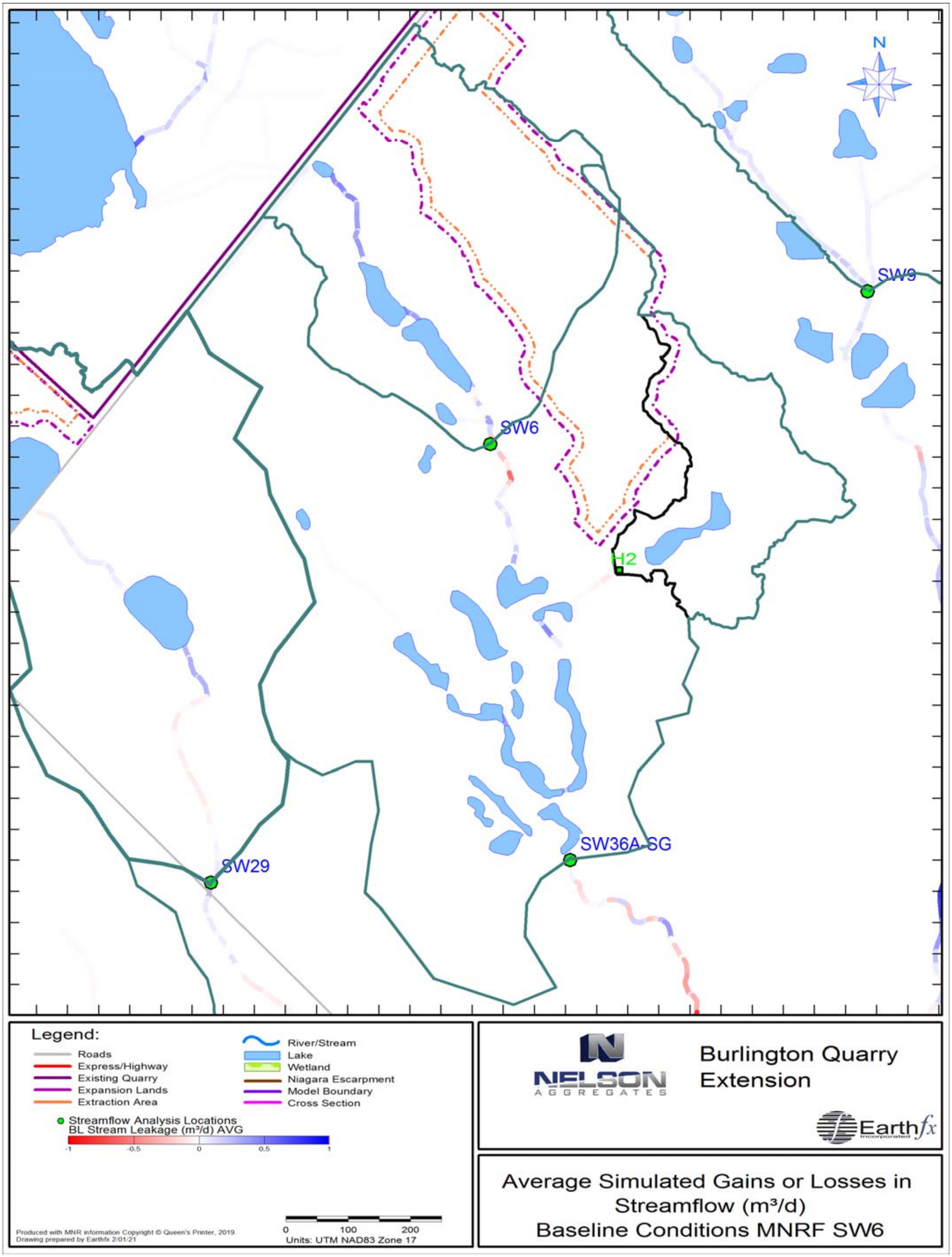
TRIBUTARY OF LAKE MEDAD - TABLE 1

BURLINGTON QUARRY
TATHAM ENGINEERING PROJECT NO.: 113187
SURFACE WATER MONITORING

WATER QUALITY SAMPLE RESULTS

Monitoring Location SW29													
		Sample Date:	24-Oct-18	24-Apr-19	19-Jun-19	25-Sep-19	20-May-20	15-Jul-20	16-Sep-20	11-Nov-20	Maximum	Minimum	Average
Parameter:	Units:	M.D.L.	CM/JG	CM/JG	CM	CM	JG	JG/JH/JM	JH/JM	JG/JH			
M-Alkalinity (pH 4.5)	mg/L as CaCO3	2		257	366						366	257	311.5
Ammonia (as N)	mg/L	0.01		0.01	0.08						0.08	0.01	0.05
BOD (5 day)	mg/L	1		1.3	1.5						1.5	1.3	1.4
Bicarbonate	mg/L as CaCO3	1		255							255	255	255
Carbonate	mg/L as CaCO3	1		2							2	2	2
Conductivity	µS/cm	1		648	878						878	648	763
Dissolved Organic Carbon	mg/L	0.4		8.1	11.4						11.4	8.1	9.8
Field pH	pH	N/A			8.3						8.3	8.3	4.2
Field Temp	°C	N/A			18						18.0	18.0	9.0
Aluminum	ug/L	1		113	79						113	79	96
Antimony	ug/L	0.5		<0.5	<0.5						<0.5	<0.5	0.5
Arsenic	ug/L	1		<1	1						1	1	1
Barium	ug/L	1		36	34						36	34	35
Beryllium	ug/L	0.5		<0.5	<0.5						<0.5	<0.5	0.5
Bismuth	ug/L	1		<1	<1						<1	<1	1
Boron	ug/L	2		10	<2						10	10	6
Cadmium	ug/L	0.1		<0.1	<0.1						<0.1	<0.1	0.1
Calcium	ug/L	500		71900	92100						92100	71900	82000
Cerium	ug/L	1		<1	<1						<1	<1	1
Cesium	ug/L	1		<1	<1						<1	<1	1
Chromium	ug/L	1		5	7						7	5	6
Cobalt	ug/L	0.1		0.2	0.3						0.3	0.2	0.25
Copper	ug/L	1		2	4						4	2	3
Europium	ug/L	1		<1	<1						<1	<1	1
Gallium	ug/L	1		<1	<1						<1	<1	1
Iron	ug/L	20		232	511						511	232	372
Lanthanum	ug/L	1		<1	<1						<1	<1	1
Lead	ug/L	0.1		0.5	0.5						0.5	0.5	0.5
Lithium	ug/L	5		<5	<5						<5	<5	5
Magnesium	ug/L	5		22200	26300						26300	22200	24250
Manganese	ug/L	10	DRY	51	529	DRY	DRY	DRY	DRY	DRY	529	51	290
Mercury	ug/L	0.1		<0.1	<0.1						<0.1	<0.1	0.1
Molybdenum	ug/L	1		<1	1						1	1	1
Nickel	ug/L	1		3	4						4	3	4
Niobium	ug/L	1		<1	<1						<1	<1	1
Phosphorus	ug/L	50		<50	104						104	104	77
Potassium	ug/L	1		2510	324						2510	324	1417
Rubidium	ug/L	1		<1	<1						<1	<1	1
Scandium	ug/L	1		<1	<1						<1	<1	1
Selenium	ug/L	0.5		0.7	<0.5						0.7	0.7	0.6
Silicon	ug/L	2		2600	2280						2600	2280	2440
Silver	ug/L	0.1		<0.1	<0.1						<0.1	<0.1	0.1
Sodium	ug/L	1000		31500	66400						66400	31500	48950
Strontium	ug/L	1		432	483						483	432	458
Sulphur	ug/L	800		11100	5920						11100	5920	8510
Tellurium	ug/L	1		<1	<1						<1	<1	1
Thallium	ug/L	0.1		<0.1	<0.1						<0.1	<0.1	0.1
Thorium	ug/L	1		<1	<1						<1	<1	1
Tin	ug/L	1		<1	<1						<1	<1	1
Titanium	ug/L	1		3	2						3	2	2.5
Tungsten	ug/L	1		<1	<1						<1	<1	1
Uranium	ug/L	1		<1	<1						<1	<1	1
Vanadium	ug/L	1		2	2						2	2	2
Yttrium	ug/L	1		<1	<1						<1	<1	1
Zinc	ug/L	1		<1	21						21	21	11
Zirconium	ug/L	1		<1	<1						<1	<1	1
pH	pH	N/A		7.97	7.8						8.0	7.8	7.9
Total Hardness (as CaCO3)	mg/L	0.1		271	338						338	271	305
Chemical Oxygen Demand	mg/L	5		32	32						32	32	32
Total Dissolved Solids	mg/L	3		437	500						500	437	469
Total Suspended Solids	mg/L	0.67		13.3	7.67						13.30	7.67	10.49
Turbidity	NTU	0.1		12.3	11.3						12.3	11.3	11.8

TRIBUTARY OF LAKE MEDAD - FIGURE 1



TRIBUTARY OF LAKE MEDAD - FIGURE 2

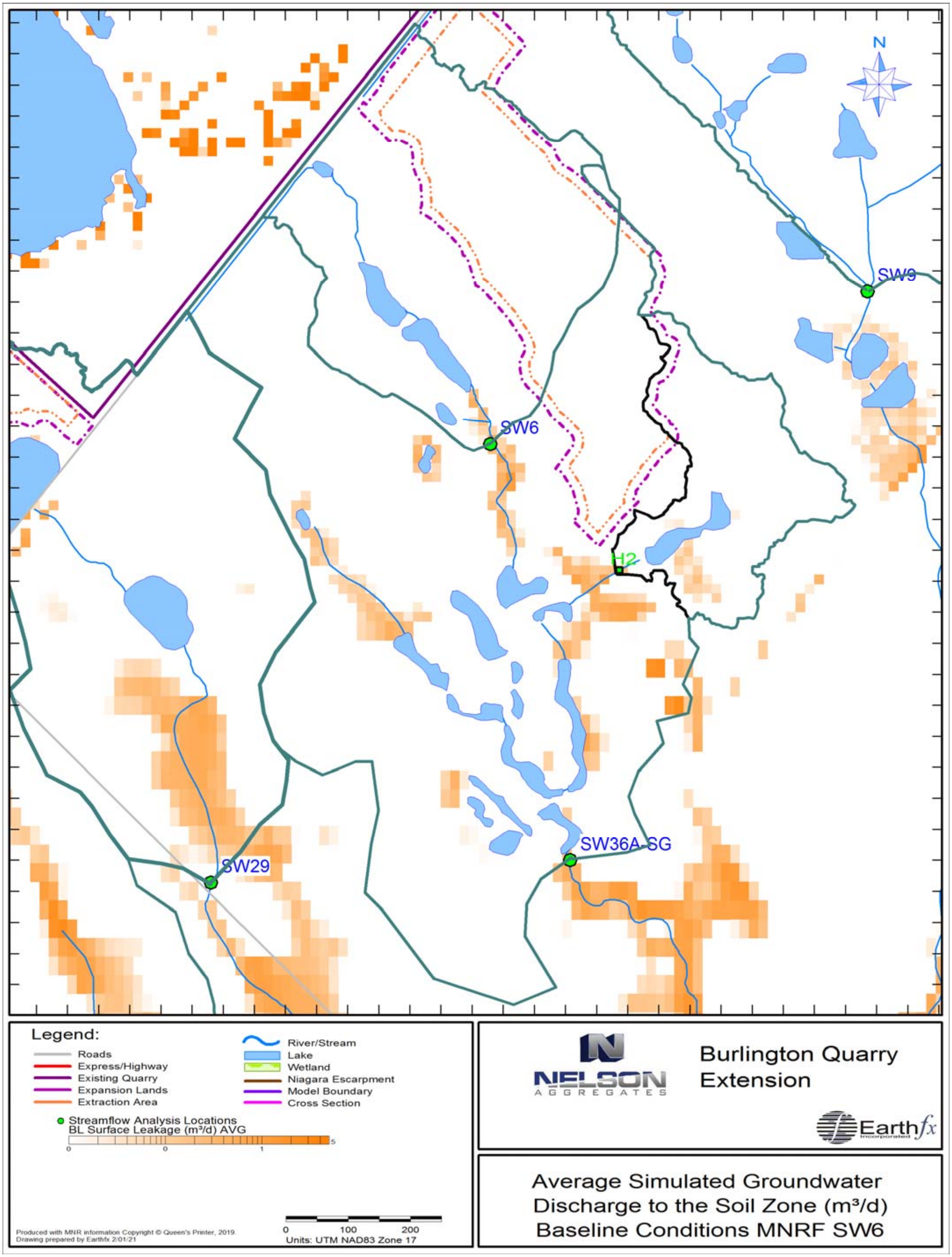


FIGURE 3A

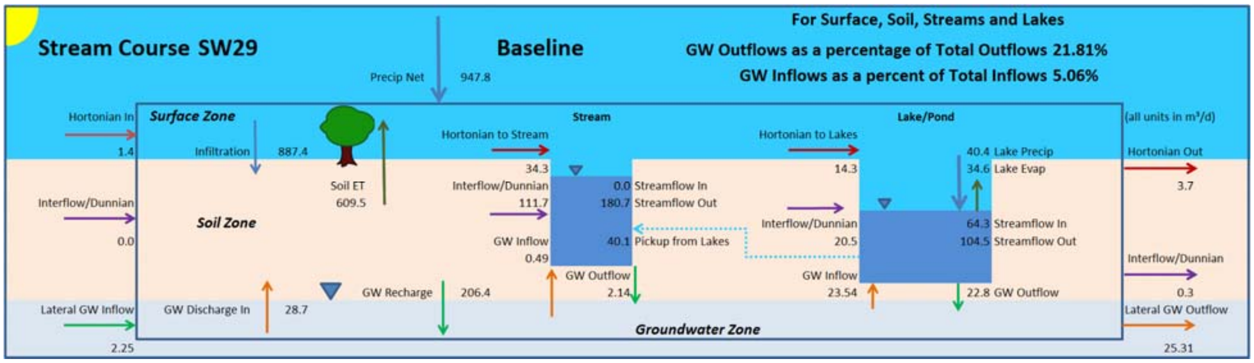


FIGURE 3B

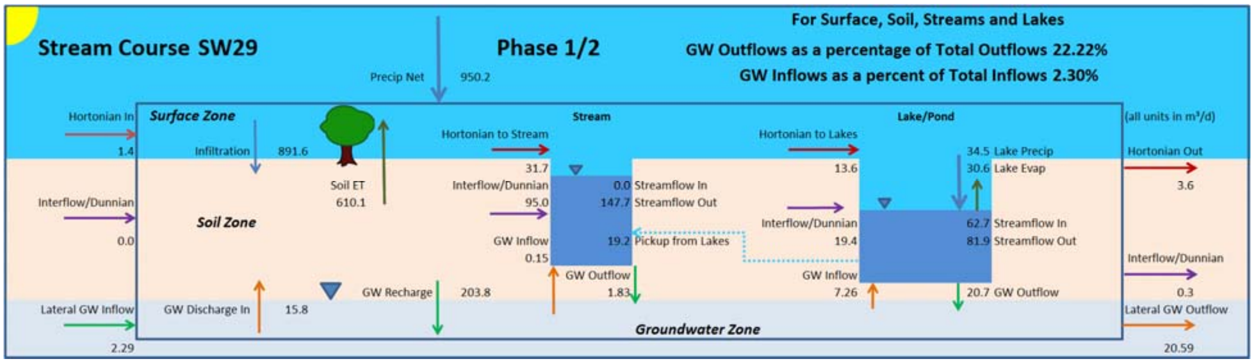


FIGURE 3C

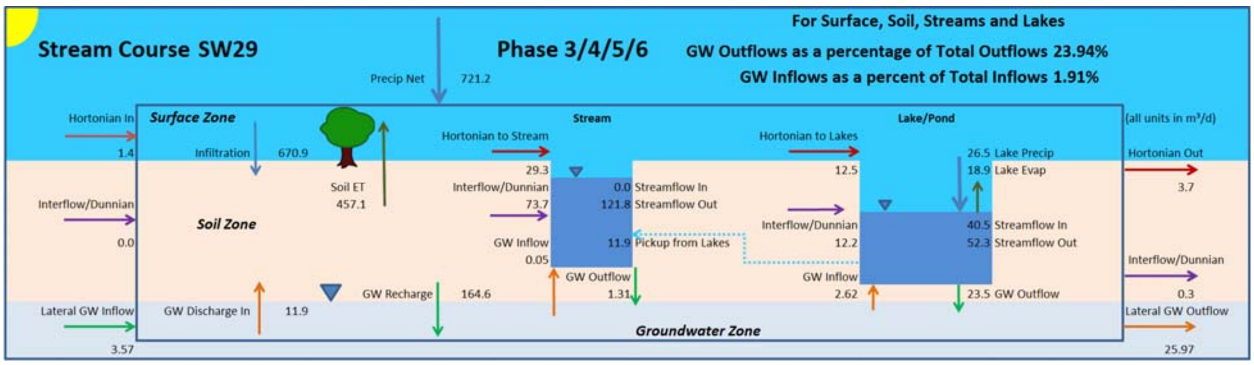


FIGURE 3D

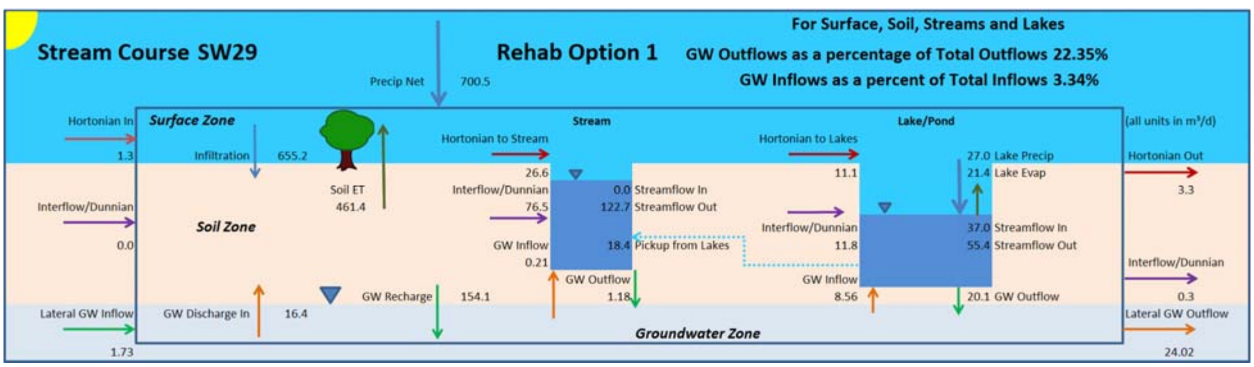
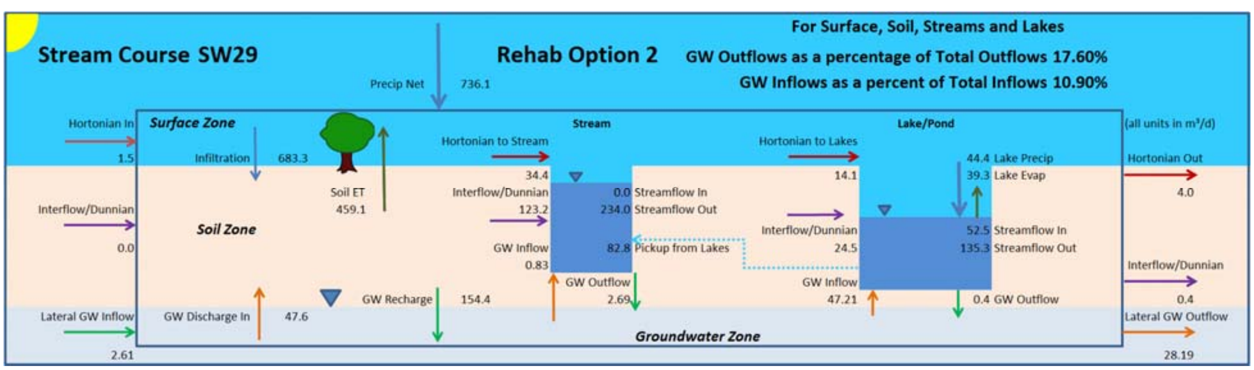
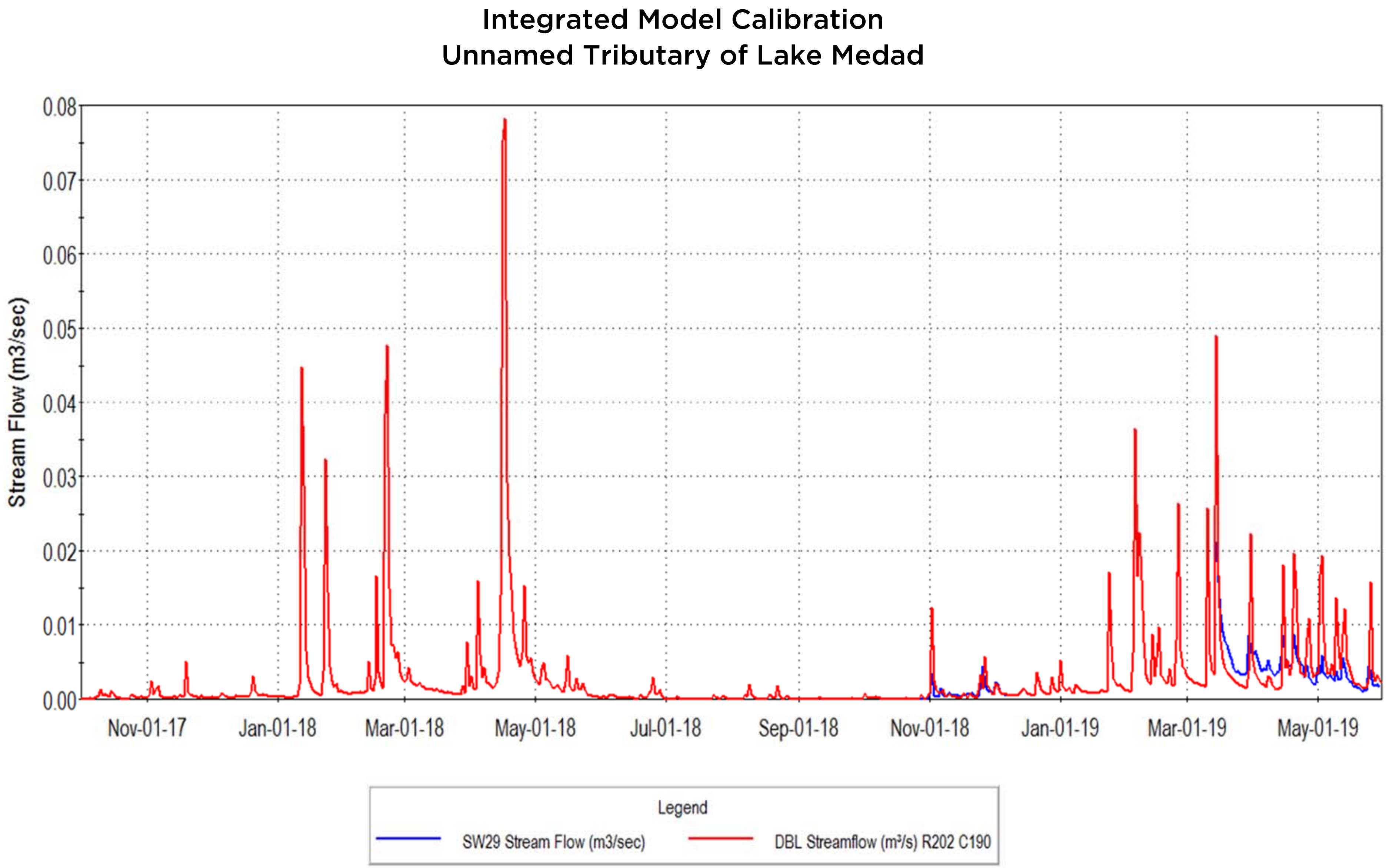
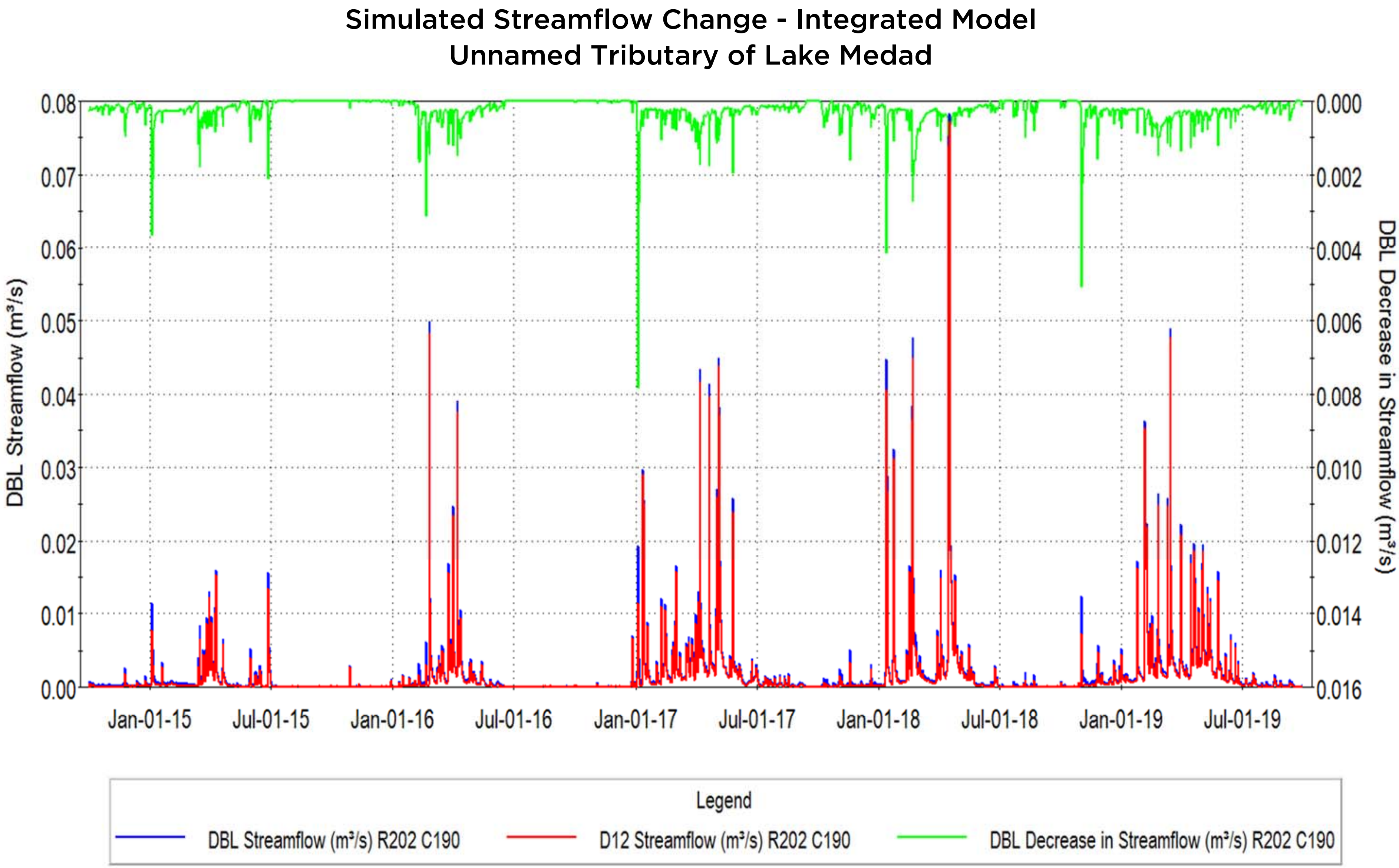


FIGURE 3E

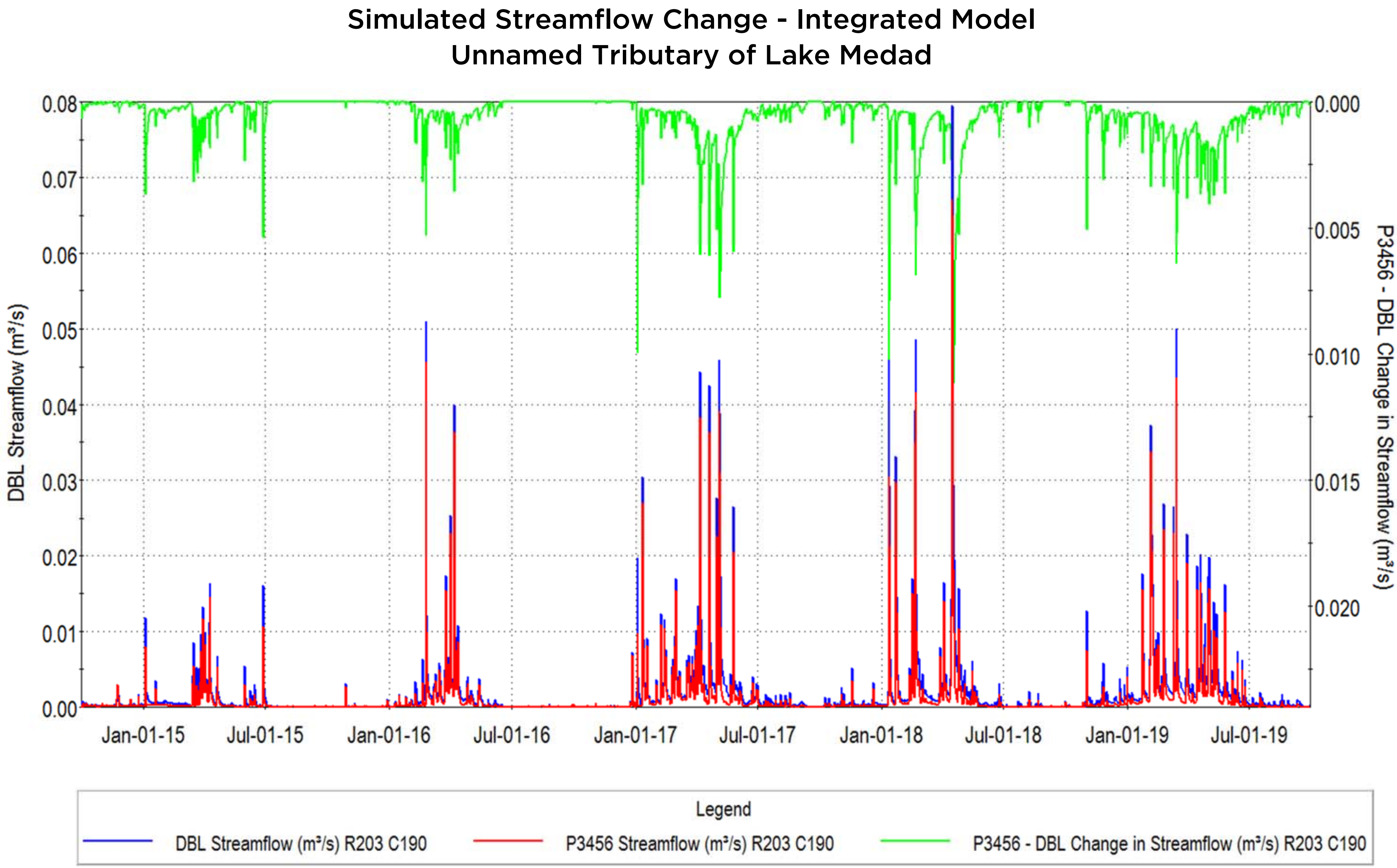


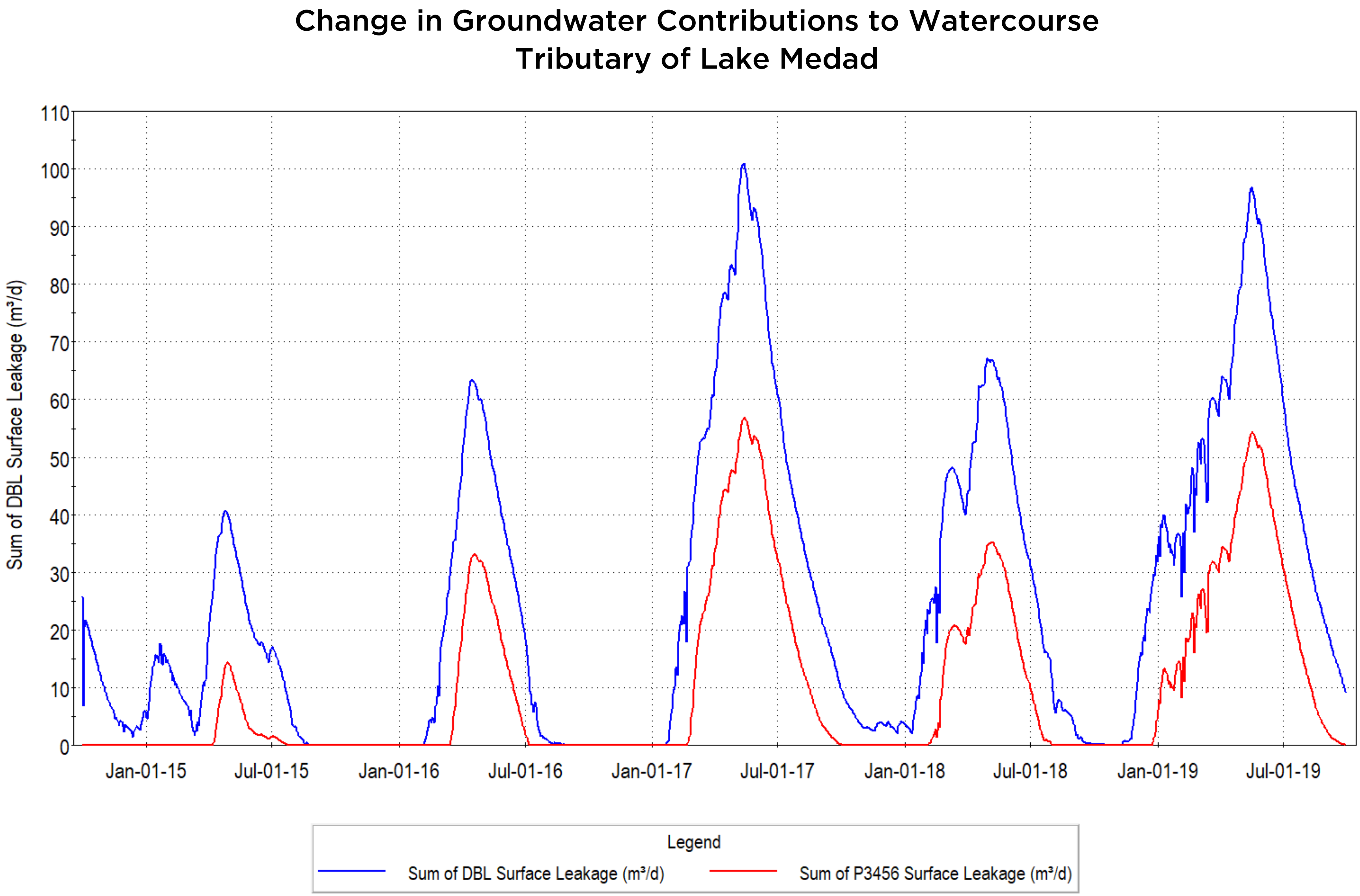
TRIBUTARY OF LAKE MEDAD - GRAPH 3



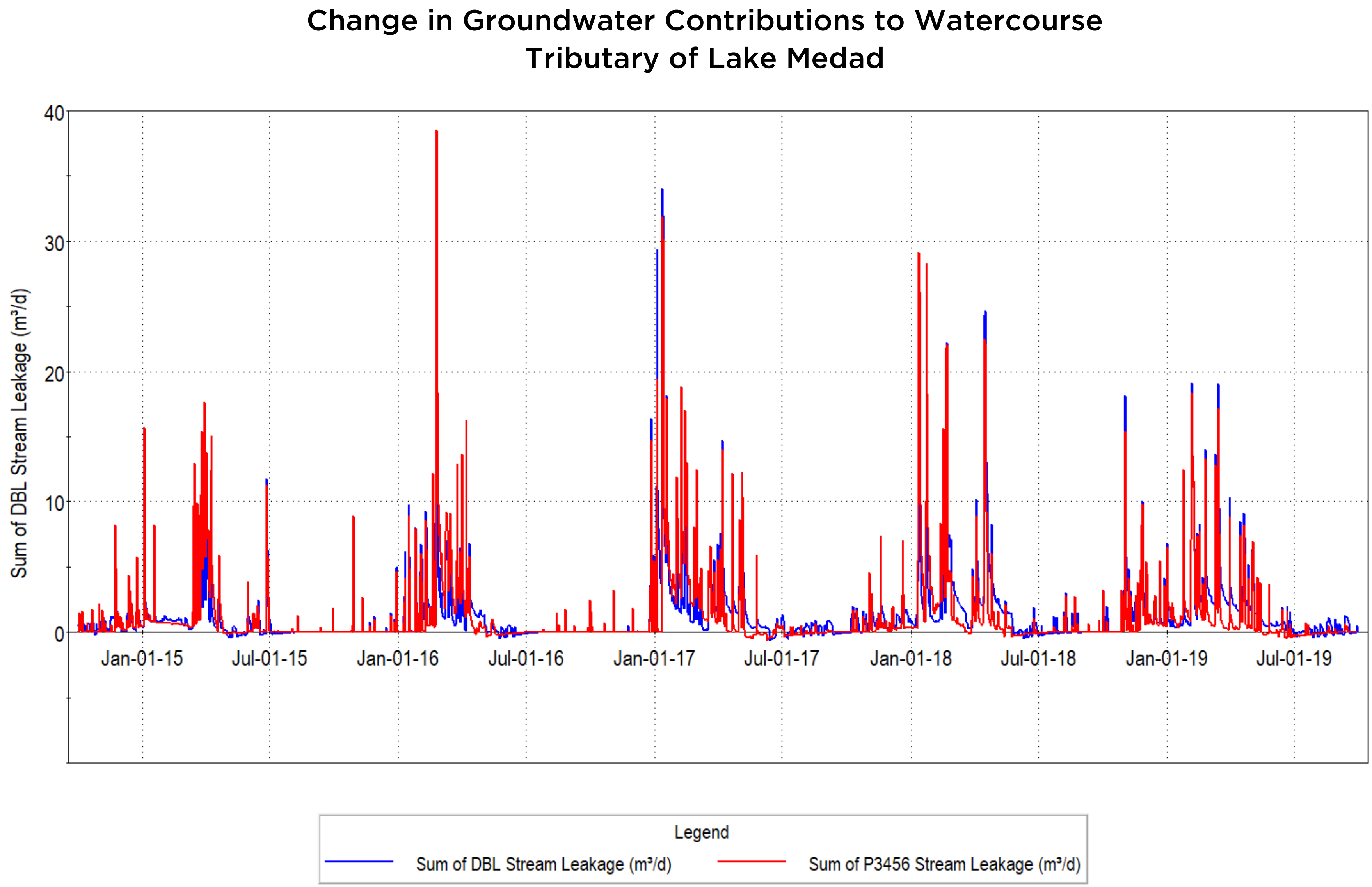

Simulated Streamflow Change - Integrated Model
Unnamed Tributary of Lake Medad
DBL Streamflow (m³/s)
DBL Decrease in Streamflow (m³/s)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R202 C190
D12 Streamflow (m³/s) R202 C190
DBL Decrease in Streamflow (m³/s) R202 C190

TRIBUTARY OF LAKE MEDAD - GRAPH 5

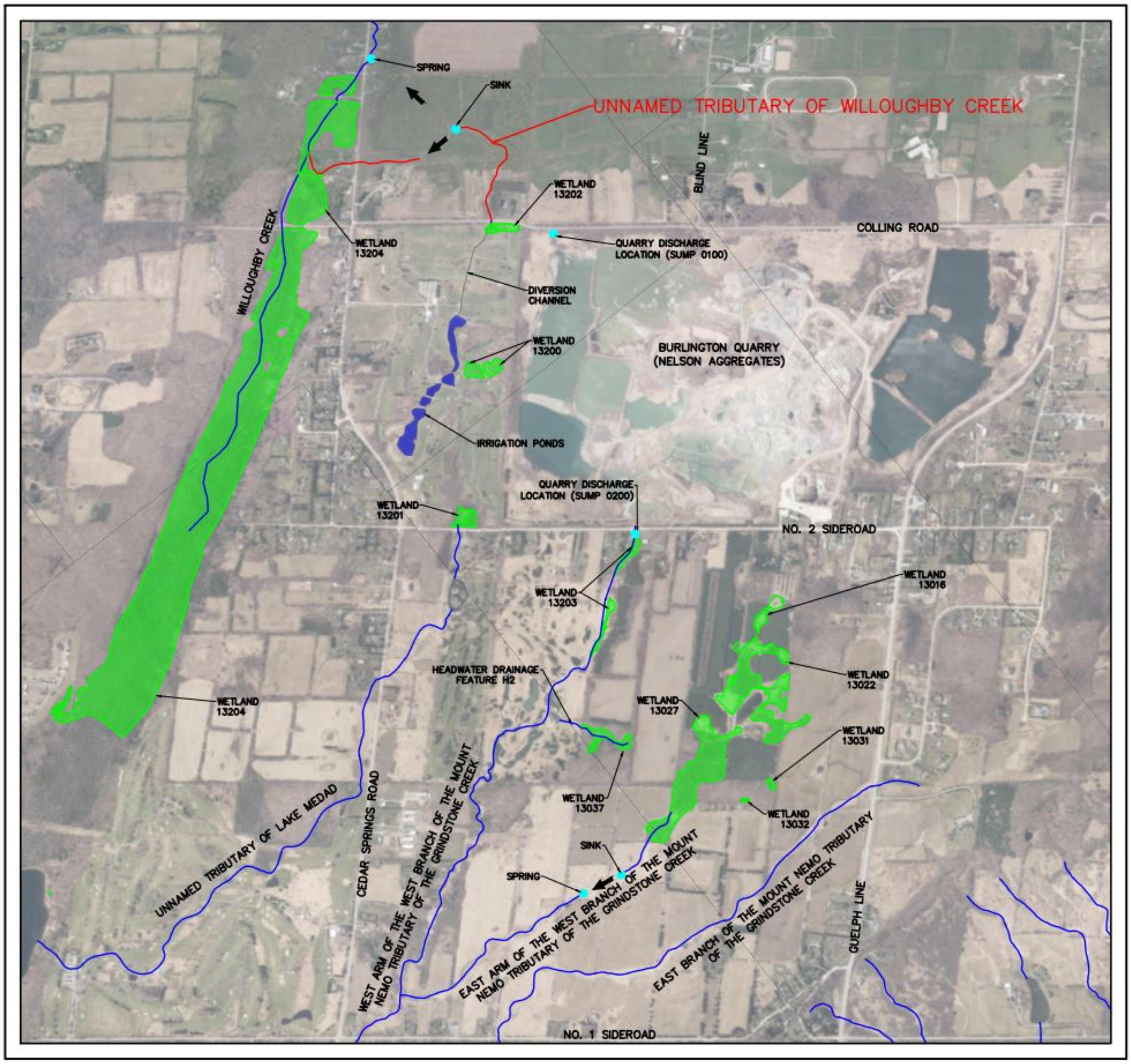


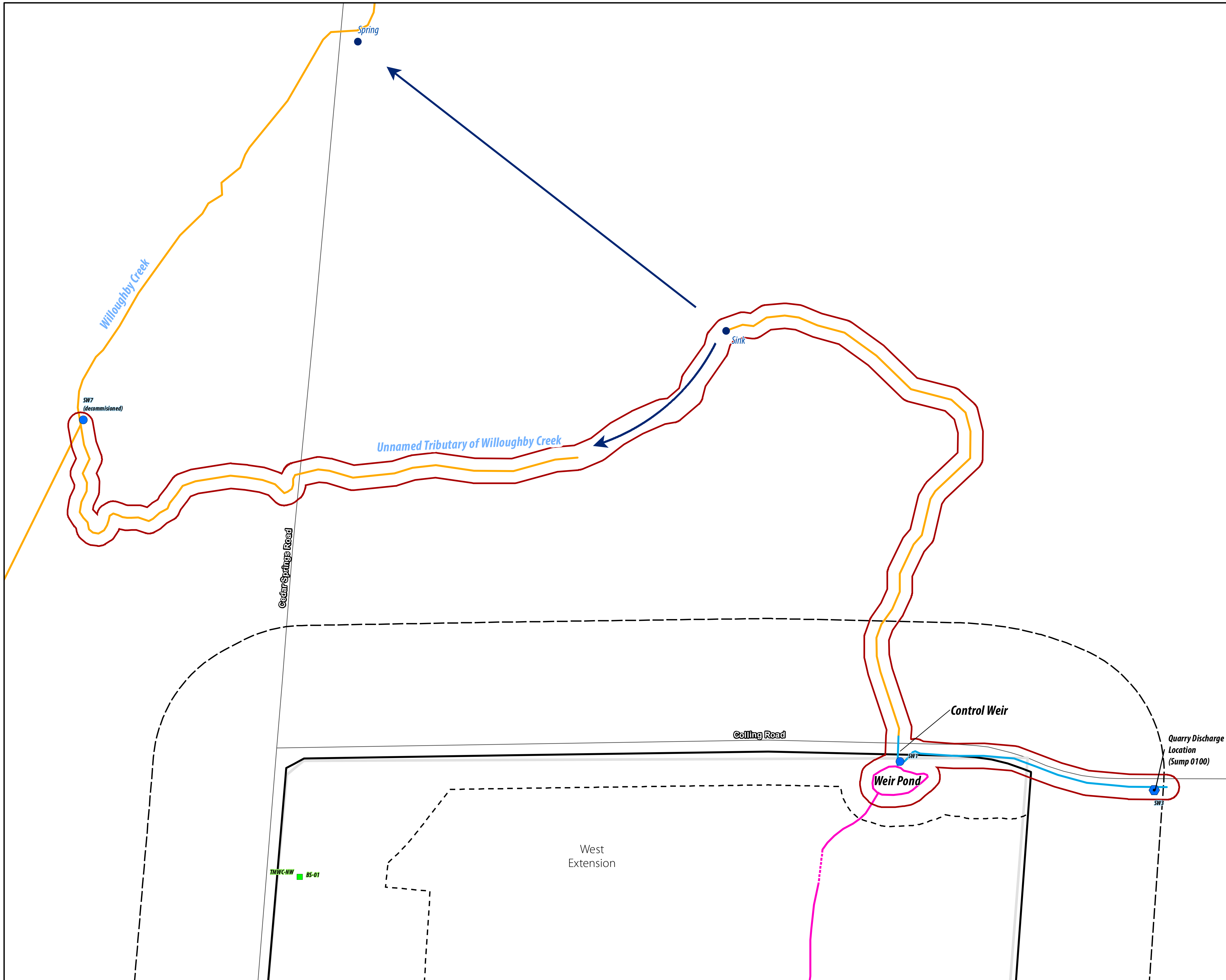

Change in Groundwater Contributions to Watercourse
Tributary of Lake Medad
Sum of DBL Surface Leakage (m³/d)
0
10
20
30
40
50
60
70
80
90
100
110
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
Sum of DBL Surface Leakage (m³/d)
Sum of P3456 Surface Leakage (m³/d)

TRIBUTARY OF LAKE MEDAD - GRAPH 7



UNNAMED TRIBUTARY OF WILLOUGHBY CREEK





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Unnamed Tributary of Willoughby Creek
- Road
- Golf Course Irrigation Ponds and Channel
- Indirect Fish Habitat
- Direct Fish Habitat
- Watercourse
- Wetland (Savanta, 2020)

Current Instrumentation

- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 13
Watercourse Characterization

Unnamed Tributary of Willoughby Creek

0 60 m
1:3,500

N

[redacted]

Unnamed Tributary of Willoughby Creek

Surface Water Characteristics	Description	Figure / Graph / Table	Reference: Report	Reference: Section / Page
Watercourse Name:	Unnamed Tributary of Willoughby Creek			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	Yes			
Catchment Area (ha):	511 ha (at confluence with Willoughby Creek)			
Catchment ID:	N/A			
Primary Source(s) of Flow:	Primary - discharge from Burlington Quarry (Sump 0100) Intermittent - discharge from Burlington Springs Golf and Country Club irrigation ponds and diversion channel The outlet from the weir pond consists of a low flow by-pass pipe designed to convey a minimum baseflow of 2 L/s downstream when flow is available and a concrete weir that can be fitted with stop blocks to further control discharge. The concrete weir with stop blocks installed creates a backwater condition upstream, diverting water to the irrigation ponds on the Burlington Springs Golf & Country Club property. Water taking from the weir pond by the Burlington Springs Golf & Country Club occurs under the approval of PTTW Number 0624-8BXML3.			
Discharge from Quarry / PTTW:	Yes - PTTW 96-P-3009		SWA (Tatham, April 2020)	Appendix A
Conditions of PTTW:	Maximum discharge rate = 4,090 L/min (68.17 L/s) Maximum discharge amount = 5,889,600 L/day		SWA (Tatham, April 2020)	Appendix A
Surface Water Monitoring:	ID: SW1 (Tatham) Installation Date: April 17, 2014 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Coordinates of Monitoring Station: Easting 589015.325, Northing 4805832.639	Graphs 1, 2 & 3 and Table 1	SWA (Tatham, April 2020)	2.1.1, Appendix B and Appendix H
Streamflow Conditions:	Intermittent (flow is dependent on quarry discharge); the tributary will dry out when quarry discharge ceases	Graphs 1, 2 & 3 and Table 1	SWA (Tatham, April 2020)	2.1.1 and Appendix B
Average Daily Flow (SW1):		Graphs 1 & 2	SWA (Tatham, April 2020)	2.1.1 and Appendix B

Month	Average Daily Streamflow (L/s): Minimum	Average	Maximum
January	0.0	92.3	226.9
February	0.0	48.8	245.0
March	0.0	28.7	68.0
April	0.0	75.8	203.5
May	0.0	86.6	249.6
June	0.0	54.2	194.3
July	0.5	48.5	313.3
August	0.0	41.9	126.9
September	0.6	48.3	147.2
October	0.0	61.6	225.7
November	0.0	102.9	549.8
December	0.0	81.0	426.9

Notes:

Minimum - lowest daily average streamflow recorded for period of record

Average - average daily streamflow recorded for period of record

Maximum - maximum daily average streamflow recorded for period of record

N/A - data not available as device removed from watercourse during winter months

Unnamed Tributary of Willoughby Creek

Surface Water Characteristics	Description					Figure / Graph / Table	Reference	
							Report	Section / Page
Watercourse Thermal Regime (SW1):	Average Daily Water Temperature (°C)				Notes:	Graph 3	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average water temperature recorded for period of record			
	January	0.8	3.5	6.9				
	February	-0.9	3.5	6.8				
	March	-1.1	4.0	8.2	Average - average daily water temperature recorded for period of record			
	April	-0.8	7.6	14.6				
	May	7.5	13.5	19.1				
	June	14.6	19.4	28.9	Maximum - maximum daily average water temperature recorded for period of record			
	July	18.9	23.0	28.5				
	August	17.3	23.6	32.3				
	September	15.9	21.5	29.5	N/A - data not available as device removed from watercourse during winter months			
	October	8.4	14.3	21.1				
	November	1.1	8.5	14.4				
	December	0.2	4.9	8.5				

Surface Water Characteristics	Description					Figure / Graph / Table	Reference	
							Report	Section / Page
Water Quality (SW1):	Water Quality Sample Results					Table 1	SWA (Tatham, April 2020)	2.4 and Appendix H
	Parameter	Units	Minimum	Average	Maximum			
	Turbidity	NTU	0.9	2.1	3.5			
	TDS	mg/L	517	564	597			
	TSS	mg/L	1	1.92	3.67			
	COD	mg/L	<5	9	12			
	BOD5	mg/L	1.0	1.4	2.4			
	DOC	mg/L	3.1	3.8	4.3			
	pH		7.97	8.01	8.03			
	Alkalinity	mg/L	112	152	180			
	Conductivity	µS/cm	742	784	877			
	Phosphorus	ug/L	<50	68.5	124			
	Ammonia	mg/L	0.02	0.04	0.11			
	Hardness	mg/L	277	318	340			

Unnamed Tributary of Willoughby Creek

Fish & Fish Habitat Features	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Fish Habitat (Direct/Indirect and Assumed/Confirmed):	1) The reach from the quarry discharge point to the Colling Road culvert has been identified as indirect fish habitat as no fish were captured in this reach during baseline fish community studies in 2019. The reach is directly connected to the Weir Pond on the golf course, which is known to contain a likely introduced population of Largemouth Bass. These fish may have access to portions of this watercourse reach, but these are excluded from the determination of providing indirect habitat, since once the drainage feature on the golf course is removed, the Largemouth Bass population will also be removed. Fish in the downstream portions of the reach (i.e., downstream from Colling Road) would not be able to move upstream into this reach based on the barrier provided by the weir at the downstream end of the Weir Pond. 2) The reach between Colling Road and the mouth of this Tributary at Willoughby Creek has been assumed to provide direct fish habitat. However, no fish community studies were possible in this reach due to private land access constraints. Conservation Halton does not have any information on the fish community of this reach and identifies it as "Unclassified Habitat" in the 2002 Bronte Creek Watershed Study. Although assumed to be present for the purposes of the NETR (Savanta 2020), the actual potential for fish in the upstream portions of this reach is limited by the presence of an underground flow section where the watercourse runs underground through karst features before re-emerging at two different locations. No upstream fish movement is expected to be possible past these two underground flow sections.		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a
Fish Species Present:	1) Largemouth Bass are known to be present in the Weir Pond, although they were not confirmed in the Unnamed Tributary of Willoughby Creek upstream from the Weir Pond during baseline studies in 2019. 2) No information on fish species present downstream from Colling Road is available as no fish community studies are known to have been completed on the private lands where this watercourse flows.		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a
Fish Community Thermal Regime:	N/A – No fish species that would be native to this watercourse have ever been captured (i.e., excluding Largemouth Bass known to be present in the drainage feature on the golf course).		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a
Fish Habitat Types Present:	1) Indirect habitat - reach upstream from Colling Road provides contributing habitat functions (e.g., flow conveyance, water quality maintenance, allochthonous inputs from riparian vegetation, sediment transport) although limited by the presence of the Weir Pond and weir. 2) Fish habitat types present in the reach downstream from Colling Road have not been confirmed due to private land issues. Visual observations from the Colling Road shoulder indicate this portion of the watercourse consists of a natural channel with well-developed riparian vegetation (woodland). If fish are present, the reach would be expected to provide habitat for all necessary life history functions required to support the species (given barriers to upstream and downstream movement).		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a
Habitat Uses by Known Fish Community:	N/A – no known fish community downstream from Colling Road culvert.		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a
Known Barriers to Fish Movement:	1) Karst sink between Colling Road and Cedar Springs road would prevent upstream fish movement. 2) Overflow weir at the outlet of the Weir Pond on the golf course is a barrier to upstream movement.		NETR (Savanta, April 2020)	19, 41-42 and Figure 9a

Unnamed Tributary of Willoughby Creek

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Underlying Deposits:</td><td>Halton Till. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was $1.2x10^{-8}$ m/s. Model value for the vertical hydraulic conductivity is $1.6x10^{-7}$ m/s, approximately an order of magnitude higher, to account for limited flow through fractures in the till.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water / Groundwater Interactions:</td><td>This reach is predominantly a losing stream up to the point where it disappears into the subsurface. There are, however, short periods of the year where the water table rises and discharges into the stream. The GW/SW interactions at a point 250 m downstream of Wetland 13202 are illustrated in Graph 4. The blue line on the graph shows the stage in the stream, which is fairly constant because of the quarry discharge. The red line shows the shallow groundwater levels, which seasonally rise up to (and slightly above) the stream stage. The green dotted line shows the GW discharge (right axis) into the riparian soil zone (this is shown in orange on the maps in Earthfx, 2020). The purple line shows stream leakage (right axis - loss of water from the stream to the GW system). In summary, the stream is mostly a losing stream, except for short periods when the water table is high.</td><td>Graph 4, Figures 1 & 2</td><td></td><td></td></tr>
<tr><td>Water Budget Results:</td><td>The baseline condition water budget results from the integrated model are presented in Figure 3a.
<table>
<tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr>
<tr><td>Baseline (Existing)</td><td>25.17%</td><td>21.97%</td></tr>
</table></td><td>Figure 3a</td><td></td><td></td></tr>
<tr><td>Integrated Model Calibration:</td><td>Section 19.4.2 (p.415) discusses the calibration of the model to North Quarry discharge. The north sump was simulated with a set of “generalized operating rules” based on information provided by Nelson and the PTTW. The rules define a 7 day per week discharge rate, with an extra stage-dependent discharge rule that kept the internal quarry pond from over-topping a specified level. Actual operations were more intermittent, but it is apparent in the data that the rules were followed more closely after January, 2016, as shown in Earthfx (p. 416) and reproduced below. Overall, the model appears to be effective at representing the north quarry discharge in recent times.</td><td>Graph 5</td><td>HHIAR (Earthfx, April 2020)</td><td>19.4.2 (page 415 & 416)</td></tr>
</table>

Unnamed Tributary of Willoughby Creek

Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alterations to Watercourse:	1) The existing temporary weir just upstream from the Colling Road culvert (i.e., at the outflow of the Weir Pond) will be replaced with a permanent overflow weir plate. This will result in a direct alteration to instream habitat and temporary disruption due to in-water work. 2) A new inlet will be constructed at the edge of the Weir Pond to divert flow into the new pond (infiltration pond) proposed on the western side of the West Extension Area. Some encroachment of the inlet into the Weir Pond may occur during installation of the diversion pipe, resulting in potential direct and indirect impacts. 3) Removal of the golf course irrigation ponds and channels could potentially result in indirect effects on the downstream watercourse (e.g., erosion and sedimentation, water quality impacts).		NETR (Savanta, April 2020)	75
Change in Primary Source of Flow:	1) Quarry discharge from Sump 0100 represents the primary source of flow to the Unnamed Tributary of Willoughby Creek. Current quarry approvals permit this discharge to cease once quarry operations are complete. Cessation of quarry discharge into the Unnamed Tributary of Willoughby Creek would be expected to have a substantial negative impact on flow availability to support current fish habitat functions and fish community assumed to be present. As discussed in the Mitigation section below, it has been recommended that quarry discharge continue indefinitely at current levels to prevent these associated negative impacts. 2) Diversion from catchment area S101 (northwest of Colling Road) will alter surface water inputs to the Unnamed Tributary. Currently, this catchment area discharges directly to the quarry and the flow would be discharged to the Unnamed Tributary through Sump 0100. Nelson is proposing to redirect surface water drainage from catchment area S101 directly into the Unnamed Tributary at the existing quarry discharge point. Overall, this diversion will result in the same volume of water being discharged to the tributary, although, given it will no longer pass through the quarry, it is expected that the hydrological regime of this discharge will be more natural, with seasonal peaks. 3) Removal of the golf course irrigation ponds and channels will alter the hydrology of the watercourse, given that no water taking would be required from the watercourse to support irrigation and that during high flow periods, there will be no discharge from the golf course back to the feature. However, the proposed new pond (infiltration pond) west of the West Extension will draw water from the Weir Pond in the same manner as the existing irrigation ponds. Therefore, there will be no net change in source water hydrology.		NETR (Savanta, April 2020)	76 and 77
Change in Watercourse Catchment Area:	Increase in catchment area of 25.8 ha. Additional catchment area will drain to the existing quarry settling ponds and be discharged to the Unnamed Tributary via Sump 0100 at rates consistent with existing. Additional storage will be provided in the settling ponds to accommodate the additional flow as the discharge to the Unnamed Tributary will not change.		SWA (Tatham, April 2020)	Drawings DP-1, DP-2 and DP-3
Simulated Streamflow Change (Integrated Model Results):	The Earthfx report discusses changes in simulated quarry discharge to the North Quarry Pond. No change was expected under Scenario P12. Scenario P3456 is discussed in Section 8.7.5 (p. 243). Under P3456 conditions, current levels of quarry discharge will continue to pass through the pond. Diversions for golf course operations will no longer be necessary, however a portion of flow will be diverted to the newly constructed infiltration pond, which will locally support groundwater levels in a similar manner as the current golf course ditch and pond system. Figure 8.71(p. 254) shows that there will be an increase in flow through the Unnamed Tributary as a result of the diversion of flow along Colling Road, and that the flow will continue through the karst conduit as under current conditions. The increase in flow will enter the Medad Valley just downstream of SW7, so there will be no significant change downstream at SW2. Under RHB1, discharge continues to the north from the quarry sump 0100 and is similar to that of P3456. Under RHB2, surface water flow in the upper reaches of a Unnamed Tributary of Willoughby Creek and the West Arm of the West Branch of Mount Nemo Tributary of Grindstone Creek will cease when the quarry discharge is discontinued, resulting in possible impact to downstream fish habitat compared to baseline conditions (See Savanta, 2020 and Tatham, 2020 for details).		HHIAR (Earthfx, April 2020)	8.7.5 (page 243)

Unnamed Tributary of Willoughby Creek

<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model are presented in Figure 3b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>25.17%</td><td>21.97%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>26.38%</td><td>22.94%</td><td>1.21%</td><td>0.97%</td></tr>
</table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model are presented in Figure 3c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>25.17%</td><td>21.97%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>25.12%</td><td>21.11%</td><td>-0.05%</td><td>-0.86%</td></tr>
</table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>25.17%</td><td>21.97%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>26.08%</td><td>22.12%</td><td>0.91%</td><td>0.15%</td></tr>
</table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>25.17%</td><td>21.97%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>34.19%</td><td>32.35%</td><td>9.02%</td><td>10.38%</td></tr>
</table></td><td>Figure 3e</td><td></td><td></td></tr>
<tr><td>Change in Groundwater Contributions to Watercourse:</td><td>The unnamed tributary of Willoughby Creek is generally a losing stream. The change in stream stage and groundwater levels under Baseline and P3456 conditions at a point 250 m downstream of Wetland 13202 is shown in Graph 6. The P3456 drawdown in groundwater levels prevents the upwelling of groundwater that occurred intermittently under baseline conditions at this point in the reach. This example illustrates the change in conditions at one point in the stream; the overall change in leakage is discussed next. During P3456 the overall average net stream leakage to groundwater from this tributary will increase from a Baseline rate of 98.23 m^3/d to 143.2 m^3/d; an increase of 44.97 m^3/d. The increase in leakage is caused by the lowering of the water table in the vicinity of the P3456 extension. This change is a very small fraction of the average baseline streamflow of 4106.0 m^3/d (which includes quarry discharge). The baseline and P3456 net stream leakage over time is shown in Graph 7. The dark blue (Baseline) and dark red (P3456) curves represent total daily leakage from the surface stream reach. The light blue and light red represent leakage from the underground karst portion of the stream (flowing along the Layer 4 bedrock interface). The surface stream leakage is less than the karst stream leakage because the surface stream is isolated from the groundwater system by the low permeability Halton Till. Leakage rates from the surface portion of the stream increase under P3456 through the winter and spring because the water table is lower due to P3456. Leakage in the summer and fall remains the same as Baseline during the summer and fall of dry years because the stream is perched above the water table under those conditions. In summary, the average increase in stream leakage under P3456 conditions, 44.97 m3/d, is a very small fraction of the average baseline streamflow of 4106.0 m^3/d.</td><td>Graphs 6 & 7</td><td></td><td></td></tr>
</table>

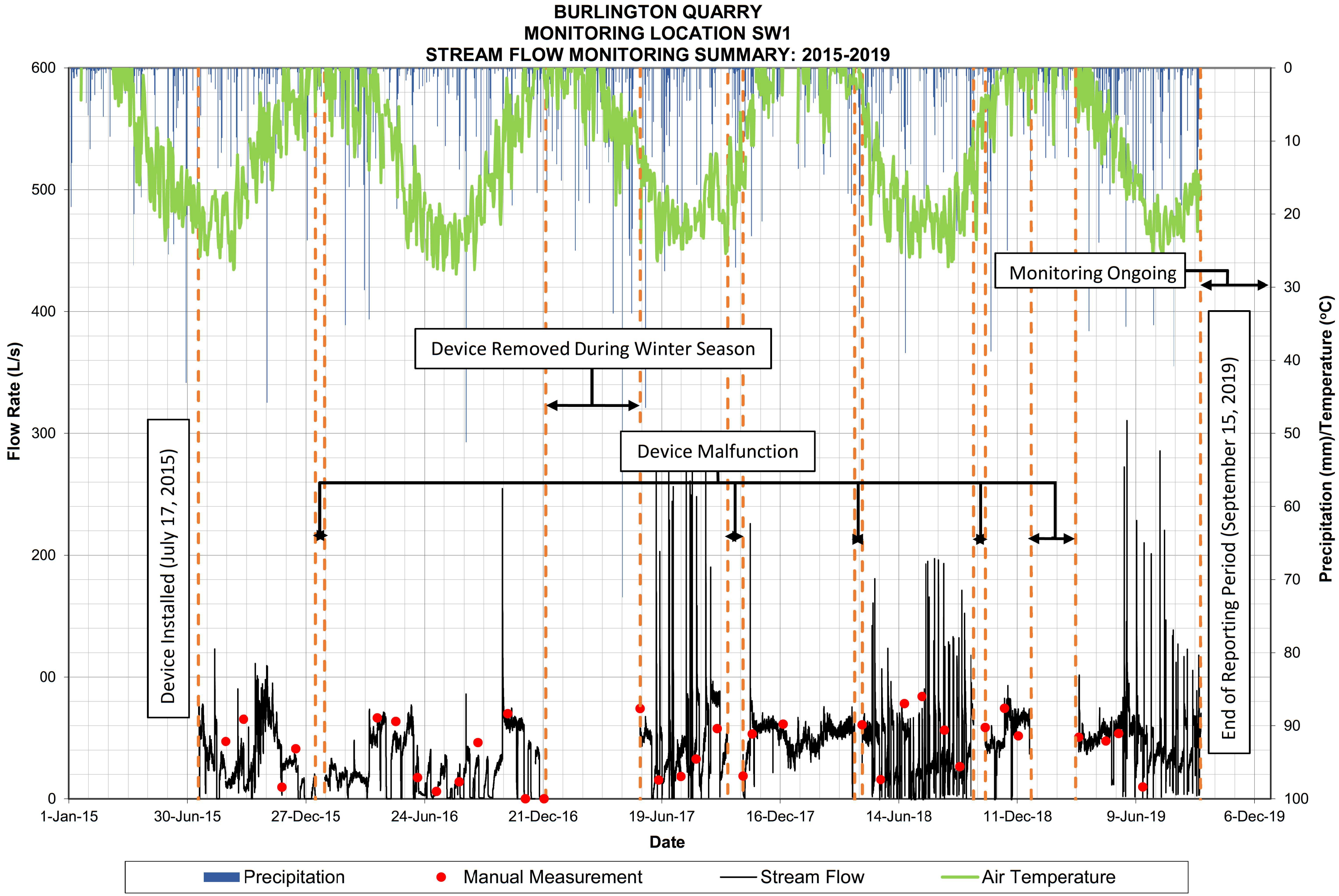
Unnamed Tributary of Willoughby Creek

Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Change in Watercourse Thermal Regime:	1) Negative changes in water temperature are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Temperature of water being discharge from Quarry Sump 0100 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water temperature is anticipated. 2) Artificial warming that may be occurring as a result of discharge of relatively warm surface water from the artificial golf course ponds into the tributary will cease once the golf course ponds are removed. This may result in a beneficial effect in downstream water temperatures, given that the ponds are anthropogenic. 3) The diversion of flow from catchment S101 directly to the Unnamed Tributary will also positively impact the thermal regime in the watercourse as it will no longer pass through the quarry settling ponds.		NETR (Savanta, April 2020)	75 76
Change in Water Quality:	1) Negative changes in water quality are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Quality of water being discharged from Quarry Sump 0100 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water quality is expected. 2) Water quality impacts that may be occurring as a result of discharge of water from the artificial golf course ponds and irrigation channels into the tributary will cease once the golf course ponds are removed. This may result in a positive effect on downstream water quality, given that golf course discharge may be having a negative impact on water quality (e.g., due to fertilizers, erosion and sedimentation, nutrients).		NETR (Savanta, April 2020)	76
Potential Impact to Form and Function of Feature:	1) Direct impacts associated with permanent weir plate installation and diversion pipe installation are not expected to have any negative effects on the general form and function of this portion of the watercourse, which provides indirect fish habitat. 2) Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the form and habitat functions of this watercourse. 3) Diversion of upstream catchment S101 is not expected to have negative impacts on the form and function of the watercourse. The more natural hydrograph predicted due to the diversion may enhance fish habitat in downstream reaches of the Tributary.		NETR (Savanta, April 2020)	75 - 77
Potential Impact to Identified Species and Habitat:	1) In-water work could potentially result in indirect negative impacts on downstream fish communities (i.e., in lower reaches of the Unnamed Tributary or in Willoughby Creek) as a result of erosion and downstream sediment and/or accidental spills during construction. 2) Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the species and habitat functions of this watercourse. 3) Diversion of upstream catchment S101 is not expected to have negative impacts on fish in the watercourse. The more natural hydrograph predicted due to the diversion may enhance fish habitat in downstream reaches of the Tributary.		NETR (Savanta, April 2020)	75 76 77

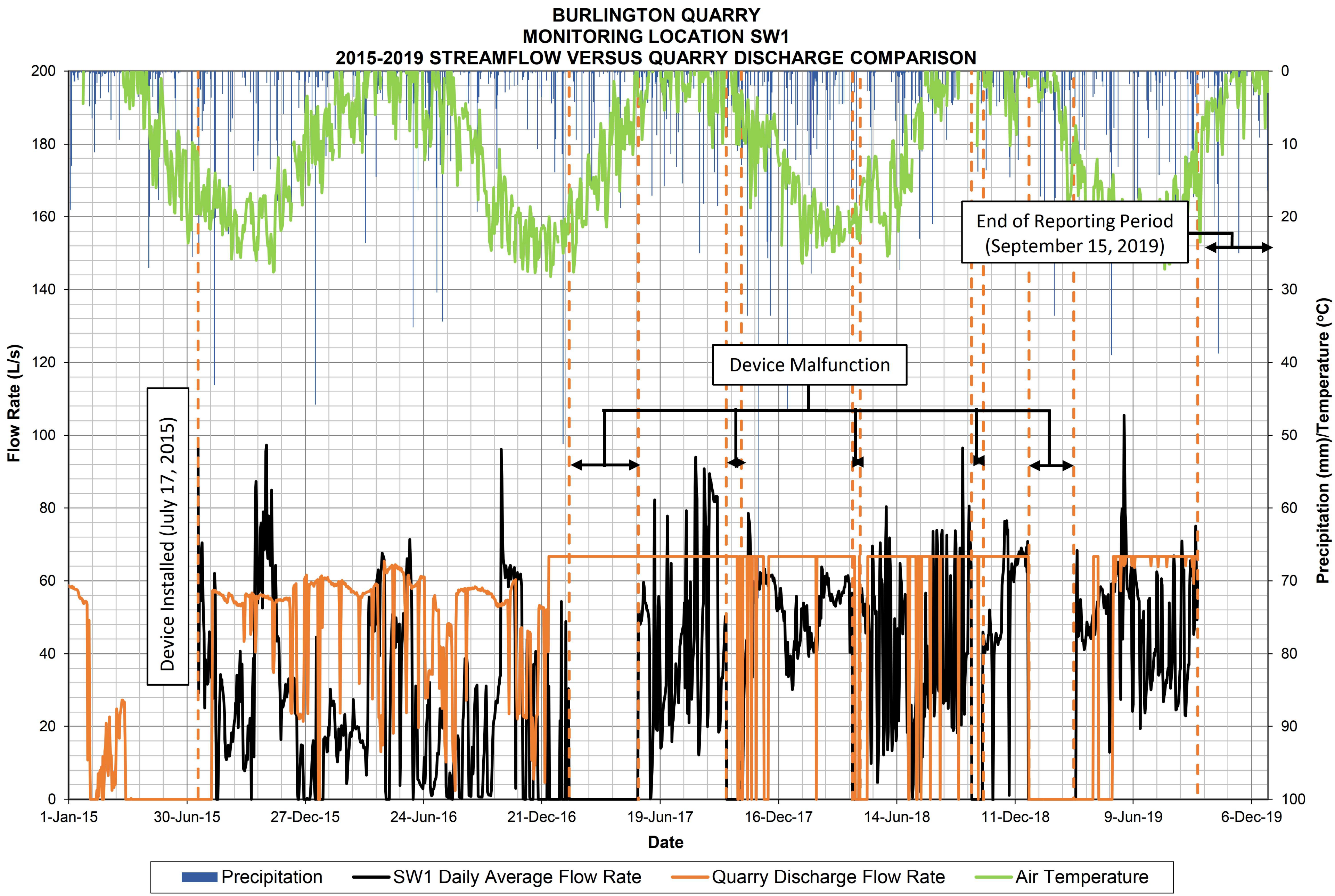
Unnamed Tributary of Willoughby Creek

Mitigation	Description	Figure / Graph	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	1) In-water work required to install the permanent weir plate and the diversion structure inlet will be completed between July 16 and August 30 to minimize the potential for indirect impacts on the reproductive activities of the downstream fish communities in the Unnamed Tributary of Willoughby Creek and in Willoughby Creek itself (e.g., due to sedimentation or accidental spills).		NETR (Savanta, April 2020)	75
	2) Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse.			66 and 67
	3) The Limit of Extraction has been set back 30 m from the limit of the bankfull channel of the Unnamed Tributary of Willoughby Creek and the Weir Pond in order to prevent disturbance to the watercourse. No operational activities will occur within the 30 m setback. A visual mitigation berm will be constructed within the 30 m setback (with associated grading encroaching a minimum of 14 m from the edge of the Weir Pond). Erosion and sedimentation control measures will be in place prior to grading for the berm. The berm will be vegetated following completion of grading to ensure soil stability and prevent erosion. 4) Where areas within the 30 m setback are not currently naturally vegetated (i.e., on portions of the active golf course), these areas will be naturalized with native species plantings to assist in maintaining and enhancing riparian functions adjacent to the watercourse.			74
	5) To mitigate potential for negative impacts during removal of the golf course irrigation ponds and channels, it is recommended that the downstream end of the irrigation channel be blocked off at the edge of the Weir Pond in order to isolate the work area from the Unnamed Tributary. If water is to be pumped from the irrigation ponds and channels, it should be appropriately treated, as may be necessary, prior to discharge to the downstream watercourse. This could include pumping to a localized treatment method (e.g., filtration bag) or direct pumping into the quarry (which would be expected to provide suitable level of water quality control, based on the quarry's existing discharge limits). If in-water work is required (e.g., to isolate the irrigation ponds and channels), it should be completed between July 16 and August 30 to minimize potential for disruption of downstream coldwater fish community reproductive activities. The existing golf cart path and culvert at the interface of the irrigation channel and Weir Pond should be removed and the area should be restored to create a naturalized pond bank.			78
Source Water Mitigation:	In order to mitigate impacts on fish and fish habitat in Willoughby Creek, pumping and discharge from the quarry are recommended to occur at the same location at the upstream end of the Unnamed Tributary of Willoughby Creek and in the same manner as existing pumping in accordance with the existing PTTW and Environmental Compliance Approvals regulating current quarry discharge.		NETR (Savanta, April 2020)	76 and 77
Groundwater Contribution Mitigation:	None required. The Unnamed Tributary is generally a losing stream with minor groundwater contributions typically occuring following spring freshet. During extraction the groundwater contributions are predicted to be reduced by less than 1.0%			
Erosion Mitigation:	Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse.			
Thermal Mitigation:	1) No specific thermal mitigation is proposed given that maintaining existing quarry outflows at Sump 0100 are expected to maintain the existing thermal regime of the watercourse without any additional mitigation.		NETR (Savanta, April 2020)	76
	2) Removal of the golf course ponds and diversion of flow from catchment S101 may have an indirect positive effect on the thermal regime of the watercourse.			78
Water Quality Mitigation:	1)No specific water quality mitigation over and above that of the existing quarry operations is proposed given that maintaining existing quarry outflows at Sump 0100 is expected to maintain the existing water quality regime of the watercourse. The quarry extension is not predicted to result in any changes in the quality of water being discharged from Sump 0100.		NETR (Savanta, April 2020)	76
	2) Removal of the golf course ponds may have an indirect positive effect on the water quality of the watercourse.			78

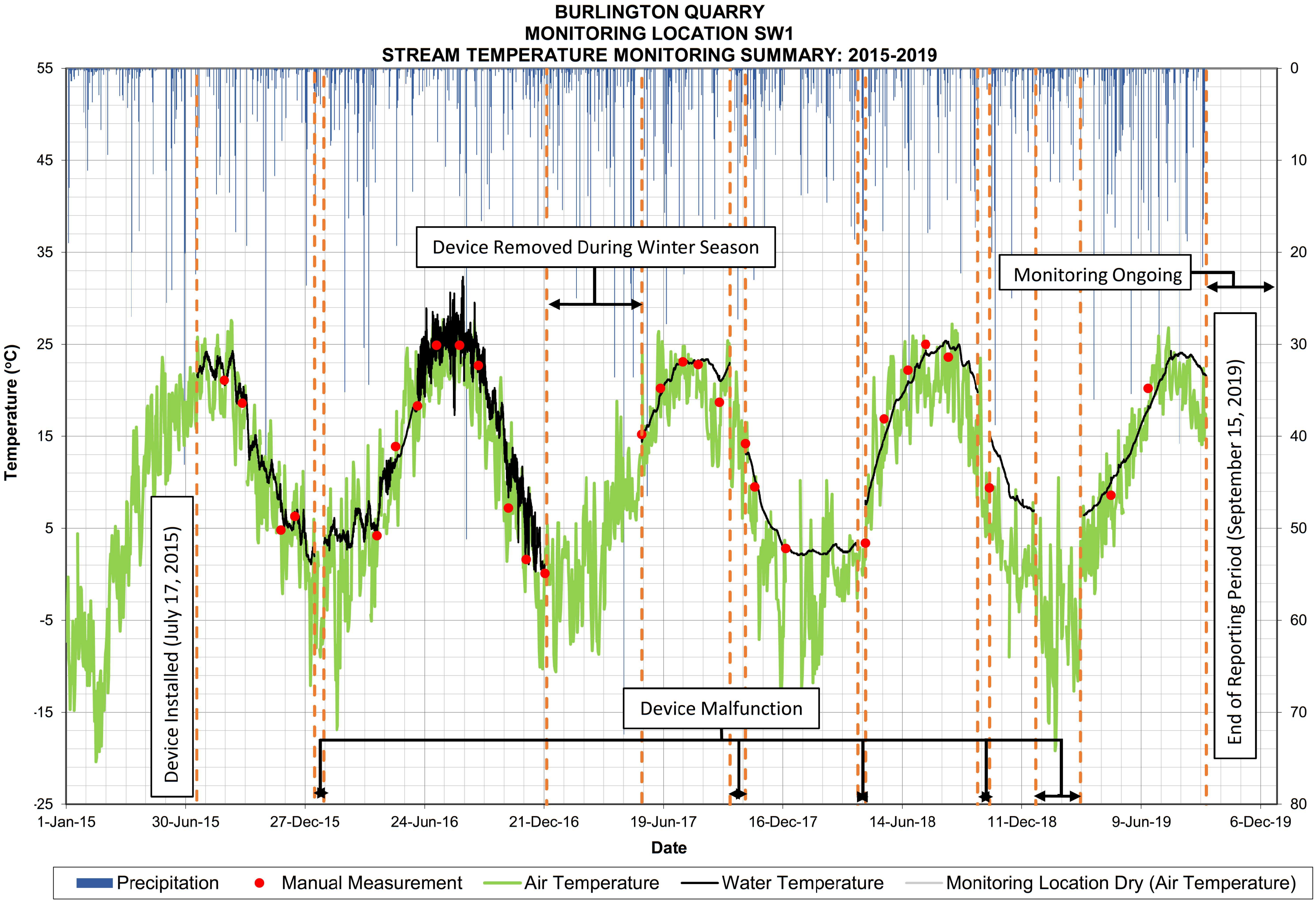
TRIBUTARY OF WILLOUGHBY CREEK - GRAPH 1



TRIBUTARY OF WILLOUGHBY CREEK - GRAPH 2



TRIBUTARY OF WILLOUGHBY CREEK - GRAPH 3



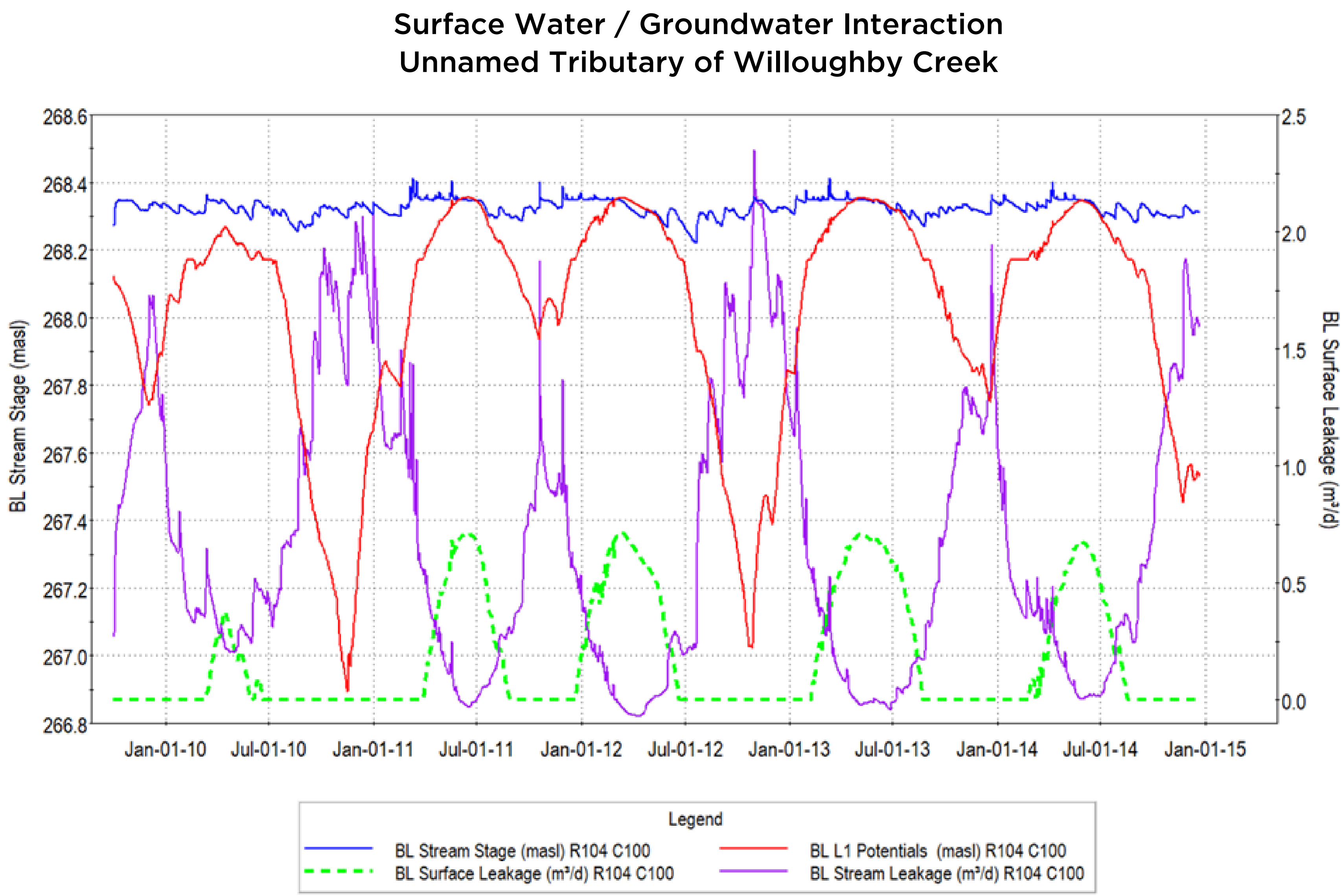
TRIBUTARY OF WILLOUGHBY CREEK - TABLE 1

BURLINGTON QUARRY
TATHAM ENGINEERING PROJECT NO.: 113187
SURFACE WATER MONITORING

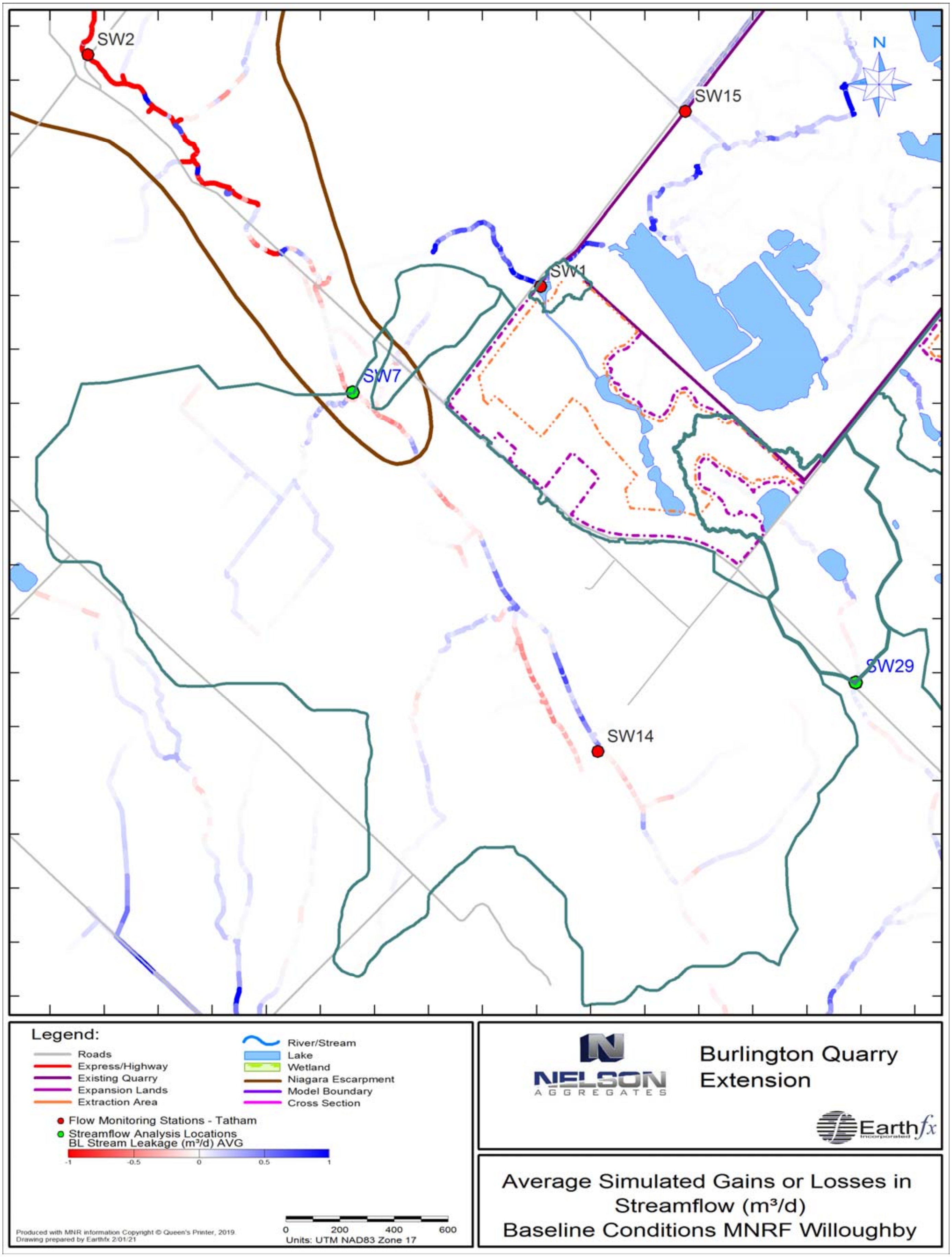
WATER QUALITY SAMPLE RESULTS

Monitoring Location SW1													
		Sample Date:	24-Oct-18	24-Apr-19	19-Jun-19	25-Sep-19	20-May-20	15-Jul-20	16-Sep-20	11-Nov-20	Maximum	Minimum	Average
Parameter:	Units:	M.D.L.	CM/JG	CM/JG	CM	CM	JG	JG/JH/JM	JH/JM	JG/JH			
M-Alkalinity (pH 4.5)	mg/L as CaCO3	2	137	179	180	112	160	94	107	117	180	112	152
Ammonia (as N)	mg/L	0.01	0.11	<0.01	0.03	0.02	<0.01	0.45	<0.01	0.01	0.11	0.02	0.04
BOD (5 day)	mg/L	1	1	2.4	1.3	1	1.6	1.1	1.3	1.2	2.4	1.0	1.4
Bicarbonate	mg/L as CaCO3	1	136	177	-	111		93	106	116	177	111	141
Carbonate	mg/L as CaCO3	1	1	2	-	<1		<1	<1	<1	2	1	1
Conductivity	µS/cm	1	877	742	763	755	790	690	799	886	877	742	784
Dissolved Organic Carbon	mg/L	0.4	4.3	4	3.1	3.7	3.9	2.3	3	3.3	4.3	3.1	3.8
Field pH	pH	N/A	8.8	8.5	8.6	8.8	8.9	8.6	8.9	9.1	8.8	8.5	8.7
Field Temp	°C	N/A	8.6	7.8	20.2	20.4	18.4	24.7	18.5	12.8	20.4	7.8	14.3
Aluminum	ug/L	1	21	64	15	9	10	50	4	2	64	9	27
Antimony	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Arsenic	ug/L	1	5	3	4	4	2	4	4	<1	5	3	4
Barium	ug/L	1	38	30	32	29	32	19	29	33	38	29	32
Beryllium	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Bismuth	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Boron	ug/L	2	109	56	31	88	59	52	108	123	109	31	71
Cadmium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Calcium	ug/L	500		77100	79600	51100	65000	39600	52300	65400	79600	51100	51950
Cerium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Cesium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Chromium	ug/L	1	<1	4	3	3	2	<1	2	3	4	3	3
Cobalt	ug/L	0.1	0.2	0.3	0.2	0.1	0.2	0.3	0.1	0.1	0.3	0.1	0.2
Copper	ug/L	1	<1	1	8	1	2	3	1	2	8	1	3
Europium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Gallium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	1
Iron	ug/L	20	40	160	210	140	253	160	160	200	210	40	138
Lanthanum	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Lead	ug/L	0.1	<1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1	0.1	0.1
Lithium	ug/L	5	9	7	8	8	8	11	12	12	9	7	8
Magnesium	ug/L	5		30700	34200	36400	34000	28800	36100	41300	36400	30700	25325
Manganese	ug/L	10	9	15	18	15	21	59	9	7	18	9	14
Mercury	ug/L	0.1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Molybdenum	ug/L	1	3	2	2	3	2	2	2	3	3	2	3
Nickel	ug/L	1	4	4	3	2	3	2	2	2	4	2	3
Niobium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Phosphorus	ug/L	50	<50	124	<50	<50	<50	<50	<50	<50	124	124	68.5
Potassium	ug/L	1	5990	4230	4510	5620	4680	3830	5920	6800	5990	4230	5088
Rubidium	ug/L	1	3	2	2	3	2	2	3	2	3	2	3
Scandium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Selenium	ug/L	0.5	1.6	1.1	<0.5	1.5	1.1	<0.5	1.7	<0.5	1.6	1.1	1.175
Silicon	ug/L	2	1600	1560	888	659	568	447	1010	616	1600	659	1177
Silver	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	0.1
Sodium	ug/L	1000	50600	36500	34900	41800	42300	43700	48900	51200	50600	34900	40950
Strontium	ug/L	1	982	942	895	823	807	564	722	982	982	823	911
Sulphur	ug/L	800	63800	49400	59200	59100	50000	40300	56300	79800	63800	49400	57875
Tellurium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Thallium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Thorium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Tin	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Titanium	ug/L	1	<1	2	<1	<1	<1	1	<1	<1	2	2	1.25
Tungsten	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Uranium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Vanadium	ug/L	1	<1	1	1	<1	<1	<1	<1	<1	1	1	1
Yttrium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Zinc	ug/L	1	5	<1	7	4	4	9	5	2	7	4	4
Zirconium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
pH	pH	N/A	8.02	8.03	8	7.97	8.34	7.97	7.86	7.88	8.0	8.0	8.0
Total Hardness (as CaCO3)	mg/L	0.1	335	319	340	277	302	217	279	333	340.000	277.000	317.750
Chemical Oxygen Demand	mg/L	5	8	12	8	<5	12	11	16	15	12	8	8
Total Dissolved Solids	mg/L	3	597	517	564	576	525	460	536	574	597	517	564
Total Suspended Solids	mg/L	0.67	1.3	3.67	1	1.7	5	4	2.3	2.7	3.67	1.00	1.92
Turbidity	NTU	0.1	2.4	3.5	1.4	0.9	2.4	2	0.5	1.2	3.5	0.9	2.1

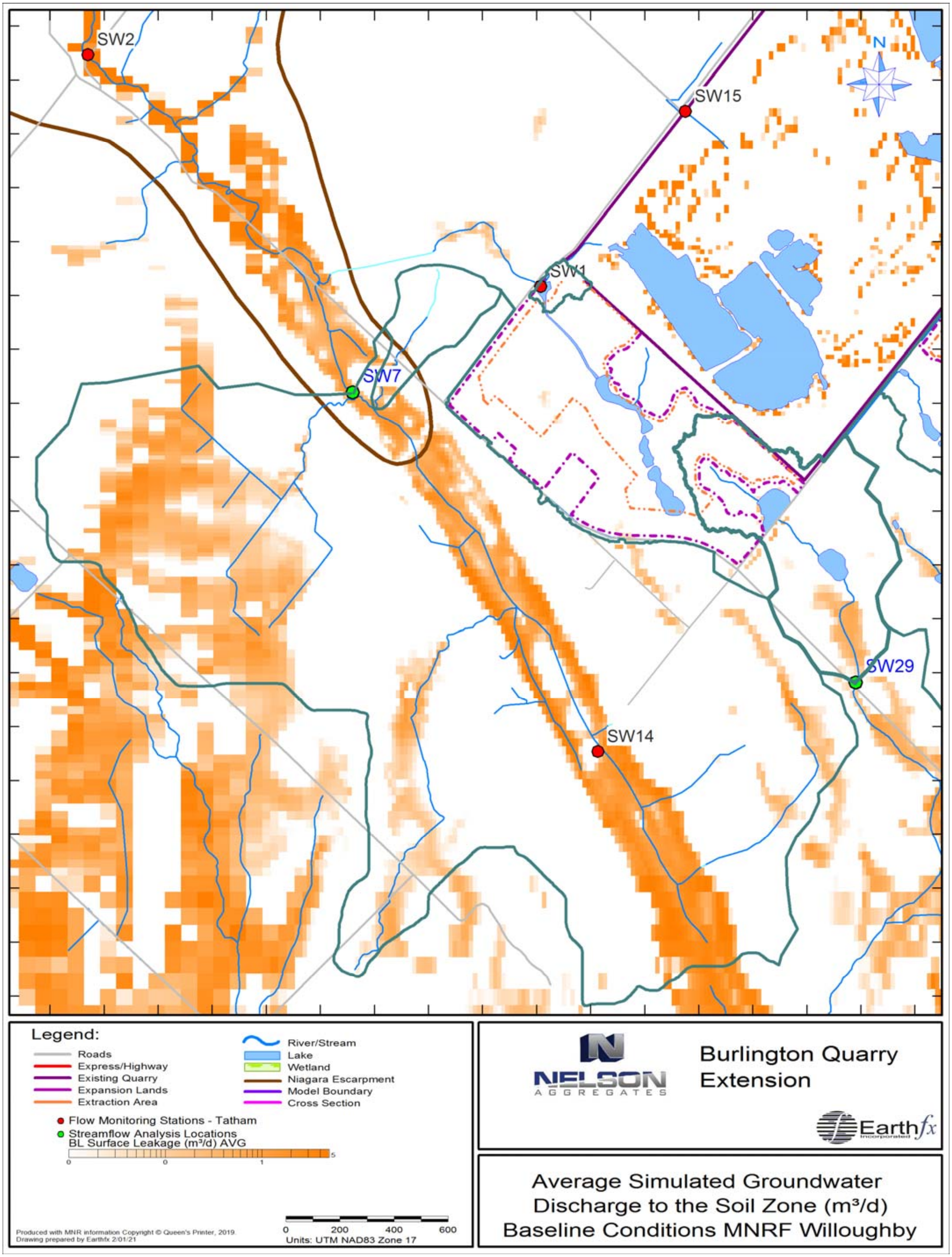
TRIBUTARY OF WILLOUGHBY CREEK - GRAPH 4



TRIBUTARY OF WILLOUGHBY CREEK - FIGURE 1



TRIBUTARY OF WILLOUGHBY CREEK - FIGURE 2



TRIBUTARY OF WILLOUGHBY CREEK

FIGURE 3A

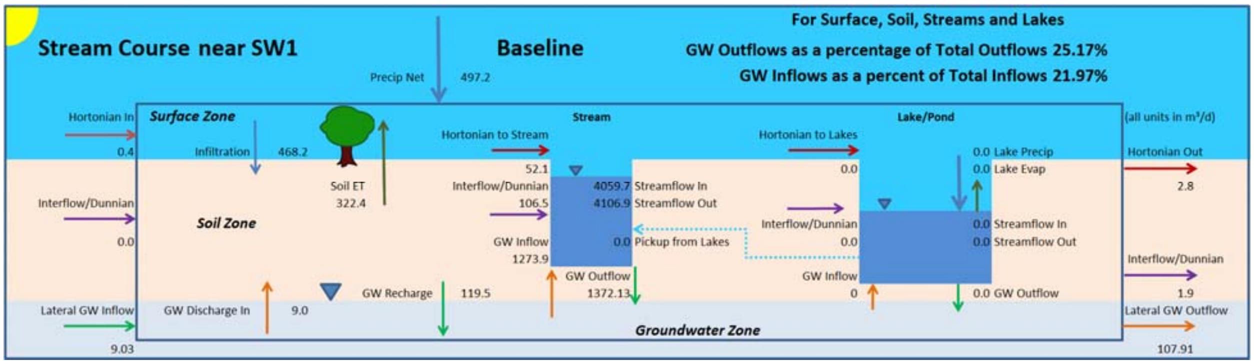


FIGURE 3B

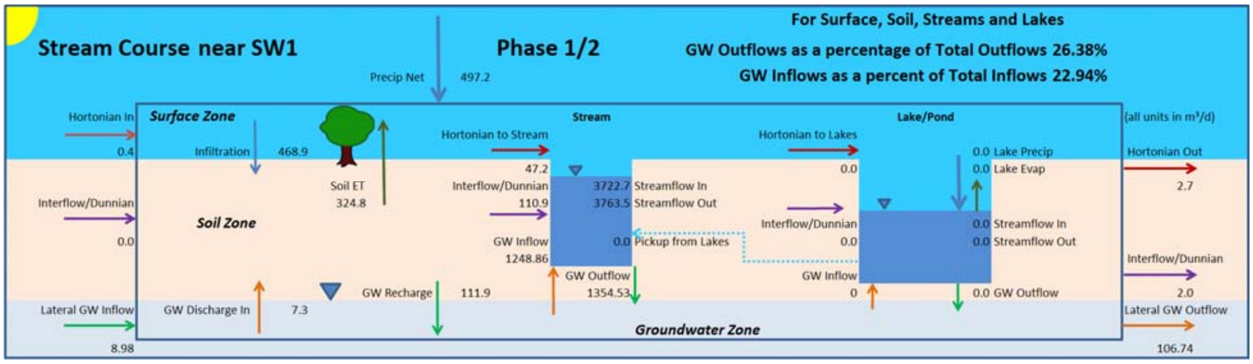


FIGURE 3C

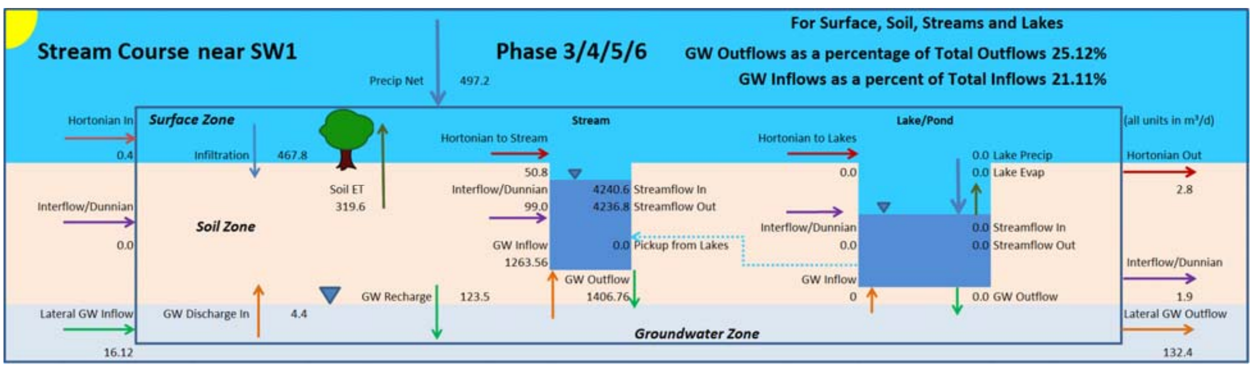


FIGURE 3D

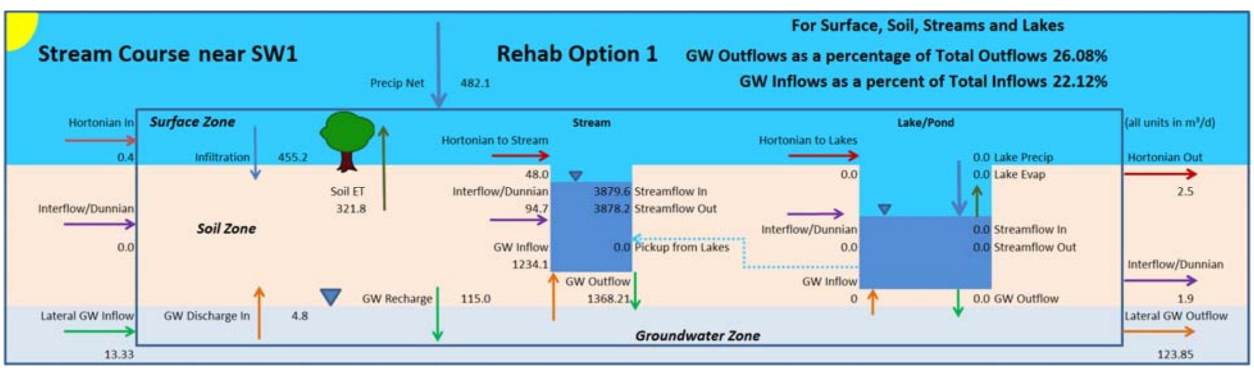
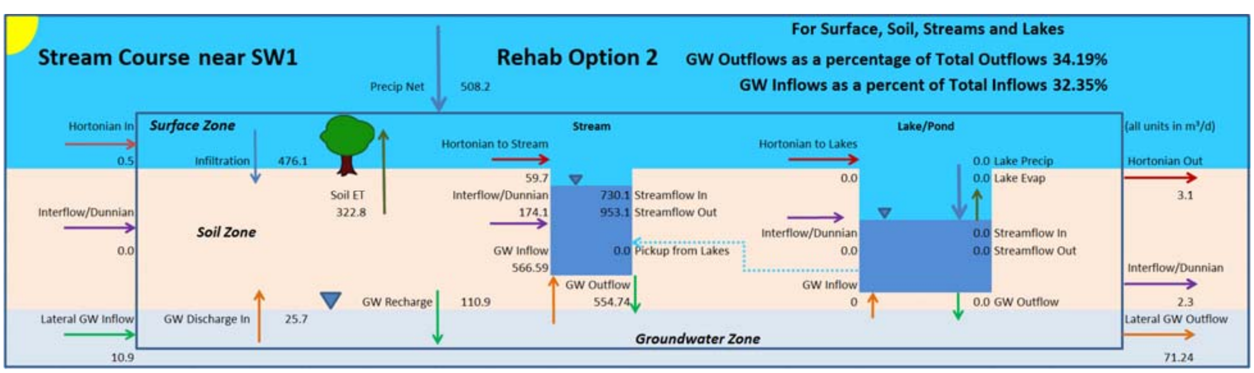
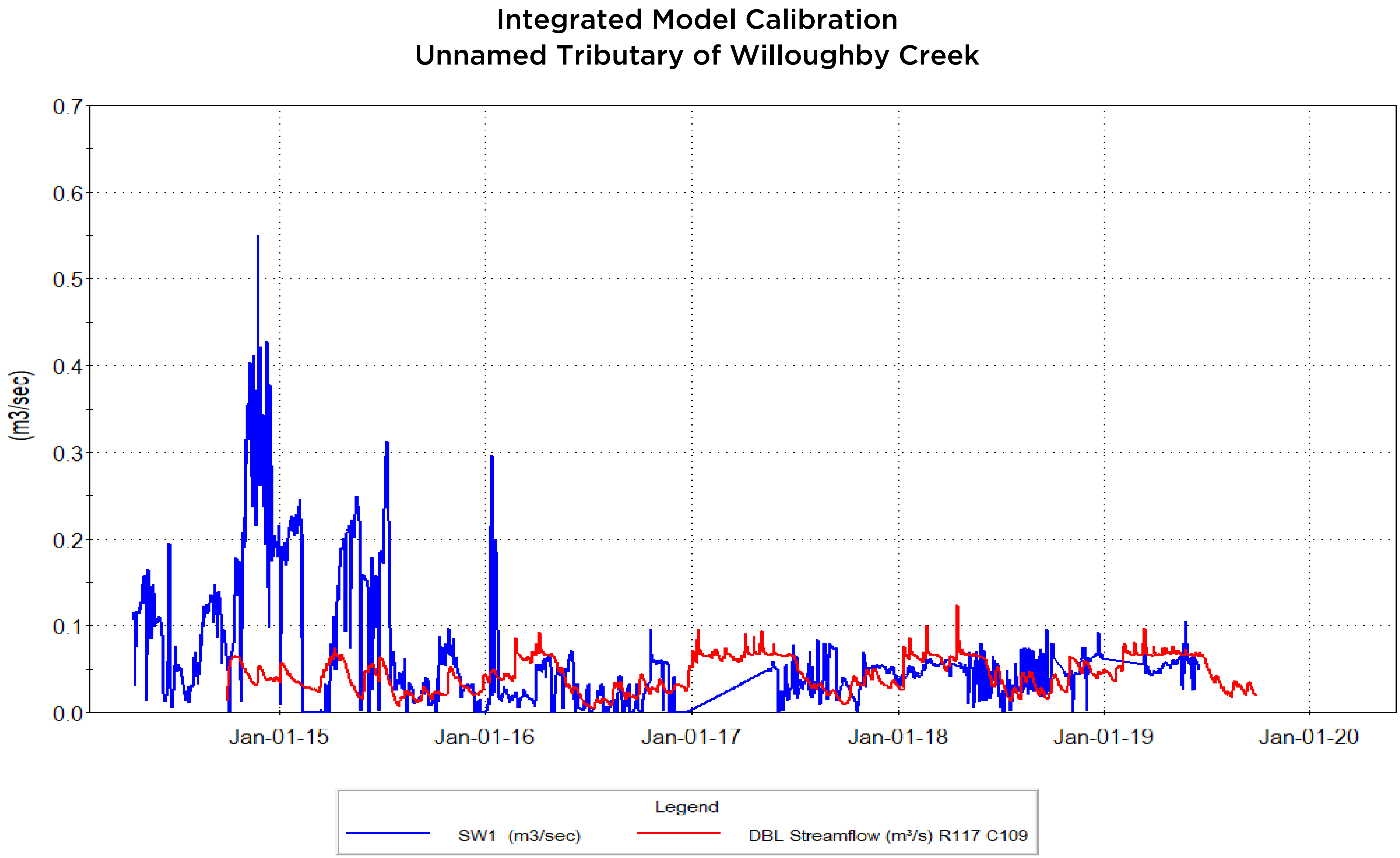
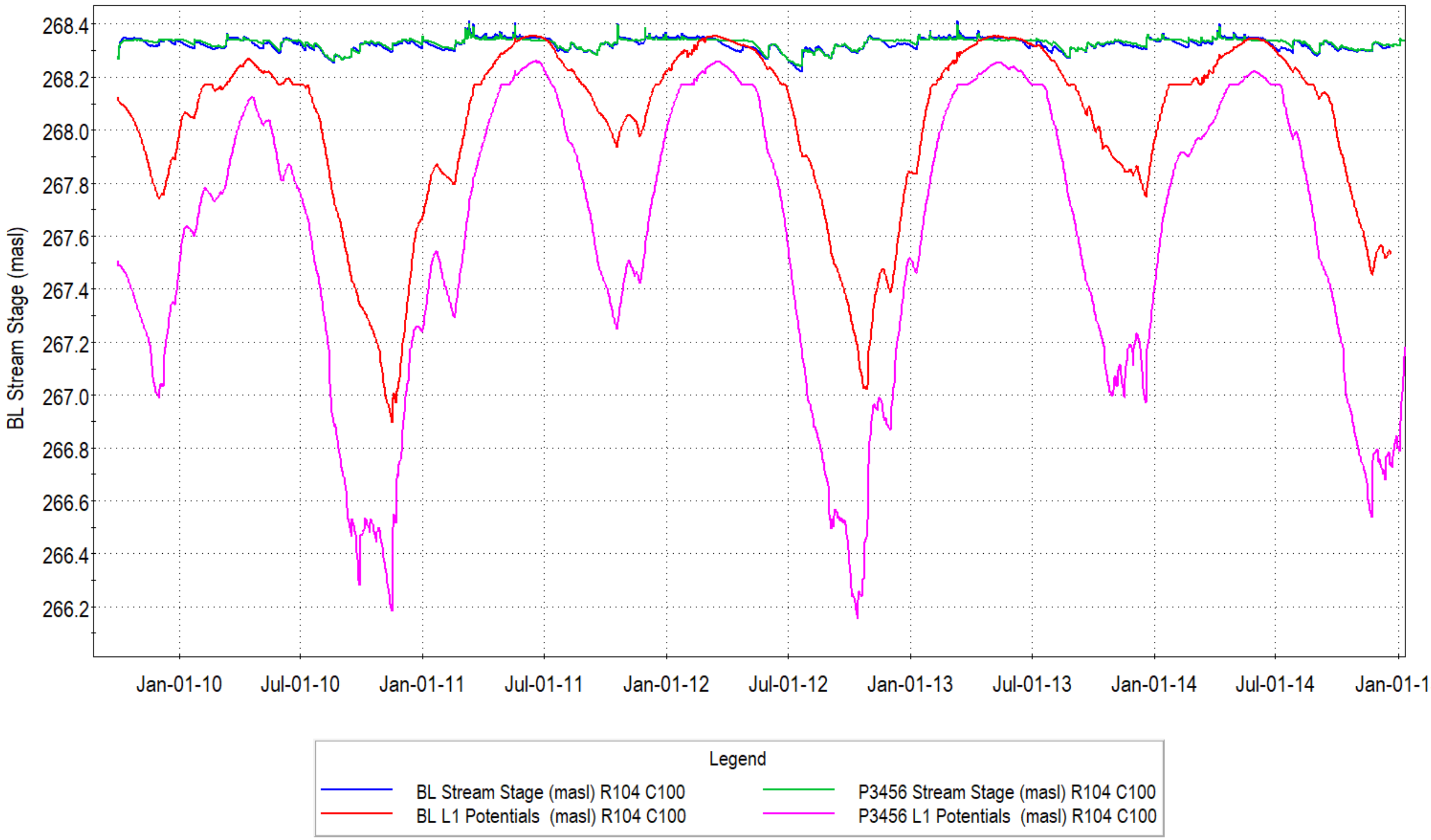


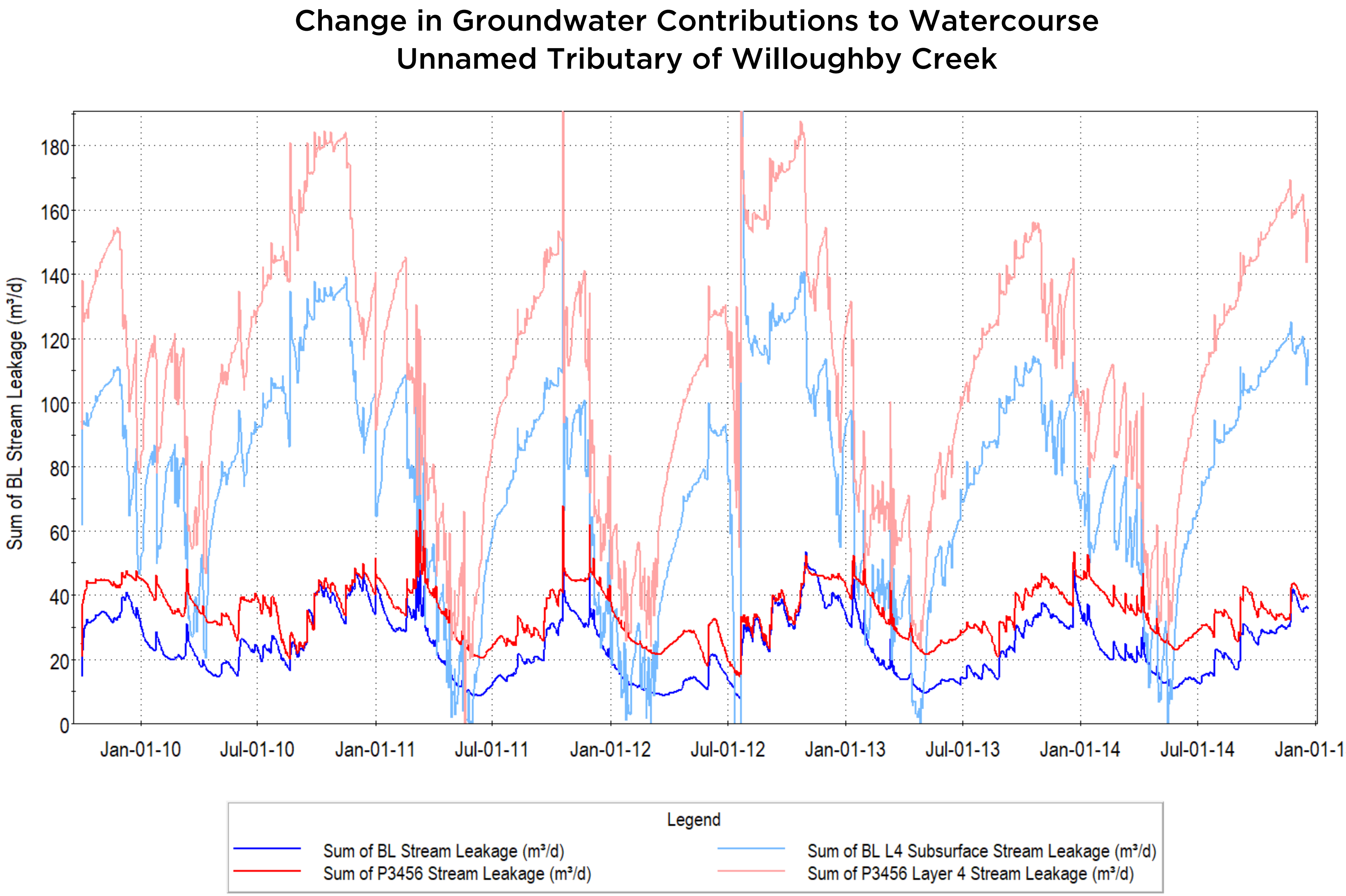
FIGURE 3E



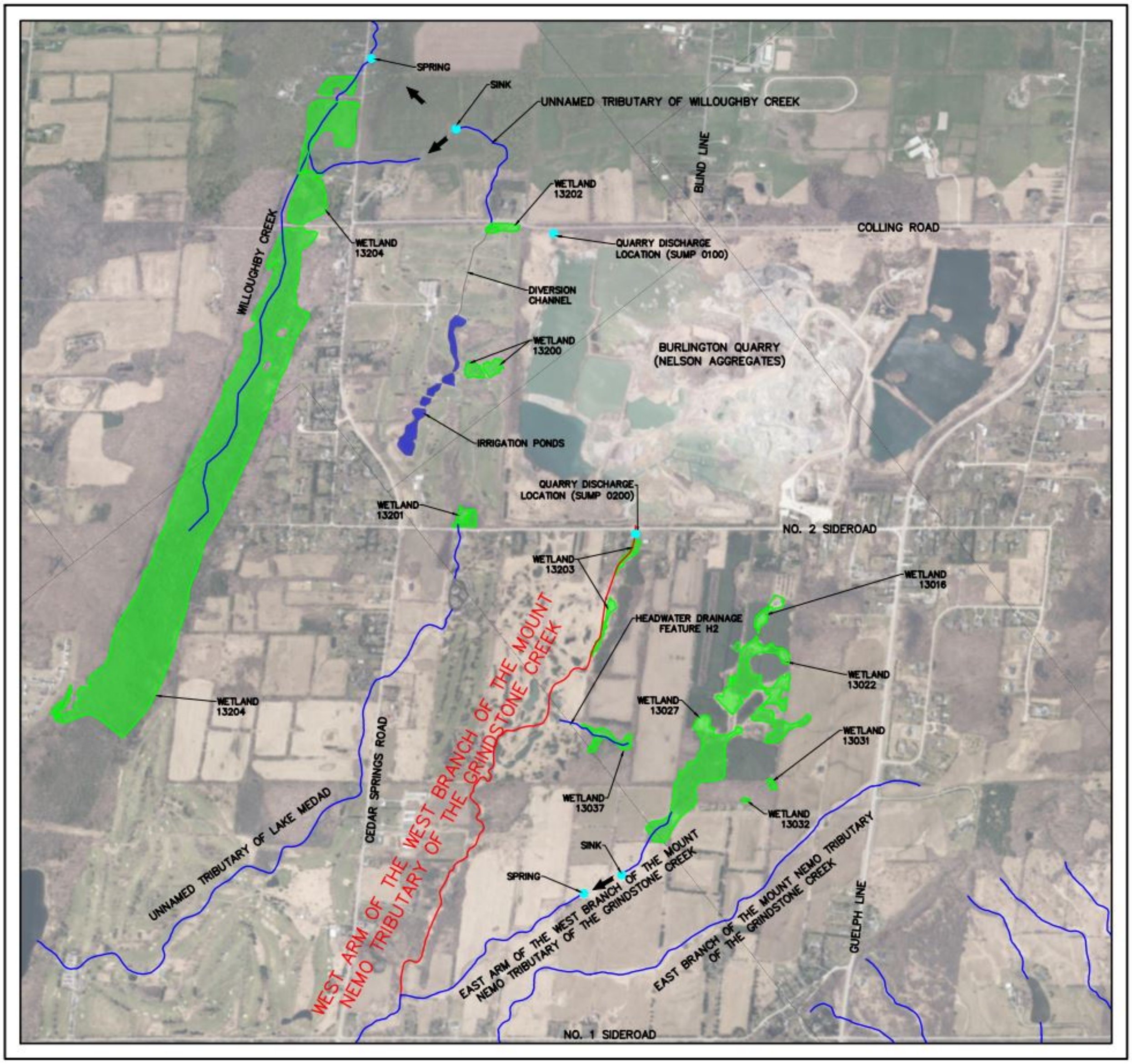

Integrated Model Calibration
Unnamed Tributary of Willoughby Creek
(m3/sec)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan-01-15
Jan-01-16
Jan-01-17
Jan-01-18
Jan-01-19
Jan-01-20
Legend
SW1 (m3/sec)
DBL Streamflow (m³/s) R117 C109

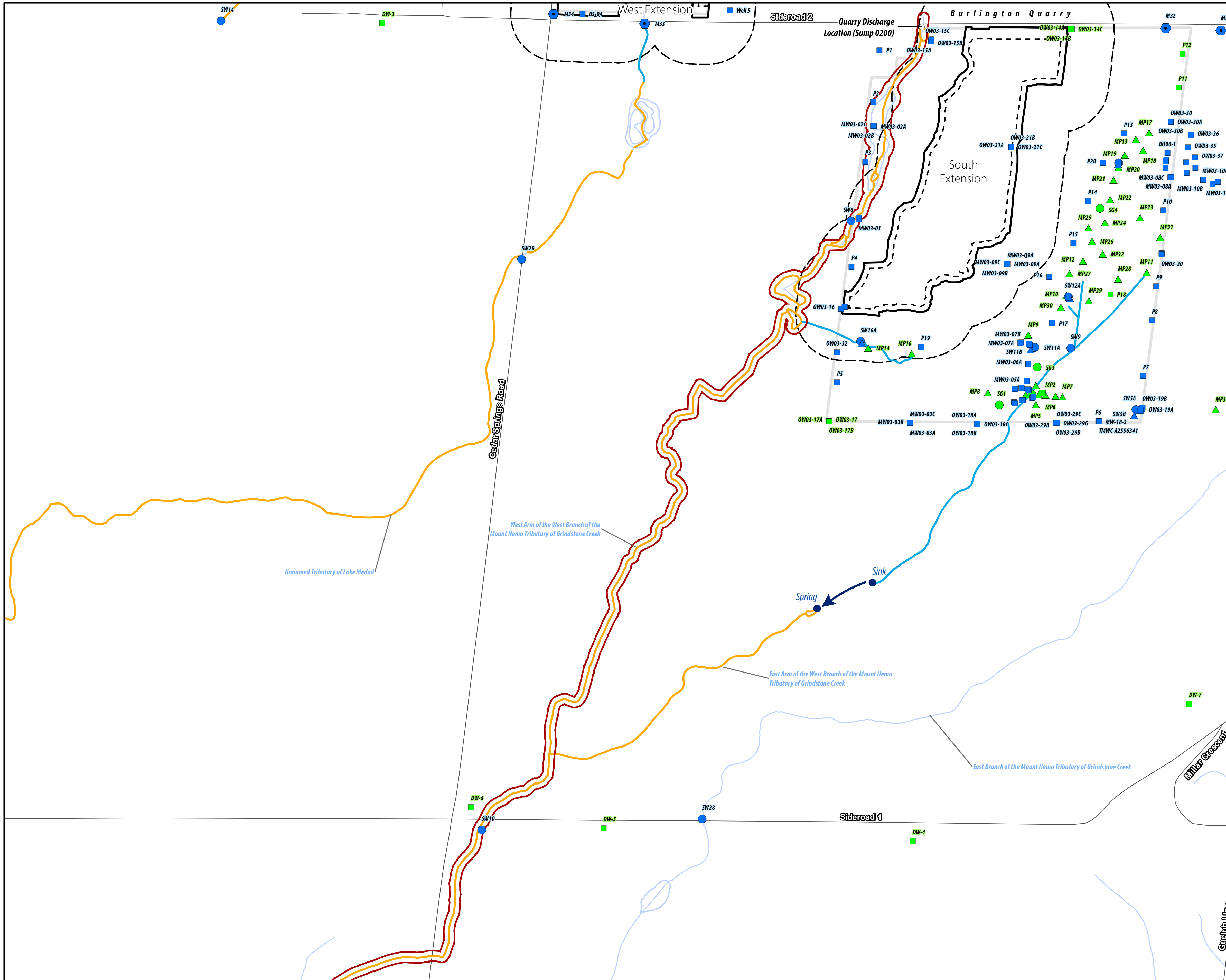
Change in Groundwater Contributions to Watercourse
Unnamed Tributary of Willoughby Creek




Change in Groundwater Contributions to Watercourse
Unnamed Tributary of Willoughby Creek
Sum of BL Stream Leakage (m³/d)
0
20
40
60
80
100
120
140
160
180
Jan-01-10
Jul-01-10
Jan-01-11
Jul-01-11
Jan-01-12
Jul-01-12
Jan-01-13
Jul-01-13
Jan-01-14
Jul-01-14
Jan-01-15
Legend
Sum of BL Stream Leakage (m³/d)
Sum of P3456 Stream Leakage (m³/d)
Sum of BL L4 Subsurface Stream Leakage (m³/d)
Sum of P3456 Layer 4 Stream Leakage (m³/d)

WEST ARM OF THE WEST BRANCH





Legend

Licensed Boundary
Limit of Extraction
120 m Adjacent Lands
Subject Lands
West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
Road
Indirect Fish Habitat
Direct Fish Habitat
Watercourse
Waterbody
Wetland (Savanta, 2020)

Current Instrumentation

Groundwater Monitoring Station (EarthFx)
Mini Piezometer (Tatham Engineering)
Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

Groundwater Monitoring Station (Golder)
Mini Piezometer (Golder)
Staff Gauge & Surface Water Monitoring Station (Golder)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 15
Watercourse Characterization

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

0 180 m
1:10,000
N

[redacted]

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2" colspan="5">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Watercourse Name:</td><td colspan="5">West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Watershed:</td><td colspan="5">Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Sub-Watershed:</td><td colspan="5">Mount Nemo Tributary of Grindstone Creek</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed Limit of Extraction:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Located in Proposed License Boundary:</td><td colspan="5">No</td><td></td><td></td><td></td></tr>
<tr><td>Catchment Area (ha):</td><td colspan="5">135 ha (at confluence with East Arm); 26.2 ha (at streamflow monitoring location SW6)</td><td></td><td></td><td></td></tr>
<tr><td>Catchment ID:</td><td colspan="5">N/A</td><td></td><td></td><td></td></tr>
<tr><td>Primary Source(s) of Flow:</td><td colspan="5">Discharge from Burlington Quarry (Sump 0200)</td><td></td><td></td><td></td></tr>
<tr><td>Discharge from Quarry / PTTW:</td><td colspan="5">Yes - PTTW 96-P-3009</td><td></td><td>SWA (Tatham, April 2020)</td><td>Appendix A</td></tr>
<tr><td>Conditions of PTTW:</td><td colspan="5">Maximum discharge rate = 945 L/min (15.75 L/s)
Maximum discharge amount = 1,360,800 L/day</td><td></td><td>SWA (Tatham, April 2020)</td><td>Appendix A</td></tr>
<tr><td>Surface Water Monitoring:</td><td colspan="5">ID: SW6 (Tatham)
Installation Date: September 19, 2014
Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve)
Coordinates of Monitoring Station: Easting 590629.123, Northing 4805071.124</td><td>Graphs 1, 2 & 3 and Table 1</td><td>SWA (Tatham, April 2020)</td><td>2.1.2, Appendix C and Appendix H</td></tr>
<tr><td>Streamflow Conditions:</td><td colspan="5">Intermittent (flow is dependent on quarry discharge); the tributary will dry out when quarry discharge ceases</td><td>Graphs 1, 2 & 3</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
<tr><td rowspan="14">Average Daily Flow (SW6):</td><td colspan="4">Average Daily Streamflow (L/s)</td><td>Notes:</td><td rowspan="14">Graphs 1 & 2</td><td rowspan="14">SWA (Tatham, April 2020)</td><td rowspan="14">2.1.2 and Appendix C</td></tr>
<tr><td>Month</td><td>Minimum</td><td>Average</td><td>Maximum</td><td rowspan="13">Minimum - lowest daily average streamflow recorded for period of record
Average - average daily streamflow recorded for period of record
Maximum - maximum daily average streamflow recorded for period of record
N/A - data not available as device removed from watercourse during winter months</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>3.6</td><td>7.4</td><td>15.3</td></tr>
<tr><td>April</td><td>0.1</td><td>6.4</td><td>14.3</td></tr>
<tr><td>May</td><td>0.0</td><td>4.6</td><td>33.8</td></tr>
<tr><td>June</td><td>0.0</td><td>6.5</td><td>31.0</td></tr>
<tr><td>July</td><td>0.0</td><td>5.3</td><td>17.7</td></tr>
<tr><td>August</td><td>0.0</td><td>5.2</td><td>23.6</td></tr>
<tr><td>September</td><td>0.0</td><td>2.4</td><td>21.6</td></tr>
<tr><td>October</td><td>0.0</td><td>2.1</td><td>16.0</td></tr>
<tr><td>November</td><td>0.0</td><td>4.1</td><td>21.9</td></tr>
<tr><td>December</td><td>0.0</td><td>7.8</td><td>44.6</td></tr>
</table>

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Surface Water Characteristics</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Watercourse Thermal Regime (SW6):</td><td>
<table>
<tr><th colspan="4">Average Daily Water Temperature (°C)</th><th>Notes:</th></tr>
<tr><th>Month</th><th>Minimum</th><th>Average</th><th>Maximum</th><td rowspan="13">Minimum - lowest daily average streamflow recorded for period of record

Average - average daily streamflow recorded for period of record

Maximum - maximum daily average streamflow recorded for period of record

N/A - data not available as device removed from watercourse during winter months</td></tr>
<tr><td>January</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>February</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>March</td><td>4.7</td><td>6.0</td><td>8.0</td></tr>
<tr><td>April</td><td>5.6</td><td>9.5</td><td>12.3</td></tr>
<tr><td>May</td><td>7.3</td><td>14.4</td><td>25.0</td></tr>
<tr><td>June</td><td>9.4</td><td>17.7</td><td>26.5</td></tr>
<tr><td>July</td><td>12.3</td><td>21.0</td><td>27.2</td></tr>
<tr><td>August</td><td>12.2</td><td>21.1</td><td>28.9</td></tr>
<tr><td>September</td><td>9.5</td><td>17.8</td><td>25.1</td></tr>
<tr><td>October</td><td>2.7</td><td>12.2</td><td>20.2</td></tr>
<tr><td>November</td><td>0.2</td><td>7.2</td><td>13.2</td></tr>
<tr><td>December</td><td>0.5</td><td>4.9</td><td>9.6</td></tr>
</table>
</td><td>Graph 3</td><td>SWA (Tatham, April 2020)</td><td>2.1.2 and Appendix C</td></tr>
<tr><td>Water Quality (SW6):</td><td>
<table>
<tr><th colspan="5">Water Quality Sample Results</th></tr>
<tr><th>Parameter</th><th>Units</th><th>Minimum</th><th>Average</th><th>Maximum</th></tr>
<tr><td>Turbidity</td><td>NTU</td><td>0.2</td><td>0.4</td><td>0.5</td></tr>
<tr><td>TDS</td><td>mg/L</td><td>593</td><td>640</td><td>695</td></tr>
<tr><td>TSS</td><td>mg/L</td><td><0.67</td><td>1.11</td><td>2.00</td></tr>
<tr><td>COD</td><td>mg/L</td><td><5</td><td>8</td><td>12</td></tr>
<tr><td>BOD5</td><td>mg/L</td><td><0.9</td><td>0.9</td><td>0.9</td></tr>
<tr><td>DOC</td><td>mg/L</td><td>2.7</td><td>3.0</td><td>3.4</td></tr>
<tr><td>pH</td><td></td><td>7.7</td><td>7.9</td><td>8.2</td></tr>
<tr><td>Alkalinity</td><td>mg/L</td><td>137</td><td>160</td><td>172</td></tr>
<tr><td>Conductivity</td><td>µS/cm</td><td>798</td><td>858</td><td>934</td></tr>
<tr><td>Phosphorus</td><td>ug/L</td><td><50</td><td><50</td><td><50</td></tr>
<tr><td>Ammonia</td><td>mg/L</td><td><0.01</td><td>0.02</td><td>0.04</td></tr>
<tr><td>Hardness</td><td>mg/L</td><td>357</td><td>364</td><td>376</td></tr>
</table>
</td><td>Table 1</td><td>SWA (Tatham, April 2020)</td><td>2.4 and Appendix H</td></tr>
</table>

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

Fish & Fish Habitat Features	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Fish Habitat (Direct/Indirect and Assumed/Confirmed):	The West Arm is known to provide direct fish habitat, based on fish community sampling completed in 2019 by Savanta. Fish were captured in a small, online pond approximately 400 m downstream from Sideroad No. 2. For the purposes of the NETR, the entire watercourse up to the quarry discharge point at Sideroad No. 2 is assumed to provide direct fish habitat.		NETR (Savanta, April 2020)	44 and Figure 9b
Fish Species Present:	1) Savanta captured Brook Stickleback in the watercourse in 2019. 2) Stantec (2010) previously reported that Brook Stickleback and Pumpkinseed were captured in the West Arm.		NETR (Savanta, April 2020)	44 and Figure 9b
Fish Community Thermal Regime:	Cool to Warmwater (based on fish species present)		NETR (Savanta, April 2020)	44 and Figure 9b
Fish Habitat Types Present:	The reach of the watercourse between the upstream end at Sideroad No. 2 and the Nelson property line generally consists of a poorly defined to well-defined natural low flow channel within a low-lying, densely vegetated floodplain. With some reaches, the low flow channel is barely observable and only approximates a shallow depression amongst dense emergent wetland vegetation. In other reaches, the low flow channel is more well defined, with observable bed and banks that are distinguishable from the riparian vegetation community. The average wetted width of the channel is approximately 2 m, with abundant vegetation and multiple flow paths through wetland areas. Water depth on June 3, 2019 ranged from 0.1 to 0.5 m. Morphology is generally uniform, consisting of long runs with soft substrate, although several deeper scour pools are present, as well as one approximately 18 m long by 10 m wide online pond. A larger (~40 m by 20 m) online pond (which receives the inflow from the quarry Sump 0200) is present immediately adjacent to Sideroad No. 2. Riparian vegetation is generally meadow marsh and cultural meadow, although shrub thickets are present at various points.		NETR (Savanta, April 2020)	44 and Figure 9b
Habitat Uses by Known Fish Community:	The local fish community likely uses the habitat for the complete range of life history processes including spawning, nursery, foraging and overwintering (primarily in the online ponds at the upstream end and mid-point of the reach). Larger online ponds are also present on the downstream golf course property and these may also provide overwintering and refuge functions for the local fish community.		NETR (Savanta, April 2020)	44 and Figure 9b
Known Barriers to Fish Movement:	A culvert is present at the downstream Subject Lands property boundary. Fish may be able to pass upstream through this culvert under lower flow rates, although at higher flows, when velocities are expected to be higher, the culvert may provide some barrier effect.		NETR (Savanta, April 2020)	44 and Figure 9b

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

Groundwater Interaction	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Underlying Deposits:	Halton Till. The harmonic mean hydraulic conductivity, based on testing by Golder (2007) of 10 mini-piezometers, was 1.2×10^{-8} m/s. Model value for the vertical hydraulic conductivity was 1.6×10^{-7} m/s, about an order of magnitude higher, to account for limited flow through fractures in the till.			
Surface Water / Groundwater Interactions:	Seasonal groundwater contributions to watercourse. Groundwater seepage under baseline conditions during spring months equates to 0.08 L/s or less. Groundwater seepage is at its maximum during and immediately following the spring freshet.	Figures 1 & 2		
Water Budget Results (300 m Upstream of SW6):	The baseline condition water budget results from the integrated model 300 m upstream of monitoring location SW6 are presented in Figure 3a. Condition | GW Out | GW In Baseline (Existing) | 8.77% | 0.00%	Figure 3a		
Water Budget Results (SW6):	The baseline condition water budget results from the integrated at monitoring location SW6 are presented in Figure 4a. Condition | GW Out | GW In Baseline (Existing) | 9.70% | 0.32%	Figure 4a		
Integrated Model Calibration:	A graph comparing simulated and observed flows at SW6 is provided in Graph 4. It should be noted that quarry discharge amounts are not specified in the model but are estimated based on simulated inflows to the quarry. As noted in Section 19.4.2 (p. 416) of the Earthfx report, the discharge to the south sump (upstream of SW6) was simulated with a set of “operating rules” and therefore also may not match the variations in the observed data. The rules defined a 5 day per week discharge rate, with an extra stage-dependent discharge rule that kept the internal quarry pond at a specified level. Actual operations were more intermittent, with spring pumping rates varied on a manual basis	Graph 4	HHIAR (Earthfx, April 2020)	19.4.2 (page 416)

Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alterations to Watercourse:	The only direct impact on this watercourse will be due to installation of an outlet from the temporary settling pond/sump outlet from the adjacent South Extension area. The outlet is expected to be constructed at the channel bank, although no detailed design has been completed to date. The outlet could be as simple as a pipe laid on the ground (given that it won’t be buried where it runs through the adjacent woodland), or it could require some structural measures (e.g., a headwall) to keep the outlet in place. Therefore, some minor disruption to the bed and banks of the watercourse could occur.		NETR (Savanta, April 2020)	75
Change in Primary Source of Flow:	Quarry discharge from Sump 0200 represents the major source of flow to the West Arm. Current quarry approvals permit this discharge to cease once quarry operations are complete. Cessation of quarry discharge into the West Arm would have a negative impact on flow available to support current fish habitat and fish community. As discussed in the Mitigation section below, it has been recommended that quarry discharge continue indefinitely at current levels to prevent these associated negative impacts.		NETR (Savanta, April 2020)	79
Change in Watercourse Catchment Area:	Reduction in catchment area of 11.7 ha. Quarry discharge from Sump 0200 represents the major source of flow to the West Arm. During Phase 1 operations, an additional source of flow will be from dewatering the Phase 1 and 2 extraction area. The quarry discharge from Sump 0200 is to continue throughout Phases 1 and 2 and no impacts are anticipated as a result of the reduction in catchment area.		SWA (Tatham, April 2020)	Drawings DP-1, DP-2 and DP-3

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Simulated Streamflow Change (Integrated Model Results):</td><td>The Earthfx report discusses changes in simulated streamflow under the different quarry expansion phases. Graph 5 reproduces Figure 8.8 (p. 202) and presents simulated baseline(red) and Scenario P12 (blue) flows at location approximately 800 m downstream of SW6. Increase in flow (green) are plotted in reverse on the upper X axis with the scale shown on the right Y axis. Streamflow is predicted to increase due to the discharge of water from dewatering the Phase 12 area. A similar figure (Graph 6) is reproduced for Phase 3456 (Figure 8.46, p. 236), although the upper X axis shows the decrease in streamflow (with positive values indicating an decrease in flow relative to baseline). Flows are generally lower in the winter and spring but higher in the summer and fall periods.</td><td>Graphs 5 & 6</td><td>HHIAR (Earthfx, April 2020)</td><td>198 - 203 and 230 - 237</td></tr>
<tr><td colspan="5">Water Budget Results 300 m Upstream of Monitoring Location SW6</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model 300 m upstream of monitoring location SW6 are presented in Figure 3b.
<table><tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr><tr><td>Baseline (Existing)</td><td>8.77%</td><td>0.00%</td><td>-</td><td>-</td></tr><tr><td>Phases 1 & 2</td><td>4.81%</td><td>0.00%</td><td>-3.96%</td><td>0.00%</td></tr></table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model 300 m upstream of monitoring location SW6are presented in Figure 3c.
<table><tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr><tr><td>Baseline (Existing)</td><td>8.77%</td><td>0.00%</td><td>-</td><td>-</td></tr><tr><td>Phases 3 through 6</td><td>5.66%</td><td>0.00%</td><td>-3.17%</td><td>0.00%</td></tr></table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model 300 m upstream of monitoring location SW6are presented in Figure 3d.
<table><tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr><tr><td>Baseline (Existing)</td><td>8.77%</td><td>0.00%</td><td>-</td><td>-</td></tr><tr><td>Rehab Scenario 1</td><td>4.83%</td><td>0.00%</td><td>-3.94%</td><td>0.00%</td></tr></table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model 300 m upstream of monitoring location SW6are presented in Figure 3e.
<table><tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr><tr><td>Baseline (Existing)</td><td>8.77%</td><td>0.00%</td><td>-</td><td>-</td></tr><tr><td>Rehab Scenario 2</td><td>6.56%</td><td>0.00%</td><td>-2.21%</td><td>0.00%</td></tr></table></td><td>Figure 3e</td><td></td><td></td></tr>
</table>

West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

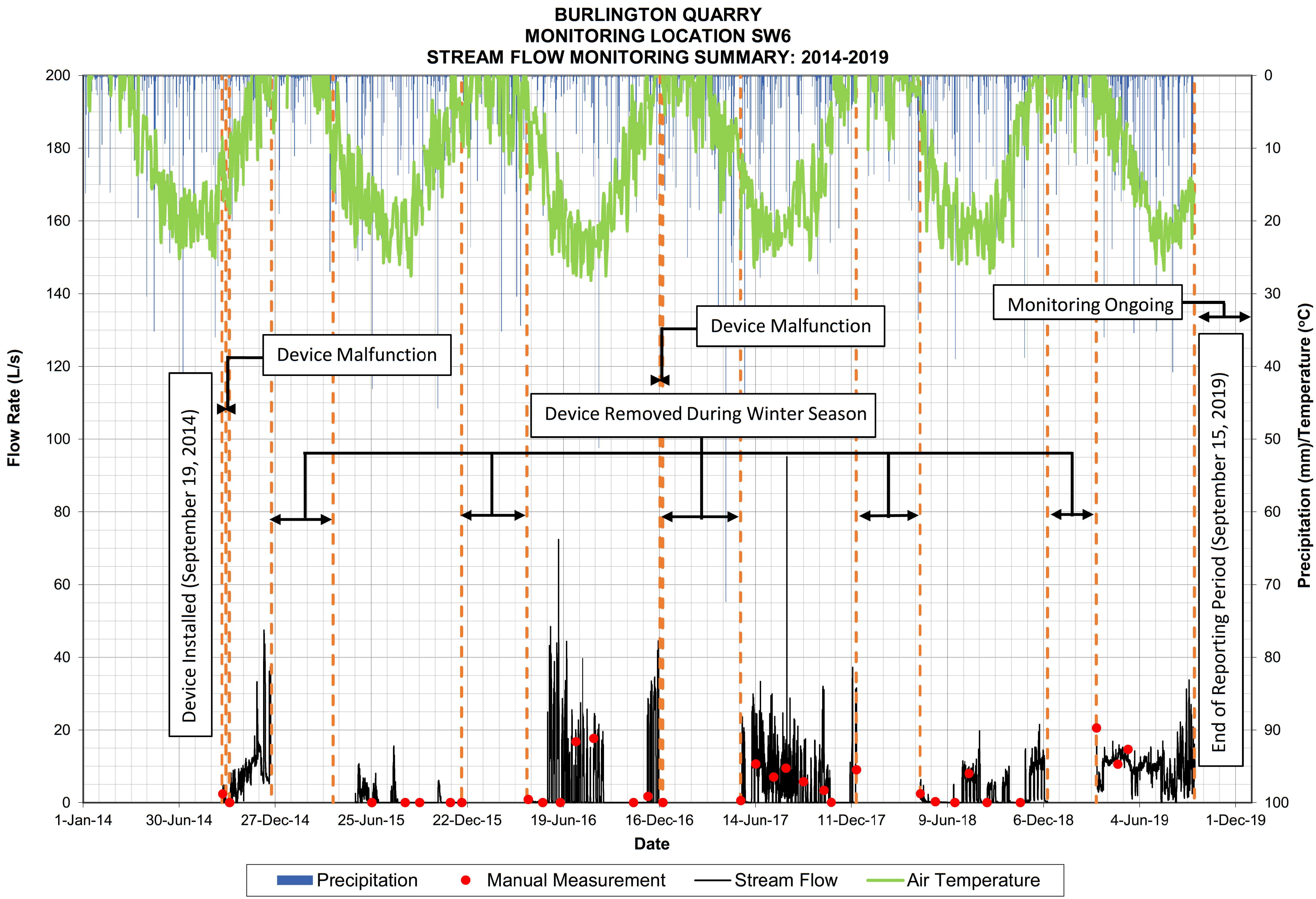
<table>
<thead>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
</thead>
<tbody>
<tr><td colspan="5">Water Budget Results at Monitoring Location SW6</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at monitoring location SW6 are presented in Figure 4b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>9.70%</td><td>0.32%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>10.07%</td><td>0.00%</td><td>0.37%</td><td>-0.32%</td></tr>
</table></td><td>Figure 4b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at monitoring location SW6 are presented in Figure 4c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>9.70%</td><td>0.32%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>7.92%</td><td>0.02%</td><td>-1.78%</td><td>-0.30%</td></tr>
</table></td><td>Figure 4c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at monitoring location SW6 are presented in Figure 4d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>9.70%</td><td>0.32%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>6.13%</td><td>0.09%</td><td>-3.57%</td><td>-0.23%</td></tr>
</table></td><td>Figure 4d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at monitoring location SW6 are presented in Figure 4e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>9.70%</td><td>0.32%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>8.76%</td><td>2.06%</td><td>-0.94%</td><td>1.74%</td></tr>
</table></td><td>Figure 4e</td><td></td><td></td></tr>
<tr><td>Change in Groundwater Contributions to Watercourse:</td><td>Groundwater seepage to the watercourse catchment under Baseline conditions is shown in Graph 7. Under P12 conditions, the dewatering associated with the excavation will reduce that seepage to zero. Under P12 conditions, the leakage from the watercourse will increase. This includes the effect of changes in the south quarry discharge.</td><td>Graphs 7 and 8</td><td></td><td></td></tr>
<tr><td>Change in Watercourse Thermal Regime:</td><td>Negative changes in water temperature are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Temperature of water being discharge from Quarry Sump 0200 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water temperature is anticipated.</td><td></td><td>NETR (Savanta, April 2020)</td><td>79</td></tr>
<tr><td>Change in Water Quality:</td><td>1) Negative changes on water quality are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Quality of water being discharged from Quarry Sump 0200 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water quality in the major source of inflow is expected.

2) Discharge from the temporary settling pond/sump from the South Extension will meet water quality discharge objectives. Therefore, no negative impacts on water quality are expected.</td><td></td><td>NETR (Savanta, April 2020)</td><td>79</td></tr>
<tr><td>Potential Impact to Form and Function of Feature:</td><td>Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the form and habitat functions of this watercourse.</td><td></td><td>NETR (Savanta, April 2020)</td><td>79</td></tr>
<tr><td>Potential Impact to Identified Species and Habitat:</td><td>Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the species and habitat functions of this watercourse.</td><td></td><td>NETR (Savanta, April 2020)</td><td>79</td></tr>
</tbody>
</table>

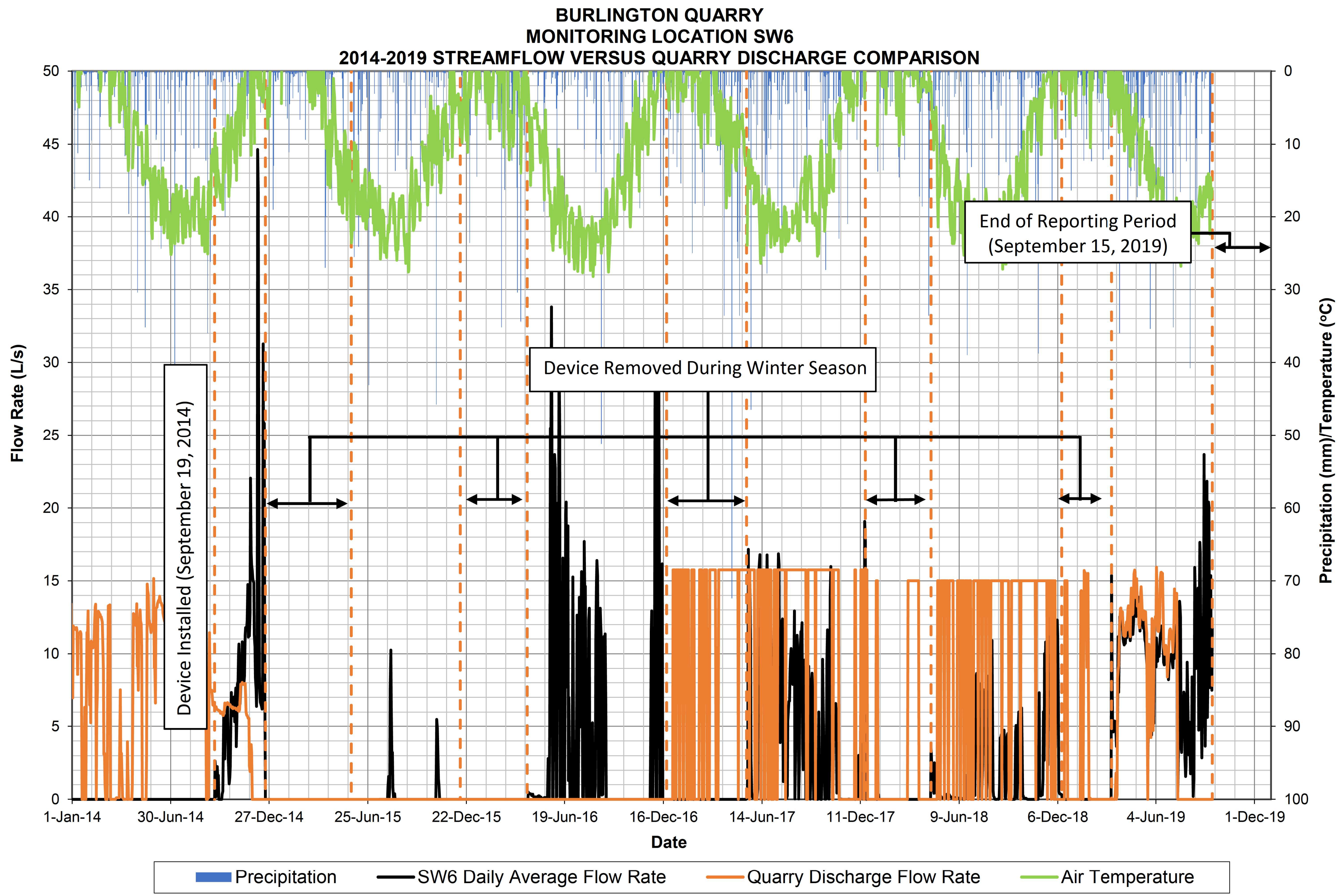
West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

Mitigation	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	1) In-water work required to install the settling pond/sump outlet is recommended to be completed between July 16 and March 14 to minimize the potential for direct and indirect impacts on the reproductive activities of the fish community in the West Arm. 2)Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse. Work-site isolation measures should be considered depending on the final design of the outlet and proposed installation methodology and location. 3) Any riparian areas disturbed during installation of the outlet should be rehabilitated with appropriate native vegetation species following installation of the outlet structure.		NETR (Savanta, April 2020)	75
Source Water Mitigation:	In order to mitigate impacts on fish and fish habitat in the West Arm, pumping and discharge are recommended to occur at the same location at the upstream end of watercourse and in the same manner as existing pumping in accordance with the existing PTTW and Environmental Compliance Approvals regulating current quarry discharge.		NETR (Savanta, April 2020)	79
Groundwater Contribution Mitigation:	None required. Predicted reductions in groundwater contribution to the West Arm are 0.32% or 0.08 L/s or less.			
Erosion Mitigation:	Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse. Work-site isolation measures should be considered depending on the final design of the outlet and proposed installation methodology and location.			
Thermal Mitigation:	No specific thermal mitigation is proposed given that maintaining existing quarry outflows at Sump 0200 are expected to maintain the existing thermal regime of the watercourse without any additional mitigation.		NETR (Savanta, April 2020)	79
Water Quality Mitigation:	1) No specific water quality mitigation over and above that of the existing quarry operations is proposed given that maintaining existing quarry outflows at Sump 0200 are expected to maintain the existing water quality regime of the watercourse without any additional mitigation. The quarry extension is not predicted to result in any changes in the quality of water being discharged from Sump 0200. 2) The temporary settling pond and longer-term sump that will discharge to the West Arm will be required to meet discharge water quality criteria with respect to total suspended solids and other potential contaminants.		NETR (Savanta, April 2020)	79

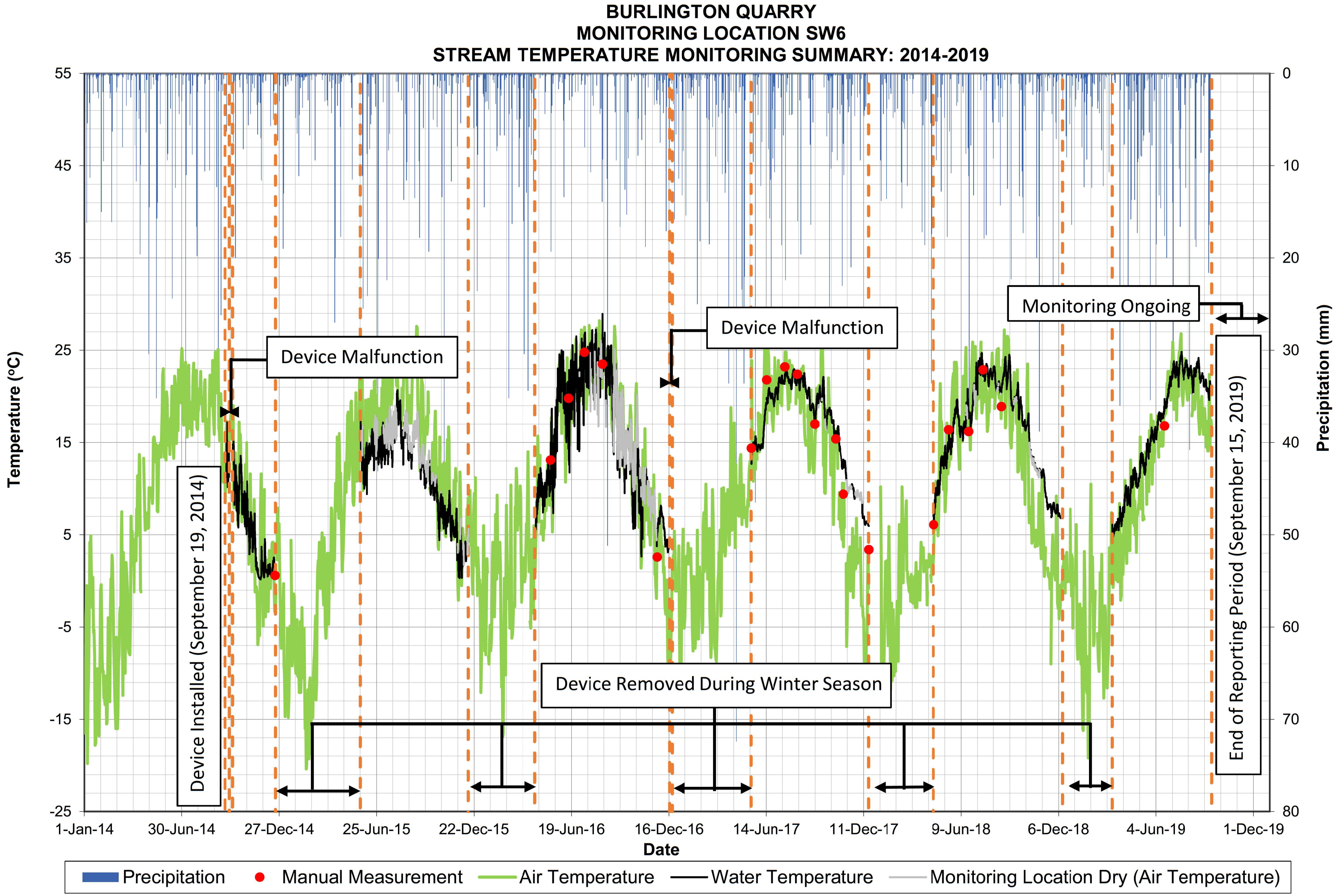
WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 1



WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 2



WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 3



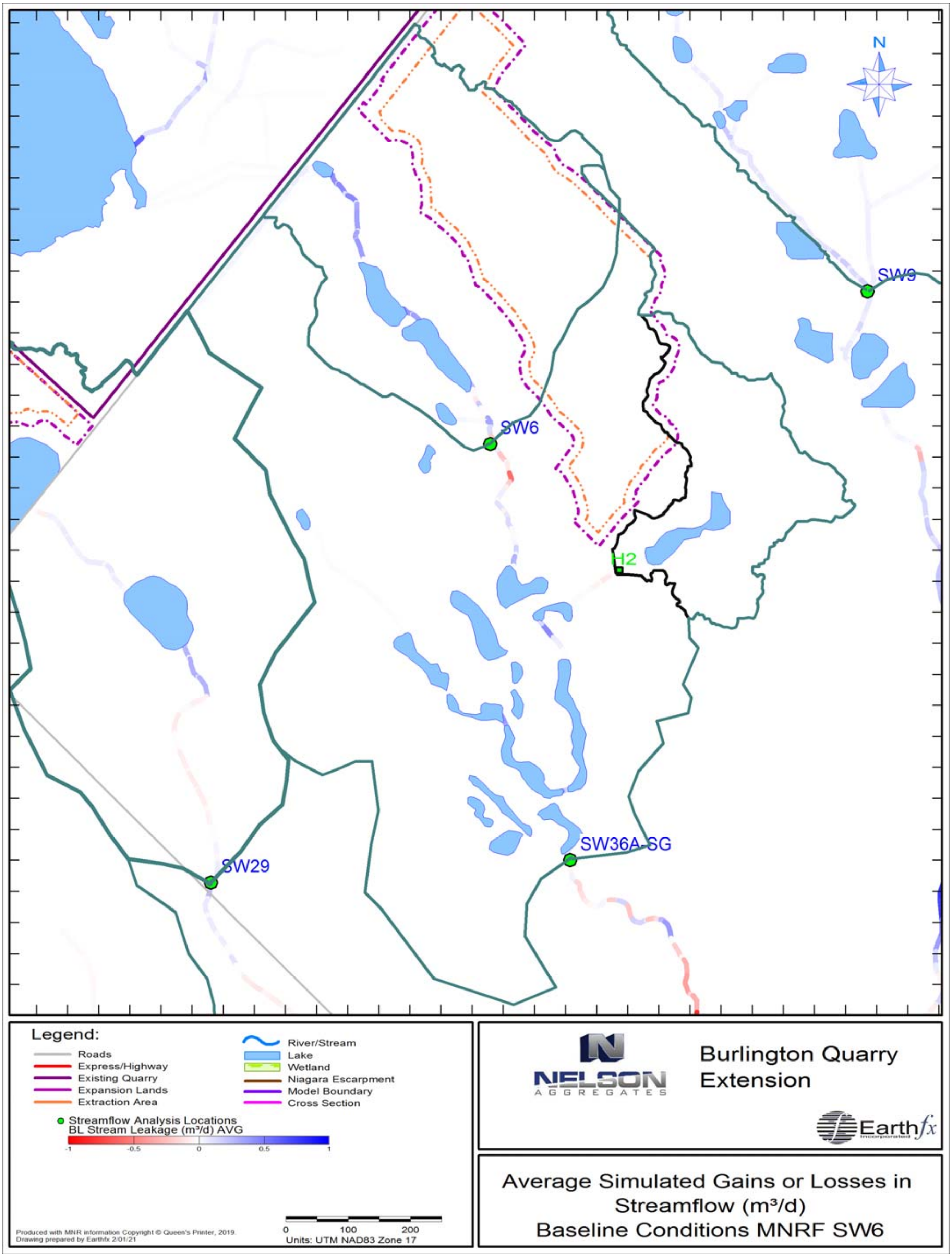
* Grey data indicates the monitoring location was dry and therefore the recorded values are respresentative of the air temperature.

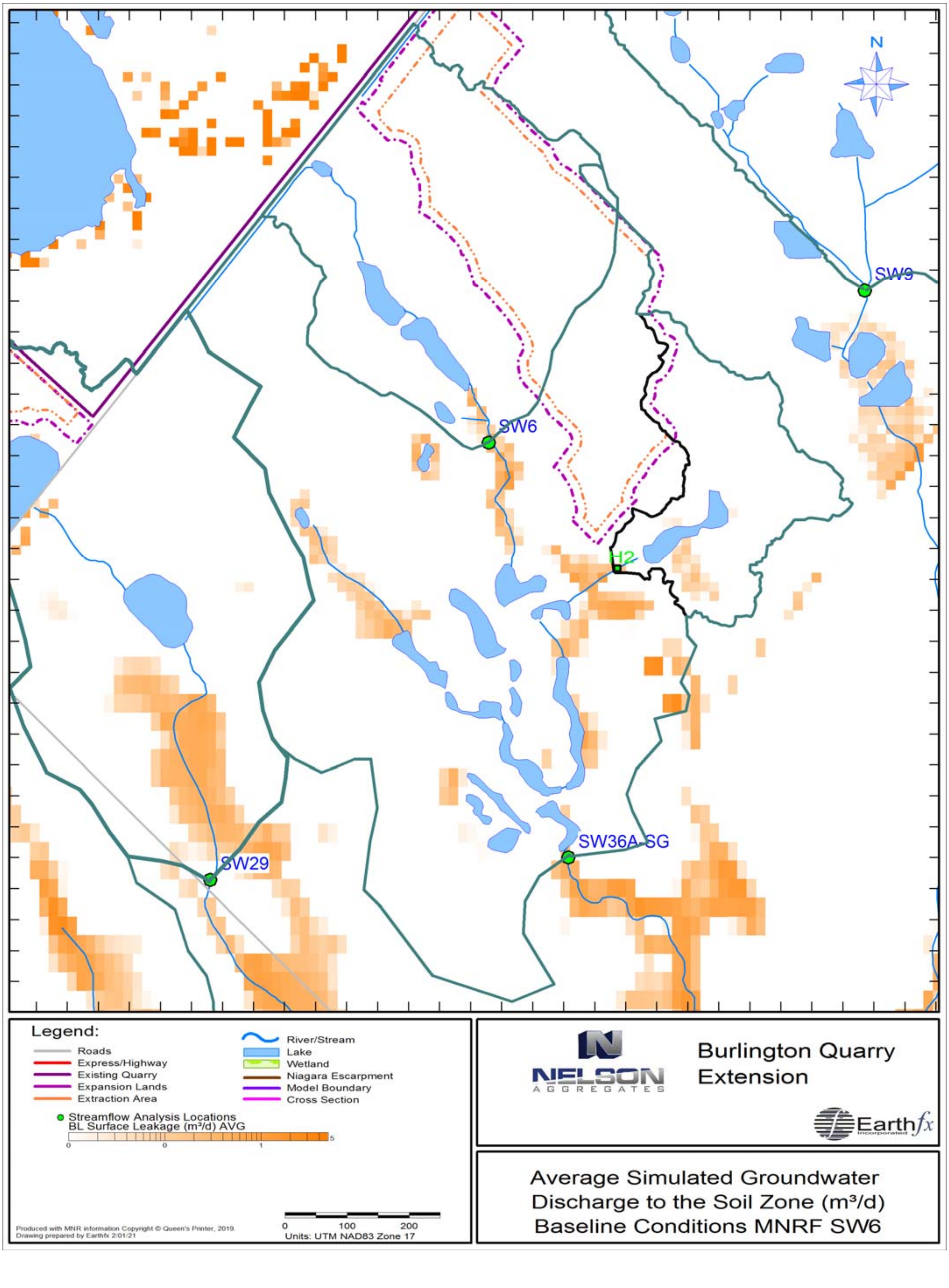
WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - TABLE 1

BURLINGTON QUARRY
TATHAM ENGINEERING PROJECT NO.: 113187
SURFACE WATER MONITORING

WATER QUALITY SAMPLE RESULTS

Monitoring Location SW6													
		Sample Date:	24-Oct-18	24-Apr-19	19-Jun-19	25-Sep-19	20-May-20	15-Jul-20	16-Sep-20	11-Nov-20	Maximum	Minimum	Average
Parameter:	Units:	M.D.L.	CM/JG	CM/JG	CM	CM	JG	JG/JH/JM	JH/JM	JG/JH			
M-Alkalinity (pH 4.5)	mg/L as CaCO3	2		170	172	137	169	125			172	137	160
Ammonia (as N)	mg/L	0.01		<0.01	0.04	0.02	<0.01	<0.01			0.04	0.02	0.02
BOD (5 day)	mg/L	1		0.9	<0.9	0.9	<1	<1			0.9	0.9	0.9
Bicarbonate	mg/L as CaCO3	1		169		136		124			169	136	102
Carbonate	mg/L as CaCO3	1		1		<1		<1			1	1	1
Conductivity	µS/cm	1		798	843	934	975	1020			934	798	858
Dissolved Organic Carbon	mg/L	0.4		2.7	3	3.4	2.2	3.4			3.4	2.7	3.0
Field pH	pH	N/A			8.4	8.7	8.4				8.7	8.4	5.7
Field Temp	°C	N/A			15.1	16.1	17.2				16.1	15.1	10.4
Aluminum	ug/L	1		6	2	<1	<1	<1			6	2	3
Antimony	ug/L	0.5		<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	<0.5	0.5
Arsenic	ug/L	1		2	3	4	2	6			4	2	3
Barium	ug/L	1		31	30	32	33	23			32	30	31
Beryllium	ug/L	0.5		<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	<0.5	0.5
Bismuth	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Boron	ug/L	2		66	71	160	116	157			160	66	99
Cadmium	ug/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	0.1
Calcium	ug/L	500		85600	85900	74700	87100	80800			85900	74700	82067
Cerium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Cesium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Chromium	ug/L	1		3	3	3	2	1			3	3	3
Cobalt	ug/L	0.1		0.2	0.2	0.1	0.2	0.2			0.2	0.1	0.2
Copper	ug/L	1		<1	4	<1	2	2			4	4	2
Europium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Gallium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Iron	ug/L	20		89	211	180	282	180			211	89	160
Lanthanum	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Lead	ug/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	0.1
Lithium	ug/L	5		10	11	13	14	23			13	10	11
Magnesium	ug/L	5		35500	39100	41300	45500	42300			41300	35500	38633
Manganese	ug/L	10	DRY	<1	31	15	8	37	DRY	DRY	31	15	19
Mercury	ug/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	0.1
Molybdenum	ug/L	1		4	4	3	4	5			4	3	4
Nickel	ug/L	1		4	4	3	4	3			4	3	4
Niobium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Phosphorus	ug/L	50		<50	<50	<50	<50	<50			<50	<50	50
Potassium	ug/L	1		3980	4380	6510	4950	6480			6510	3980	4957
Rubidium	ug/L	1		2	2	3	2	3			3	2	2
Scandium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Selenium	ug/L	0.5		1.7	1.1	0.9	2.2	<0.5			1.7	0.9	1.2
Silicon	ug/L	2		670	900	1230	500	1550			1230	670	933
Silver	ug/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	0.1
Sodium	ug/L	1000		30400	36800	46100	48200	44500			46100	30400	37767
Strontium	ug/L	1		1270	1190	1380	1310	1440			1380	1190	1280
Sulphur	ug/L	800		63600	74400	79100	82400	83800			79100	63600	72367
Tellurium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Thallium	ug/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	0.1
Thorium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Tin	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Titanium	ug/L	1		2	<1	<1	<1	<1			2	2	1
Tungsten	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Uranium	ug/L	1		<1	<1	<1	1	1			<1	<1	1
Vanadium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Yttrium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
Zinc	ug/L	1		<1	3	1	3	3			3	1	2
Zirconium	ug/L	1		<1	<1	<1	<1	<1			<1	<1	1
pH	pH	N/A		7.89	7.82	7.85	8.24	7.66			7.9	7.8	7.9
Total Hardness (as CaCO3)	mg/L	0.1		360	376	357	405	376			376	357	364
Chemical Oxygen Demand	mg/L	5		8	12	<5	<5	<5			12	8	8
Total Dissolved Solids	mg/L	3		593	631	695	709	724			695	593	640
Total Suspended Solids	mg/L	0.67		<0.67	<0.67	2	1	<0.67			2.00	2.00	1.11
Turbidity	NTU	0.1		0.5	0.4	0.2	0.4	0.2			0.5	0.2	0.4


N
SW9
SW6
H2
SW36A-SG
SW29
Legend:
Roads
Express/Highway
Existing Quarry
Expansion Lands
Extraction Area
River/Stream
Lake
Wetland
Niagara Escarpment
Model Boundary
Cross Section
Streamflow Analysis Locations
BL Stream Leakage (m³/d) AVG
-1
-0.5
0
0.5
1
NELSON AGGREGATES
Burlington Quarry Extension
Earthfx Incorporated
Average Simulated Gains or Losses in Streamflow (m³/d)
Baseline Conditions MNRF SW6
Produced with MNR information Copyright © Queen's Printer, 2019.
Drawing prepared by Earthfx 2/01/21
0
100
200
Units: UTM NAD83 Zone 17


N
SW9
SW6
H2
SW36A-SG
SW29
Legend:
Roads
Express/Highway
Existing Quarry
Expansion Lands
Extraction Area
River/Stream
Lake
Wetland
Niagara Escarpment
Model Boundary
Cross Section
Streamflow Analysis Locations
BL Surface Leakage (m³/d) AVG
0
0
1
5
Produced with MNR information Copyright © Queen's Printer, 2019.
Drawing prepared by Earthfx 2/01/21
0 100 200
Units: UTM NAD83 Zone 17
NELSON AGGREGATES
Burlington Quarry Extension
Earthfx Incorporated
Average Simulated Groundwater Discharge to the Soil Zone (m³/d) Baseline Conditions MNRF SW6

WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK

FIGURE 3A

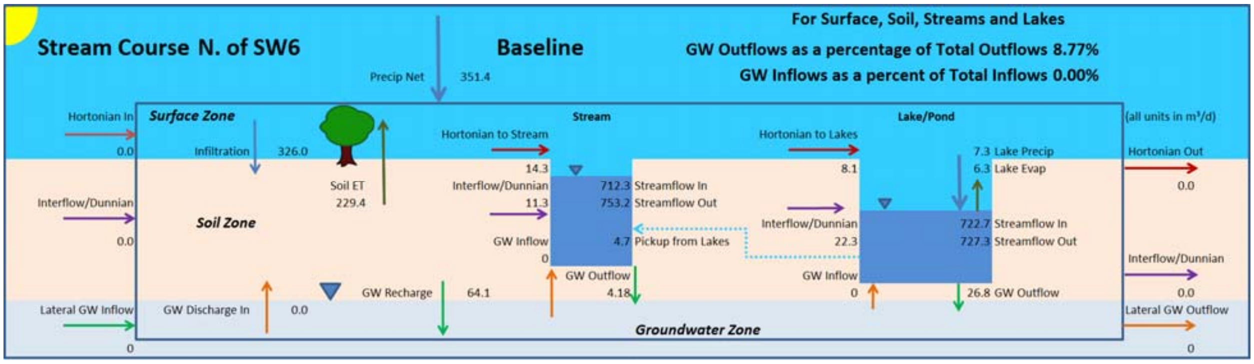


FIGURE 3B

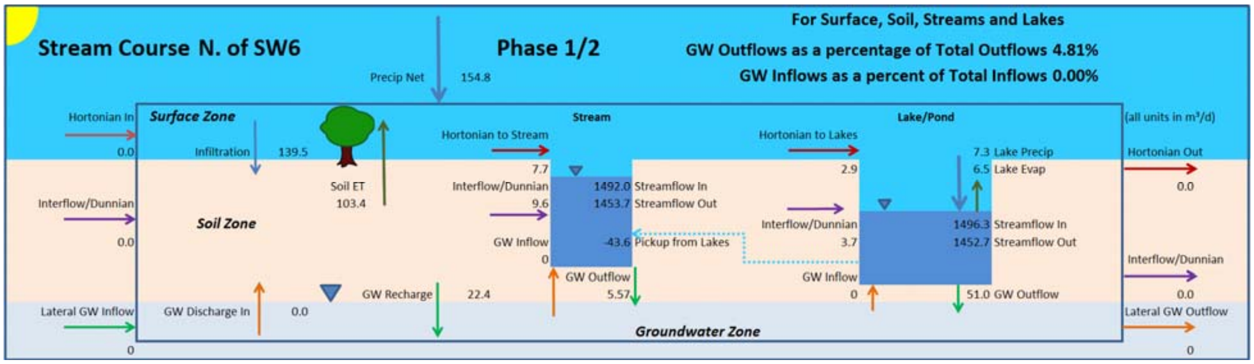


FIGURE 3C

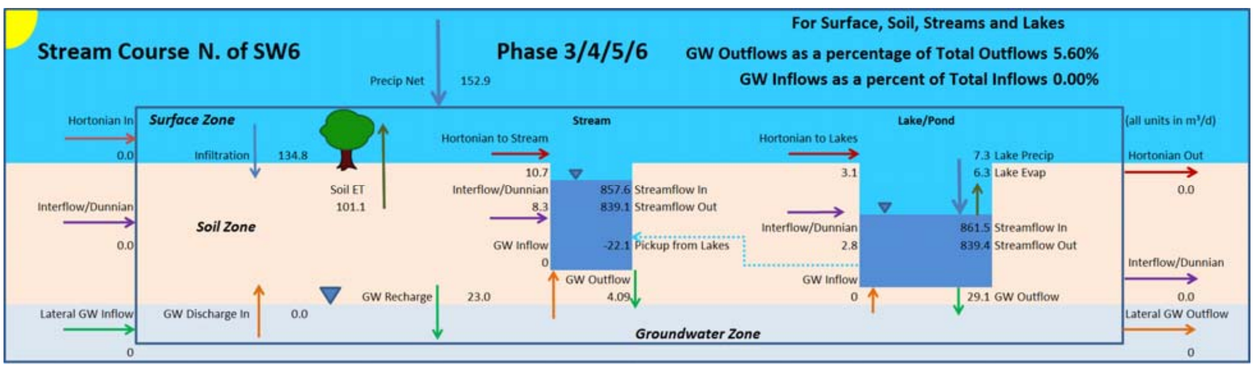


FIGURE 3D

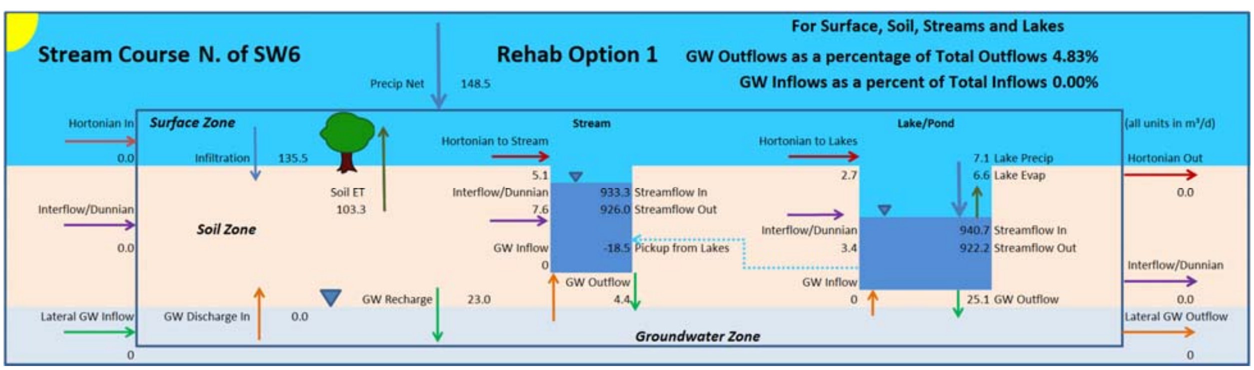
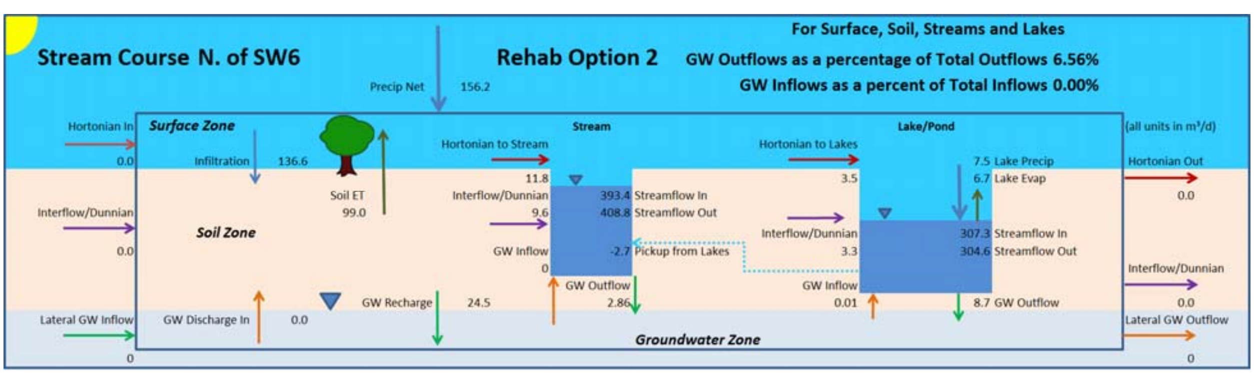


FIGURE 3E



WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK

FIGURE 4A

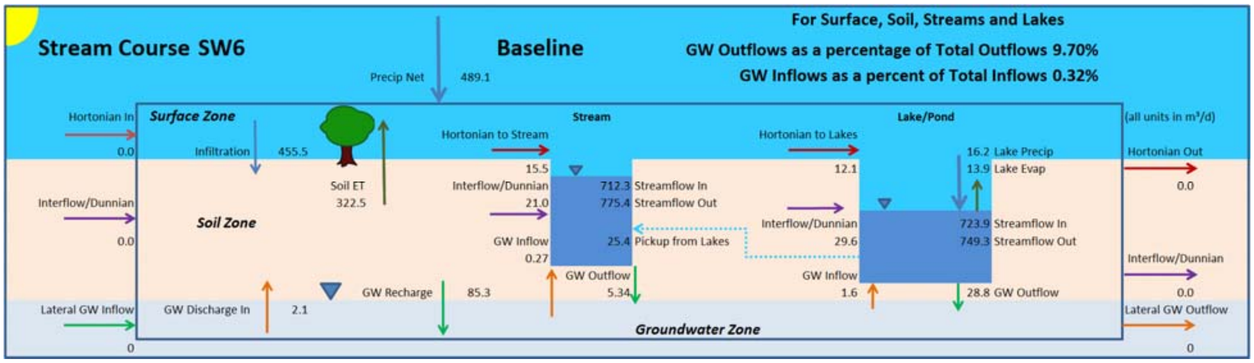


FIGURE 4B

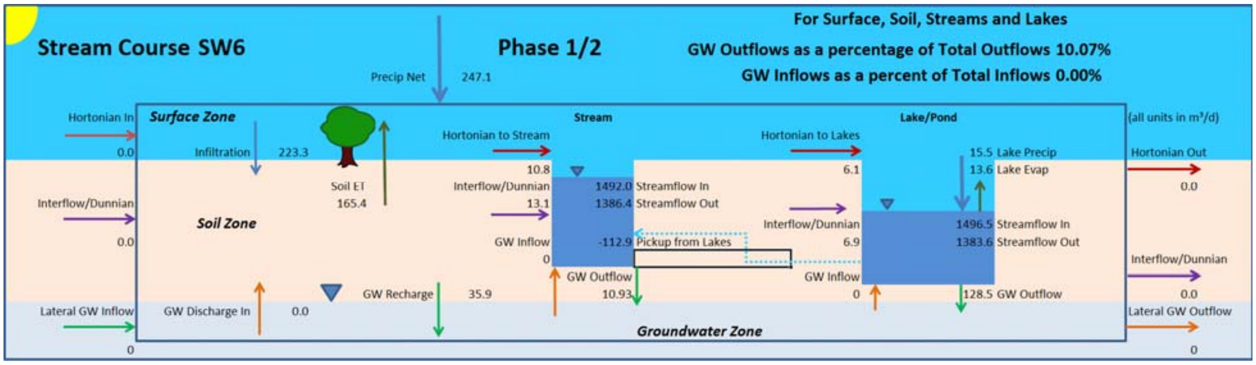


FIGURE 4C

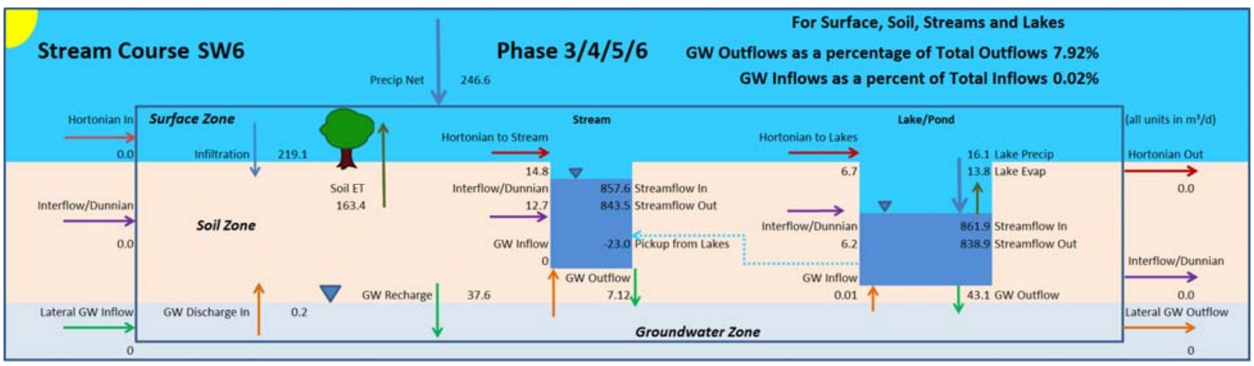


FIGURE 4D

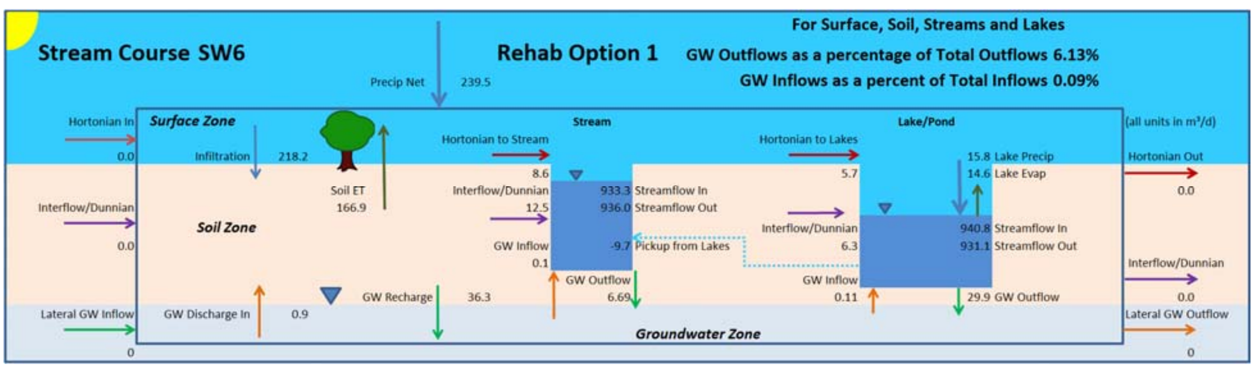
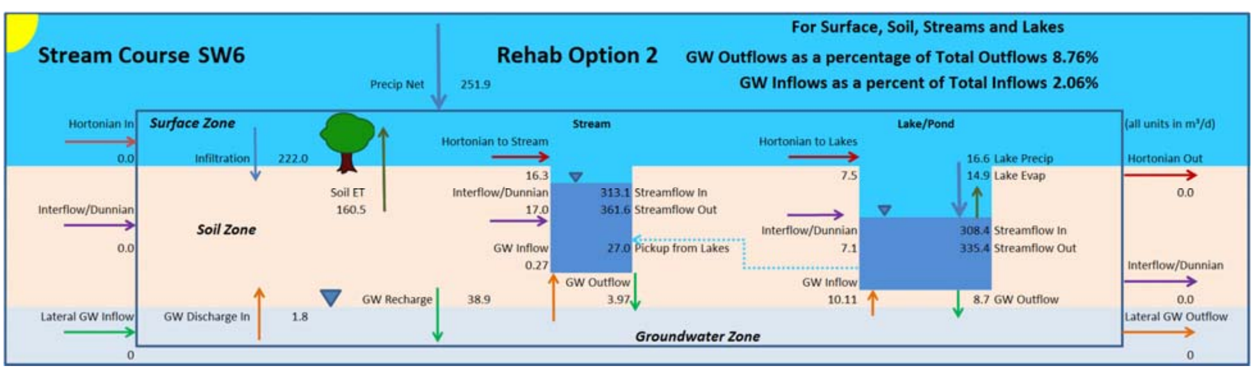
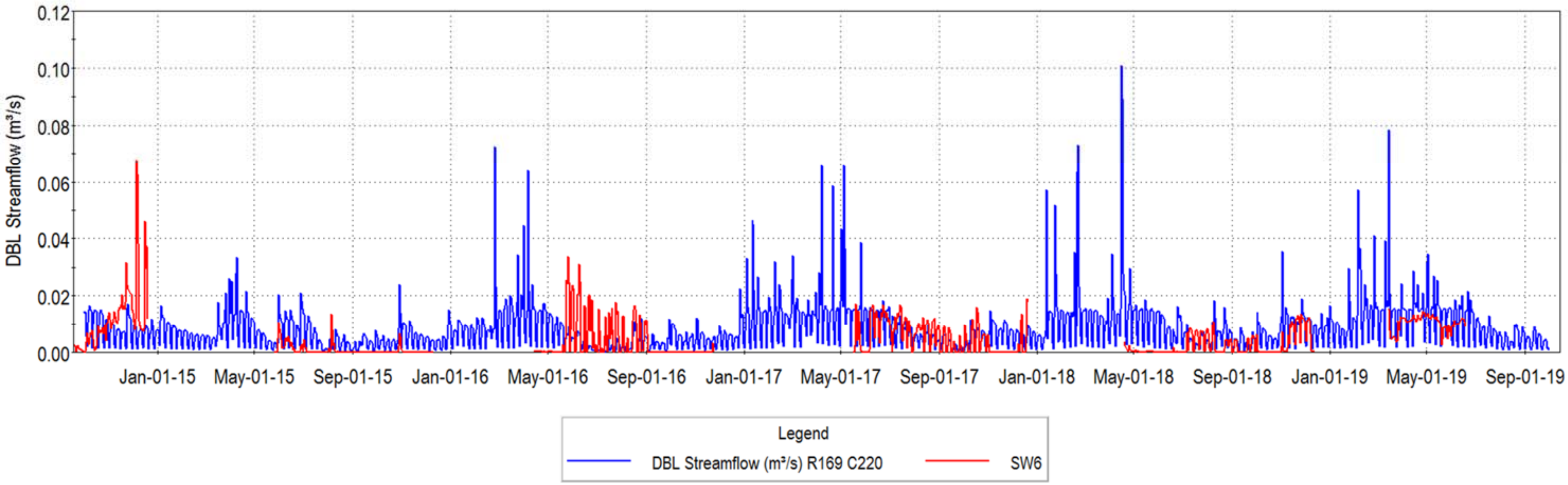
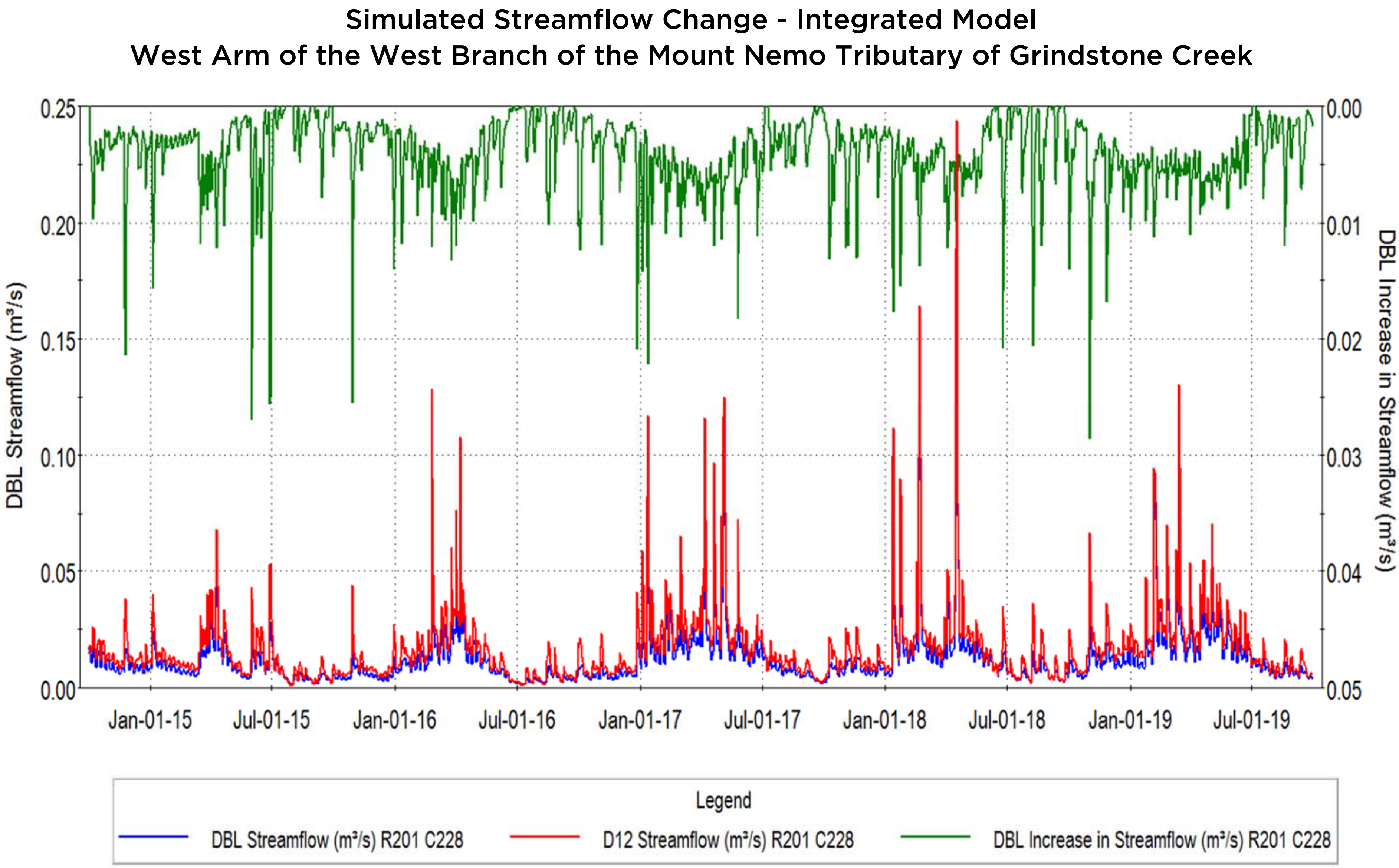


FIGURE 4E

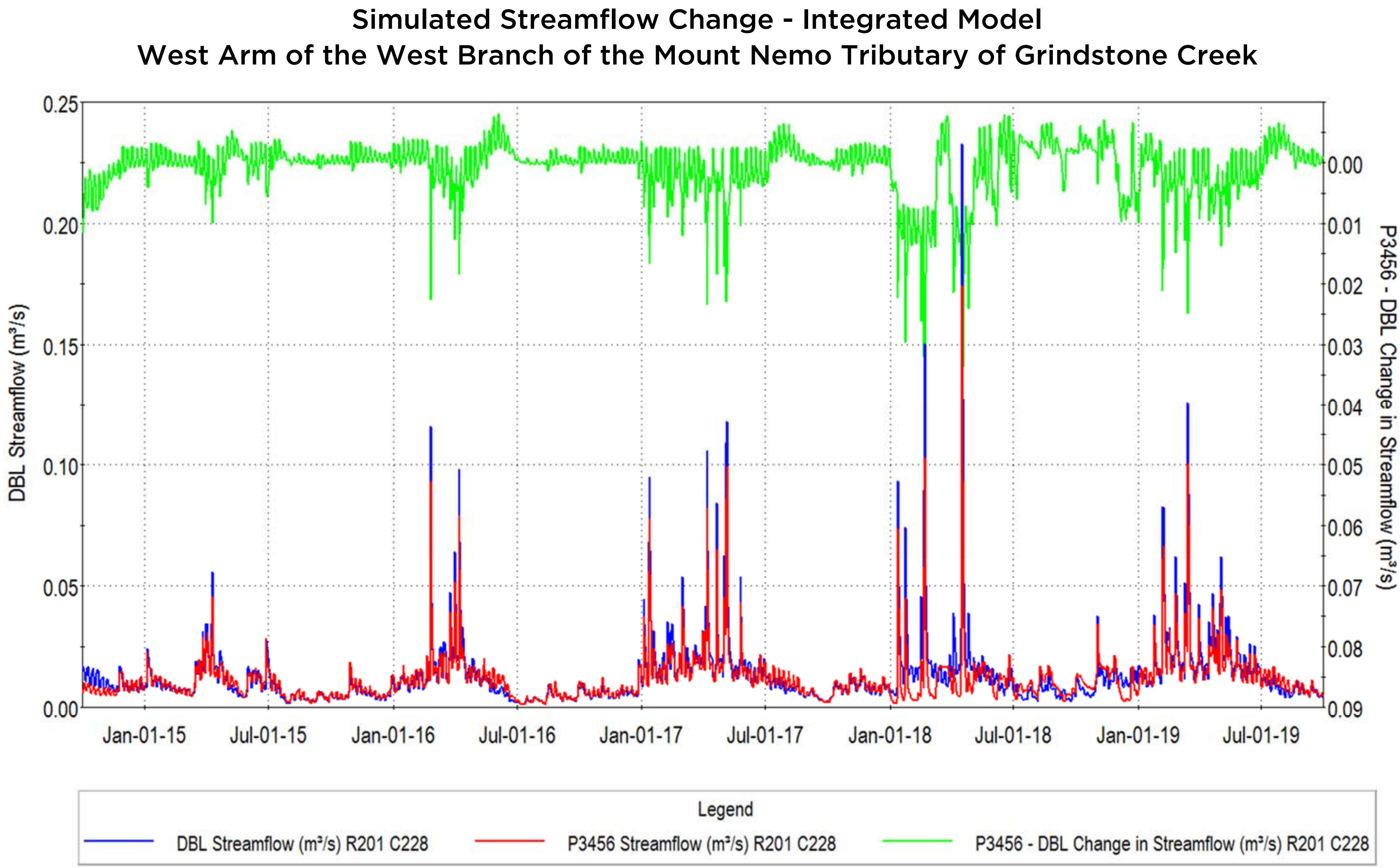


Integrated Model Calibration
West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek

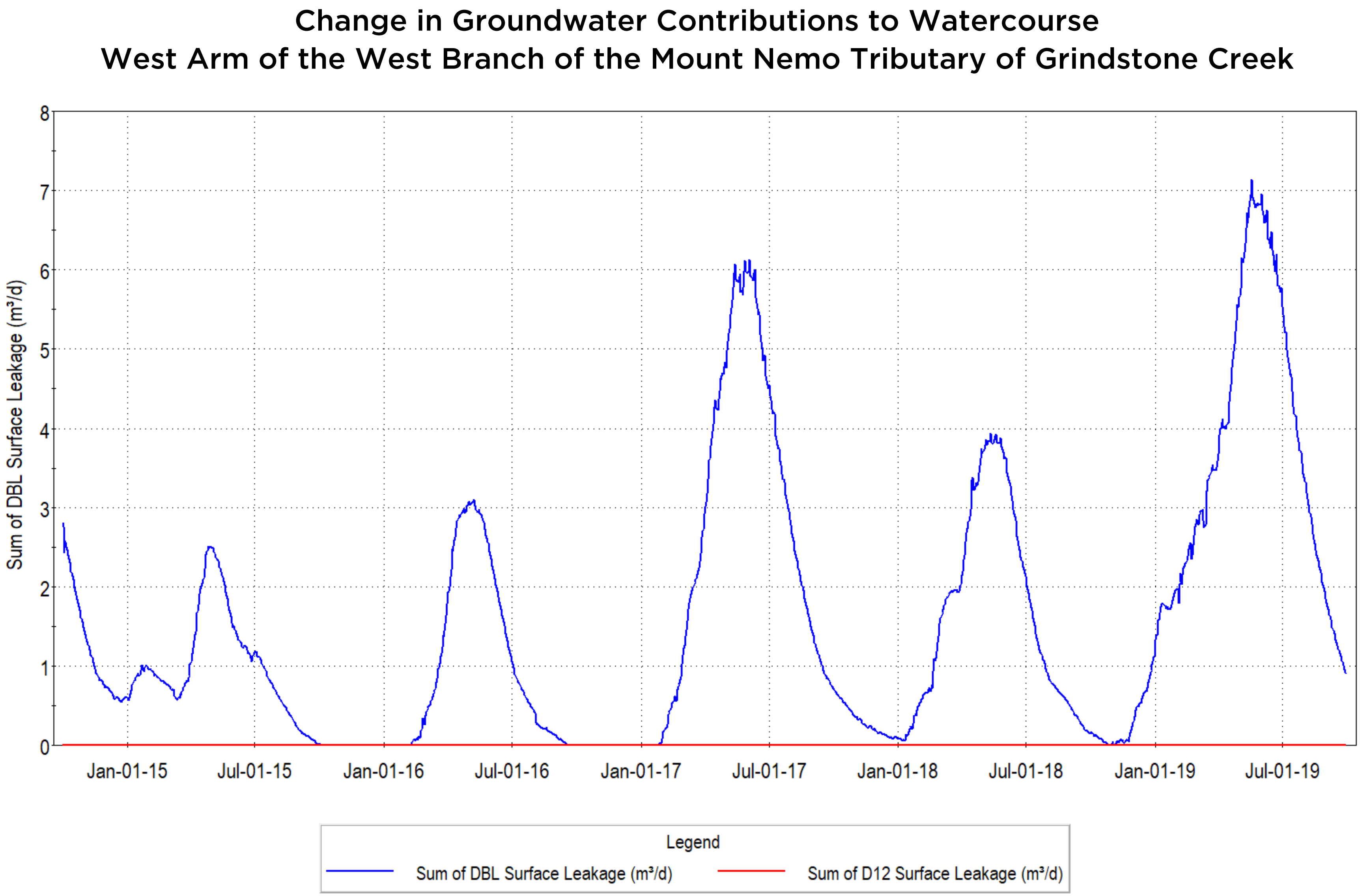


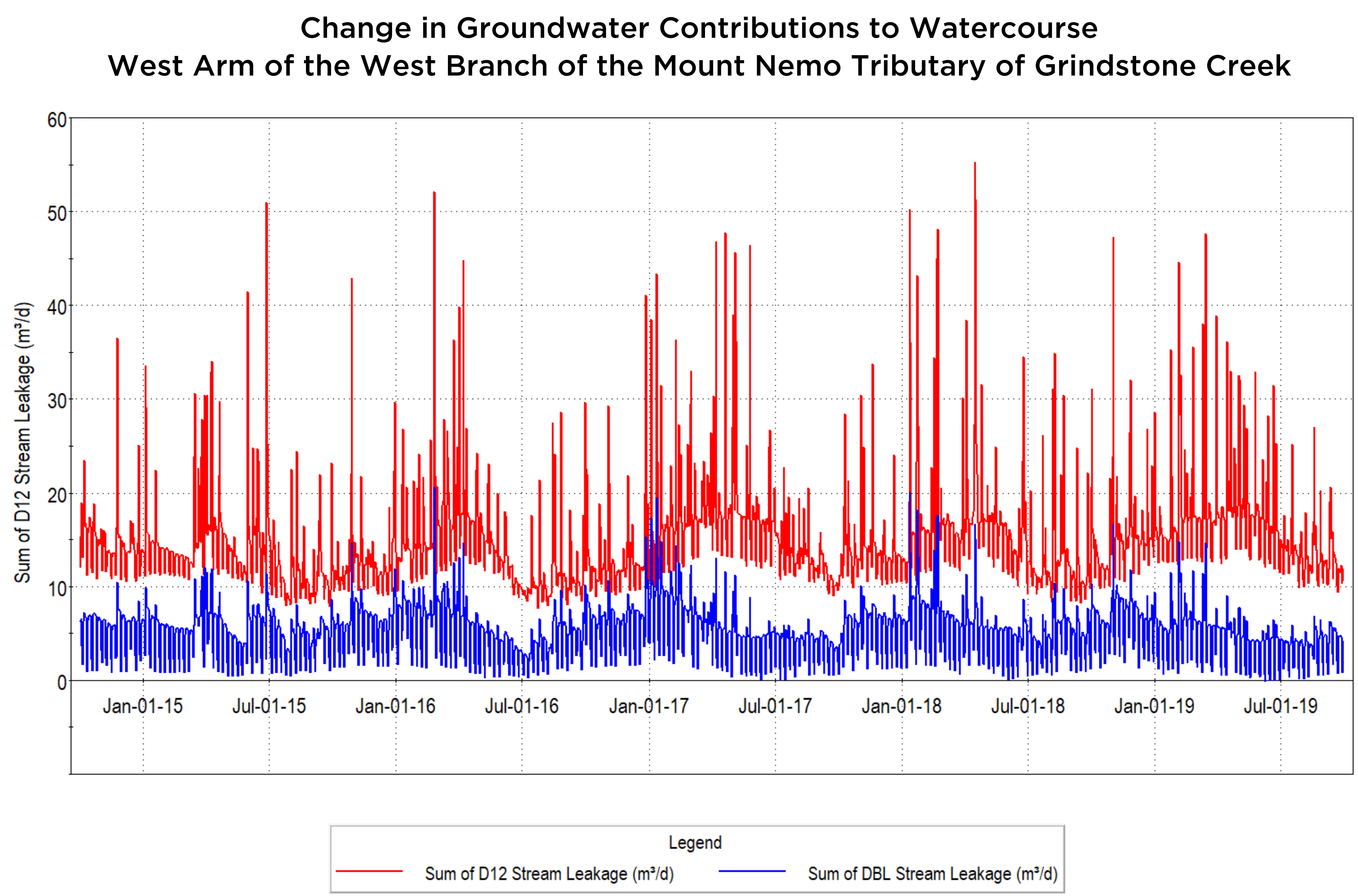

Simulated Streamflow Change - Integrated Model
West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
DBL Streamflow (m³/s)
0.25
0.20
0.15
0.10
0.05
0.00
DBL Increase in Streamflow (m³/s)
0.00
0.01
0.02
0.03
0.04
0.05
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R201 C228
D12 Streamflow (m³/s) R201 C228
DBL Increase in Streamflow (m³/s) R201 C228

WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 6

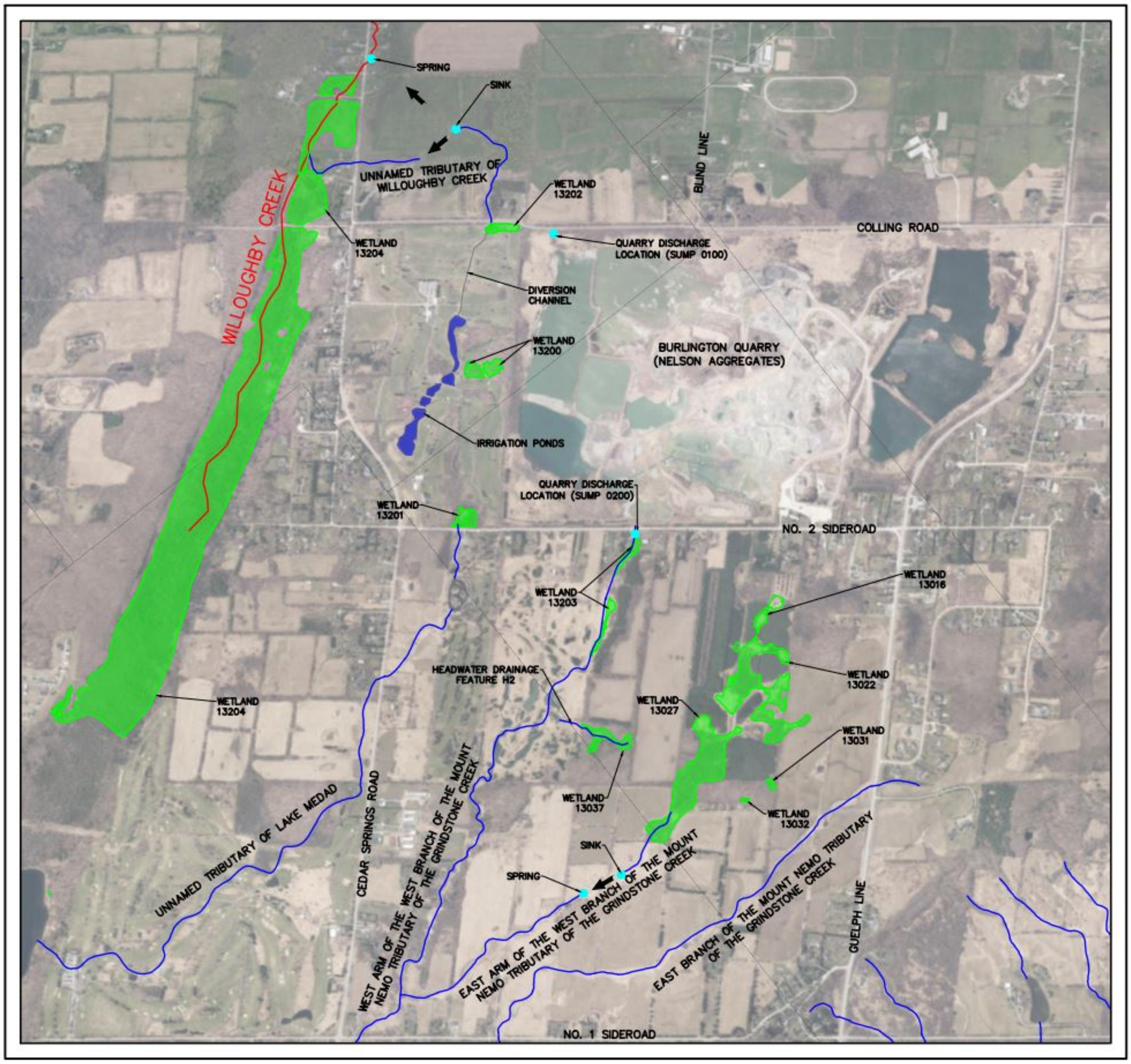


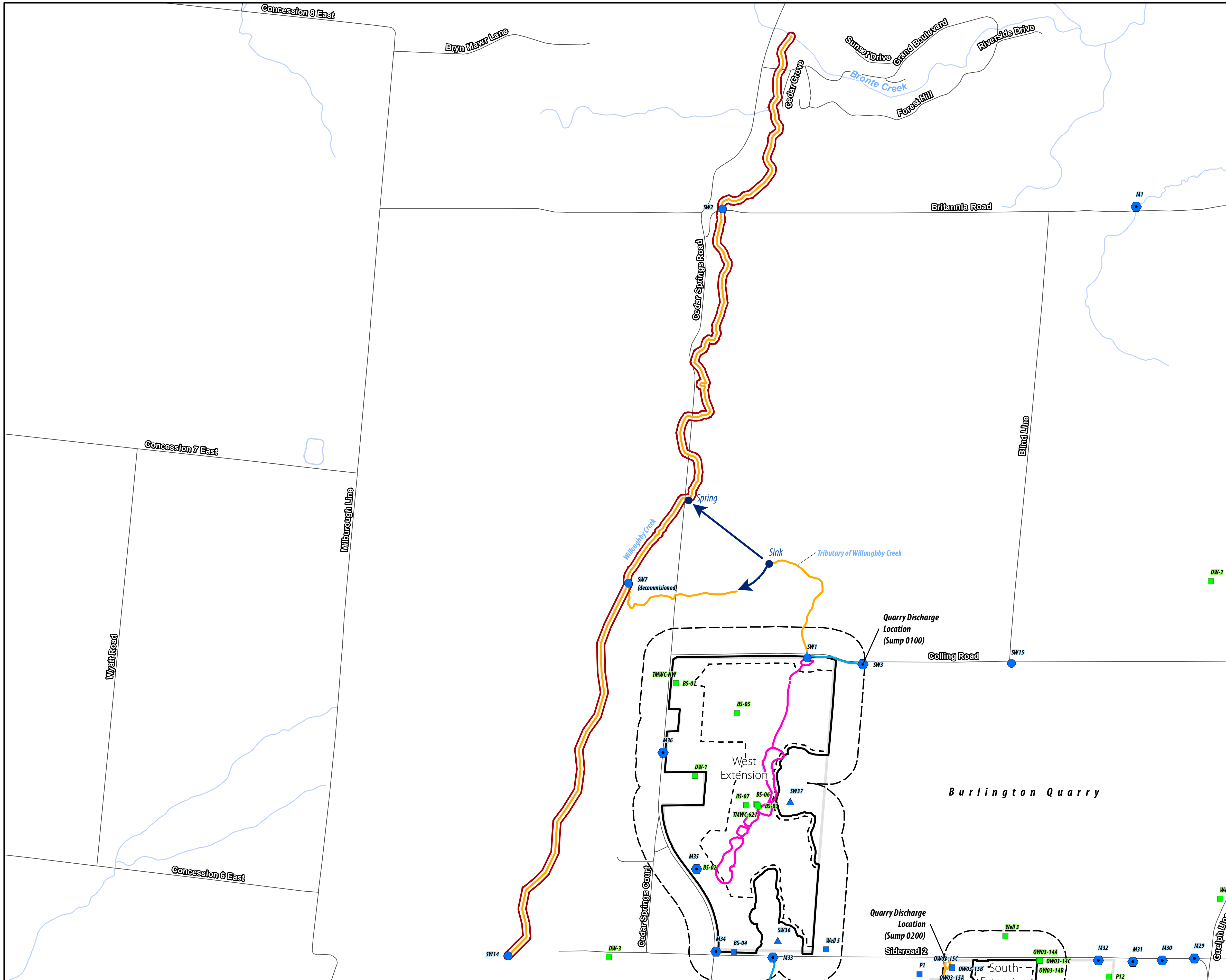
WEST ARM OF THE WEST BRANCH OF THE MOUNT NEMO TRIBUTARY OF GRINDSTONE CREEK - GRAPH 7




Change in Groundwater Contributions to Watercourse
West Arm of the West Branch of the Mount Nemo Tributary of Grindstone Creek
Sum of D12 Stream Leakage (m³/d)
60
50
40
30
20
10
0
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
Sum of D12 Stream Leakage (m³/d)
Sum of DBL Stream Leakage (m³/d)

WILLOUGHBY CREEK





Legend

- Licensed Boundary
- Limit of Extraction
- 120 m Adjacent Lands
- Subject Lands
- Willoughby Creek
- Road
- Golf Course Irrigation Ponds and Channel
- Indirect Fish Habitat
- Direct Fish Habitat
- Watercourse
- Waterbody
- Wetland (Savanta, 2020)

Current Instrumentation

- Groundwater Monitoring Station (EarthFx)
- Mini Piezometer (Tatham Engineering)
- Staff Gauge & Surface Water Monitoring Station (Tatham Engineering)
- Manual Stream Flow Measurement (Tatham Engineering)

Previous Instrumentation

- Groundwater Monitoring Station (Golder)
- Staff Gauge & Surface Water Monitoring Station (Golder)

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Orthoimagery © First Base Solutions, 2021. Imagery taken in 2019.

Project 8133

Burlington Quarry Extension
Nelson Aggregates Co.

Figure 12
Watercourse Characterization

Willoughby Creek

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Path: C:\Savanta\8133 - Burlington Quarry\figures\report_figures\2021 01 21 natural feature tech summary\8133_rpt_watercourse_char_mapbook.mxd April 8, 2021

Willoughby Creek

Surface Water Characteristics	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Watercourse Name:	Willoughby Creek			
Watershed:	Bronte Creek Watershed			
Sub-Watershed:	Willoughby Creek Watershed			
Located in Proposed Limit of Extraction:	No			
Located in Proposed License Boundary:	No			
Catchment Area (ha):	1091 ha (at Britannia Road)			
Catchment ID:	N/A			
Primary Source(s) of Flow:	Primary - discharge from Burlington Quarry (Sump 0100) Secondary - surface runoff Tertiary - groundwater seepage			
Discharge from Quarry / PTTW:	Yes - PTTW 96-P-3009		SWA (Tatham, April 2020)	Appendix A
Conditions of PTTW:	Maximum discharge rate = 4,090 L/min (68.17 L/s) Maximum discharge amount = 5,889,600 L/day		SWA (Tatham, April 2020)	Appendix A
Surface Water Monitoring:	ID: SW2 (Tatham) Installation Date: April 17, 2014 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Coordinates of Monitoring Station: Easting 589015.325, Northing 4805832.639	Graphs 1 & 2 and Table 1	SWA (Tatham, April 2020)	2.1.1, Appendix B and Appendix H
	ID: SW7 (Tatham) Installation Date: September 19, 2014 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Location Coordinates: Easting 588319.945, Northing 4805441.072	Graphs 3 & 4	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	ID: SW14 (Tatham) Installation Date: October 2, 2014 Data Collection: Continuous water level and temperature, manual monthly in-situ streamflow measurements and calibration data (water level converted to flow using rating curve) Location Coordinates: Easting 589226.754, Northing 4804106.857	Graphs 5 & 6 and Table 2	SWA (Tatham, April 2020)	2.1.1, Appendix B and Appendix H
Streamflow Conditions:	Permanent watercourse at Britannia Road (SW2), intermittent watercourse at monitoring locations SW7 and SW14. Watercourse dependent on quarry discharge downstream of confluence with Unnamed Tributary of Willoughby Creek.	Graphs 1, 3 & 5	SWA (Tatham, April 2020)	2.1.1 and Appendix B

Surface Water Characteristics	Description					Figure / Graph / Table	Reference	
							Report	Section / Page
Average Daily Flow (SW2):	Average Daily Streamflow (L/s)				Notes:	Graph 1	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average streamflow recorded for period of record Average - average daily streamflow recorded for period of record Maximum - maximum daily average streamflow recorded for period of record N/A - data not available as device removed from watercourse during winter months			
	January	37.3	119.9	512.7				
	February	39.8	116.5	779.3				
	March	35.1	150.0	989.1				
	April	86.1	219.0	697.8				
	May	36.4	207.8	1275.7				
	June	41.5	117.7	939.1				
	July	35.3	81.0	402.5				
	August	27.8	91.2	1511.3				
	September	29.3	83.9	300.2				
	October	31.6	86.2	282.9				
	November	38.8	105.8	513.3				
	December	30.8	90.7	230.6				
Average Daily Flow (SW7):	Average Daily Streamflow (L/s)				Notes:	Graph 3	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average streamflow recorded for period of record Average - average daily streamflow recorded for period of record Maximum - maximum daily average streamflow recorded for period of record N/A - data not available as device removed from watercourse during winter months			
	January	N/A	N/A	N/A				
	February	N/A	N/A	N/A				
	March	102.1	217.9	665.9				
	April	31.8	115.1	314.4				
	May	16.7	75.0	285.2				
	June	9.1	41.7	329.4				
	July	3.3	19.4	78.3				
	August	0.9	15.0	58.1				
	September	1.8	16.0	87.2				
	October	1.8	24.1	99.3				
	November	7.5	38.0	288.3				
	December	7.1	35.0	140.4				
Average Daily Flow (SW14):	Average Daily Streamflow (L/s)				Notes:	Graph 5	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average streamflow recorded for period of record Average - average daily streamflow recorded for period of record Maximum - maximum daily average streamflow recorded for period of record N/A - data not available as device removed from watercourse during winter months			
	January	N/A	N/A	N/A				
	February	N/A	N/A	N/A				
	March	N/A	N/A	N/A				
	April	6.1	25.3	67.5				
	May	2.7	17.0	56.6				
	June	0.0	8.4	45.3				
	July	0.0	3.1	23.9				
	August	0.0	2.8	28.4				
	September	0.0	1.7	19.3				
	October	0.0	5.8	34.6				
	November	0.0	6.3	74.3				
	December	0.0	2.9	10.0				

Surface Water Characteristics	Description					Figure / Graph / Table	Reference	
							Report	Section / Page
Watercourse Thermal Regime (SW2):	Average Daily Water Temperature (°C)				Notes:	Graph 2	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average water temperature recorded for period of record			
	January	-1.4	1.8	5.0				
	February	-1.6	1.9	7.9				
	March	-1.1	3.1	9.6	Average - average daily water temperature recorded for period of record			
	April	0.6	6.7	16.0				
	May	3.5	12.0	21.7				
	June	10.0	16.2	23.8	Maximum - maximum daily average water temperature recorded for period of record			
	July	13.2	18.9	25.9				
	August	12.9	18.7	24.5				
	September	11.4	17.1	23.2	N/A - data not available as device removed from watercourse during winter months			
	October	6.2	12.3	19.4				
	November	1.1	6.7	13.7				
	December	-1.5	3.3	8.9				
Watercourse Thermal Regime (SW7):	Average Daily Water Temperature (°C)				Notes:	Graph 4	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average water temperature recorded for period of record			
	January	N/A	N/A	N/A				
	February	N/A	N/A	N/A				
	March	0.7	1.8	5.4	Average - average daily water temperature recorded for period of record			
	April	1.0	6.2	12.5				
	May	5.0	11.4	20.4				
	June	9.6	14.4	20.9	Maximum - maximum daily average water temperature recorded for period of record			
	July	12.2	16.6	212.7				
	August	13.7	17.3	23.1				
	September	11.1	16.2	20.9	N/A - data not available as device removed from watercourse during winter months			
	October	6.6	12.2	18.9				
	November	1.6	7.0	13.4				
	December	1.4	4.5	8.1				
Watercourse Thermal Regime (SW14):	Average Daily Water Temperature (°C)				Notes:	Graph 6	SWA (Tatham, April 2020)	2.1.1 and Appendix B
	Month	Minimum	Average	Maximum	Minimum - lowest daily average water temperature recorded for period of record			
	January	N/A	N/A	N/A				
	February	N/A	N/A	N/A				
	March	N/A	N/A	N/A	Average - average daily water temperature recorded for period of record			
	April	-0.2	3.1	10.2				
	May	3.5	10.3	19.4				
	June	8.8	14.2	23.3	Maximum - maximum daily average water temperature recorded for period of record			
	July	11.2	16.9	25.0				
	August	11.4	17.3	23.8				
	September	4.5	15.3	23.5	N/A - data not available as device removed from watercourse during winter months			
	October	0.9	10.8	17.6				
	November	-1.4	6.2	14.6				
	December	-0.5	3.9	11.7				

Surface Water Characteristics	Description						Figure / Graph / Table	Reference: Report	Reference: Section / Page
Water Quality (SW2):	Water Quality Sample Results						Table 1	SWA (Tatham, April 2020)	2.4 and Appendix H
	Parameter	Units	Minimum	Average	Maximum				
	Turbidity	NTU	0.9	2.2	3.6				
	TDS	mg/L	433	521	589				
	TSS	mg/L	1	3	6				
	COD	mg/L	8	9	12				
	BOD5	mg/L	0.8	0.9	1				
	DOC	mg/L	0.4	3	4.7				
	pH		8.1	8.1	8.2				
	Alkalinity	mg/L	166	218	261				
	Conductivity	µS/cm	668	771	881				
	Phosphorus	ug/L	<50	<50	<50				
	Ammonia	mg/L	<0.01	0.02	0.04				
	Hardness	mg/L	309	327	346				
Water Quality (SW14):	Water Quality Sample Results						Table 2	SWA (Tatham, April 2020)	2.4 and Appendix H
	Parameter	Units	Minimum	Average	Maximum				
	Turbidity	NTU	1.3	1.8	2.1				
	TDS	mg/L	313	395	479				
	TSS	mg/L	3.67	4.59	5.70				
	COD	mg/L	20	21	24				
	BOD5	mg/L	0.8	1.0	1.0				
	DOC	mg/L	5.1	5.9	10.7				
	pH		8	8.1	8.2				
	Alkalinity	mg/L	239	292	324				
	Conductivity	µS/cm	457	587	696				
	Phosphorus	ug/L	<50	<50	<50				
	Ammonia	mg/L	0.03	0.04	0.07				
	Hardness	mg/L	239	302	347				

Fish & Fish Habitat Features	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Fish Habitat (Direct/Indirect and Assumed/Confirmed):	Willoughby Creek is known to provide direct fish habitat, based on fish community sampling information from Conservation Halton (2002, 2013, 2018). Fish community sampling is not known to be have been completed in the upper reaches of Willoughby Creek, although for the purposes of this assessment, the entire watercourse (as mapped by MNRF in the Land Information Ontario database) is assumed to provide direct fish habitat. Willoughby Creek is known to provide direct fish habitat, based on fish community sampling information from Conservation Halton (2002, 2013, 2018). Fish community sampling is not known to be have been completed in the upper reaches of Willoughby Creek, although for the purposes of this assessment, the entire watercourse (as mapped by MNRF in the Land Information Ontario database) is assumed to provide direct fish habitat.		NETR (Savanta, April 2020)	19 and 20
Fish Species Present:	1) Conservation Halton Station BRO-219 (600 m downstream from the mouth of the Unnamed Tributary): a)Blacknose Dace, Brook Stickleback, Creek Chub, Fantail Darter, White Sucker b)"Poor" index of Biotic Integrity assigned to the overall fish community at this station by Conservation Halton in 2018 2) Conservation Halton Station BRO-42 (approximately 1 km downstream from the mouth of the Unnamed Tributary): a)Atlantic Salmon (Young-of-the-year), Brook Trout, Blacknose Dace and Fantail Darter b)Reach stocked with Atlantic Salmon eggs in 2012 c)"Good" index of Biotic Integrity assigned to the overall fish community at this station by Conservation Halton in 2018		NETR (Savanta, April 2020)	19 and 20
Fish Community Thermal Regime:	Cool to coldwater		NETR (Savanta, April 2020)	19 and 20
Fish Habitat Types Present:	Site specific investigations were not completed in Willoughby Creek as part of the NETR as a result of private property access issues. However, based on the presence of a generally diverse fish community, it is assumed a range of habitat is available to support life history processes.		NETR (Savanta, April 2020)	19 and 20
Habitat Uses by Known Fish Community:	The local fish community likely uses the habitat for the complete range of life history processes including spawning, nursery, foraging and overwintering. Lower reaches of the creek may provide spawning and nursery habitat for migratory fish from Bronte Creek.		NETR (Savanta, April 2020)	19 and 20
Known Barriers to Fish Movement:	None confirmed. Numerous culverts and private online ponds may provide some barriers to localized movement, but this was not confirmed as part of the NETR.		NETR (Savanta, April 2020)	19 and 20

<table>
<tr><th rowspan="2">Groundwater Interaction</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Underlying Deposits:</td><td>The Medad Valley is a partly-buried gorge that carried meltwater from the receding ice for a period of time (Karrow, 1987). The infill deposits are likely coarse-grained glaciofluvial deposits overlain by organic deposits. While there is limited data for the Medad Valley, there is some evidence that the sand deposits are thicker in the valley to the north and south of the site. Model value for the horizontal hydraulic conductivity of the MIS sands was 5.0×10^{-5} m/s and 2.5×10^{-5} m/s for vertical hydraulic conductivity.</td><td></td><td></td><td></td></tr>
<tr><td>Surface Water / Groundwater Interactions:</td><td>Gaining Stream</td><td>Figures 1 & 2</td><td></td><td></td></tr>
<tr><td>Water Budget Results (SW14):</td><td>The baseline condition water budget results from the integrated model at monitoring location SW14 are presented in Figure 3a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>17.42%</td><td>26.50%</td></tr></table></td><td>Figure 3a</td><td></td><td></td></tr>
<tr><td>Water Budget Results (5328 Cedar Springs Road Driveway Crossing):</td><td>The baseline condition water budget results from the integrated model at the driveway crossing for 5328 Cedar Springs Road are presented in Figure 4a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>17.82%</td><td>24.11%</td></tr></table></td><td>Figure 4a</td><td></td><td></td></tr>
<tr><td>Water Budget Results (SW7):</td><td>The baseline condition water budget results from the integrated model at monitoring location SW7 are presented in Figure 5a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>15.72%</td><td>21.10%</td></tr></table></td><td>Figure 5a</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Road Culvert Crossing at 5535 Cedar Springs Road):</td><td>The baseline condition water budget results from the integrated model at the road culvert crossing at 5535 Cedar Springs Road are presented in Figure 6a.<table><tr><td>Condition</td><td>GW Out</td><td>GW In</td></tr><tr><td>Baseline (Existing)</td><td>17.98%</td><td>28.27%</td></tr></table></td><td>Figure 6a</td><td></td><td></td></tr>
<tr><td>Integrated Model Calibration:</td><td>Section 19.4.3 (p. 418-419) in the Earthfx report describes the model calibration to flows in Willoughby Creek. The section focused on the SW2 gauge which represents the total streamflow exiting the northern portion of the Medad Valley. Hydrographs illustrate the model matches to flow peak timing for the period of record and WY2017, but the model may underestimate low flows from Feb. 2018 to Feb. 2019. Several reasons were discussed.</td><td>Graphs 7, 8 & 9</td><td>HHIAR (Earthfx, April 2020)</td><td>19.4.3 (page 418 - 419)</td></tr>
</table>

Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alterations to Watercourse:	1) No direct alterations to this watercourse will occur as a result of the proposed Quarry Extension. 2) Potential direct effects on the Unnamed Tributary of Willoughby Creek (e.g., due to weir plate, diversion channel inlet, golf course pond/irrigation channel removal) could potentially cause indirect effects on Willoughby Creek (e.g., sedimentation), as discussed in more detail in the Unnamed Tributary of Willoughby Creek summary table.		NETR (Savanta, April 2020)	75
Change in Primary Source of Flow:	1) Quarry discharge from Sump 0100 represents a major source of flow to Willoughby Creek. Current quarry approvals permit this discharge to cease once quarry operations are complete. Cessation of quarry discharge into the Unnamed Tributary of Willoughby Creek and ultimately Willoughby Creek itself would have a negative impact on flow availability to support existing fish habitat and the current fish community. As discussed in the Mitigation section below, it has been recommended that quarry discharge continue indefinitely at current levels to prevent these associated negative impacts. 2) Diversion from catchment area S101 (northwest of Colling Road) will alter surface water inputs. Currently, this catchment area discharges directly to the quarry and the flow is eventually discharged to the Unnamed Tributary through Sump 0100 (and ultimately to Willoughby Creek). Nelson is proposing to redirect surface water drainage from catchment area S101 directly into the Unnamed Tributary at the existing quarry discharge point. Overall, this diversion will result in the same volume of water from catchment area S101 being discharged to the tributary and ultimately Willoughby Creek, although, given it will no longer pass through the quarry, it is expected that the hydrological regime of this discharge will be more natural, with seasonal peaks as opposed to being discharged at a generally more constant rate through the quarry sump. 3) Removal of the golf course irrigation ponds and channels will alter the hydrology of the watercourse, given that no water taking would be required from the watercourse to support golf course irrigation and that during high flow periods, there will be no discharge from the golf course back to the feature. However, the proposed new pond (infiltration pond) west of the West Extension will draw water from the Weir Pond in the same manner as the existing irrigation ponds. Therefore, there will be no net change in source water hydrology.		NETR (Savanta, April 2020)	76 and 77
Change in Watercourse Catchment Area:	Increase in catchment area of 7.2 ha. Additional catchment area will drain to the existing quarry settling ponds and be discharged to the Unnamed Tributary via Sump 0100 at rates consistent with existing. Additional storage will be provided in the settling ponds to accommodate the additional flow.		SWA (Tatham, April 2020)	Drawings DP-1, DP-2 and DP-3
Simulated Streamflow Change (Integrated Model Results):	The Earthfx report discusses changes in simulated quarry discharge to the North Quarry Pond. No change was expected under Scenario P12. Scenario P3456 is discussed in Section 8.7.5 (p. 243). Under P3456 conditions, current levels of quarry discharge will continue to pass through the pond. Diversions for golf course operations will no longer be necessary, however a portion of flow will be diverted to the newly constructed infiltration pond, which will locally support groundwater levels in a similar manner as the current golf course ditch and pond system. Figure 8.71(p. 254) showed that there will be an increase in flow through the north quarry discharge stream, and that the flow will continue through the karst conduit as under current conditions. The increase in flow will enter the Medad Valley just downstream of SW7, so there will be no significant change downstream at SW2. Under RHB1, discharge continues to the north from the quarry sump 0100 and is similar to that of P3456. Under RHB2, surface water flow in the upper reaches of the Unnamed Tributary of Willoughby Creek and the West Arm of the West Branch of Mount Nemo Tributary of Grindstone Creek will cease when the quarry discharge is discontinued, resulting in possible impact to downstream fish habitat compared to baseline conditions (See Savanta, 2020 and Tatham, 2020 for details).	Graphs 10 & 11	HHIAR (Earthfx, April 2020)	198 - 230 and 230 - 237

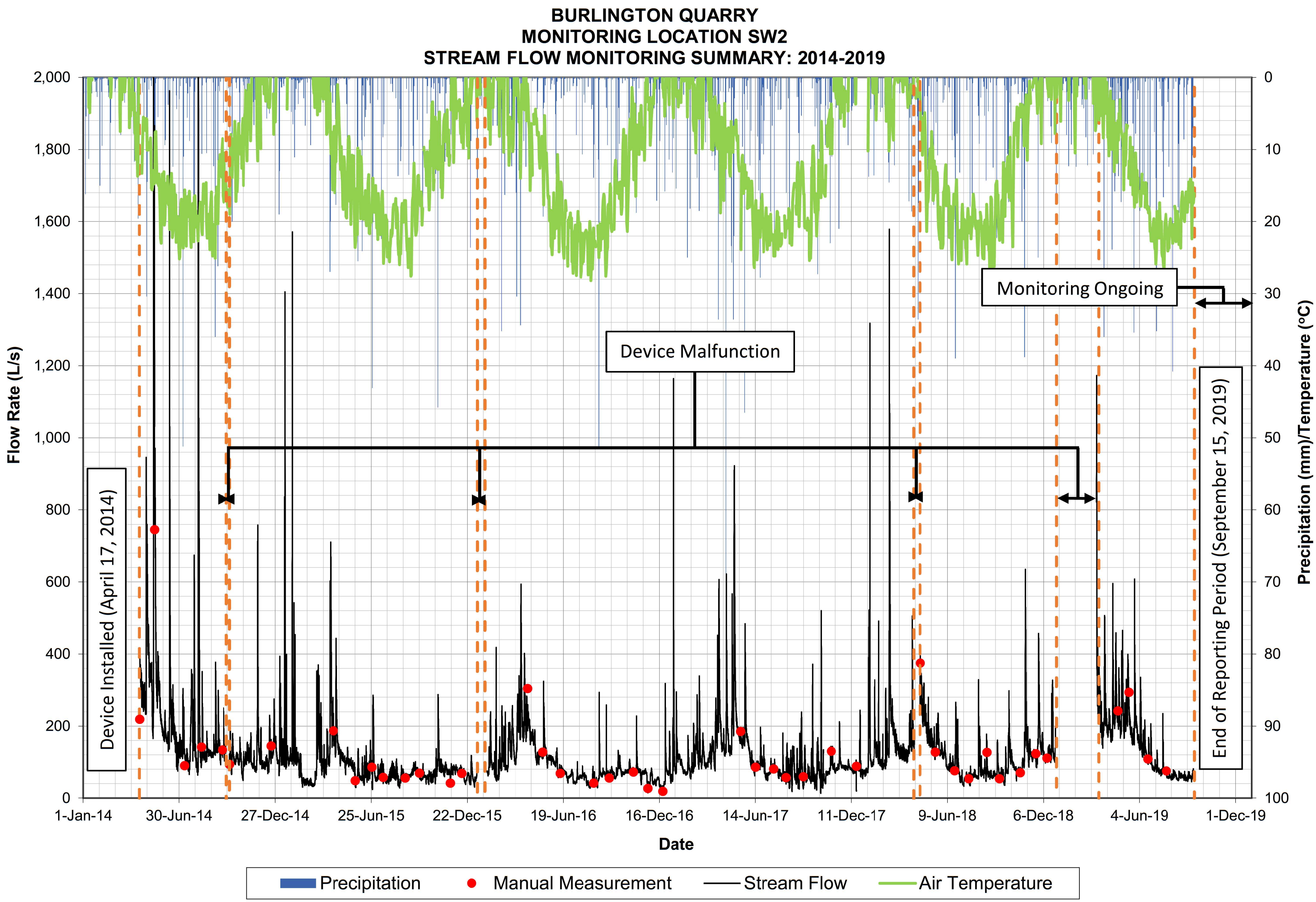
<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at monitoring location SW14 are presented in Figure 3b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.42%</td><td>26.50%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>17.21%</td><td>25.76%</td><td>-0.21%</td><td>-0.74%</td></tr>
</table></td><td>Figure 3b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at monitoring location SW14 are presented in Figure 3c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.42%</td><td>26.50%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>17.90%</td><td>25.75%</td><td>0.48%</td><td>-0.75%</td></tr>
</table></td><td>Figure 3c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at monitoring location SW14 are presented in Figure 3d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.42%</td><td>26.50%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>17.06%</td><td>26.44%</td><td>-0.36%</td><td>-0.06%</td></tr>
</table></td><td>Figure 3d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at monitoring location SW14 are presented in Figure 3e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.42%</td><td>26.50%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>18.26%</td><td>26.59%</td><td>0.84%</td><td>0.09%</td></tr>
</table></td><td>Figure 3e</td><td></td><td></td></tr>
<tr><td colspan="5">Water Budget Results at 5328 Cedar Springs Road Driveway Crossing</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at 5328 Cedar Springs Road Driveway Crossing are presented in Figure 4b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.82%</td><td>26.50%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>17.51%</td><td>23.36%</td><td>-0.31%</td><td>-0.75%</td></tr>
</table></td><td>Figure 4b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at 5328 Cedar Springs Road Driveway Crossing are presented in Figure 4c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.82%</td><td>24.11%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>18.57%</td><td>22.23%</td><td>0.75%</td><td>-1.88%</td></tr>
</table></td><td>Figure 4c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at 5328 Cedar Springs Road Driveway Crossing are presented in Figure 4d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.82%</td><td>24.11%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>17.61%</td><td>23.39%</td><td>-0.21%</td><td>-0.72%</td></tr>
</table></td><td>Figure 4d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at 5328 Cedar Springs Road Driveway Crossing are presented in Figure 4e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.82%</td><td>24.11%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>18.54%</td><td>25.30%</td><td>0.72%</td><td>1.19%</td></tr>
</table></td><td>Figure 4e</td><td></td><td></td></tr>
</table>

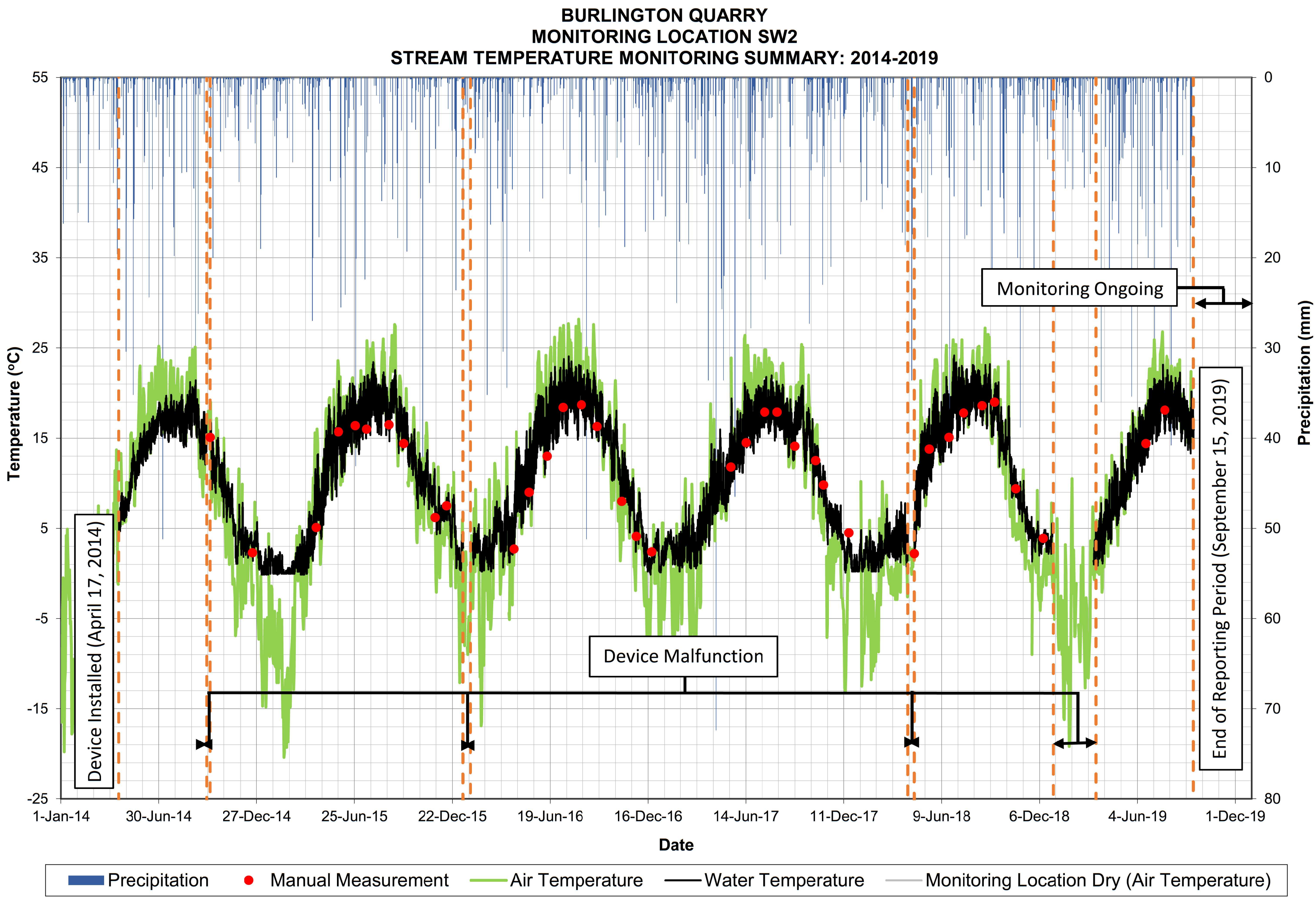
<table>
<tr><th rowspan="2">Impact Assessment</th><th rowspan="2">Description</th><th rowspan="2">Figure / Graph / Table</th><th colspan="2">Reference</th></tr>
<tr><th>Report</th><th>Section / Page</th></tr>
<tr><td colspan="5">Water Budget Results at Monitoring Location SW7</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at monitoring location SW7 are presented in Figure 5b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>15.27%</td><td>21.10%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>14.95%</td><td>20.37%</td><td>-0.32%</td><td>-0.73%</td></tr>
</table></td><td>Figure 5b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at monitoring location SW7 are presented in Figure 5c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>15.27%</td><td>21.10%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>15.58%</td><td>18.83%</td><td>0.31%</td><td>-2.27%</td></tr>
</table></td><td>Figure 5c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at monitoring location SW7 are presented in Figure 5d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>15.27%</td><td>21.10%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>14.83%</td><td>19.84%</td><td>-0.44%</td><td>-1.26%</td></tr>
</table></td><td>Figure 5d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at monitoring location SW7 are presented in Figure 5e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>15.27%</td><td>21.10%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>15.85%</td><td>22.19%</td><td>0.58%</td><td>1.09%</td></tr>
</table></td><td>Figure 5e</td><td></td><td></td></tr>
<tr><td colspan="5">Water Budget Results at Road Culvert Crossing at 5535 Cedar Springs Road</td></tr>
<tr><td>Water Budget Results (Operational Phases 1 & 2):</td><td>The Operational Phases 1 and 2 water budget results from the integrated model at the road culvert crossing at 5535 Cedar Springs Road are presented in Figure 6b.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.98%</td><td>28.27%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 1 & 2</td><td>18.01%</td><td>21.73%</td><td>0.03%</td><td>-6.54%</td></tr>
</table></td><td>Figure 6b</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Operational Phases 3 Through 6):</td><td>The Operational Phases 3 through 6 water budget results from the integrated model at the road culvert crossing at 5535 Cedar Springs Road are presented in Figure 6c.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.98%</td><td>28.27%</td><td>-</td><td>-</td></tr>
<tr><td>Phases 3 through 6</td><td>18.28%</td><td>20.24%</td><td>0.30%</td><td>-8.03%</td></tr>
</table></td><td>Figure 6c</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 1):</td><td>The Rehabilitation Scenario 1 water budget results from the integrated model at the road culvert crossing at 5535 Cedar Springs Road are presented in Figure 6d.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.98%</td><td>28.27%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 1</td><td>17.96%</td><td>21.19%</td><td>-0.02%</td><td>-7.08%</td></tr>
</table></td><td>Figure 6d</td><td></td><td></td></tr>
<tr><td>Water Budget Results (Rehabilitation Scenario 2):</td><td>The Rehabilitation Scenario 2 water budget results from the integrated model at the road culvert crossing at 5535 Cedar Springs Road are presented in Figure 6e.
<table>
<tr><td>Condition</td><td>GW Outflow</td><td>GW Inflow</td><td>%Δ GW Outflow</td><td>%Δ GW Inflow</td></tr>
<tr><td>Baseline (Existing)</td><td>17.98%</td><td>28.27%</td><td>-</td><td>-</td></tr>
<tr><td>Rehab Scenario 2</td><td>17.63%</td><td>24.06%</td><td>-0.35%</td><td>-4.21%</td></tr>
</table></td><td>Figure 6e</td><td></td><td></td></tr>
</table>

Impact Assessment	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Change in Groundwater Contributions to Watercourse:	The total change in surface leakage (seepage) between Baseline and P3456 in catchment SW7 is shown in Graph 12. A small percentage of groundwater seepage will be intercepted by P3456 and discharged to the Medad Valley just downstream of SW7. This change in seepage is relatively uniform over time. The loss of seepage is diffuse and will not be observable. Additional maps and discussion are included in Earthfx, 2020. The stream leakage under Baseline and P3456 conditions is nearly identical, as shown in Graph 13.	Graphs 12 & 13		
Change in Watercourse Thermal Regime:	1)Negative changes in water temperature are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Temperature of water being discharge from Quarry Sump 0100 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water temperature is anticipated. 2) Artificial warming that may be occurring as a result of discharge of relatively warm surface water from the artificial golf course ponds into the tributary will cease once the golf course ponds are removed. This may result in a beneficial effect in downstream water temperatures, given that the ponds are anthropogenic.		NETR (Savanta, April 2020)	75 - 78
Change in Water Quality:	1) Negative changes in water quality are not expected given that the watercourse will continue to receive its primary input from quarry discharge. Quality of water being discharged from Quarry Sump 0100 is not expected to change as a result of the proposed Quarry Extension, therefore, no change in water quality is expected. 2) Water quality impacts that may be occurring as a result of discharge of water from the artificial golf course ponds and irrigation channels into the tributary will cease once the golf course ponds are removed. This may result in a beneficial effect in downstream water quality, given that golf course discharge may be having a negative impact on water quality (e.g., due to fertilizers, erosion and sedimentation, nutrients).		NETR (Savanta, April 2020)	76 and 77
Potential Impact to Form and Function of Feature:	1) Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the form and habitat functions of this watercourse. 2) Diversion of upstream catchment S101 is not expected to have negative impacts on the form and function of the watercourse. The more natural hydrograph predicted due to the diversion may enhance fish habitat in downstream reaches of the Tributary. 3) Predicted decreases in streamflow are very minor and are not expected to have any negative impact on form and function of the watercourse.		NETR (Savanta, April 2020)	76 and 77
Potential Impact to Identified Species and Habitat:	1) Alterations to quarry discharge (if unmitigated) could potentially have negative impacts on the species and habitat functions of this watercourse. 2) Diversion of upstream catchment S101 is not expected to have negative impacts on fish in the watercourse. The more natural hydrograph predicted due to the diversion may enhance fish habitat in downstream reaches of the Tributary. 3) Predicted decreases in streamflow are very minor and are not expected to have any negative impact on form and function of the watercourse.		NETR (Savanta, April 2020)	76 and 77

Mitigation	Description	Figure / Graph / Table	Reference	
			Report	Section / Page
Direct Alteration Mitigation:	1) In-water work required to install the permanent weir plate and the diversion structure inlet will be completed between July 16 and August 30 to minimize the potential for indirect impacts on the reproductive activities of the downstream fish communities in the Unnamed Tributary of Willoughby Creek and in Willoughby Creek itself (e.g., due to sedimentation or accidental spills). 2) Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse. 3) The Limit of Extraction has been set back 30 m from the limit of the bankfull channel of the Unnamed Tributary of Willoughby Creek and the Weir Pond in order to prevent disturbance to the watercourse. No operational activities will occur within the 30 m setback. A visual mitigation berm will be constructed within the 30 m setback (with associated grading encroaching a minimum of 14 m from the edge of the Weir Pond). Erosion and sedimentation control measures will be in place prior to grading for the berm. The berm will be vegetated following completion of grading to ensure soil stability and prevent erosion. 4) Where areas within the 30 m setback are not currently naturally vegetated (i.e., on portions of the active golf course), these areas will be naturalized with native species plantings to assist in maintaining and enhancing riparian functions adjacent to the watercourse.		NETR (Savanta, April 2020)	75 66 and 67
Source Water Mitigation:	In order to mitigate impacts on fish and fish habitat in Willoughby Creek, pumping and discharge are recommended to occur at the same location at the upstream end of the Unnamed Tributary of Willoughby Creek and in the same manner as existing pumping in accordance with the existing PTTW and Environmental Compliance Approvals regulating current quarry discharge.		NETR (Savanta, April 2020)	76
Groundwater Contribution Mitigation:	Infiltration pond is intended to maintain seepage to GW in the vicinity of the West Expansion to maintain levels and GW discharge to the Medad Valley.			
Erosion Mitigation:	Erosion and sedimentation control measures and spill prevention and response measures will be used throughout the duration of any in-stream works in the watercourse.			
Thermal Mitigation:	1) No specific thermal mitigation is proposed given that maintaining existing quarry outflows at Sump 0100 are expected to maintain the existing thermal regime of the watercourse without any additional mitigation. 2) Removal of the golf course ponds may have an indirect positive effect on the thermal regime of the watercourse.		NETR (Savanta, April 2020)	78
Water Quality Mitigation:	1) No specific water quality mitigation over and above that of the existing quarry operations is proposed given that maintaining existing quarry outflows at Sump 0100 are expected to maintain the existing water quality regime of the watercourse without any additional mitigation. The quarry extension is not predicted to result in any changes in the quality of water being discharged from Sump 0100. 2) Removal of the golf course ponds may have an indirect positive effect on the water quality of the watercourse.		NETR (Savanta, April 2020)	78

WILLOUGHBY CREEK - GRAPH 1




BURLINGTON QUARRY
MONITORING LOCATION SW2
STREAM TEMPERATURE MONITORING SUMMARY: 2014-2019
Temperature (°C)
Precipitation (mm)
Date
55
45
35
25
15
5
-5
-15
-25
0
10
20
30
40
50
60
70
80
1-Jan-14
30-Jun-14
27-Dec-14
25-Jun-15
22-Dec-15
19-Jun-16
16-Dec-16
14-Jun-17
11-Dec-17
9-Jun-18
6-Dec-18
4-Jun-19
1-Dec-19
Monitoring Ongoing
Device Installed (April 17, 2014)
End of Reporting Period (September 15, 2019)
Device Malfunction
Precipitation
Manual Measurement
Air Temperature
Water Temperature
Monitoring Location Dry (Air Temperature)

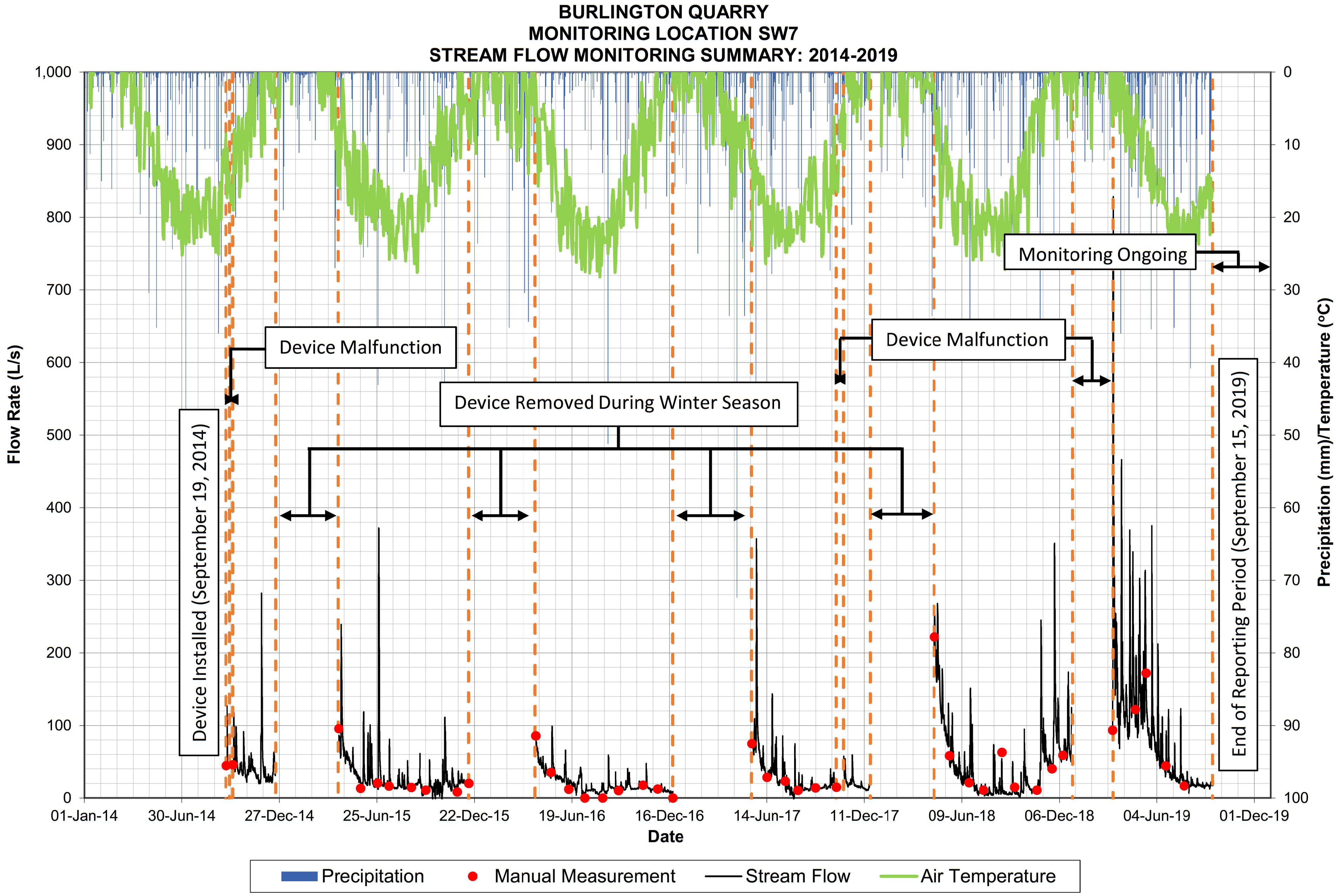
WILLOUGHBY CREEK - TABLE 1

BURLINGTON QUARRY
TATHAM ENGINEERING PROJECT NO.: 113187
SURFACE WATER MONITORING

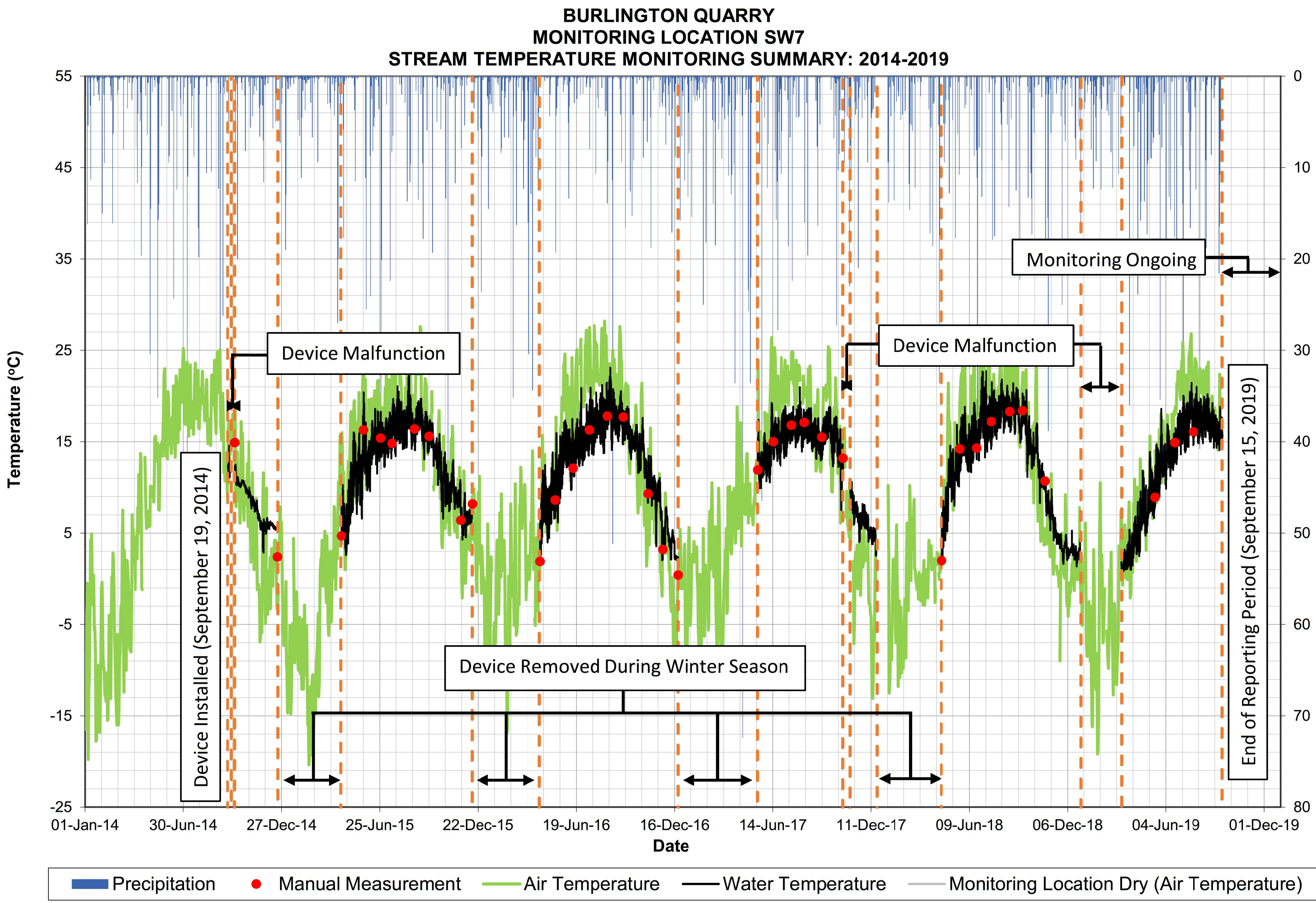
WATER QUALITY SAMPLE RESULTS

Monitoring Location SW2													
		Sample Date:	24-Oct-18	24-Apr-19	19-Jun-19	25-Sep-19	20-May-20	15-Jul-20	16-Sep-20	11-Nov-20	Maximum	Minimum	Average
Parameter:	Units:	M.D.L.	CM/JG	CM/JG	CM	CM	JG	JG/JH/JM	JH/JM	JG/JH			
M-Alkalinity (pH 4.5)	mg/L as CaCO3	2	196	250	261	166	238	180	152	178	261	166	218.25
Ammonia (as N)	mg/L	0.01	0.04	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	0.04	0.02	0.02
BOD (5 day)	mg/L	1	1	0.9	0.9	0.8	1	<1	1.4	1.8	1.0	0.8	0.9
Bicarbonate	mg/L as CaCO3	1	194	247	-	164		178		176	247	164	202
Carbonate	mg/L as CaCO3	1	3	3	-	2		2		2	3	2	3
Conductivity	µS/cm	1	881	668	740	793	768	758	150	900	881	668	771
Dissolved Organic Carbon	mg/L	0.4	4	4.7	0.4	2.8	4.9	3.6	2	2.8	4.7	0.4	3.0
Field pH	pH	N/A	8.7	8.7	8.7	8.9	8.9	8.6	858	8.1	8.9	8.7	8.8
Field Temp	°C	N/A	8.3	6.7	15.2	16.6	12.9	18.9	4	9.4	16.6	6.7	11.7
Aluminum	ug/L	1	<1	11	17	<1	14	60	8	<1	17	11	8
Antimony	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Arsenic	ug/L	1	2	1	1	2	<1	2	2	2	2	1	1.5
Barium	ug/L	1	55	48	57	55	54	46	51	53	57	48	54
Beryllium	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Bismuth	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Boron	ug/L	2	77	28	7	73	37	39	87	94	77	7	46.25
Cadmium	ug/L	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
Calcium	ug/L	500	-	74800	85200	66700	73800	60000	65200	78700	85200	66700	56800
Cerium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Cesium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Chromium	ug/L	1	<1	5	5	3	3	1	3	4	5	3	4
Cobalt	ug/L	0.1	0.1	0.2	0.1	<0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.125
Copper	ug/L	1	<1	<1	2	<1	2	2	1	2	2	2	1
Europium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Gallium	ug/L	1	<1	1	1	<1	1	2	2	2	1	1	1
Iron	ug/L	20	<20	157	237	170	317	251	233	232	237	157	146
Lanthanum	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Lead	ug/L	0.1	<0.1	<0.1	0.2	<0.1	0.2	0.3	<0.1	<0.1	0.2	0.2	0.125
Lithium	ug/L	5	7	<5	6	8	6	9	11	10	8	6	6.5
Magnesium	ug/L	5	-	29600	32300	35200	32800	28800	34300	41500	35200	29600	24276
Manganese	ug/L	10	9	17	26	7	22	45	7	5	26	7	15
Mercury	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Molybdenum	ug/L	1	2	<1	1	2	1	2	2	2	2	1	2
Nickel	ug/L	1	4	3	3	3	3	2	2	3	4	3	3
Niobium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Phosphorus	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50
Potassium	ug/L	1	4490	2490	2840	4630	3420	2970	4940	5220	4630	2490	3613
Rubidium	ug/L	1	2	1	1	2	1	2	2	2	2	1	2
Scandium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Selenium	ug/L	0.5	0.9	0.8	<0.5	<0.5	0.7	<0.5	1.5	0.8	0.9	0.8	0.675
Silicon	ug/L	2	2100	2640	2700	1960	2380	1790	1820	2260	2700	1960	2350
Silver	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sodium	ug/L	1000	48600	27800	31800	43500	38700	41500	47800	51400	48600	27800	37925
Strontium	ug/L	1	715	417	510	678	499	478	653	800	715	417	580
Sulphur	ug/L	800	47400	20300	32500	48100	31400	30000	49200	65200	48100	20300	37075
Tellurium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Thallium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Thorium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Tin	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Titanium	ug/L	1	<1	1	<1	<1	<1	1	<1	<1	1	1	1
Tungsten	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Uranium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Vanadium	ug/L	1	<1	1	1	1	1	<1	1	1	1	1	1
Yttrium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Zinc	ug/L	1	9	<1	4	2	5	6	3	<1	9	2	4
Zirconium	ug/L	1	9	<1	<1	<1	<1	<1	<1	<1	9	9	3
pH	pH	N/A	8.16	8.14	8.18	8.09	8.4	8.13	8.09	8.08	8.2	8.1	8.1
Total Hardness (as CaCO3)	mg/L	0.1	342	309	346	312	319	268	304	367	346.000	309.000	327.250
Chemical Oxygen Demand	mg/L	5	8	12	12	<5	8	11	<5	15	12	8	9
Total Dissolved Solids	mg/L	3	589	433	515	548	508	484	533	580	589	433	521
Total Suspended Solids	mg/L	0.67	1	2	6	3	7.33	5.3	1.7	1.3	6.00	1.00	3.00
Turbidity	NTU	0.1	0.9	1.7	3.6	2.6	1.9	2.4	0.8	1.2	3.6	0.9	2.2

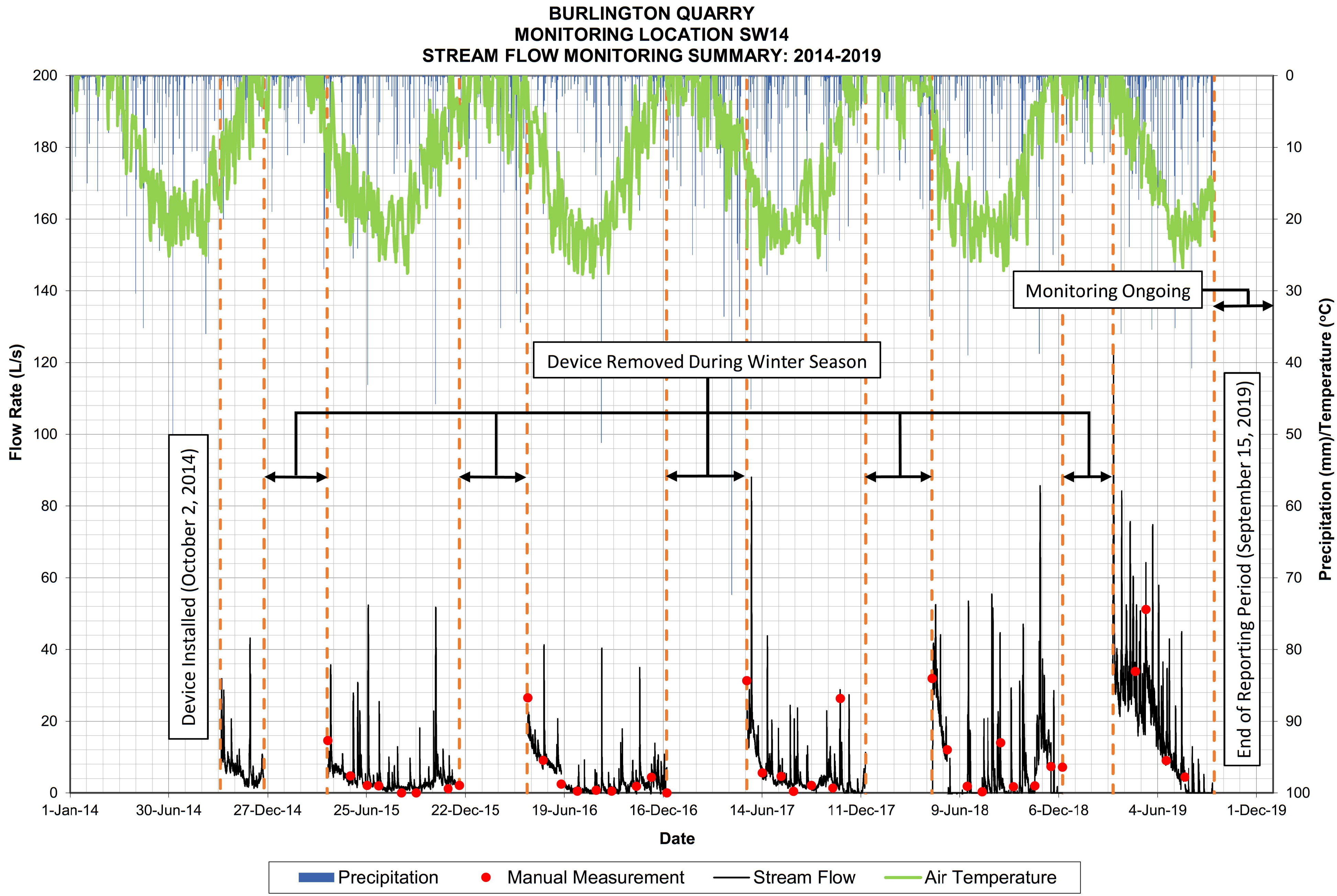
WILLOUGHBY CREEK - GRAPH 3



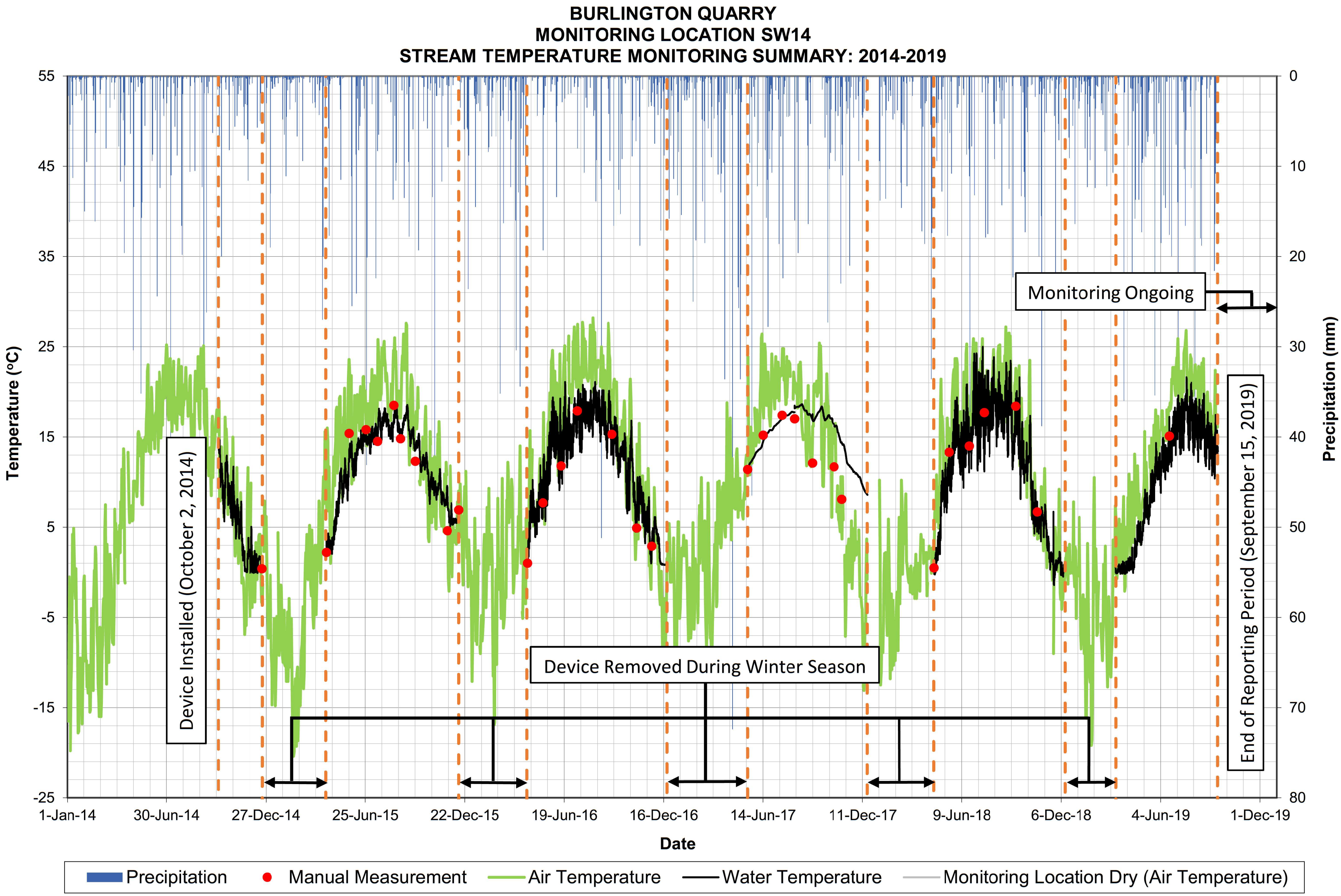
WILLOUGHBY CREEK - GRAPH 4



WILLOUGHBY CREEK - GRAPH 5



WILLOUGHBY CREEK - GRAPH 6



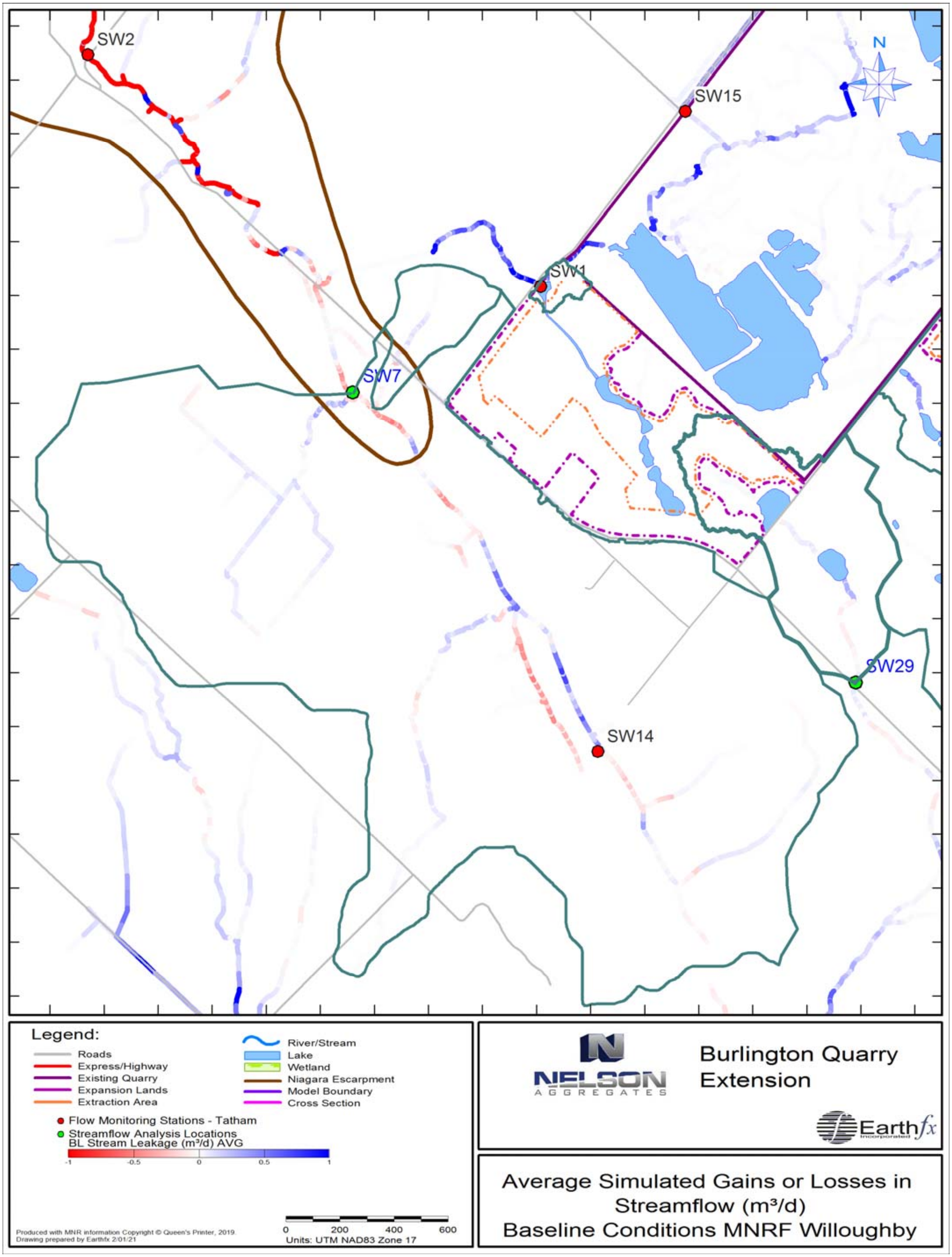
WILLOUGHBY CREEK - TABLE 2

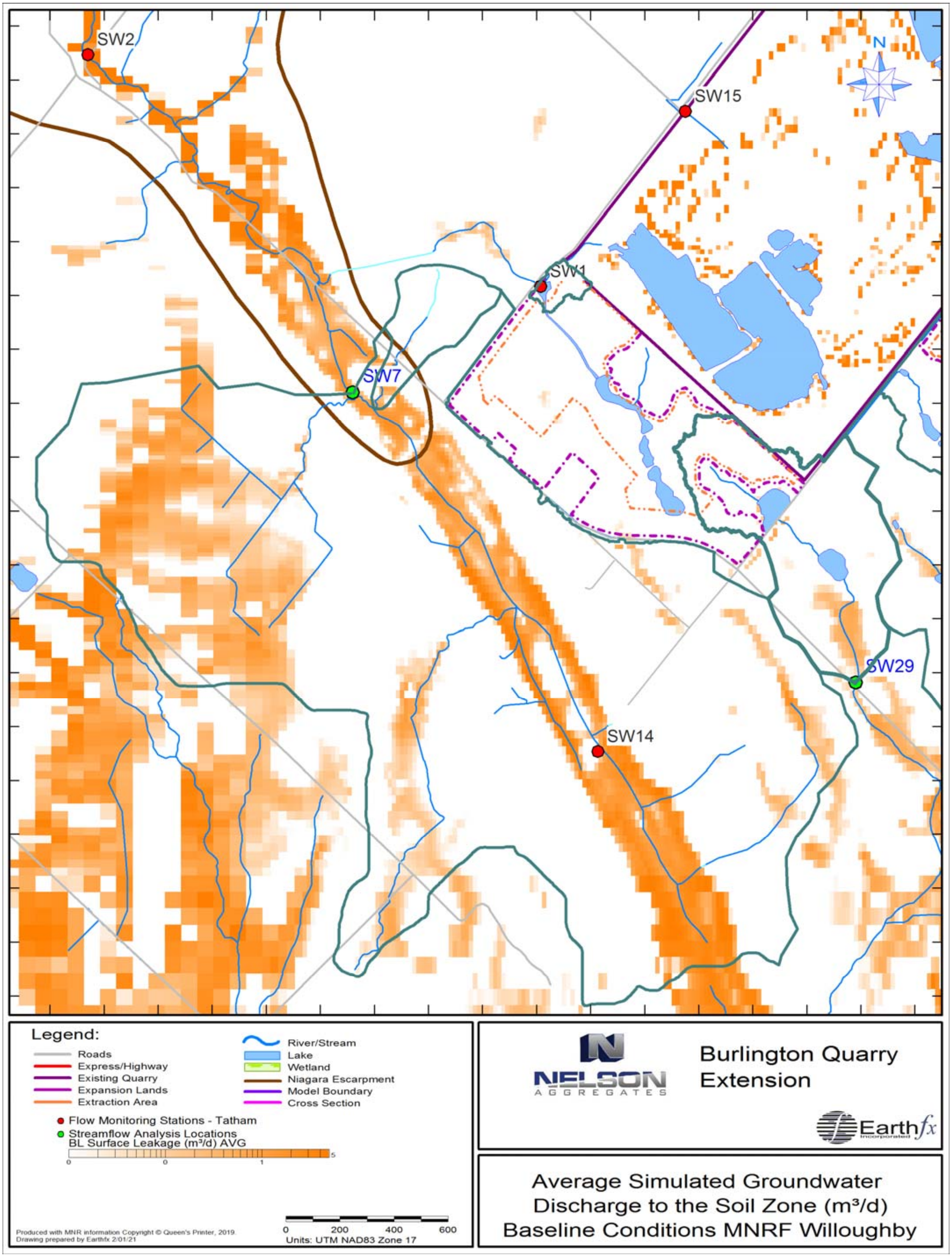
BURLINGTON QUARRY
TATHAM ENGINEERING PROJECT NO.: 113187
SURFACE WATER MONITORING

WATER QUALITY SAMPLE RESULTS

Monitoring Location SW14													
		Sample Date:	24-Oct-18	24-Apr-19	19-Jun-19	25-Sep-19	20-May-20	15-Jul-20	16-Sep-20	11-Nov-20	Maximum	Minimum	Average
Parameter:	Units:	M.D.L.	CM/JG	CM/JG	CM	CM	JG	JG/JH/JM	JH/JM	JG/JH			
M-Alkalinity (pH 4.5)	mg/L as CaCO3	2	303	239	302	324	265	320	329	296	324	239	292
Ammonia (as N)	mg/L	0.01	0.04	<0.01	0.07	0.03	<0.01	<0.01	<0.01	0.1	0.07	0.03	0.04
BOD (5 day)	mg/L	1	<1	0.8	<0.9	1	<1	1.1	1.5	<1	1.0	0.8	1.0
Bicarbonate	mg/L as CaCO3	1	300	237		319		315	325	293	319	237	214
Carbonate	mg/L as CaCO3	1	3	2		4		5	4	3	4	2	2.25
Conductivity	µS/cm	1	646	457	549	696	566	683	770	664	696	457	587
Dissolved Organic Carbon	mg/L	0.4	10.7	7.4	<0.4	5.1	6.3	6.4	5	10	10.7	5.1	5.9
Field pH	pH	N/A	8.6	8.8	8.8	8.8	8.8		9	8.9	8.8	8.6	8.8
Field Temp	°C	N/A	5.4	4.2	15.1	17	11.9		15.7	11.2	17.0	4.2	10.4
Aluminum	ug/L	1	<1	5	5	19	4	26	6	5	19	5	8
Antimony	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Arsenic	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Barium	ug/L	1	63	48	64	82	57	59	73	63	82	48	64
Beryllium	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Bismuth	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Boron	ug/L	2	6	8	<2	17	<2	3	21	19	17	6	8.25
Cadmium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Calcium	ug/L	500	-	57000	72500	80000	65200	83600	94300	79400	80000	57000	52500
Cerium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Cesium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Chromium	ug/L	1	<1	3	5	7	4	3	5	5	7	3	4
Cobalt	ug/L	0.1	0.2	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.125
Copper	ug/L	1	<1	<1	1	<1	<1	1	<1	3	1	1	1
Europium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Gallium	ug/L	1	1	<1	1	1	1	2	2	2	1	1	1
Iron	ug/L	20	150	137	191	319	248	246	275	281	319	137	199
Lanthanum	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Lead	ug/L	0.1	<0.1	0.4	0.2	1	0.3	0.5	0.1	0.2	1	0.2	0.425
Lithium	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5
Magnesium	ug/L	5	-	23400	29300	35800	31100	32300	37000	35700	35800	23400	22126
Manganese	ug/L	10	69	17	19	61	22	42	9	13	69	17	42
Mercury	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Molybdenum	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Nickel	ug/L	1	3	2	2	2	2	2	2	3	3	2	2
Niobium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Phosphorus	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50
Potassium	ug/L	1	1430	1160	892	1140	1160	1140	1100	1740	1430	892	1156
Rubidium	ug/L	1	<1	<1	<1	1	<1	1	1	2	1	1	1
Scandium	ug/L	1	<1	<1	<1	<1	<1	1	1	1	<1	<1	1
Selenium	ug/L	0.5	0.5	<0.5	<0.5	<0.5	1.2	<0.5	0.8	<0.5	0.5	0.5	0.5
Silicon	ug/L	2	3550	2300	3260	4020	2830	3430	3980	4420	4020	2300	3283
Silver	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sodium	ug/L	1000	15000	6600	8680	18800	11300	15400	20900	17800	18800	6600	12270
Strontium	ug/L	1	116	98	108	127	108	123	135	137	127	98	112
Sulphur	ug/L	800	2700	5290	5710	10100	5900	7100	11300	11900	10100	2700	5950
Tellurium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Thallium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Thorium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Tin	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Titanium	ug/L	1	1	<1	<1	2	<1	<1	<1	<1	2	1	1.25
Tungsten	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Uranium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Vanadium	ug/L	1	<1	1	2	2	1	1	2	2	2	1	1.5
Yttrium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Zinc	ug/L	1	11	<1	3	12	4	14	4	20	12	3	7
Zirconium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
pH	pH	N/A	8.06	7.96	8.11	8.17	8.24	8.18	8.15	8	8.2	8.0	8.1
Total Hardness (as CaCO3)	mg/L	0.1	318	239	302	347	291	342	388	345	347	239	302
Chemical Oxygen Demand	mg/L	5	20	24	20	20	19	38	8	464	24	20	21
Total Dissolved Solids	mg/L	3	416	313	371	479	342	433	459	23	479	313	395
Total Suspended Solids	mg/L	0.67	5.7	4	3.67	5	4.7	19.7	5.7	1	5.70	3.67	4.59
Turbidity	NTU	0.1	1.9	2	1.3	2.1	0.9	0.8	1.4	13.8	2.1	1.3	1.8

WILLOUGHBY CREEK - FIGURE 1





Average Simulated Groundwater Discharge to the Soil Zone (m³/d)
Baseline Conditions MNRF Willoughby

WILLOUGHBY CREEK

FIGURE 3A

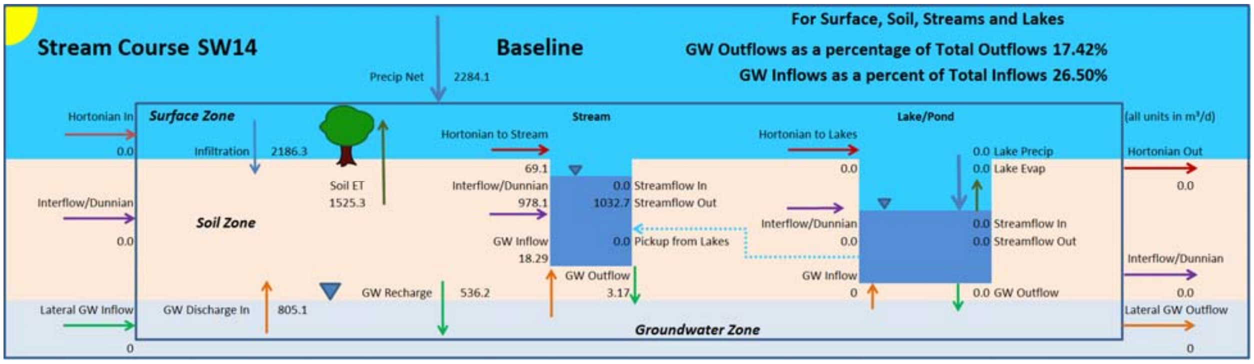


FIGURE 3B

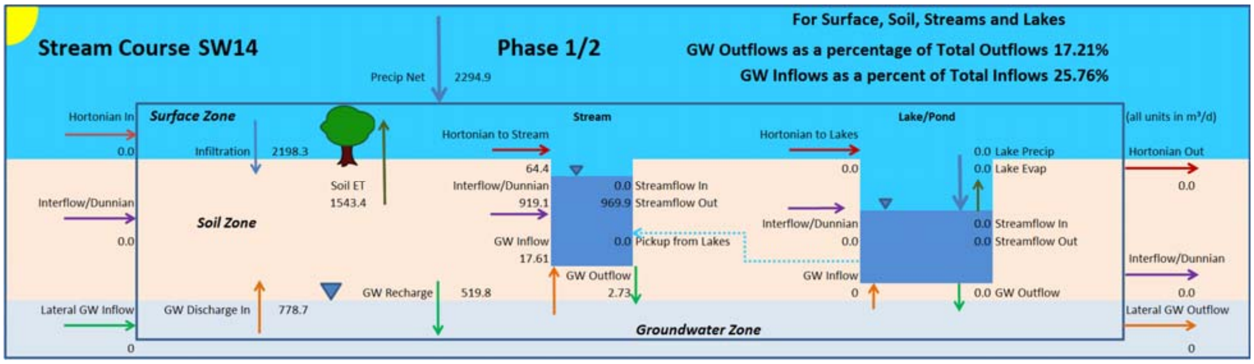


FIGURE 3C

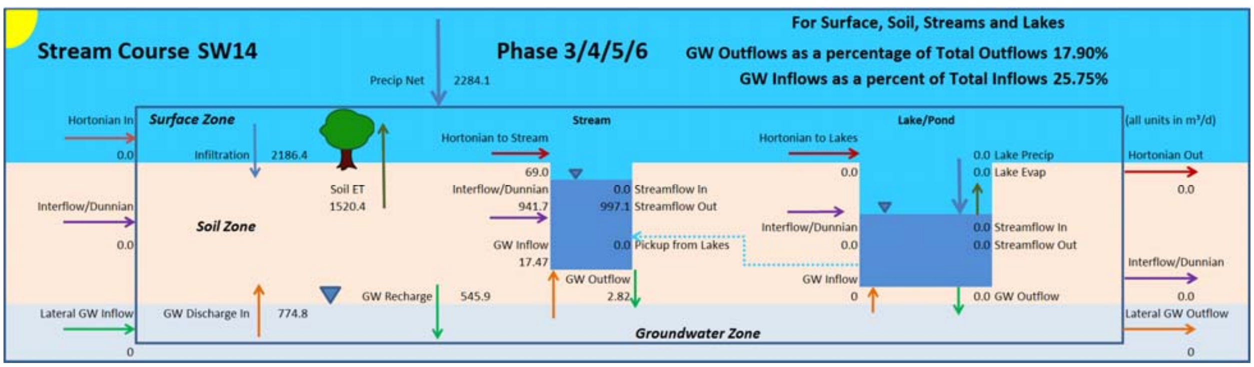


FIGURE 3D

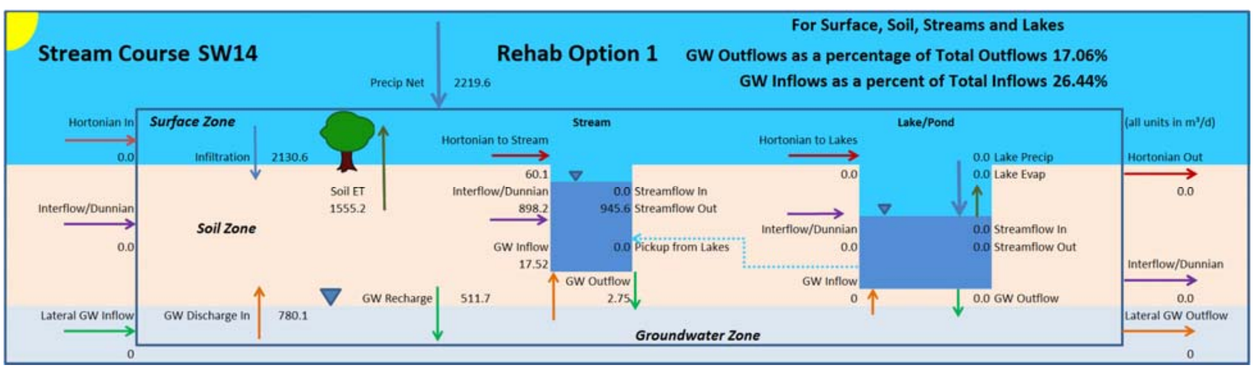
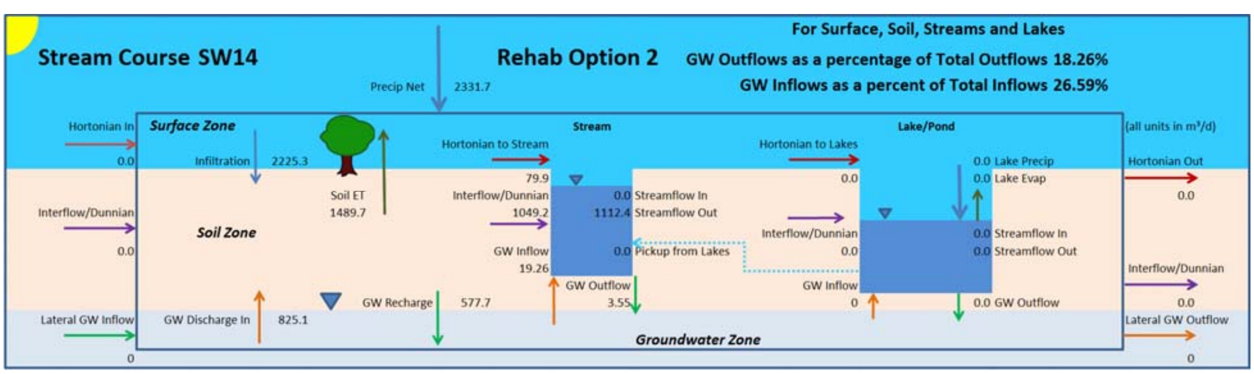


FIGURE 3E



WILLOUGHBY CREEK

FIGURE 4A

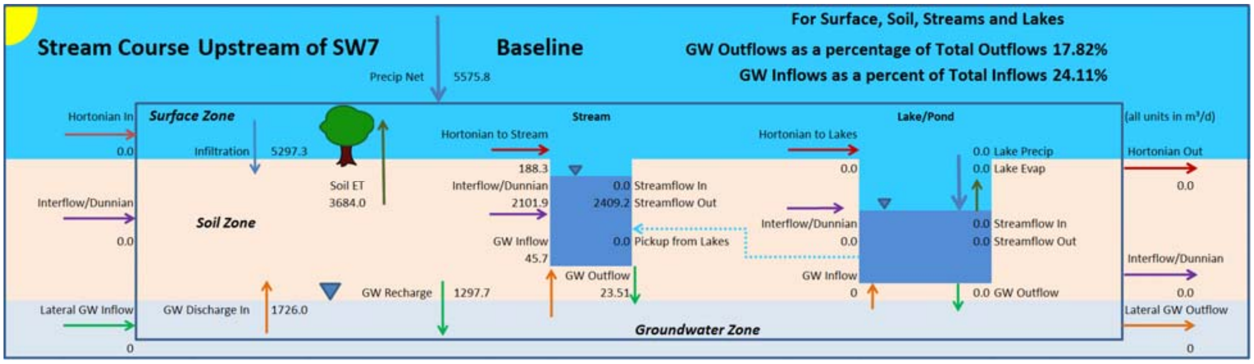


FIGURE 4B

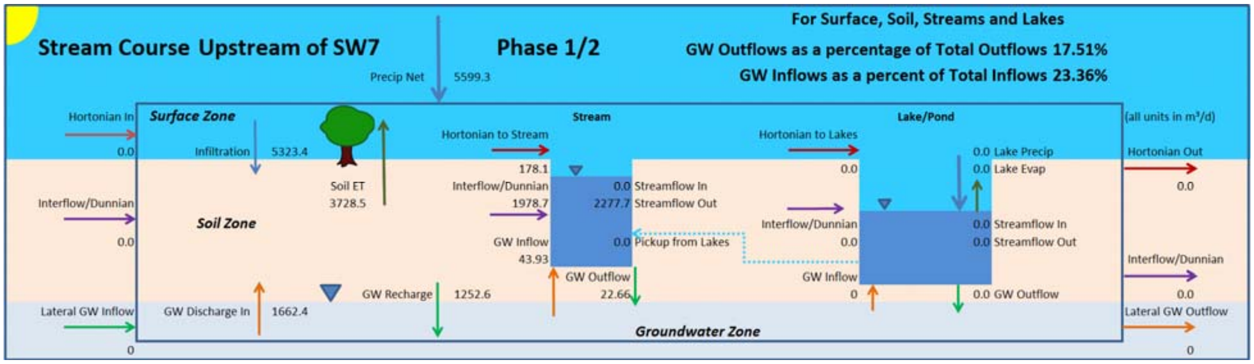


FIGURE 4C

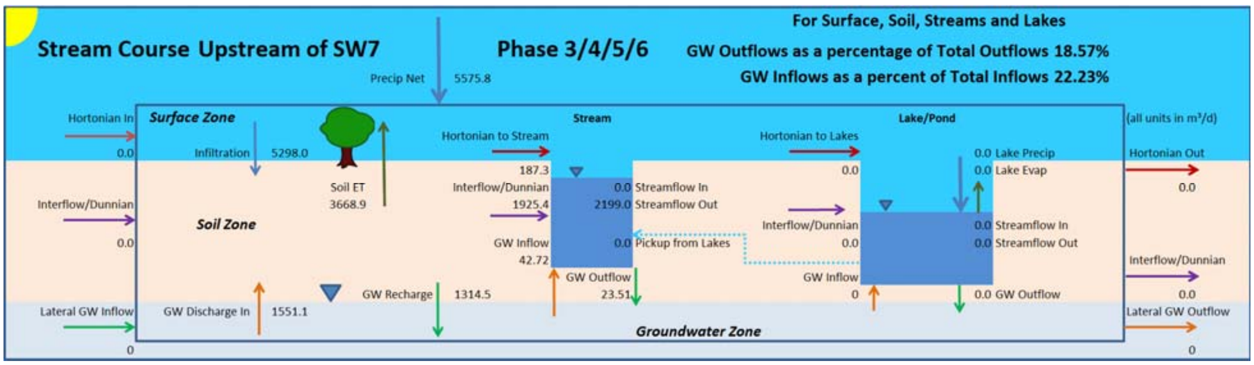


FIGURE 4D

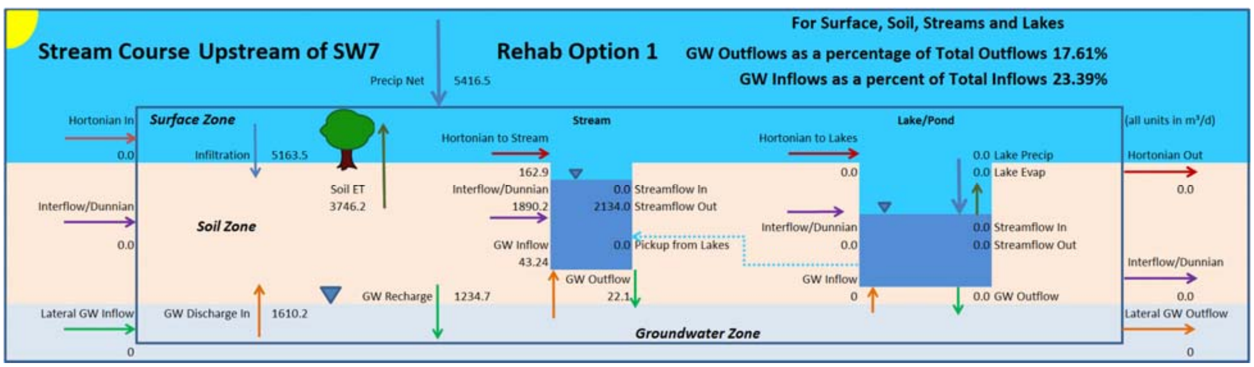
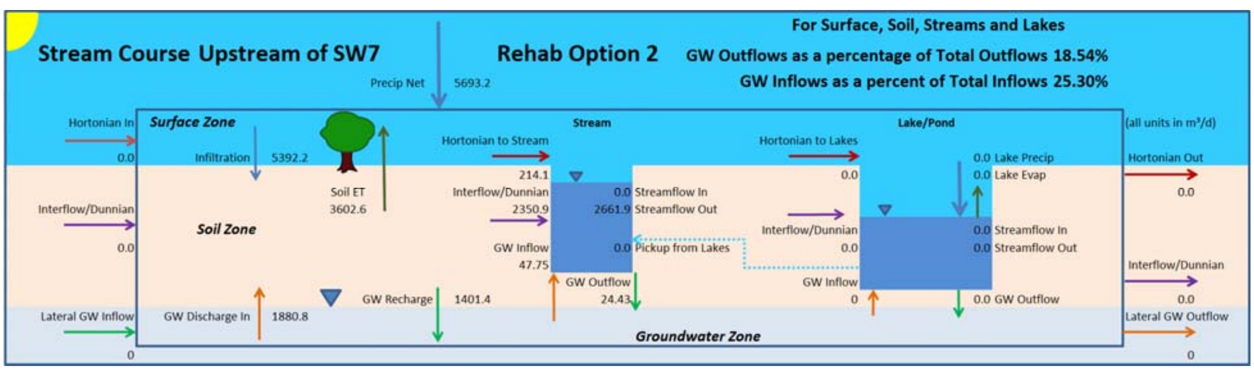


FIGURE 4E



WILLOUGHBY CREEK

FIGURE 5A

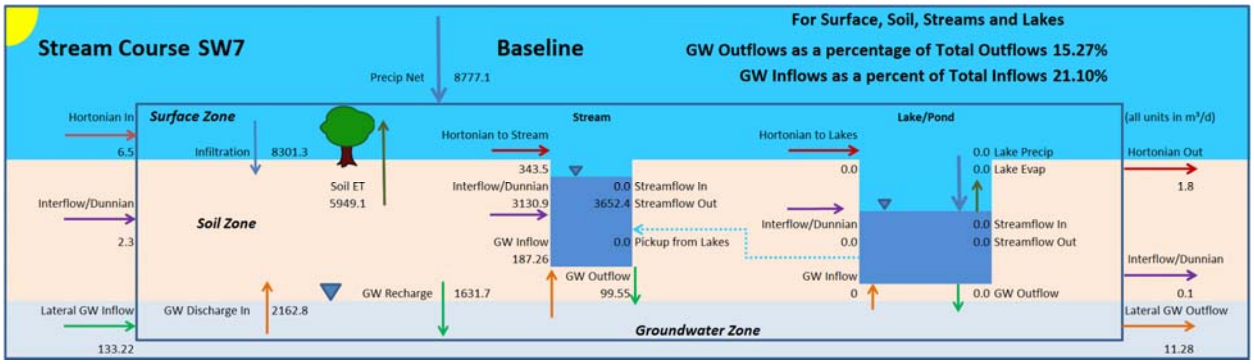


FIGURE 5B

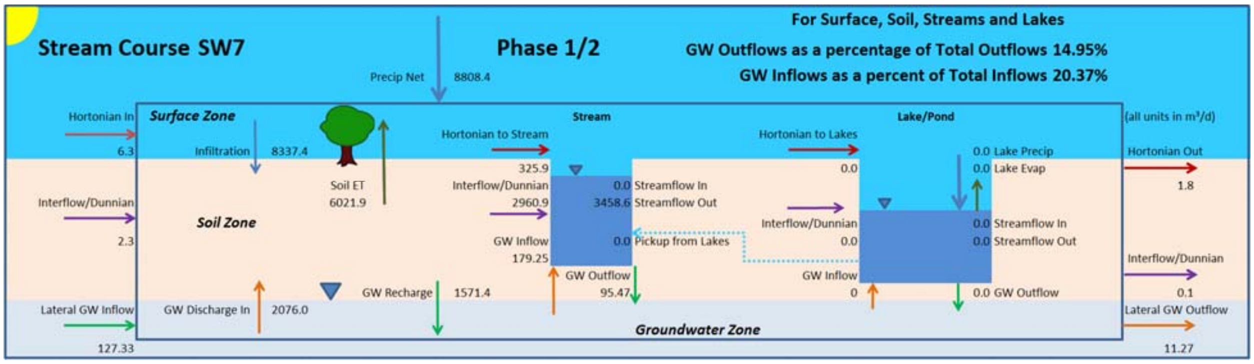


FIGURE 5C

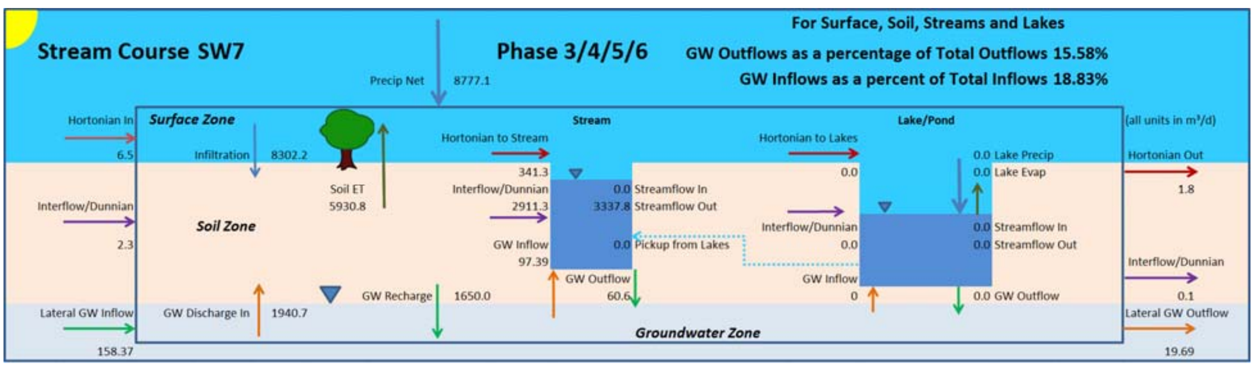


FIGURE 5D

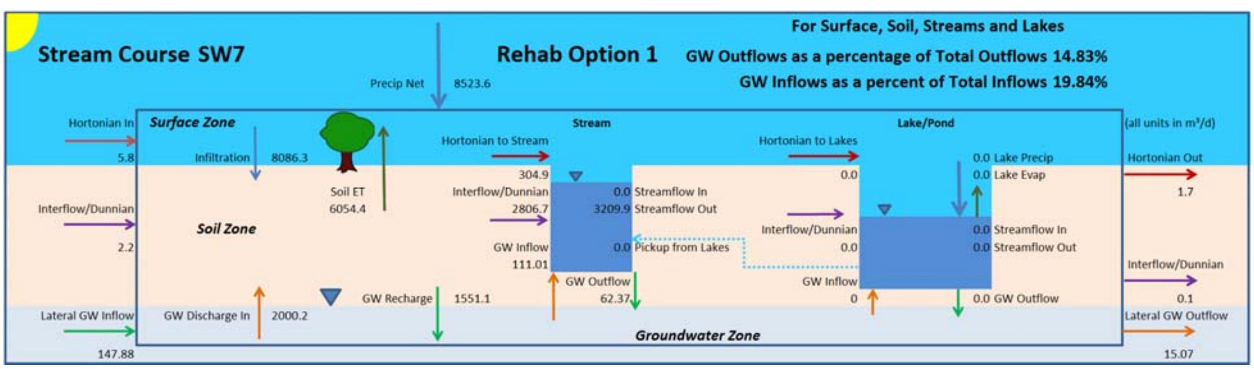
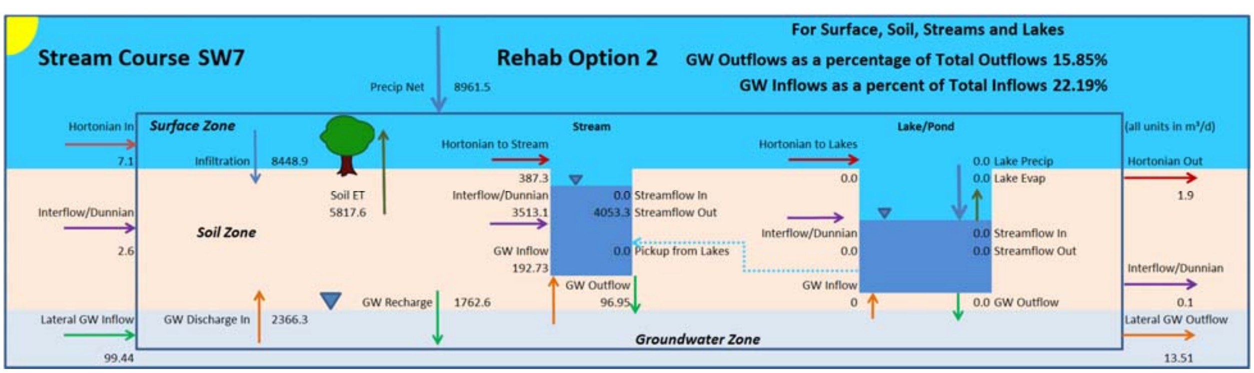


FIGURE 5E



WILLOUGHBY CREEK

FIGURE 6A

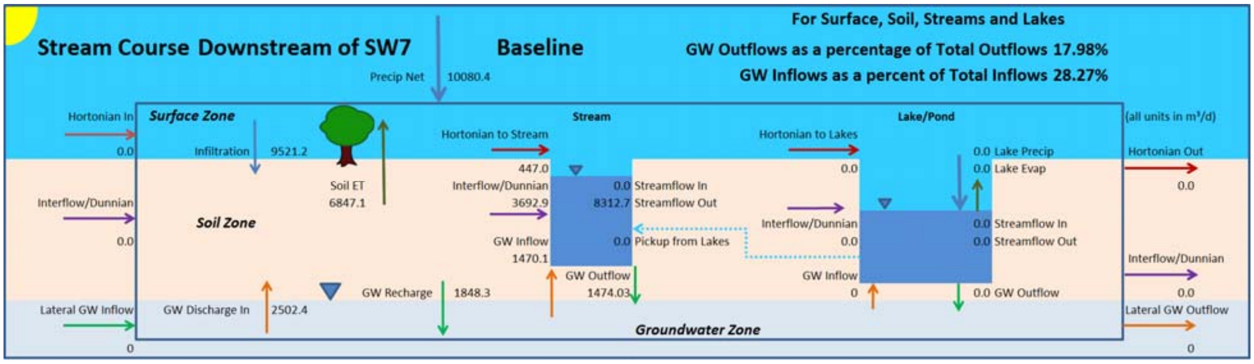


FIGURE 6B

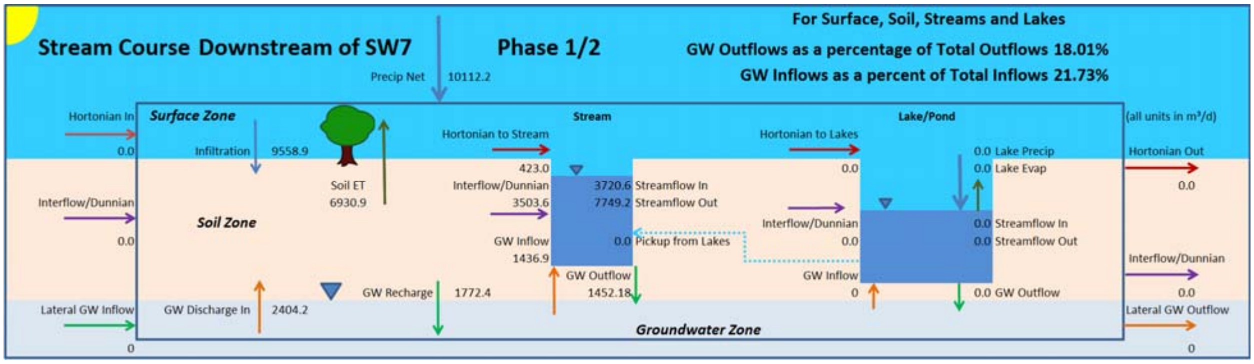


FIGURE 6C

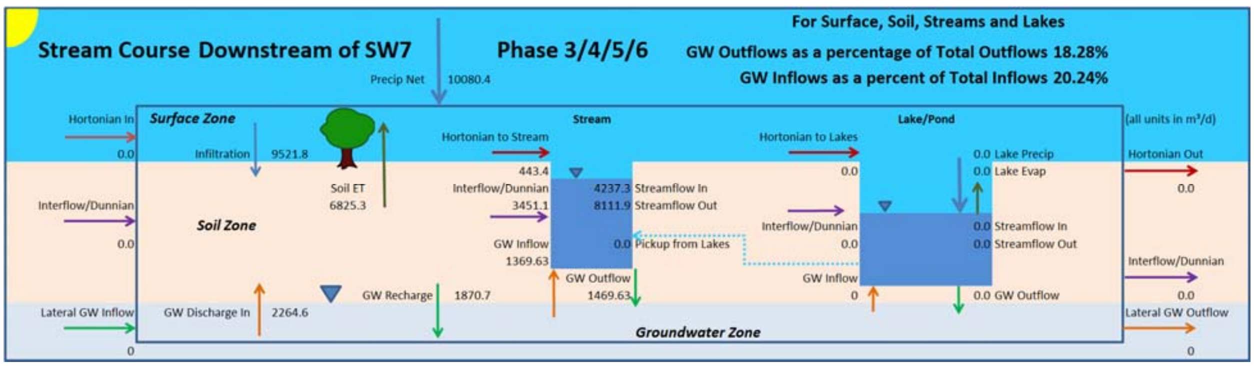


FIGURE 6D

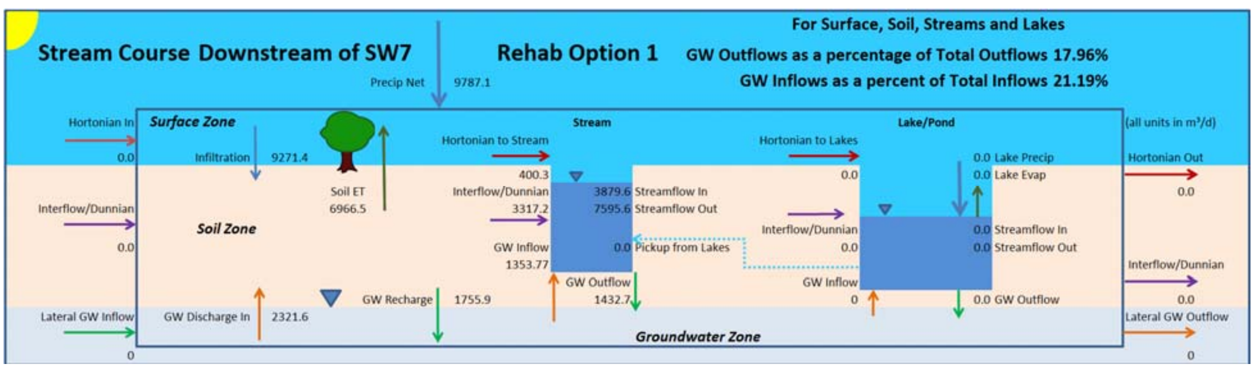
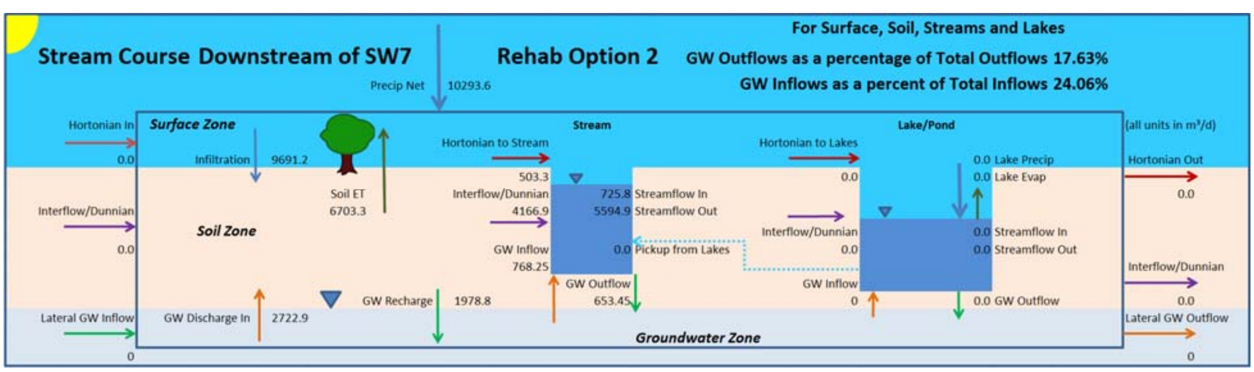
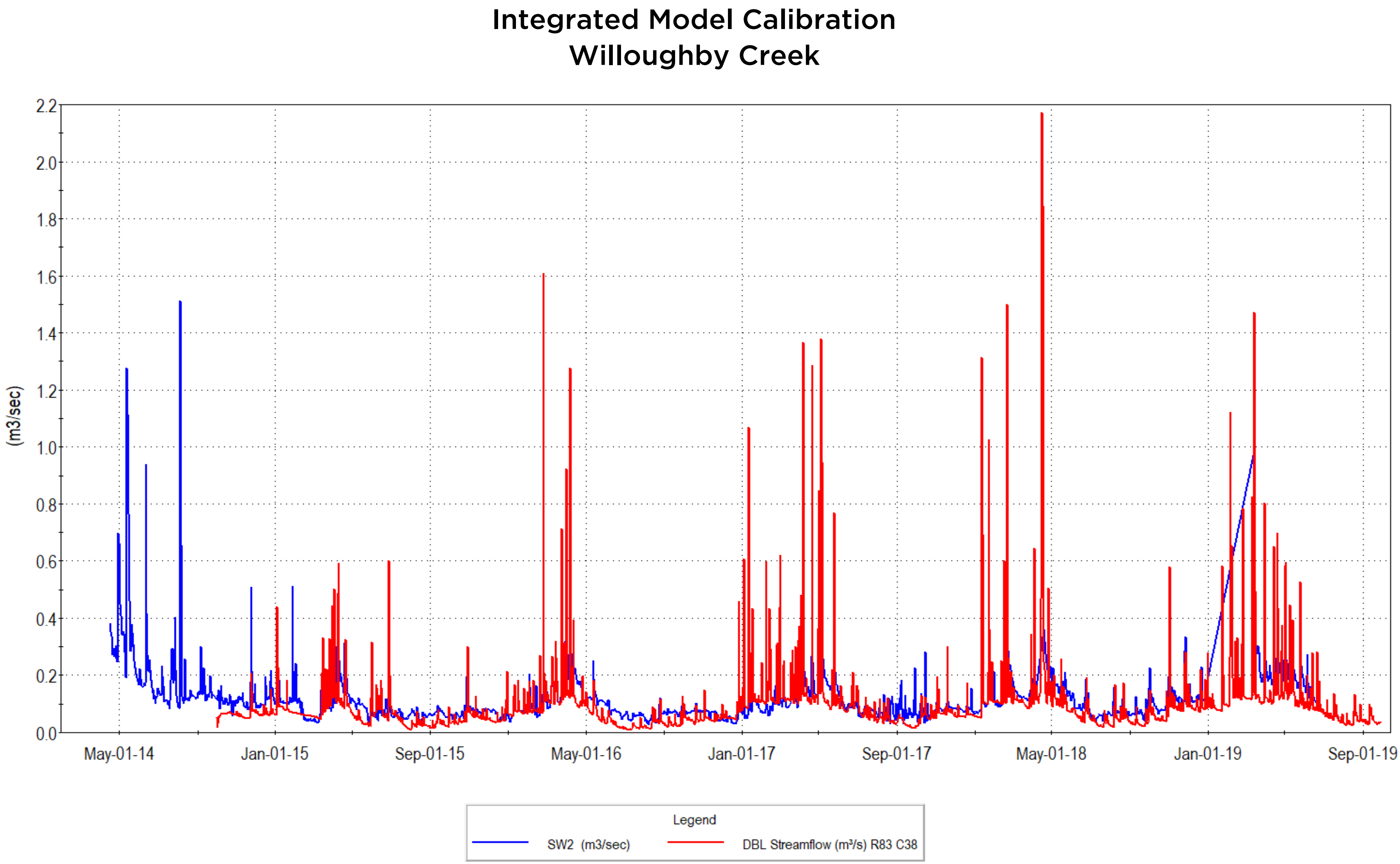
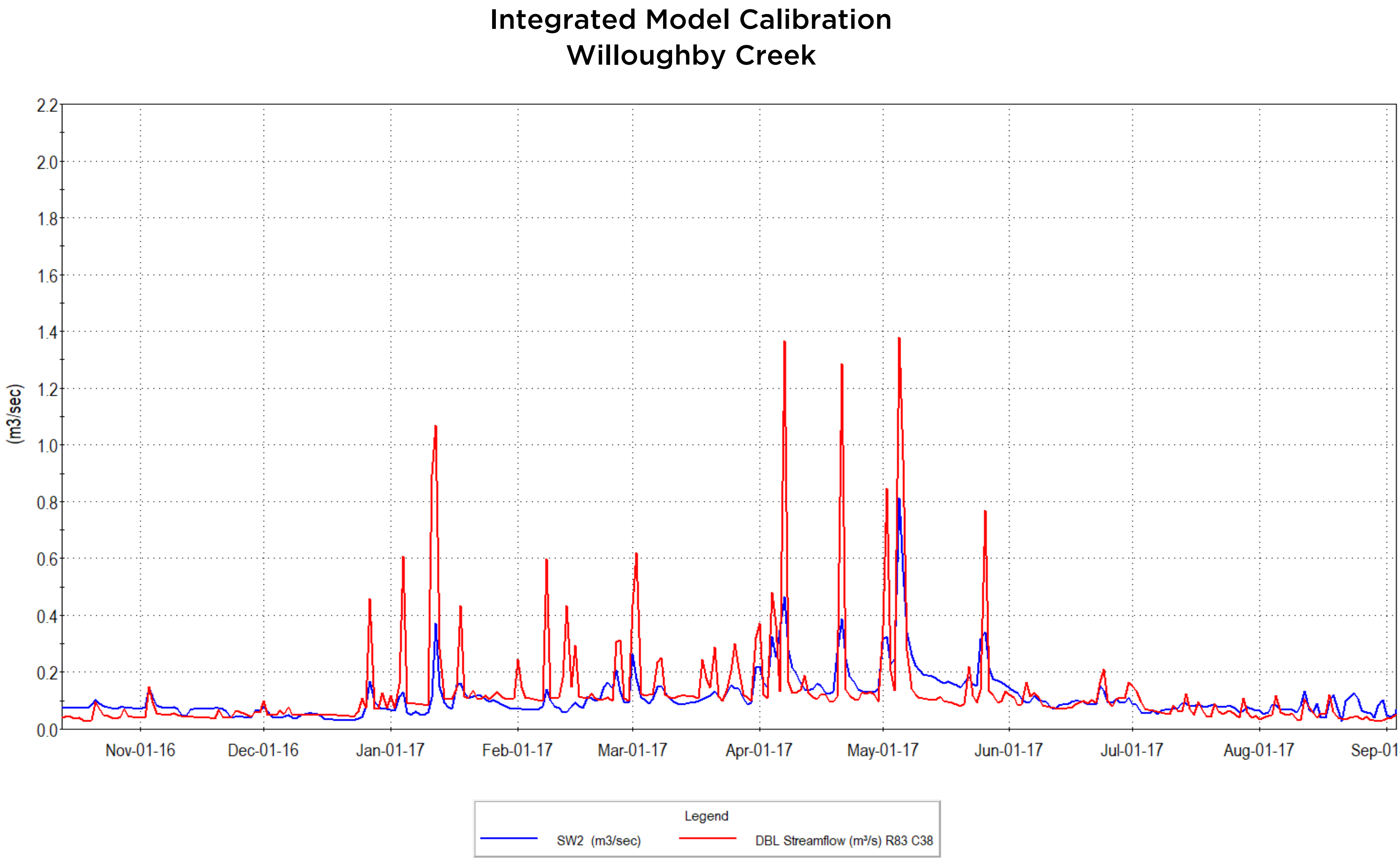


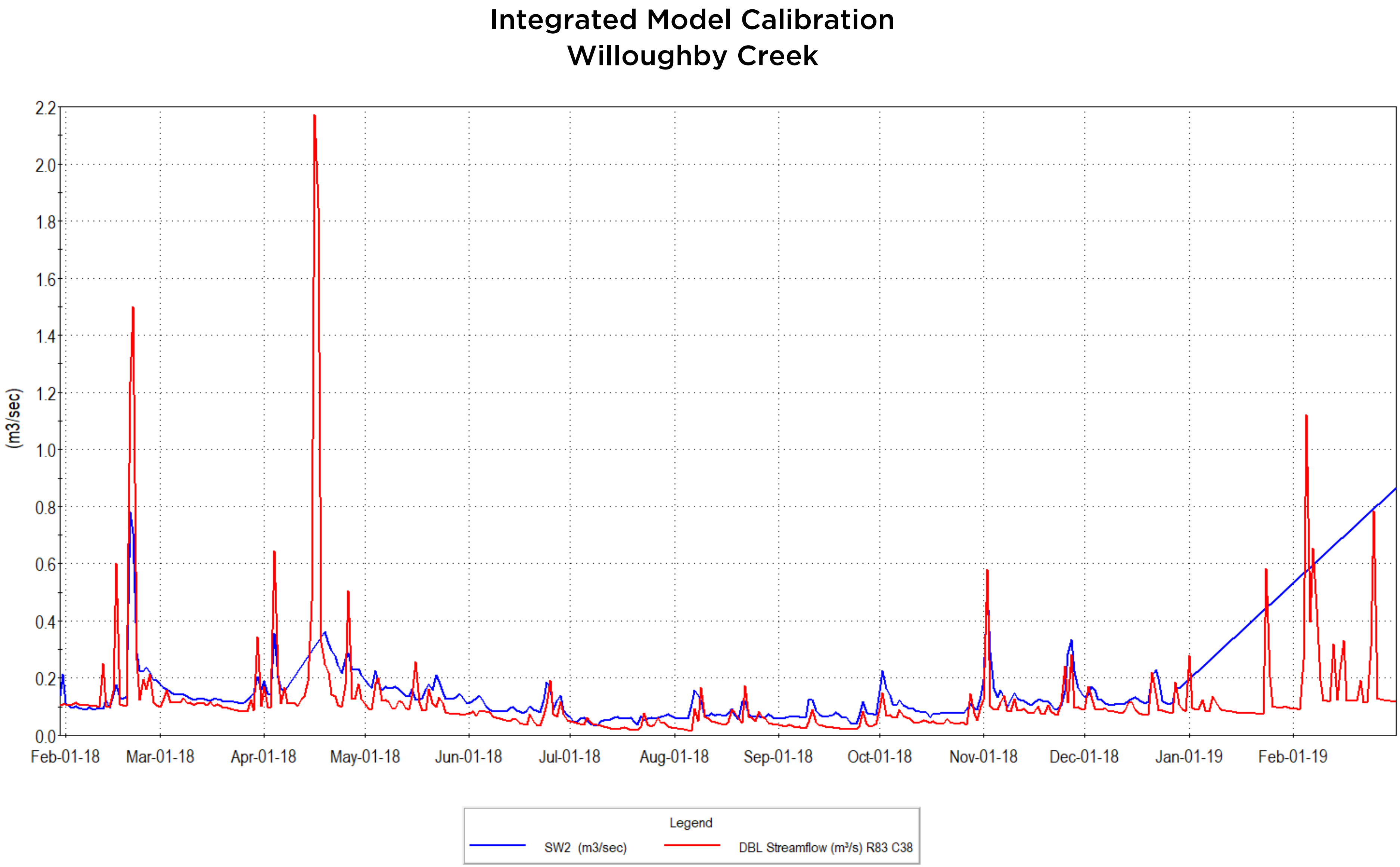
FIGURE 6E

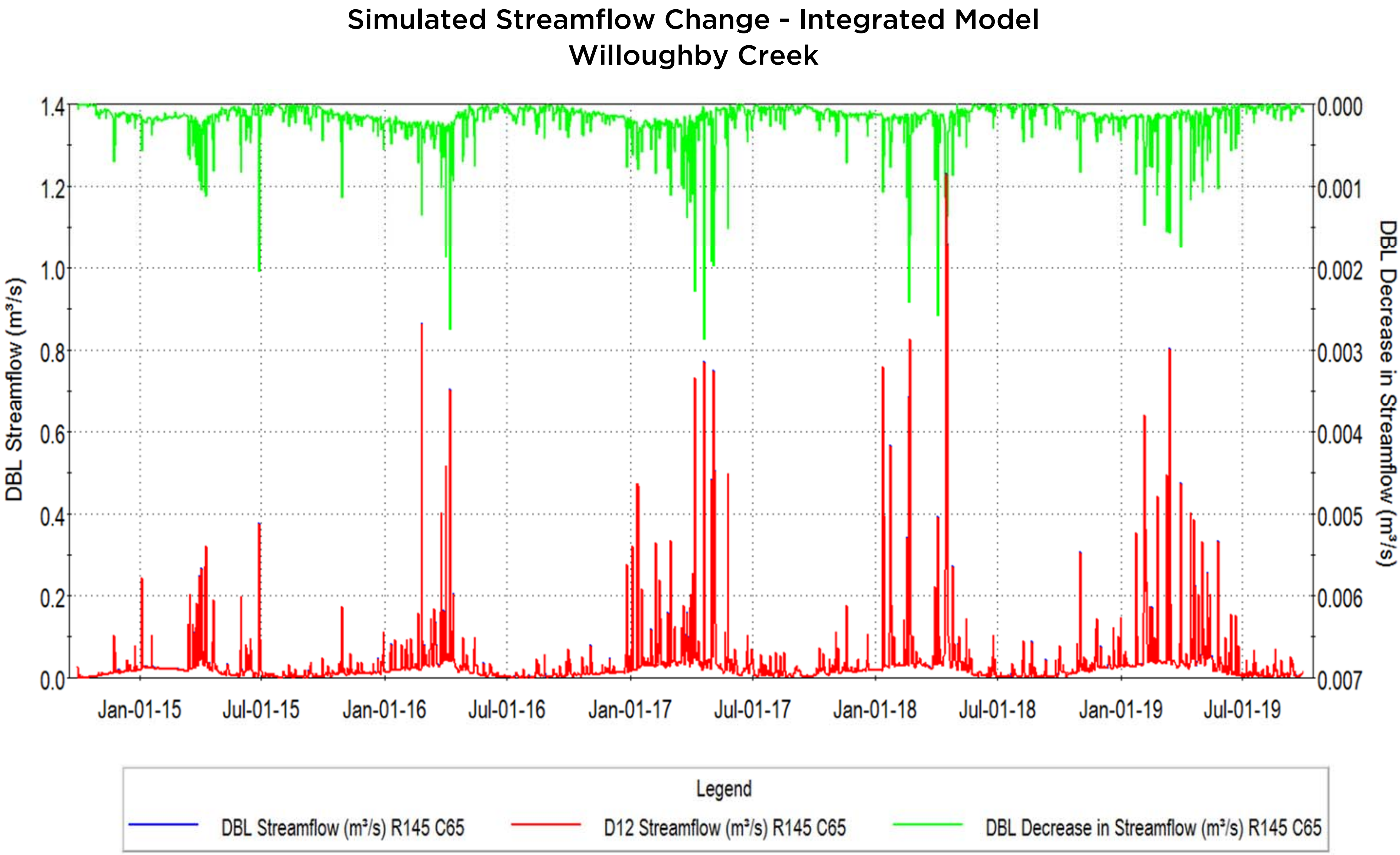


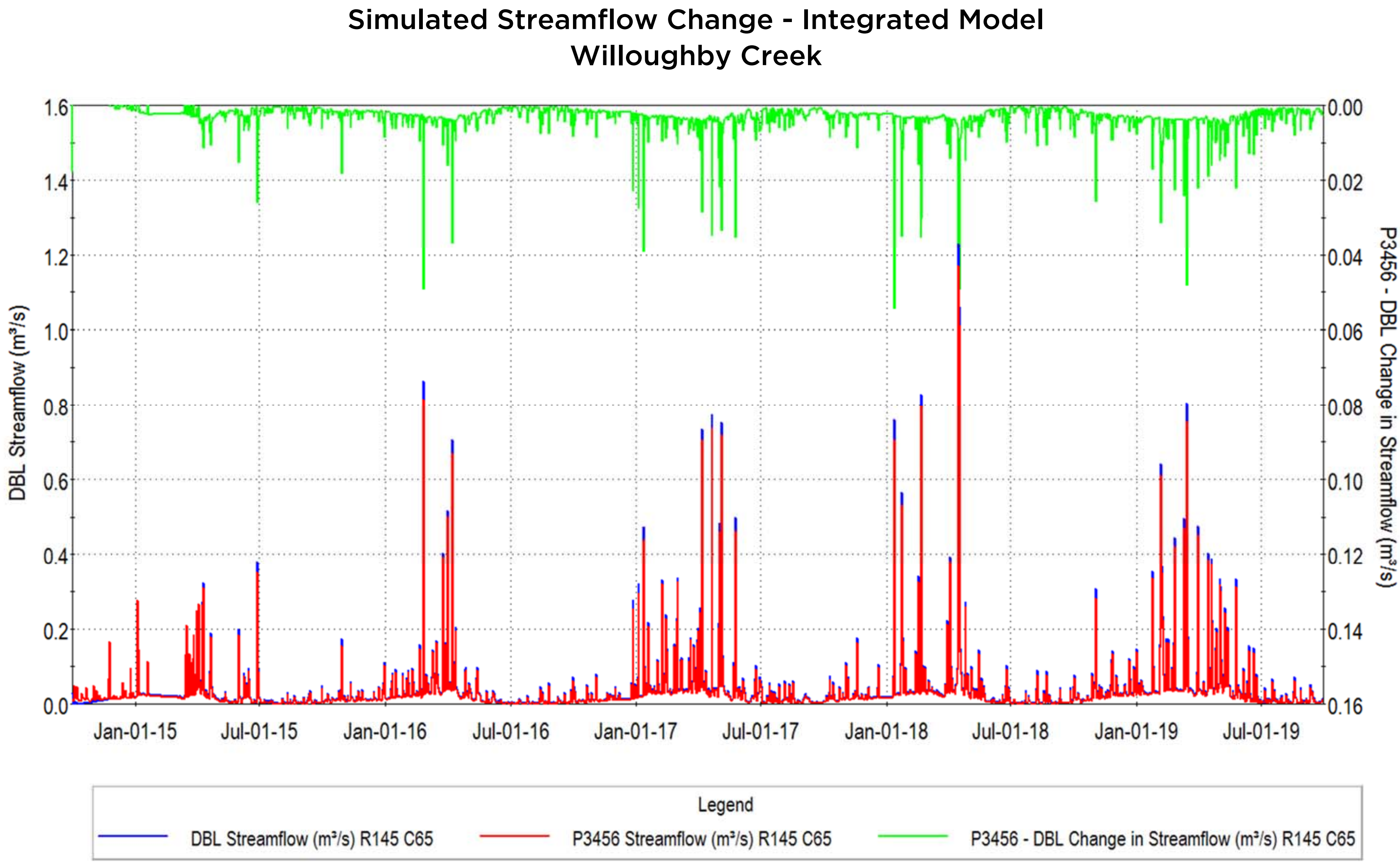
WILLOUGHBY CREEK - GRAPH 7



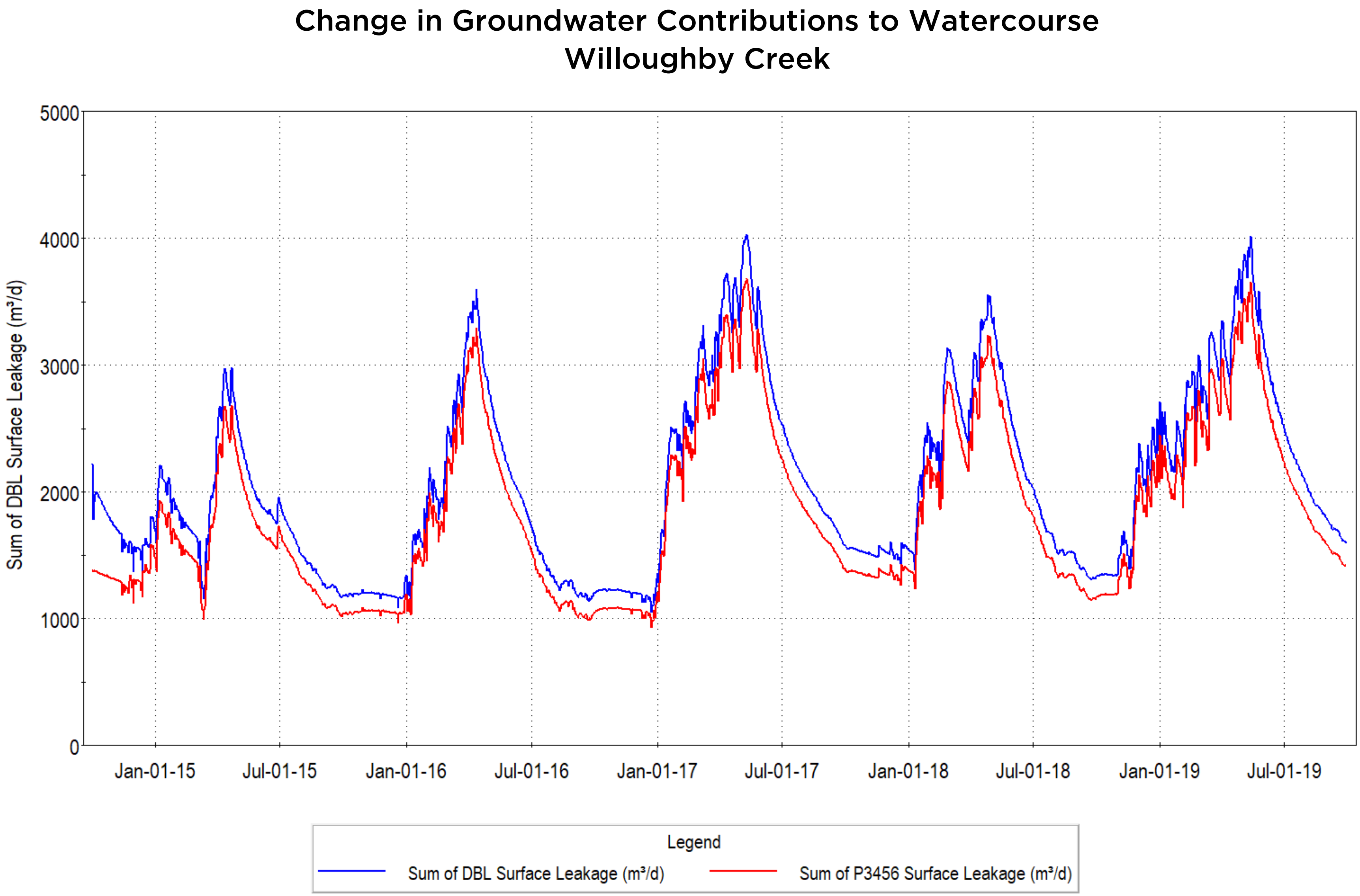

Integrated Model Calibration
Willoughby Creek
(m3/sec)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Nov-01-16
Dec-01-16
Jan-01-17
Feb-01-17
Mar-01-17
Apr-01-17
May-01-17
Jun-01-17
Jul-01-17
Aug-01-17
Sep-01-
Legend
SW2 (m3/sec)
DBL Streamflow (m³/s) R83 C38

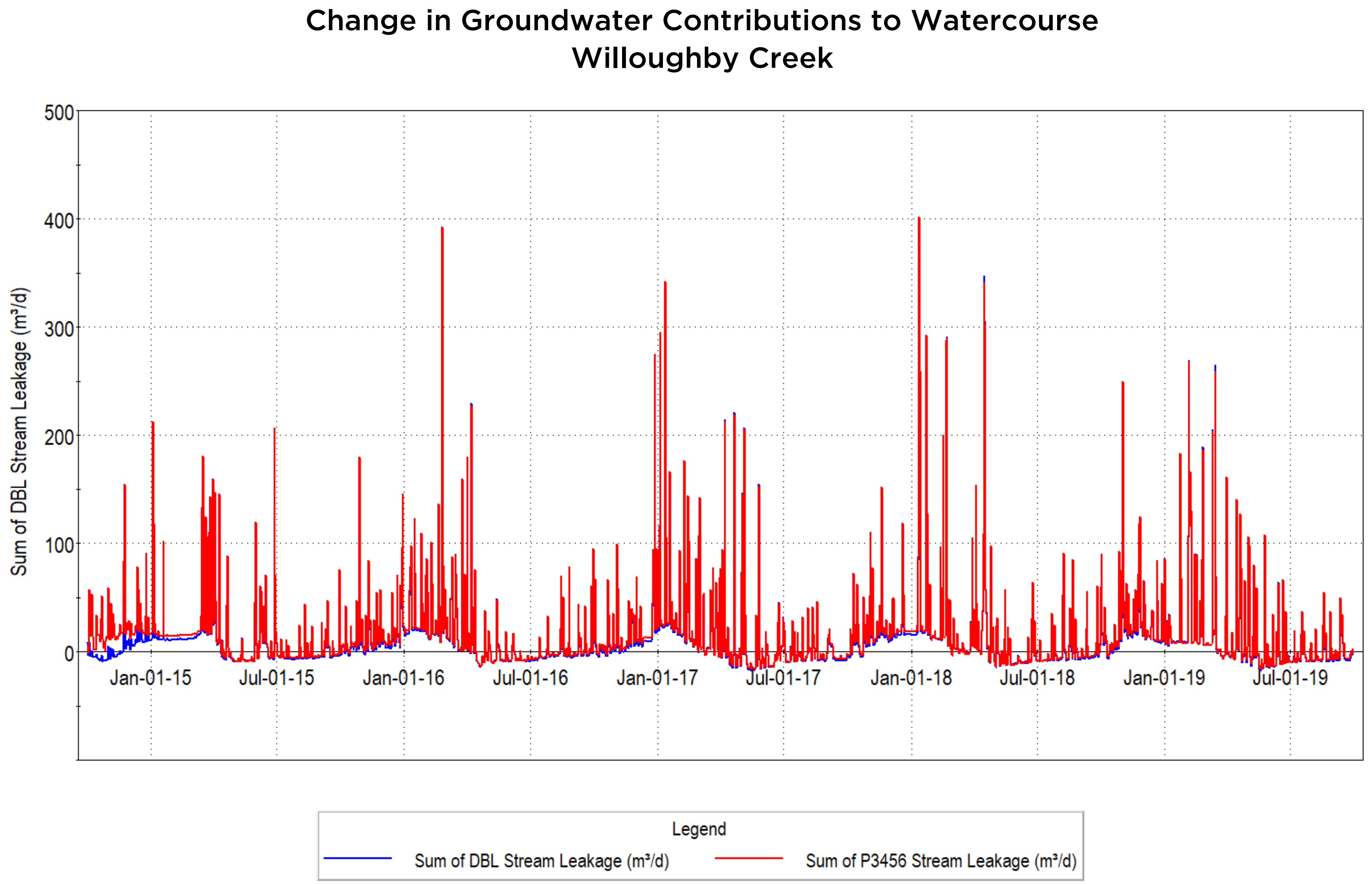

Integrated Model Calibration
Willoughby Creek
(m3/sec)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Feb-01-18
Mar-01-18
Apr-01-18
May-01-18
Jun-01-18
Jul-01-18
Aug-01-18
Sep-01-18
Oct-01-18
Nov-01-18
Dec-01-18
Jan-01-19
Feb-01-19
Legend
SW2 (m3/sec)
DBL Streamflow (m³/s) R83 C38


Simulated Streamflow Change - Integrated Model
Willoughby Creek
DBL Streamflow (m³/s)
DBL Decrease in Streamflow (m³/s)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.000
0.001
0.002
0.003
0.004
0.005
0.006
0.007
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R145 C65
D12 Streamflow (m³/s) R145 C65
DBL Decrease in Streamflow (m³/s) R145 C65


Simulated Streamflow Change - Integrated Model
Willoughby Creek
DBL Streamflow (m³/s)
P3456 - DBL Change in Streamflow (m³/s)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
DBL Streamflow (m³/s) R145 C65
P3456 Streamflow (m³/s) R145 C65
P3456 - DBL Change in Streamflow (m³/s) R145 C65

WILLOUGHBY CREEK - GRAPH 12





Change in Groundwater Contributions to Watercourse
Willoughby Creek
Sum of DBL Stream Leakage (m³/d)
500
400
300
200
100
0
Jan-01-15
Jul-01-15
Jan-01-16
Jul-01-16
Jan-01-17
Jul-01-17
Jan-01-18
Jul-01-18
Jan-01-19
Jul-01-19
Legend
Sum of DBL Stream Leakage (m³/d)
Sum of P3456 Stream Leakage (m³/d)

Attachment 3 – Spill Contingency and Pollution Prevention Plan

SPILL CONTINGENCY AND POLLUTION PREVENTION PLAN

BURLINGTON QUARRY

Revised February 6, 2019

PERSONS RESPONSIBLE FOR ACTIVATING THE BURLINGTON QUARRY SPILL CONTINGENCY AND POLLUTION PREVENTION PLAN

Quarry Manager:
Bill White
24-hour Contact - Cell: 1-905-407-8442

Environmental Manager:
Tecia White
24-hour Contact - Cell: 1-705-888-7064

SPILL PROCEDURE

In the event of a problem involving equipment operated within the Burlington Quarry that results in the release of a hazardous substance into the environment, the following steps are to be taken immediately.

Hazardous materials that are likely to be released from equipment operated by Aggregate Resources are fuel oil (diesel fuel), engine oils, transmission fluid or engine coolant as well as the product being transported. Specifically, the hazardous material which may be transported or stored within the area serviced by the works include:

- ACE Methyl Hydrate
- Injector Kleen
- Handigas
- Anti-Seize Sealing Compound
- Air Intake Kleen
- Original Gas Line Anti-Freeze
- Mobile Delvac 1300 Super 10W-30
- Kleen-Start Starting Fluid
- Diesel Fuel Conditioner

The Material Safety Data Safety Sheets (MSDS) for each of these materials are provided in Appendix A.

When a spill involving these materials is discovered ensure (as far as is practical) that the unit involved is stopped and secured in a safe location. Try to stay away clear of any location that might be affected by the release of these materials. Where practical stay away from catch basins and do not allow liquids to enter any water feature, including standing water, drainage ditches, ponds, or sump locations. Drain inlets, catch basins and culvert inlets should be blocked to prevent the entry of contaminants. If stopped on a grade try to prevent liquids from flowing down gradient and entering catch basins at some location remote from your location.

Equipment Operator:
Upon detecting a liquid spill or spill of material take necessary steps to contain the spill.

- Identify the material and the applicable hazards. Try to determine the quantity of material spilled.
- If flammable remove all sources of ignition including electricity and rope off the area if possible.
- Ensure the proper PPE is obtained before entering spill area.
- Stop product loss by closing valves and stopping pumps as required.
- Remove injured persons from danger area
- Block off any sewer entrances. Use absorbing material or sand/soil to create a dike around the spill area. Create walls of sand or absorbing material ahead of the product flow.
- Secure the area and ensure only the required people are present. Keep the area clear for the emergency vehicles.
- Contact Quarry or Environmental Manager

ROLES AND RESPONSIBILITIES

Environmental Manager:

- Oversee clean-up and reporting
- Notify Ministry of the Environment and Climate Change (unless exempt under O.Reg. 675/98)

Quarry Manager:

- Upon being notified of a spill will assign a designated cleanup crew who will respond with additional spill kits, shovels, brooms and containers to receive contaminated waste from spill cleanup.
- Assist with the cleanup of the spill.
- Coordinate quarry staff and third party clean up companies to ensure the work completed immediately after the spill occurred. Report progress to Environmental Manager and Operations Manager.

Health and Safety Manager:

- Ensure accident, spill and cleanup activities meet Ministry of Labour regulations.

Quarry or Environmental Manager to complete the following Spill Response Forms (Schedule A):

- Spill Incident Report
- Spill Clean Up Log

MEDIA RELATIONS

All requests for information from reporters or other media sources must be referred to the office of the President.

TRAINING

Tecia White (Environmental Manager) completed the Spill Response Online Training Course (F.A.S.T: First Aid Safety Training) November 10, 2017. The course provided extensive information about responding to minor spills; those spills where the worker can take the necessary measures to control, contain and clean up spilled materials.

All operators of equipment operated by Nelson will be instructed in this spill procedure and their function when reacting to a spill of hazardous materials involving the unit they are operating. All supervisory and responding cleanup crew will receive training in spill management, containment, and spill cleanup.

SPILL KITS

Fuel Truck: 5 gal pail:

- ten absorbent pads
- 10’ sock
- Latex gloves
- Safety goggles

Shop Kit: Red Zenith Universal Kit

- two absorbent pillows
- Nitrile gloves
- Safety goggles
- Disposal bag
- 12 10’ socks
- 20 absorbent pads

EMERGENCY CONTACT NUMBERS

Local Police	911
Ministry of the Environment Spills Action Centre (24 - hour, province wide, toll-free number)	1-800-268-6060
Ministry of Labour	1-416-314-5300
Ministry of the Environment and Climate Change District Office (Burlington)	1-800-335-5906

EMERGENCY HAZARDOUS WASTER CLEANUP COMPANIES

Catch Basin Cleaning	1-416-231-4696
Burlington Hydro-Vac	1-905-545-1117

Figure 1: Burlington Quarry Map

Spill Incident Report

Date:	
Time:	
Spill Reported By (Employee Name):	
Exact Location of Spill:	
Show on attached map	
Equipment Involved:	
Spill Details	
Material Spilled:	
Estimated Volume Spilled:	
Is the Spill Contained:	
Environmental Factors	
Distance from Ponds	
Distance from Sumps	
Distance from Drainage Ditches	
Nelson Personal Contacted	
Operations Manager	
Environmental Manager	
Health and Safety Manager	
Emergency / Agency Personal Contacted	
Emergency 911	
Ministry of the Environment and Climate Change	
Ministry of Labour	

Spill Clean Up Log

Date	Time	Action Taken

APPENDIX A

Material Safety Data Safety Sheets