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Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Blast Impact Analysis Uppers Quarry

Part of Lots 119, 120, 136 and 137, Part of the road allowance
between Lots 120 and 136 (Geographic Township of Stamford), City
of Niagara Falls, Regional Municipality of Niagara



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EXECUTIVE SUMMARY

ExploTech Engineering Ltd. was retained in November 2016 to provide a Blast Impact Analysis for the proposed Uppers Quarry located on Part of Lots 119, 120, 136 and 137. The Assessment also takes into account potential extraction of the portion of Upper's Lane and part of the unopened road allowance between Lots 120 and 136 (geographic township of Stamford), where they exist between Thorold Townline Road and Beechwood Road, all in the City of Niagara Falls, Regional Municipality of Niagara.

Vibration levels assessed in this report are based on the Ministry of the Environment, Conservation and Parks (MECP) Model Municipal Noise Control By-law with regard to guidelines for blasting in Mines and Quarries. We have assessed the area surrounding the proposed licence area as it relates to potential damage from blasting operations and compliance with the aforementioned By-law document.

We have inspected the property and reviewed the available site plans. ExploTech is of the opinion that the planned aggregate extraction on the proposed property can be carried out safely and within MECP guidelines as set out in NPC 119 of the By-Law.



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INTRODUCTION

Walker Aggregates (Walker) intends to apply for a Class A, Category 2 Licence for the property legally described as Part of Lots 119, 120, 136 and 137, former Township of Stamford, now in the City of Niagara Falls, in the Regional Municipality of Niagara. Two municipal road allowances (Upper's Lane and an unopened road allowance between Part of Lots 120 and 136 in the former Township of Stamford) separate the proposed quarry site into three extraction areas:

- i) North Extraction Area: extraction area North of Upper's Lane;
- ii) Mid Extraction Area: extraction area South of Upper's Lane and North of the unopened road allowance between Township Lots 120 & 136 in the former Township of Stamford, now in the City of Niagara Falls ("unopened road allowance"); and
- iii) South Extraction Area: extraction area South of the unopened road allowance. Part of the road allowance between Lots 120 and 136 (geographic township of Stamford), City of Niagara Falls, Regional Municipality of Niagara.

This Blast Impact Analysis assesses the ability of the proposed licence (whether the two road allowances are ultimately included in the extraction area or not) to operate within the prescribed blast guideline limits as required by the Ontario Ministry of the Environment, Conservation and Parks (MECP).

While not specifically required as part of the scope of the Blast Impact Analysis under the Aggregate Resources Act, this report also touches on the topics of the flyrock and residential water wells for general informational purposes only. Details related to residential water wells are addressed in the hydrogeological report while specific flyrock control is addressed at the operational level given significant influences related to blast design, geology and field accuracy. Additionally, potential impacts on the adjacent TC Energy pipeline, electrical transmission towers, and nearby waterbodies are discussed to confirm compliance with applicable external corporate policies and guidelines.

The proposed Uppers Quarry operation is bounded by farm land to the North and South, Beechwood Road to the East, a residential subdivision (Fernwood) to the Southeast and Thorold Townline Road to the West. A residential and employment subdivision (Rolling Meadows) has been approved West of Thorold Townline Road. The extraction areas will be accessed via Thorold Townline Road and Upper's Lane.



The proponent currently owns the lands housing the residences designated as 5872 Thorold Townline Road and 5497 Beechwood Road. The closest sensitive receptor not owned by the proponent is the property designated as 5329 Beechwood Road.

This Blast Impact Analysis has been prepared based on the MECP Model Municipal Noise Control By-law with regard to Guidelines for Blasting in Mines and Quarries (NPC 119).

Given that mining operations have not been undertaken in the past on this property, site-specific blast monitoring data is not available. We have therefore applied data generated across a spectrum of quarries and construction projects which provides a conservative approximation of anticipated vibration levels from the operation. It has been our experience that this data represents a conservative starting point for blasting operations. It is a recommendation of this report that a vibration monitoring program be initiated on-site upon the commencement of blasting operations and maintained for the duration of all blasting activities to confirm compliance with MECP guideline limits for ground vibration and overpressure based on actual measurements taken during blast times.



EXISTING CONDITIONS

The licenced area for the proposed Uppers Quarry encompasses a total area of approximately 103.6HA. The total extraction area is approximately 89.1HA.

The site is separated into eight (8) extraction phases. The phases are designated as 1a, 1b, 2a, 2b, 3a, 3b, 4 and 5 with phased extraction progressing initially from the Northwest corner of Phase 1a along the West end of the property (Refer to Appendix A).

The topography of the proposed licence area is generally lowest in the North portion of the site at an elevation in the order of 177masl rising towards the West and South with the highest elevations (185masl) lying in the middle of the West boundary of the site (Phase 1b). The design final quarry floor elevation is 141masl –148.7masl leading to the likely execution of 2 to 3 benches to achieve final grade.

The lands surrounding the proposed licence area are largely characterized by agricultural areas with a limited number of residential structures within 500m aside from a subdivision located Southeast of the boundary limits. All sensitive receptors within 500m of the licence boundary are as follows:

Address	Distance to Receptor from Licence Boundary (m)	Direction from Licence Boundary
9337 Beaversdam Road	475	North
9417 Beaversdam Road	447	North
9582 Beaversdam Road	151	North
9722 Beaversdam Road	234	North
10138 Beaversdam Road	442	North
10148 Beaversdam Road	184	North
5329 Beechwood Road	63	East
5584 Beechwood Road	81	Southeast
5769 Beechwood Road	287	Southeast
5821 Beechwood Road	360	Southeast
9312 Madison Crescent	417	Southeast
9315 Madison Crescent	445	Southeast
9324 Madison Crescent	404	Southeast
9325 Madison Crescent	434	Southeast

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Address	Distance to Receptor from Licence Boundary (m)	Direction from Licence Boundary
9336 Madison Crescent	390	Southeast
9337 Madison Crescent	423	Southeast
9349 Madison Crescent	415	Southeast
9352 Madison Crescent	370	Southeast
9361 Madison Crescent	407	Southeast
9366 Madison Crescent	354	Southeast
9373 Madison Crescent	391	Southeast
9380 Madison Crescent	338	Southeast
9385 Madison Crescent	371	Southeast
9397 Madison Crescent	351	Southeast
9409 Madison Crescent	334	Southeast
9421 Madison Crescent	316	Southeast
9433 Madison Crescent	299	Southeast
9445 Madison Crescent	280	Southeast
9457 Madison Crescent	260	Southeast
5599 Osprey Avenue	251	Southeast
5607 Osprey Avenue	259	Southeast
5610 Osprey Avenue	311	Southeast
5615 Osprey Avenue	271	Southeast
5622 Osprey Avenue	323	Southeast
5623 Osprey Avenue	284	Southeast
5631 Osprey Avenue	290	Southeast
5632 Osprey Avenue	331	Southeast
5639 Osprey Avenue	299	Southeast
5642 Osprey Avenue	341	Southeast
5647 Osprey Avenue	311	Southeast
5652 Osprey Avenue	350	Southeast
5655 Osprey Avenue	321	Southeast
5663 Osprey Avenue	333	Southeast
5668 Osprey Avenue	362	Southeast
5671 Osprey Avenue	339	Southeast
5679 Osprey Avenue	350	Southeast
5687 Osprey Avenue	362	Southeast
5695 Osprey Avenue	374	Southeast



Address	Distance to Receptor from Licence Boundary (m)	Direction from Licence Boundary
5703 Osprey Avenue	383	Southeast
5711 Osprey Avenue	393	Southeast
5719 Osprey Avenue	404	Southeast
5727 Osprey Avenue	415	Southeast
5735 Osprey Avenue	424	Southeast
5743 Osprey Avenue	438	Southeast
5751 Osprey Avenue	448	Southeast
5759 Osprey Avenue	459	Southeast
5767 Osprey Avenue	470	Southeast
5772 Osprey Avenue	499	Southeast
5775 Osprey Avenue	480	Southeast
5783 Osprey Avenue	490	Southeast
9245 Shoveller Drive*	410	Southeast
9314 Shoveller Drive	494	Southeast
9324 Shoveller Drive	488	Southeast
9334 Shoveller Drive	478	Southeast
9344 Shoveller Drive	467	Southeast
9354 Shoveller Drive	460	Southeast
9364 Shoveller Drive	450	Southeast
9374 Shoveller Drive	443	Southeast
9385 Shoveller Drive	392	Southeast
9394 Shoveller Drive	428	Southeast
9395 Shoveller Drive	383	Southeast
9404 Shoveller Drive	423	Southeast
9405 Shoveller Drive	374	Southeast
9414 Shoveller Drive	416	Southeast
9424 Shoveller Drive	412	Southeast
9434 Shoveller Drive	405	Southeast
9446 Shoveller Drive	400	Southeast
9045 Eagle Ridge Drive	457	Southeast
9355 Eagle Ridge Drive	494	Southeast
9365 Eagle Ridge Drive	481	Southeast
9375 Eagle Ridge Drive	469	Southeast
9385 Eagle Ridge Drive	471	Southeast

Address	Distance to Receptor from Licence Boundary (m)	Direction from Licence Boundary
9395 Eagle Ridge Drive	464	Southeast
9415 Eagle Ridge Drive	448	Southeast
9425 Eagle Ridge Drive	445	Southeast
9435 Eagle Ridge Drive	443	Southeast
9440 Eagle Ridge Drive*	484	Southeast
9445 Eagle Ridge Drive	436	Southeast
9461 Eagle Ridge Drive	427	Southeast
9484 Eagle Ridge Drive	480	Southeast
9490 Eagle Ridge Drive	478	Southeast
9494 Eagle Ridge Drive	477	Southeast
9500 Eagle Ridge Drive	474	Southeast

*Multiple units located at address, closest unit to licence boundary included above

Table 1: Sensitive Receptors within 500m of the Licence Boundary

The properties on the proposed licenced land (5205 and 5497 Beechwood Road, 5872 Thorold Townline Road, 9764 Upper's Lane, 9903 Upper's Lane and 10200 Upper's Lane) are within the proposed extraction limits. Upon commencement of extraction, the use of these structures will be such that they do not qualify as sensitive receptors.

The utility buildings (4832 Thorold Townline Road) located directly adjacent the proposed licence do not qualify as sensitive receptors as defined by the MECP (refer to Appendix E for Definitions) but will remain in place and operational for the foreseeable future. In order to safeguard the integrity of this structure, we recommend that vibrations at the utility buildings be maintained below 50mm/s in accordance with research performed by the United States Bureau of Mines (USBM RI8507). It is a recommendation of this report that this structure shall be monitored for ground vibration when vibration calculations suggest vibrations in excess of 35mm/s.



PROPOSED MINERAL EXTRACTION

An existing watercourse runs North-South through Phase 3a, Phase 4 and Phase 5 of the extraction limits. The proposed existing watercourse realignment will relocate the watercourse inside the excavation limits on the Western limits of extraction inside Phase 1b and 2b.

The extraction operations will begin with a sinking cut at the Northwest portion of Phase 1a (Mid Extraction Area) and will retreat Easterly and Southerly through Phase 1a. Phase 1b is located on the Western edge of Phase 1a and borders the Western most boundary for the proposed licence. In the Mid Extraction Area, Phase 1a will be extracted to a final floor elevation of 141 – 145masl and given existing topography of 181 – 185masl, it is anticipated that Phase 1a extraction will take place in 2 – 3 benches. Phase 1b will be extracted to a depth of no greater than 155masl in order to facilitate the construction of the new realigned watercourse. The Phase 1a and Phase 1b areas are also located in the South Extraction area separated by a road allowance not owned by the proponent. As a result, an additional sinking cut in the Northwest corner of Phase 1a (South Extraction Area) will be required. Phase 1a (South Extraction Area) will retreat Easterly and Southerly through Phase 1a (South Extraction Area). Phase 1b (South Extraction Area) is located on the Western edge of Phase 1a and borders the Western most boundary for the proposed licence. In the South Extraction Area, Phase 1a will be extracted to a final floor elevation of 141 – 145masl and given existing topography of 182 – 185masl, it is anticipated that Phase 1a (South Extraction Area) extraction will take place in 2 – 3 benches. Phase 1b (South Extraction Area) will be extracted to a depth of no greater than 155masl in order to facilitate the construction of the new realigned watercourse.

Phase 2a (North Extraction Area) is located North of Phase 1a and will begin with a sinking cut at the Southwest corner of Phase 2a and will retreat Easterly and Northerly through Phase 2a. Phase 2b is located on the Western and Northern edge of Phase 2a and borders the Western most boundary for the proposed licence. Phase 2a will be extracted to a final floor elevation of 144 – 145masl and given existing topography of 180 – 182masl, it is anticipated that Phase 2a extraction will take place in 2 – 3 benches. Phase 2b will be extracted to a depth no greater than an elevation of 155masl in order to facilitate the construction of the new realigned watercourse whereas the watercourse alignment transition area found at the North end of Phase 2b will only be extracted to a depth of no greater than 174masl in order to facilitate the construction of the new realigned watercourse.

Phase 3a (North Extraction Area) is located to the East of Phase 2a and is currently traversed by the existing watercourse. The existing watercourse is to be

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relocated to the West perimeter of the site after the successful completion of the Phase 1b and 2b extraction.

A sinking cut in the Southwest corner of Phase 3b will initiate extraction with a Northerly and Easterly retreat. Extraction for Phase 3a will leverage the face created by extraction in Phase 2a with a Easterly retreat. ***

Phase 3a/3b will be extracted to a final floor elevation of 146masl – 149masl and given existing topography of 177masl – 183masl, it is anticipated that Phase 3 extraction will take place in 2 – 3 benches.

Phase 4 is located in the middle of the proposed licence area (Mid Extraction Area) and progresses from the Eastern Phase 1a limit (Mid Extraction Area) Easterly to the East proposed extraction limits. Extraction of Phase 4 will utilize the Eastern face of Phase 1a and will be extracted in 2 – 3 benches to a depth ranging from 141masl – 149masl given existing topography in Phase 4 of 177masl - 184masl.

Phase 5 is located in the South of the proposed licence area (South Extraction Area) and progresses from the Eastern Phase 1a limit (South Extraction Area) Easterly to the South and East extraction limits. Extraction of Phase 5 will utilize the Eastern face of Phase 1a and will be extracted in 2 – 3 benches to a depth ranging from 141masl – 149masl given existing topography in Phase 5 of 178masl - 182masl.

All extraction phases bordering the perimeter limits of the quarry (namely phases 1b, 2b, and 3a) will have a catchment bench located at elevation 149masl – 155masl depending on the phase.

As quarry operations migrate across the property, the closest sensitive receptors to the required blasting operations will vary. The closest receptor to the proposed Upper's Quarry licence area over the life of the quarry is 5329 Beechwood Road at a distance of 63m from the licence boundary.

***Alternatively, if the existing watercourse is realigned prior to the extraction operations in Phase 3, extraction may begin in Phase 3a. Phase 3a will leverage the existing Phase 2a face and retreat Easterly. Phase 3b will then leverage the Phase 3a face and retreat Easterly. If this alternate extraction proceeds, the conclusions of this report are unchanged.



BLAST VIBRATION AND OVERPRESSURE LIMITS

The Ontario MECP guidelines for blasting in quarries are among the most stringent in North America.

Studies by the U.S. Bureau of Mines have shown that normal temperature and humidity changes can cause more damage to residences than blast vibrations and overpressure in the range permitted by the MECP. The guideline limits set by the MECP are as follows.

Vibration _____ 12.5mm/sec Peak Vector Sum (PVS)

Overpressure _____ 128 dBL Peak Sound Pressure Level (PSPL)

The above guidelines apply when blasts are being monitored. Cautionary levels are slightly lower and apply when blasts are not monitored on a routine basis. It is a recommendation of this report that all blasts at the operation be monitored to quantify and record ground vibration and overpressure levels employing a minimum of two (2) digital seismographs, one installed at the closest sensitive receptor in front of the blast, or closer, and a second installed at the closest sensitive receptor behind the blast, or closer.



BLAST MECHANICS AND DERIVATIVES

The detonation of explosives within a borehole results in the development of very high gas and shock pressures. This energy is transmitted to the surrounding rock mass, crushing the rock immediately surrounding the borehole (approximately 1 borehole radius) and permanently distorts the rock to several borehole diameters (5-25, depending on the rock type, prevalence of joint sets, etc.).

The intensity of this stress wave decays quickly so that there is no further permanent deformation of the rock mass. The remaining energy from the detonation travels through the unbroken material in the form of a pressure wave or shock front which, although it causes no plastic deformation of the rock mass, is transmitted in the form of vibrations.

Particle velocity is the descriptor of choice when dealing with vibrations because of its superior correlation with the appearance of cosmetic cracking. As such, for the purposes of this report, ground vibration units have been listed in mm/s.

In addition to the ground vibrations; overpressure, or air vibrations are generated through the direct action of the explosive venting through cracks in the rock or through the indirect action of the rock movement. In either case, the result is a pressure wave which travels through the air, measured in decibels (or dB) for the purposes of this report.



VIBRATION AND OVERPRESSURE THEORY

Transmission and decay of vibrations and overpressure can be estimated by the development of attenuation relations. These relations utilize empirical data relating measured velocities at specific separation distances from the vibration source to predict particle velocities at variable distances from the source. While the resultant prediction equations are reliable, divergence of data occurs as a result of a wide variety of variables, most notably site-specific geological conditions and blast geometry and design for ground vibrations and local prevailing climatic conditions for overpressure.

In order to circumvent this scatter and improve confidence in forecast vibration levels, probabilistic and statistical modeling is employed to increase conservatism built into prediction models, usually by the application of 95% confidence lines to attenuation data.

The attenuation relations are not designed to conclusively predict vibration levels at a specific location as a result of a specific blast design, application of this probabilistic model creates confidence that for any given scaled distance, 95% of the resultant velocities will fall below the calculated 95% regression line.

While the data still provides insight into probable vibration intensities, attenuation relations for overpressure tends to be less reliable and precise than results for ground vibrations. This is due primarily to wider variations in variables outside of the influence of the blast design which impact propagation of the vibrations. Atmospheric factors such as temperature gradients and prevailing winds (refer to Appendix B) as well as local topography can all serve to significantly alter overpressure attenuation characteristics. Fortunately, as described above, the conservatism built into the equations and the on-site vibration and overpressure monitoring performed at the quarry will aid in quantifying the vibrations and overpressures specific to the area in order to further reduce the likelihood of damage to all structures adjacent the quarry limits.

Our experience and analysis demonstrates that blast overpressure is greatest when blasting towards receptors, and blast vibrations are greatest when retreating towards the receptors.



GROUND VIBRATION LEVELS AT THE NEAREST SENSITIVE RECEPTOR

The most commonly used formula for predicting Peak Particle Velocity (PPV) is known as the Bureau of Mines (BOM) prediction formula or Propagation Law. We have used this formula to predict the PPV's at the closest house for the initial operations.

$$PPV = k \left(\frac{d}{\sqrt{w}} \right)^e$$

Where, PPV = the predicted peak particle velocity (mm/s)

K, e = site factors

d = distance from receptor (m)

w = maximum explosive charge per delay (kg)

The value of K and e are variable and influenced by many factors (i.e. rock type, geology, thickness of overburden, etc.). As such, these site factors are developed empirically through the measurement of vibration characteristics at the specific operations of interested.

The portion of the BOM prediction formula contained within the parentheses is referred to as the *Scaled Distance* and represents another important PPV relation. It correlates the separation distance between a blast and receptor to the energy (usually expressed as explosive weight) released at any given instant in time. The two most popular approaches are square root scaling and cube root scaling:

$$(SDSR = \frac{R}{\sqrt{W}})$$

$$(SDCR = \frac{R}{\sqrt[3]{W}})$$

Where, SDSR = Scaled distance square root method

SDCR = Scaled distance cube root method

R = Separation distance between receptor site and blast (m)

W = Maximum explosive load per delay period (kg)

Historically, square root scaling is employed in situations whereby the explosive load is distributed in a long column (i.e. blasthole) while cube root scaling is employed for point charges. In accordance with industry standard, square root scaling was adopted for ground vibration analysis for the purposes of this report.

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For a distance of 710m (the standoff distance to the closest sensitive receptor for the initial Phase 1a blasting (Mid Extraction Area), namely 10148 Beaversdam Road) and a maximum explosive load per delay of 118kg (101mm diameter hole, 15m deep, 3m surface collar and 1 hole per delay), we can calculate the maximum PPV at the closest building using the following formulae:

Imperial Equations:

Oriard 50% Bound (2002) $v = 160\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$

Oriard 90% Bound (2002) $v = 242\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$

Quarry Production Blast
(Bulletin 656 – 1971) $v = 182\left(\frac{D}{\sqrt{W}}\right)^{-1.82}$

Typical limestone Quarry
(Pader report – 1995) $v = 52.2\left(\frac{D}{\sqrt{W}}\right)^{-1.38}$

Typical Coal Mine
(RI8507 1980) $v = 133\left(\frac{D}{\sqrt{W}}\right)^{-1.5}$

Metric Equations:

General Blasting
(Dupont) $v = 1140\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$

Construction Blasting
(Dowding 1998) $v = 1326\left(\frac{D}{\sqrt{W}}\right)^{-1.38}$

Agg. Quarry Blasting
(Explotech 2005) $v = 5175\left(\frac{D}{\sqrt{W}}\right)^{-1.76}$

Agg. Quarry blasting
(Explotech 2003) $v = 7025\left(\frac{D}{\sqrt{W}}\right)^{-1.85}$

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The equations described above accommodate for a range of geological conditions. The proposed blast parameters were applied to the formulae to estimate a range of the potential vibrations to be imparted on the closest sensitive receptor behind the blast. As discussed in previous sections, the MECP guideline for blast-induced vibration is 12.5 mm/s (0.5 in/s). Appendix C demonstrates that the maximum (ie worst-case) calculated value for the vibration intensities imparted on the closest sensitive receptor based on all equations is 4.14mm/s for the initial blasting, well below the MECP guideline limit. All blasts will be monitored for overpressure and ground vibrations with blast designs adjusted in response to readings on site in order to confirm consistent compliance with established limits.

All vibration calculations and tables going forward will utilize the formula providing the worst case scenario for all geological conditions (Construction Blasting (Dowding 1998)).

An **example** of this calculation is as follows:

For a distance of 710m (the standoff distance to the closest sensitive receptor for the initial Phase 1a blasting, namely 10148 Beaversdam Road) and a maximum explosive load per delay of 118kg (101mm diameter hole, 15m deep, 3m surface collar and 1 hole per delay), we can calculate the maximum PPV at the closest sensitive receptor as follows:

$$ppv = 1326 \left(\frac{710}{\sqrt{118}} \right)^{-1.38} = 4.14 \text{ mm/s}$$

As discussed in previous sections, the MECP guideline for blast-induced vibration is 12.5 mm/s (0.5 in/s). The calculated 95% predicted PPV (based on the proposed blasting data discussed above) would be 4.14mm/s, well below the MECP guideline limit. It is understood that as separation distance to the receptors decreases, adjustments to blast designs may be necessary to maintain compliance with the guideline limits.

Similarly, the above equation used to calculate PPV can be reformatted to find an approximation of the distance at which a vibration velocity of 12.5mm/s would occur if all blasting parameters are kept the same as used in the equation above:

$$12.5 = 1326 \left(\frac{d}{\sqrt{118}} \right)^{-1.38} = 319.0 \text{ m}$$

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The above result suggests that design modifications to the above preliminary design of an explosive load of 118kg/delay would be required once blasting operations encroach to within 319m of any sensitive receptor. Fortunately, vibration data will be continually collected and analyzed as the sensitive receptors are approached in order to confirm the requirement for any design modifications. An abundance of design modifications are available which would readily maintain vibration intensities below guideline limits. This is based on conservative assumptions which will be confirmed through monitoring.

Given the separation distances that will be involved at the proposed Uppers Quarry, Table 2 below provides initial guidance on maximum loads per delay based on various separation distances. The following maximum loads per delay were derived from the equation for ground vibrations listed above and are based on a maximum intensity of 12.5mm/s:

Separation distance between sensitive receptor and closest borehole (meters)	Maximum recommended explosive load per delay (Kilograms)
500	290
450	235
400	185
350	140
300	105
250	70
200	45
150	25
100	11

Table 2: Maximum Loads per Delay to Maintain 12.5mm/s at Various Separation Distances

It is noteworthy that the above values are typically conservative and are intended as a guideline only as the ground vibration attenuation equation is based on a calculated 95% regression line. Actual loads can be adjusted on the basis of the results of the monitoring program in place.

The closest separation distance between a sensitive receptor and the licence boundary is 63m. While blasting at this separation distance is feasible from a technological perspective, given current blasting technology and techniques, market economics will dictate the feasibility of extracting rock at lesser separation distances. Monitoring and changes in blasting designs will be required in order to

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confirm all blasts are within MECP guidelines when blasting comes closer to adjacent sensitive receptors.

Similarly to the paragraph above, the closest separation distance between a non-sensitive receptor (namely the utility buildings located at 4832 Thorold Townline Road) and the extraction limits of the licence is 40m. Using the above equation and keeping the same blasting parameters with a suggested limit of 50mm/s, the calculation would suggest that once blasting encroaches to 116m removed from the utility buildings, modifications may be required.



OVERPRESSURE LEVELS AT THE NEAREST SENSITIVE RECEPTOR

It is unusual for overpressure to reach damaging levels and when it does, the evidence is typically immediate and obvious in the form of broken windows in the area. However, overpressure remains of interest due to its ability to travel further distances as well as cause audible sounds and excitation in windows and walls.

Air overpressure decays in a known manner in a uniform atmosphere, however, a uniform atmosphere is not a normal condition. As such, air overpressure attenuation is far more variable due to its intimate relationship with environmental influences. Air vibrations decay slower than ground vibrations with an average decay rate of 6dB for every doubling of distance.

Air overpressure levels are analyzed using cube root scaling based on the following equation:

$$P = k \left(\frac{d}{\sqrt[3]{w}} \right)^e$$

Where, P = the peak overpressure level (psi – imperial, Pa, dB - metric)
K, e = site factors
d = distance from receptor (ft – imperial, m - metric)
w = maximum explosive charge per delay (lbs – imperial, kg - metric)

The value of K and e are variable and are influenced by many factors (i.e. rock type, geology, thickness of overburden, environmental conditions, etc.). As such, these site factors are developed empirically through the measurement of overpressure characteristics at the specific operations of interested.

As discussed in previous sections, the MECP guideline for blast-induced overpressure is 128dB. For a distance of 710m (i.e. the standoff distance to the closest sensitive receptor in front of the blast for the initial Phase 1a blasting (Mid Extraction Area), namely 10148 Beaversdam Road) and a maximum explosive load of 118kg (101mm diameter hole, 15m deep, 3m surface collar and 1 hole per delay), we can calculate the overpressure at the nearest receptor in front of the blast using the following equations:

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Imperial Equations:

$$\text{USBM RI8485 (Behind Blast)} \quad P = 0.056 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.515}$$

$$\text{USBM RI8485 (Front of Blast)} \quad P = 1.317 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.966}$$

$$\text{USBM RI8485 (Full Confined)} \quad P = 0.061 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.96}$$

$$\text{Construction Average (Oriard 2005)} \quad P = 1 \left(\frac{D}{\sqrt[3]{W}} \right)^{-1.1}$$

Metric Equations:

$$\text{Ontario Quarry - dB (Explotech)} \quad P = 159 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.0456}$$

$$\text{Limestone - dB (Explotech)} \quad P = 206 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.1}$$

$$\text{Ontario Quarry - Pa (Explotech)} \quad P = 1222 \left(\frac{D}{\sqrt[3]{W}} \right)^{-0.669}$$

Appendix C demonstrates that the maximum calculated value for the overpressure intensities imparted on the closest sensitive receptor based on all equations is 126.8 dB(L) for the initial blasting, below the MECP guideline limit. For initial blasting, all blasts should be scheduled on days with favourable weather conditions to assist in mitigating overpressure levels.

The initial blasting area is also located in the most optimal location such that the direction of extraction will only increase the distance removed from where the front face is directed towards the sensitive receptor. Every subsequent blast in Phase 1a when retreating to the East and South from the initial Phase 1a sinking cut area will result in progressively lower overpressure results. All blasts will be monitored for overpressure and ground vibrations with blast designs adjusted in response to readings on site in order to maintain consistent compliance with established limits.

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Based on the above calculation and the assumed blast parameters, and the conservatism built into the equations, overpressures from blasting operations can remain compliant with the MECP NPC 119 guideline limit of 128dB(L). The design method of retreat has been planned so as to direct overpressures generated as much as practicable in the direction of vacant lands. All overpressure calculations and tables going forward will utilize the formula providing the worst case scenario for all geological conditions (Ontario Quarry – Pa (Explotech)).

We reiterate that air overpressure attenuation is far more variable due to its intimate relationship with environmental influences and as such, the equation employed is less reliable than that developed for ground vibration. Overpressure monitoring performed on site shall be used to guide blast design as it pertains to the control of blast overpressures. As demonstrated in Appendix B, prevailing winds during quarry operational periods are predominantly out of the Southwest.

The overpressure equation used to calculate PSPL can be reformatted to find an approximation of the distance at which an overpressure of 128 dB(L) would occur. If all blasting parameters are kept the same as above, a distance of 580m from the closest sensitive receptor in front of the blast would have a calculated overpressure of 128db(L). Once again, the on-site monitoring program will accurately delineate the overpressure intensities and provide guidance for the timing for any design changes.

Given the correlation between overpressure and environmental conditions as stated previously, care must be taken to avoid blasting on days when weather patterns are less favourable. Extraction directions have been selected so as to minimize overpressure impacts on adjacent receptors.

Table 3 below can be used as an initial guide showing maximum loads per delay based on various separation distances for receptors in front of the blast face. The following maximum loads per delay are derived from the air overpressure equation above and are based on a peak overpressure level of 128dB(L):



Separation distance between sensitive receptor and closest blasthole (meters)	Maximum recommended explosive load per delay (Kilograms)
1000	610
900	440
800	310
700	208
600	130
500	75

Table 3: Maximum Calculated Loads per Delay to Maintain 128dB(L) at Various Separation Distances for Receptors in Front of the Face

We note that the above values are conservative and are intended as a guideline only as the air overpressure attenuation is based on a calculated 95% regression line. Actual loads employed shall be based on the results of the monitoring program in place.



ADDITIONAL CONSIDERATIONS OUTSIDE OF THE BLAST IMPACT ANALYSIS SCOPE

The following headings are addressed for general information purposes and are not strictly required as part of the scope of the Blast Impact Analysis as required under the ARA to assess compliance with MECP NPC-119 guidelines. Considerations for the TC Energy Pipeline and Hydro One transmission towers can be expanded upon under separate cover with direct input from the owners as required. The hydrogeological study prepared by WSP as part of the licence application will address residential water wells in detail. Flyrock control is addressed at the operational level given significant influences related to blast design, geology and field accuracy which render concrete recommendations related to control inappropriate at the licencing phase. Considerations for aquatic species in the existing watercourse are further addressed in the Stantec report.

TC ENERGY HIGH PRESSURE NATURAL GAS PIPELINE

A TC Energy High Pressure Natural Gas Pipeline runs adjacent to the Northwest corner of the proposed quarry limits (refer to Appendix A). The MECP guideline for blast-induced vibration (12.5mm/s) does not apply to pipelines as they are not classified as sensitive receptors. Two (2) welded steel pipelines exist within the TC Energy right of way (ROW), one 20" and one 36" diameter pipeline. TC Energy Policy employs a 50mm/s vibration limit for welded steel pipelines. Based on the proposed Operations Plan for the Uppers Quarry, initial blasting operations are anticipated to be required approximately 345m from the subject pipeline, however, will reach as close as 7m throughout the course of extraction.

Applying the equation from Predicated Vibration Limits at the Nearest Sensitive Receptor, for a distance of 345m (the conservative standoff distance to the pipeline for the initial blasting (Mid Extraction Area)) and a maximum explosives load per delay of 118kg (101mm diameter hole, 15m deep, 3m surface collar and 1 hole per delay), we can calculate the maximum PPV at the pipeline as follows for the initial blast:

$$ppv = 1326 \left(\frac{345}{\sqrt{118}} \right)^{-1.38} = 11.22 \text{ mm/s}$$

The calculated 95% predicted PPV (based on the proposed blasting data discussed above) would be 11.22mm/s, well below the TC Energy limit of 50mm/s for a steel welded pipeline located adjacent to the proposed quarry.

EXPLOTECH

While this initial value resides below the required threshold, it is anticipated that design modifications will be necessary to maintain compliance as the separation distance to the pipeline decreases and column loads increase. Fortunately, a variety of blast design alternatives are available to accomplish this including but not limited to reductions in blast hole diameter, change in explosives types, adjustment in bench heights and decking of holes.

We do note that the TC Energy Blasting Specification requires the presence of a vibration monitoring program when blasting operations are to be conducted within 100m of a pipeline. The proposed Operational Plan dictates that blasting is to encroach within 7m of the ROW and as such, it is a recommendation of this report that an independent third party firm be retained to conduct vibration monitoring on this pipeline when separation encroaches within 100m of the pipeline or when calculations suggest ground vibrations in excess of 35mm/s as measured at the pipeline are anticipated. The results of this monitoring program will determine what blast design alterations shall be necessary as the separation distance to the subject pipeline decreases. Walker will adhere to the guidelines set by TC Energy with respect to blasting in proximity of the gas lines.

EXPLOTECH

FLYROCK

Flyrock is the term used to define rocks which are propelled from the blast area by the force of the explosion. This action is a predictable and necessary component of a blast and requires that every blast have an exclusion zone established within which no persons or property which may be harmed are permitted.

Government regulations strictly prohibit the ejection of flyrock off of a quarry property. The regulations regarding flyrock are enforced by the Ministries of Natural Resources, Environment and Labour. In the event of an incident where flyrock does leave a site, the punitive measures include suspension / revocation of licences and fines to both the blaster and quarry owner / operator. Fortunately, flyrock incidents are extremely rare due to the possible serious consequences of such an event. It is in the best interest of all, stakeholders and non-stakeholders, to ensure that dangerous flyrock does not occur. Through proper blast planning and design, it is possible to control and mitigate the possibility for flyrock.

THEORETICAL HORIZONTAL FLYROCK CALCULATIONS

Flyrock occurs when explosives in a hole are poorly confined by the stemming or rock mass and the high pressure gas breaks out of confinement and launches rock fragments into the air. The three primary sources of fly rock are as follows:

- **Face burst:** Lack of confinement by the rock mass in front of the blast hole results in fly rock in front of the face.
- **Cratering:** Insufficient stemming height or weakened collar rock results in a crater being formed around the hole collar with rock projected in any direction.
- **Stemming Ejection:** Poor stemming practice can result in a high angle throw of the stemming material and loose rocks in the blasthole wall and collar.

The horizontal distance flyrock can be thrown (L_H) from a blast hole is determined using the expression:

$$L_H = \frac{V_o^2 \sin 2\theta_0}{g} \quad [1]$$

EXPLOTECH

where: V_o = launch velocity (m/s)
 θ_0 = launch angle (degrees)
 g = gravitational constant (9.8 m/s²)

The theoretical maximum horizontal distance fly rock will travel occurs when $\theta_0 = 45$ degrees, thereby yielding the equation:

$$L_{H \max} = \frac{V_o^2}{g} \quad [2]$$

The normal range of launch velocity for blasting is between 10m/s - 30m/s. To calculate the launch velocity of a blast the following formula is used:

$$V_o = k \left(\frac{\sqrt{m}}{B} \right)^{1.3} \quad [3]$$

where: k = a constant
 m = charge mass per meter (kg/m)
 B = burden (m)

By combining equations 2 and 3 and taking into account the different sources of fly rock, the following equations can be used to calculate the maximum fly rock thrown from a blast:

Face burst:
$$L_{H \max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{B} \right)^{2.6}$$

Cratering:
$$L_{H \max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH} \right)^{2.6}$$

EXPLOTECH

Stemming Ejection:
$$L_{H \max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH} \right)^{2.6} \sin 2\theta$$

- where:
- θ = drill hole angle
 - $L_{h\max}$ = maximum flyrock throw (m)
 - m = charge mass per meter (kg/m)
 - B = burden (m)
 - SH = stemming height (m)
 - g = gravitational constant
 - k = a constant

The range for the constant k is 13.5 for soft rocks and 27 for hard rocks. Given the proposed licence area is predominantly limestone, we have applied a k value of 21. The explosive density is assigned to be 1.2 g/cc for emulsion products and the drill hole angles are assumed to be 90 degrees (i.e. vertical).

For calculation purposes, we have applied the initial blasting parameters which utilize 101mm (4") diameter holes on a 3.05m x 3.05m (10' x 10') pattern, with a lift height of 15m (49') and a collar length of 3.0m (10'). The following does not apply to the sinking cut which will require highly specialized designs and additional considerations for flyrock. Based on a free face blast, maximum anticipated horizontal flyrock projection distances are calculated as follows in Table 4:

Table 4 – Maximum Flyrock Horizontal		
Collar Lengths (m)	Maximum Throw Face Burst (m)	Maximum Throw Cratering and Stemming Ejection (m)
1.5	48	302
2.0	48	143
2.5	48	80
3.0	48	50
3.5	48	33

EXPLOTECH

Different collar lengths are displayed in the table above to account for over or under loaded holes. As demonstrated with these various collar lengths, any deviation, no matter how slight, can greatly affect these maximum values. The current proposed initial blasting parameters have the potential to send flyrock 50m assuming all holes achieve the designed collar lengths of 3.0m. Blast mats or sand can be placed on top of the initial blast to further reduce the distance for potential flyrock.

Through proper blast design and diligence in inspecting the geology before every blast, flyrock can readily be maintained within the quarry limits. It may be necessary to increase collars and adjust designs accordingly when blasting along the perimeter to accommodate the reduced deportation distance to receptors and to maintain flyrock within the property limits. The operational plan for the quarry has been designed to retreat towards the closest receptors thereby projecting flyrock and overpressures away from the receptors.



TRANSMISSION AND HYDRO TOWERS

Transmission towers (Namely the Hydro One Corridor) runs parallel to the Southern limits of the proposed quarry licence noted on the proposed Operational Plan (refer to Appendix A). The MECP guideline for blast-induced vibration (12.5mm/s) does not apply to transmission/hydro towers as they are not classified as sensitive receptors. In order to safeguard the integrity of these structures, Hydro One has set a vibration limit of 50mm/s at the foundations of the transmission towers.

As per direction from Hydro One, calculations will be based on the 50mm/s limit. The tower shall be monitored for ground vibration and overpressure when vibration calculations suggest vibrations in excess of 35mm/s at the tower base. Based on the proposed Operations Plan for the Uppers Quarry, initial blasting operations are anticipated to be approximately 530m from the closest tower, however, will reach as close as 30m throughout the course of extraction at the Southern limits of Phase 1b and Phase 5.

Applying the equation from Predicated Vibration Limits at the Nearest Sensitive Receptor, for a distance of 530m (the conservative standoff distance to the transmission tower for the initial blasting) and a maximum explosives load per delay of 118kg (101mm diameter hole, 15m deep, 3m surface collar and 1 hole per delay), we can calculate the maximum PPV at the transmission tower for the initial blast as follows:

$$ppv = 1326 \left(\frac{530}{\sqrt{118}} \right)^{-1.38} = 6.2mm / s$$

The calculated 95% predicted PPV (based on the proposed blasting data discussed above) would be 6.2mm/s, well below the limit of 50mm/s. While this value resides below the 50mm/s threshold, it is anticipated that design modifications will be necessary to maintain compliance as the separation distance to some of the towers decreases and column loads increase. Fortunately, a variety of blast design alternatives are available to accomplish this including but not limited to reductions in blast hole diameter, change in explosives types, adjustment in bench heights and decking of holes.



RESIDENTIAL WATER WELLS

Possible impacts to the water quality and production capacity of groundwater supply wells is a common concern for residents near blasting operations. Complaints related to changes in water quality often include the appearance of turbidity, water discolouration and changes in water characteristics (including nitrate, e-coli, and coliform contamination). Complaints regarding water production most often involve loss of quantity production, air in water and damage to well screens and casings. A review of research and common causes of these problems indicates that most of these concerns are not related to blasting and can be shown to be the direct impact of environmental factors and poor well construction and maintenance.

There is significant research and scientific substantiation demonstrating that outside of the immediate radius of approximately 20-25 blasthole diameters from a loaded hole, there is no permanent ground displacement resulting from a blast. As such, barring blasting activity within several meters of an existing well, the probability of damage to residential wells is essentially non-existent.

Despite the scientific support for the above conclusion, numerous studies have been performed to verify the validity of this statement. These studies have investigated the effects of blasting on varied well configurations and in varied geological mediums to permit conclusions to be readily extrapolated to diverse blasting operations. The conclusion of these studies has confirmed that with the exception of possible temporary increases in turbidity, blasting operations did not result in any permanent impact on wells outside of the immediate blast zone of the blast until vibrations levels reached exceedingly high intensities. Applying universally accepted threshold levels for ground vibrations eliminates the possibility for any long term adverse effects on wells in the vicinity of blasting operations.

In a study by Froedge (1983), blast vibration levels of up to 32.3mm/s were recorded at the bottom of a shallow well located at a distance of 60 meters (200 feet) from an open pit blast. There was no report of visible damage to the well nor was there any change in the water pumping flow rate. This study concluded that the commonly accepted limit of 50mm/s PPV level is adequate to protect wells from any damage. We reiterate, the current guideline limit for vibrations from quarry and mining operations is 12.5mm/s.

EXPLOTECH

Rose et al. (1991) studied the effect of blasting in close proximity to water wells near an open pit mine in Nevada, USA. Blasts of up to 70 kilograms of explosives per delay period were detonated at a distance of 75 meters (245 feet) from a deep water well. There was no reported visible damage to the well. Fluctuations in water level and flow rate were evident immediately after the blast. However, the well water level and flow rate quickly stabilized.

The U.S. Bureau of Mines conducted a study (Robertson et al., 1990) to determine the changes in well capacity and water quality. This involved pumping from wells before and after nearby blasting. One experiment with a well in sandstone showed no change in well capacity after blasts induced PPV's at the surface of 84mm/s and there was no change in water level after PPV's of 141mm/s, well above the current guideline limit of 12.5mm/s.

Matheson et al. (1997) brought together available information on the most common complaints, the possible causes of the complaints and the relation between blasting and the complaint causes. This study yet again reaffirmed the fact that the attribution of well problems to blast sources are unfounded.

The MECP vibration limit of 12.5mm/s effectively excludes any possibility of damage to residential water wells. Based on available research and our extensive experience in Ontario quarry blasting, blasting at the Upper's Quarry will induce no permanent adverse impacts on the residential water wells on properties surrounding the site.



BLAST IMPACT ON ADJACENT WATERCOURSES

The detonation of explosives in or near water can produce compressive shock waves which initiate damage to the internal organs of fish in close proximity, ultimately resulting in the death of the organism. Additionally, ground vibrations imparted on active spawning beds have the ability to adversely impact the incubating eggs and spawning activity. In an effort to alleviate adverse impacts on fish populations as a result of blasting, the Department of Fisheries and Oceans (DFO) developed the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (1998). This publication establishes limits for water overpressure and ground vibrations which are intended to mitigate impacts on aquatic organisms while providing sufficient flexibility for blasting to proceed. Specifically, water overpressures are to be limited to 100kPa and, in the presence of active spawning beds, ground vibrations at the bed are to be limited to 13mm/s.

An existing watercourse currently runs in a North/South direction through the middle of Phase 3a and the Western sections of Phases 4 and 5. The operational plan has proposed for the realignment of the existing watercourse as part of the licence but will remain in its current location during blasting in Phases 1a and 1b. The operational plan shows the existing watercourse alignment, prior to its realignment, at an approximate 26m setback distance from all surrounding phases. Based on these separation distances and our experience on similar operations, water overpressures generated by the blasting will reside below the DFO 100kPa guideline limit and will have no impact on the adult fish populations present.

As per a preliminary document completed by Stantec, one of the fish species identified (Pike) in the adjacent watercourse have two (2) distinct spawning areas but technically anywhere that vegetation is flooded could be potential spawning habitat. The closest area of potential spawning lies approximately 208m from the initial Phase 1a (Mid Extraction Area) Sinking Cut Area blasting operations. The spawning time for the identified fish species in the adjacent watercourses has been established from March – July. As such, active spawning beds present would be subject to the DFO guideline vibration limit of 13mm/s. During spawning season, vibration monitoring will be required at the shoreline adjacent the closest spawning area on the blast side of the water body in order to confirm compliance with DFO limits for ground vibration.

Table 5 below is presented as initial guidance showing maximum permissible loads per delay based on various separation distances from spawning beds. The following maximum loads per delay are derived from the equation for ground vibrations listed earlier in this report and are based on a maximum vibration intensity of 13.0mm/s as experienced at the active spawning habitat:

Separation distance between possible spawning bed and closest borehole (meters)	Maximum recommended explosive load per delay (Kilograms)
500	305
450	245
400	195
350	150
300	110
250	75
200	49
150	27
100	12
75	6.5
50	3
30	1

Table 5: Maximum Loads per Delay to Maintain 13.0mm/s at Various Separation Distances

The generation of suspended solids within the watercourse as a result of the blasting activities will be negligible and grossly subordinate to suspended solids generated as a result of spring runoff and rain activity.



RECOMMENDATIONS

It is recommended that the following conditions be applied for all blasting operations at the proposed Upper's Quarry:

1. An attenuation study shall be undertaken by an independent blasting consultant during the first 12 months of operation in order to obtain sufficient quarry data to confirm the initial guideline parameters and assist in refining future blast designs.
2. All blasts shall be monitored for both ground vibration and overpressure at the closest privately owned sensitive receptors adjacent the site, or closer, with a minimum of two (2) instruments – one installed in front of the blast and one installed behind the blast.
3. Blasts shall be designed to maintain vibrations below 13mm/s at the location of the closest identified active spawning bed as per DFO guidelines. When blasting during active spawning season, a minimum of one supplemental vibration monitor shall be installed on the shoreline closest to the spawning bed to confirm the vibration levels.
4. The guideline limits for vibration and water overpressure shall adhere to standards as outlined in the Guidelines For the Use of Explosives In or Near Canadian Fisheries Waters (1998) or any such document, regulation or guideline which supersedes this standard.
5. All blasts shall be monitored for ground vibration at the adjacent TC Energy High Pressure Natural Gas Pipeline when blasting within 100m of the pipeline or when calculations suggest vibrations in excess of 35mm/s.
6. Blasts shall be designed to maintain vibrations at the transmission towers in the Hydro One Corridor below 50mm/s or any such document, regulation or corporate policy in effect at the time. When vibration calculations suggest vibrations at the towers may exceed 35mm/s, the towers shall be monitored for ground vibration.
7. Blasts shall be designed to maintain vibrations at the 4832 Thorold Townline Road utility buildings below 50mm/s. When vibration calculations suggest vibrations at the utility buildings may exceed 35mm/s, the buildings shall be monitored for ground vibration.
8. The guideline limits for ground vibration and air overpressure shall adhere to standards as outlined in the Model Municipal Noise Control By-law



publication NPC 119 (1978) or any such document, regulation or guideline which supersedes this standard.

9. Orientation of the aggregate extraction operation will be designed and maintained so that the direction of the overpressure propagation will be away from structures as much as possible.
10. Blast designs shall be continually reviewed with respect to fragmentation, ground vibration and overpressure. Blast designs shall be modified as required to maintain compliance with current applicable guidelines and regulations.
11. Detailed blast records shall be maintained in accordance with current industry best practices.

The blast parameters described within this report are supported by the modelling in the attached appendices. As the quarry progresses and as site-specific data is collected from the on-going operation, the blast parameters can be refined, as necessary, to maintain continual compliance with MECP Guidelines.



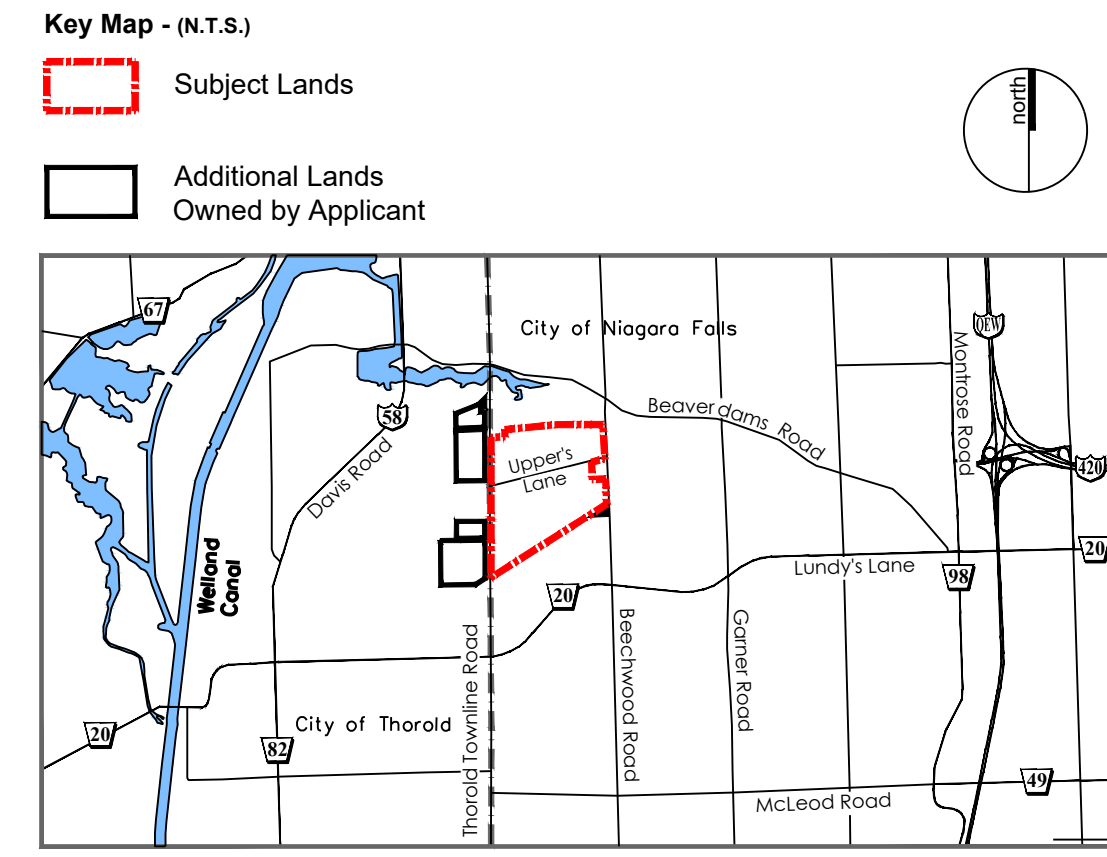
CONCLUSION

The blast parameters described within this report will provide a good basis for the initial blasting operations at this location. As site specific blast vibration and overpressure data becomes available, it will be possible to refine these parameters on an ongoing basis.

Blasting operations required for operations at the proposed Uppers Quarry site can be carried out safely and within governing guidelines set by the Ministry of the Environment, Conservations and Parks.

Modern blasting techniques will permit blasting to take place with explosives charges below allowable charge weights ensuring that blast vibrations and overpressure will remain minimal at the nearest receptors.

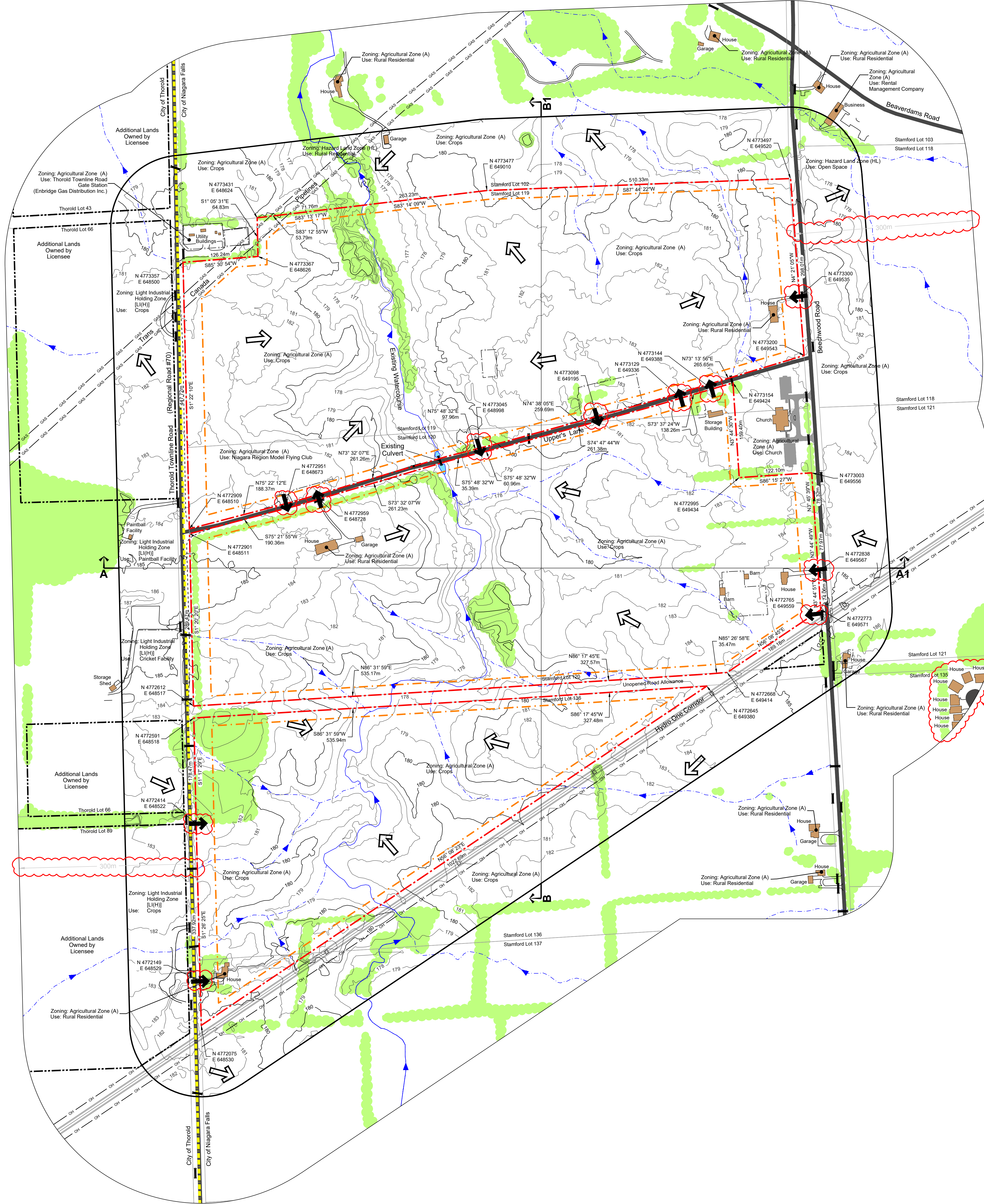
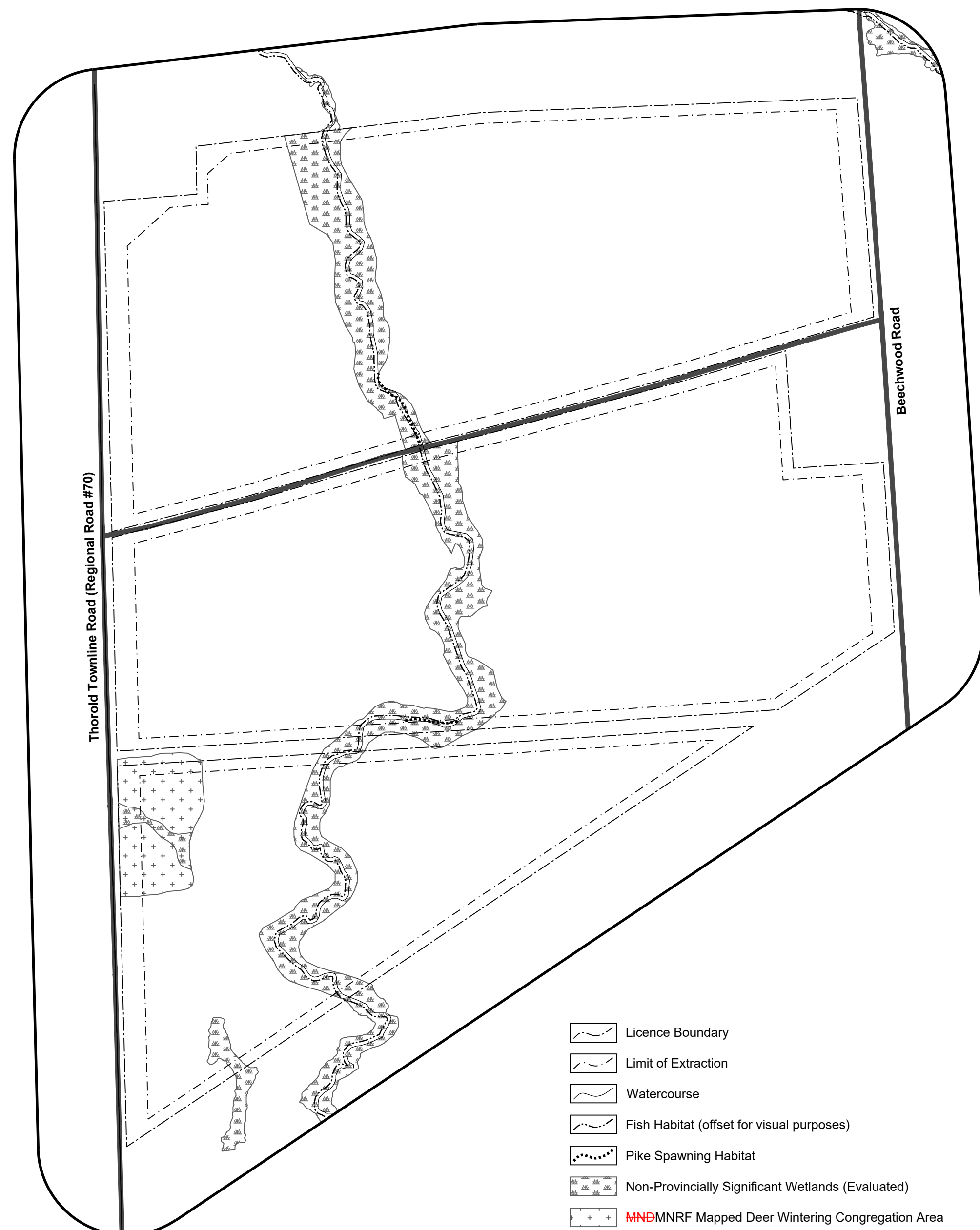
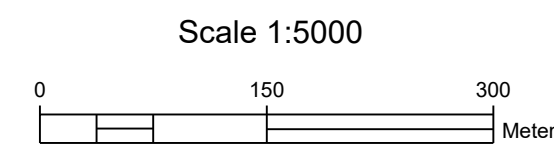
Appendix A



- A. General**
- This Site Plan is prepared under the Aggregate Resources Act for a Class A Licence for a quarry below the ground water table.
 - Areas to be licensed: 103.6 ha. (±256.0 ac.)
Areas to be extracted: 89.1 ha. (±220.2 ac.)
- B. References**
- Contour information was obtained from a topographic survey prepared by TEC Engineering (formerly Renshaw (Canada) Limited) using October 2016 and February 2017 aerial photography and are displayed in one metre intervals. Elevations shown are in metres above sea level (masl).
 - Topographic information was obtained from numerous sources including Ontario GeoInfo (Land Information Ontario), Google Earth Pro aerial photography captured on July 18, 2018 and field investigations for technical reports.
 - All topographic features and structures are shown to scale in Universal Transverse Mercator (UTM) with North American Datum 1983 (NAD83), Zone 17 (metre), Central Meridian 81 degrees west coordinate system.
 - Property boundaries were obtained from a Plan of Survey prepared by Matthew, Cameron, Heywood-Kerry T. Howe Surveying Ltd. dated April 5, 2012. Other property boundaries were established using Municipal Property Assessment Corporation (MPAC) parcel fabric data.
 - Zoning categories on or within 120 metres of the licence boundary are from the City of Niagara Falls Zoning By-law No. ZS-200 (Schedules A3 and A4 - Consolidation April 2015).
 - Land use information on or within 120 metres of the licence boundary has been compiled from October 2016 orthophotography, site visits and water well survey data.
- C. Groundwater**
- The maximum predicted water table is 184.9 masl and the contact aquifer potentiometric contours ranges between 176.0 and 184.9 masl (as per WSP's "Proposed Upper's Quarry - Maximum Predicted Water Table Report", dated October 2021).
- D. Drainage**
- Existing surface water drainage on and within 120 metres of the licence boundaries are by overland flow in the direction shown by arrows on the plan view.
- E. Site Access and Fencing**
- There are two (2) existing site accesses on Thorold Townline Road, six (6) existing site accesses on Upper's Lane, and three (3) existing site accesses on Beechwood Road.
 - Post and wire fencing (unless otherwise noted) exists in the locations shown on the plan view.
- F. Significant Features**
- All significant natural features on and within 120 metres of the licence boundary are shown on the Key Natural Heritage Features Schematic on this drawing.
 - All significant human-made features on and within 120 metres of the licence boundary are shown on the plan view.

- G. Aggregate Related Site Features**
- There are no existing aggregate operations or features within the licence boundaries such as stationary or portable equipment, stockpiles, recyclable materials, scrap, fuel storage, haul roads, berms or excavation faces.
- H. Technical Reports - References**
- Upper's Quarry: Acoustic Assessment Report, RWDI, October 2021 August 2, 2023.
 - Agricultural Impact Assessment for Upper's Quarry, Coville Consulting Inc., October 2021.
 - Upper's Quarry: Air Quality Assessment, RWDI Air Inc., October 2024 July 12, 2023.
 - Archaeological Assessments:
 - Stage 1 Archeological Resource Assessment of Walker Aggregates Proposed South Niagara Quarry, Part of Lots 102, 119, 120, 136 & 137, Archeological Services Inc., December 2008.
 - Stage 1-2 Archeological Assessment of Part 9764 Upper's Lane, Part of Lots 119 & 120, Archeological Assessments Ltd., November 3, 2005.
 - Stage 2-3 Archeological Assessment, Part of Lots 102, 119, 120, 136 & 137, Archeological Assessments Ltd., November 21, 2012.
 - Stage 1-2 Archeological Assessments, Upper's Quarry Additional Lands, Part of Lots 1188, 120, Archeological Research Associates Ltd., April 20, 2020.
 - Stage 3 Mitigation of Development Impacts, Final Excavation Report, Walker XI (AgGT-411), Upper's Quarry, Archeological Research Associates Ltd., May 28, 2021.
 - Stage 4 Mitigation of Development Impacts, Final Excavation Report, Walker XI (AgGT-178), Upper's Quarry, Archeological Research Associates Ltd., July 22, 2021.
 - Blast Impact Analysis, Upper's Quarry, Explotech, October 2021 August 2023.
 - Cultural Heritage Impact Assessment Report, Proposed Upper's Quarry, MHBC, October 2021.
 - Economic Benefits Analysis, Prism, October 2021 February 2023.
 - Level 2 Water Study Report and Response to JART Hydrogeological Comments, WSP, October 2021 October 3, 2022.
 - Maximum Predicted Water Table Report, WSP, October 2021.
 - Upper's Quarry, Niagara: Level 1 and Level 2 Natural Environment Technical Report and Environmental Impact Study, Stantec, October 2021 August 2023.
 - Planning Justification Report and Summary Statement, MHBC, October 2021 August 2023.
 - Traffic Impact Study and TIS Addendum, Upper's Quarry, TMIG TVL, October 2021 March 23, 2023.
 - Visual Impact Assessment, Proposed Upper's Quarry, MHBC, October 2021.

Key Natural Heritage Features Schematic



Added additional homes within 300 metres of the licence boundary.

Legal Description

Part of Lots 119, 120, 136 & 137
City of Niagara Falls (Geographic Township of Stamford)
Regional Municipality of Niagara

- Licence Boundary
- Limit of Extraction
- Additional Lands Owned by Licensee
- Municipal Boundary
- Contours with Elevation (Metres above sea level (MASL))
- Public Road
- Fence (1.2m post & wire fence unless otherwise noted)
- Watercourse (Direction of flow indicated by arrows)
- Surface Drainage Feature (Direction of flow indicated by arrows)
- Water Feature
- Wooded Area
- 120m Offset From Licence Boundary
- Parcel Fabric
- Trans Canada Pipeline Easement
- Hydro One Easement
- Existing Site Access (Update symbol to be a solid black hatch)
- Direction of Surface Drainage
- Existing Culvert
- Building/Structure
- Cross Sections

- Site Plan Acronyms**
- ARA - Aggregate Resources Act
 - MNDMNR - Ministry of Northern Development, Mines, Natural Resources and Forestry
 - MHSTCI - Ministry of Heritage, Sport, Tourism and Culture Industries
 - MECP - Ministry of the Environment, Conservation and Parks
 - MGCS - Ministry of Government and Consumer Services
 - DFO - Department of Fisheries and Oceans Canada
 - ECA - Environmental Compliance Approval
 - BMPP - Best Management Practices Plan
 - PTTW - Permit to Take Water
 - MASL - Metres above sea level
 - TCPL - Trans Canada Pipeline
 - ROW - Right of way
 - HMA - Hot mix asphalt
 - PWQO - Provincial Water Quality Objectives
 - MISA - Municipal Industrial Strategy for Abatement
 - TSS - Total Suspended Solids

No.	Date	Description	By
1	January 2022	Added Key Natural Heritage Features Schematic and Section F to the site plan notes	C.P.
2	August 2023	Update site plan to incorporate JART and MNR comments	C.P.

No.	Date	Description	By

MHBC
PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE
113 COLLIER STREET, BARRE, ON, L4M 1H2 | P: 705.728.0445 F: 705.728.2010 | WWW.MHBC.PA.COM

MHBC Stamp
Debra Walker
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 0.2(3)(f) of Ontario Regulation 244/97 to prepare and certify site plans.

MHBC Stamp
Christopher Poole
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 0.2(3)(f) of Ontario Regulation 244/97 to prepare and certify site plans.

Applicant
 Walker Aggregates Inc.
2800 Thorold Townline Road
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Project
Upper's Quarry

MNDMNR Licence Reference No. / **Applicant's Signature**

Plan Scale: 1:3000 (Arch E) / **Date:** October 2021

Drawn By: C.P. / **File No.:** 9811V

Checked By: D.W.

File Name: Existing Features

Drawing No.: 1 of 6

File Path: N:\9811V - Walker Upper Quarry Drawings\Site Plan\CAD\9811V - Site Plan.dwg

A. General

- This plan depicts a schematic operations sequence for the property based on the best information available at the time of preparation.
- Phases do not represent any specific or equal time period.
- The direction of extraction will generally be in accordance with the General Direction of Excavation (shown on the plan view) unless otherwise authorized by MNR. Notwithstanding the operational and rehabilitation notes, demand for certain products, blending of materials or Water Study Contingency measures may require minor deviations in the extraction and rehabilitation sequence. Any major deviations from the operations sequence shall require approval from the MNR. The maximum combined disturbed area which includes the processing plant, berms, stockpiles, silt pond, active extraction area and area being stripped for the next area of extraction within the licence boundary identified on this Drawing but excludes the area of Phase 1A needed for the continued operation of the asphalt plant for the life of the quarry. Concurrent extraction of phases is permitted for blending purposes provided the overall maximum combined disturbed area does not exceed 40 hectares to ensure progressive rehabilitation of the site is being undertaken as required by the Site Plans.

- Progressive and final rehabilitation will be completed in direct correlation to the development of the quarry as the extraction limits are reached and enough area is available to ensure that rehabilitation activities will not interfere with the production, stockpiling and processing of aggregate materials.

B. Initial Site Preparation

- Generally, site preparation in Phases 1 and 2 to include but not limited to:
 - Constructing the main entrance and cross over(s) in accordance with entrance permit approvals
 - Establishing fencing around licensed boundary (see Section N Variations from Control and Operation Standards on drawing 2 of 6)
 - Removal of trees and existing buildings (in accordance with all site plan requirements and applicable regulations)
 - Proceed with stripping of overburden/topsoil from Phase 1 and, if necessary, Phase 2
 - Construction of berms/acoustic barriers within the perimeter setback of the licence boundary (as shown on the plan view)
- Install water management and erosion and sediment control measures (silt fencing) in accordance with note D.1 on this drawing and note E.1.c on drawing 4 of 6.
- Commence portable crushing/screening plant set up. The plant shall operate in accordance with Section A on drawing 4 of 6 for all Phases.

C. Phase 1 (1A and 1B)

- Commence extraction in the 'Initial Sinking Cut Area' identified in the Mid and South Extraction Area (see plan view for location).
- Phase 1A shall be extracted in up to three (3) lifts to a depth ranging between 140 masl and 145 masl.
- Phase 1B shall be extracted in one (1) to two (2) lifts to a depth of 155 masl.
- A portable pump shall be utilized as necessary in the Mid Extraction Area and the South Extraction Area to discharge water to a man-made pond for aggregate washing or to a sediment forebay before being discharged to the existing watercourse. During heavy rainfall events (25 mm or more), the pump will be deactivated as necessary to prevent flooding along the watercourse downstream of the site. The discharge pond and forebay locations will move with the quarry face until the final quarry depth is reached. At this point, a permanent sump will be established in each extraction area.
- During Phase 1, a new watercourse channel shall be constructed along the east side of Thorold Townline Road (within Phase 1B) for the eventual realignment of the existing watercourse. As resource extraction is completed in Phase 1B, this area will be filled with clay overburden material from on-site to an elevation ranging between 173 to 178 masl. The new watercourse and riparian wetland channel shall be constructed, designed and vegetated in accordance with DFO's authorization and this Rehabilitation Plan (drawing 5 of 6).
- As extraction reaches the final quarry floor, and there is sufficient separation from the quarry floor working areas in Phase 1A, a 2:1 setback along the easterly and northerly limit of Phase 1B shall be backfilled with either: (i) overburden stockpiled on-site; (ii) overburden in Phase 2; or (iii) material imported from Licence Numbers 11175 and 4437.
- Commence site preparation of Phase 2.

D. Phase 2 (2A & 2B)

- Commence extraction in the 'Initial Sinking Cut Area' identified in the North Extraction Area (see plan view for location).
- Phase 2A shall be extracted in up to three (3) lifts to a depth ranging between 141 masl to 145 masl.
- Phase 2B shall be extracted in one (1) to two (2) lifts to a depth of 155 masl.

- A portable pump shall be utilized as necessary to discharge water to a man-made pond for aggregate washing or to a sediment forebay before being discharged to the existing watercourse. During heavy rainfall events (25 mm or more), the pump will be deactivated as necessary to prevent flooding along the watercourse downstream of the site. The discharge pond and forebay locations will move with the quarry face until the final quarry depth is reached. At this point, a permanent sump will be established.
- Similar to Phase 1, the new watercourse channel shall be constructed within Phase 2 running along the east side of Thorold Townline Road (Phase 2B) for the eventual realignment of the existing watercourse. As resource extraction is completed in Phase 2B, this area will be filled with clay overburden material from on-site to an elevation ranging between 173 to 178 masl. The new watercourse and riparian wetland channel will be constructed, designed and vegetated in accordance DFO authorization and Rehabilitation Plan (drawing 5 of 6).
- As extraction reaches the final quarry floor, and there is sufficient separation from the quarry floor working areas in Phase 2A, a 2:1 setback along the easterly and northerly limit of Phase 2B shall be backfilled with either: (i) overburden stockpiled on-site; (ii) overburden in Phase 3B; or (iii) material imported from Licence Numbers 11175 and 4437.
- Commence site preparation of Phase 3.

E. Phase 3 (3A & 3B)

- Proceed with stripping of overburden/topsoil.
- Prior to undertaking any works within Phase 3A that may result in any serious harm to fish, according to 35(1) of the Fisheries Act, the Licensee shall obtain a Fisheries Act Authorization from the Department of Fisheries and Oceans (DFO) and shall fulfill any other conditions required by the DFO as stated on its authorization. Once obtained, a copy of the Fisheries Act Authorization shall be provided to the MNR. Once the watercourse has been realigned to the satisfaction of DFO, stripping of overburden and topsoil can proceed in Phase 3A.
- In the event that watercourse relocation has not been approved or completed, extraction in Phase 3B may proceed before extraction in Phase 3A.
- In the event that Phase 3B is extracted before Phase 3A, a portable pump shall be utilized as necessary to discharge water to a man-made pond for aggregate washing or to a sediment forebay before being discharged to the existing watercourse. During heavy rainfall events (25 mm or more), the pump will be deactivated as necessary to prevent flooding along the watercourse downstream of the site. The discharge pond and forebay locations will move with the quarry face until the final quarry depth is reached. At this point, a permanent sump will be established.
- Phase 3A and 3B shall be extracted in up to three (3) lifts to a depth ranging between 145 masl to 149 masl. Extraction will proceed in an easterly direction, moving gradually from north to south.
- Once the existing watercourse has been realigned, extraction in Phase 3A may proceed.
- Continue progressive rehabilitation of the quarry perimeter where limits of extraction have been reached and there is sufficient separation from the quarry floor working areas.
- Commence site preparation of Phase 4.

F. Phase 4

- Proceed with stripping of overburden/topsoil.
- Commence Phase 4 extraction in an easterly direction, moving gradually from north to south.
- Phase 4 shall be extracted in up to three (3) lifts to a depth ranging between 142 masl in and 147 masl.
- Continue progressive rehabilitation of the quarry perimeter where limits of extraction have been reached and there is sufficient separation from the quarry floor working areas.

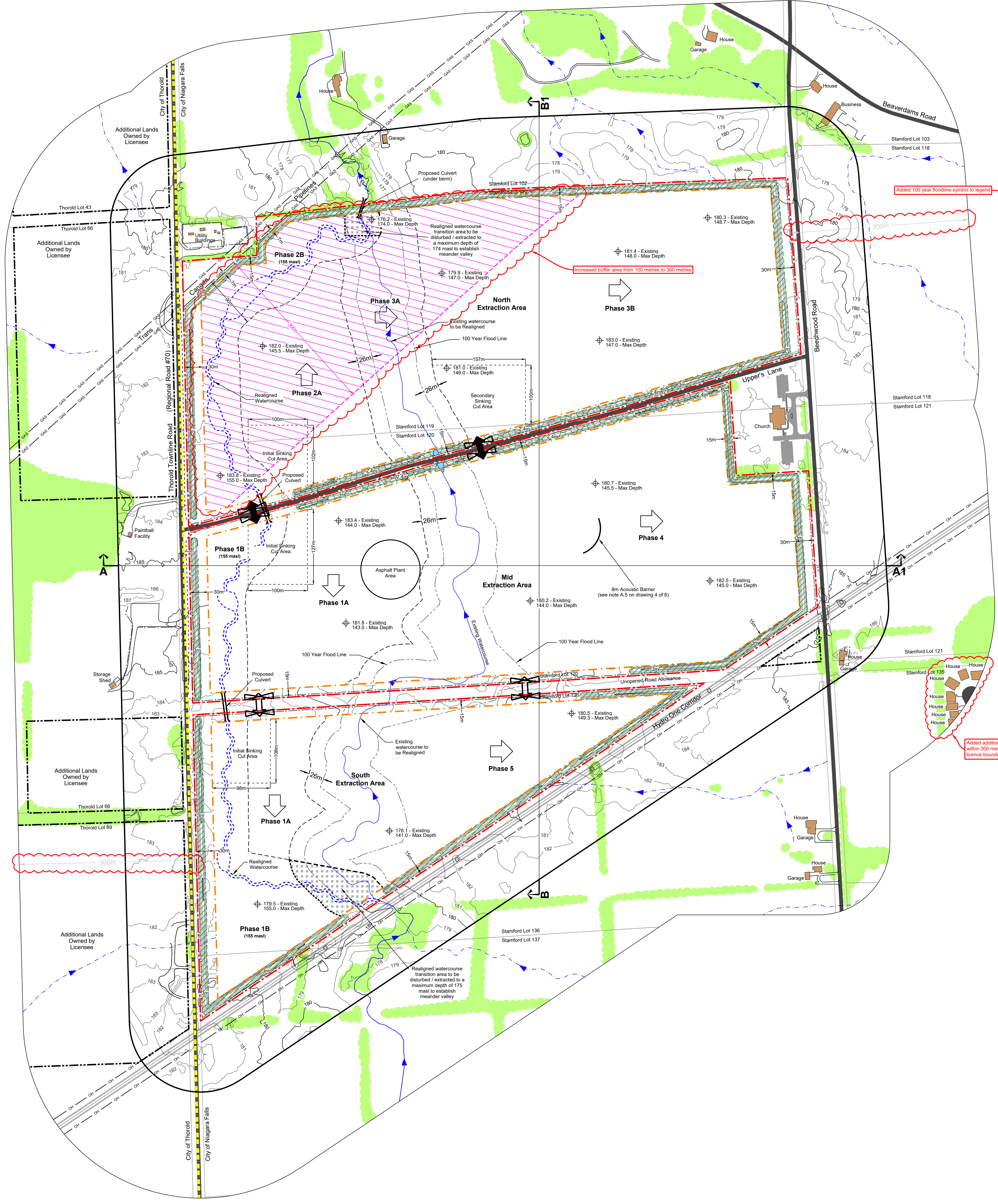
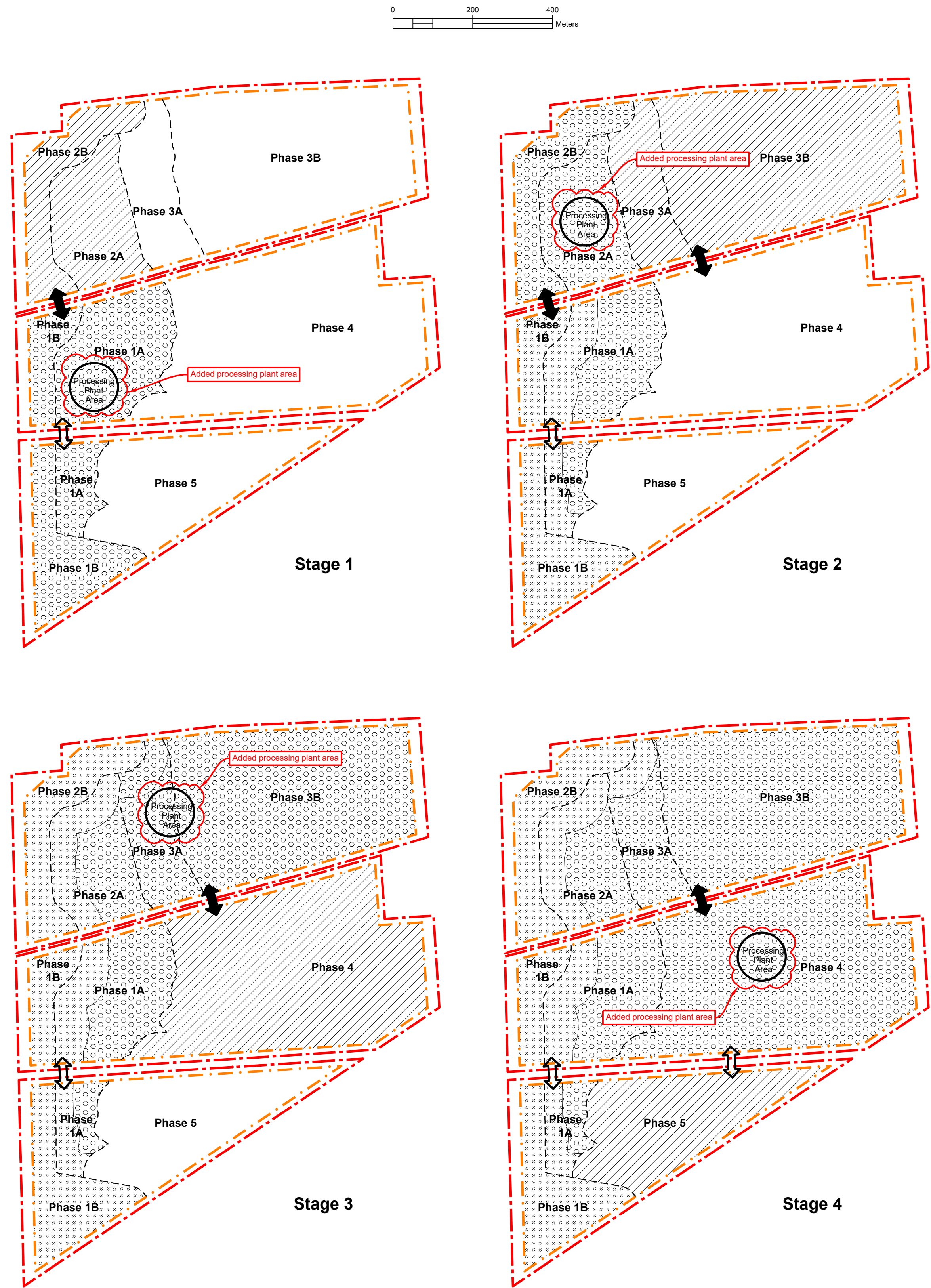
G. Phase 5

- Proceed with stripping of overburden/topsoil.
- Commence Phase 5 extraction in an easterly direction, moving gradually from north to south.
- Phase 5 shall be extracted in up to three (3) lifts to a depth ranging between 140 masl and 143 masl.
- Continue progressive rehabilitation of the quarry perimeter where limits of extraction have been reached and there is sufficient separation from the quarry floor working areas.

H. Final Phase

- Complete extraction of any remaining resource in the extraction limit near the entrance in Phase 1A and 1B (e.g. ramp).
- As part of the final operations of the site, remove office/scale house and scales, asphalt plant, recycled asphalt material and any other equipment and scrap from the site.
- Continue with final rehabilitation of the site. Complete quarry face backfilling on the remaining quarry faces as identified on drawing 5 of 6.

Extraction Sequence Schematic
Scale 1:7500



Legal Description
Part of Lots 119, 120, 136 & 137
City of Niagara Falls (Geographic Township of Stamford)
Regional Municipality of Niagara

Legend

- Licence Boundary
- Limit of Extraction
- Additional Lands Owned by Licensee
- Municipal Boundary
- Contours with Elevation (Metres above sea level (MASL))
- Public Road
- Fence (1.2m post & wire fence unless otherwise noted)
- Watercourse (Direction of flow indicated by arrows)
- Surface Drainage Feature (Direction of flow indicated by arrows)
- Watercourse - Re-aligned (Direction of flow indicated by arrows) (Statoc, 2020)
- Water Feature
- Wooded Area
- Watercourse Realignment Transition Area
- 120m Offset From Licence Boundary
- Trans Canada Blasting Buffer Area (See Note D.3 on drawing 4 of 6)
- Parcel Fabric
- Trans Canada Pipeline Easement
- Hydro One Easement
- Entrance / Exit
- Limited Service Access (For Phases 1A, 1B and 5 in South Extraction Area)
- Gate
- Culvert
- General Direction of Excavation & Boundary
- Berm (Top - Existing, Bottom - Maximum Depth of Extraction)
- Building/Structure
- Spot Elevation (Metres above sea level (MASL)) (Top - Existing, Bottom - Maximum Depth of Extraction)
- Cross Sections (A1)

- Site Plan Acronyms**
- ARA - Aggregate Resources Act
 - MNDMNR - Ministry of Northern Development, Mines, Natural Resources and Forestry
 - MHSTCI - Ministry of Heritage, Sport, Tourism and Culture Industries
 - MECP - Ministry of the Environment, Conservation and Parks
 - MGCS - Ministry of Government and Consumer Services
 - DFO - Department of Fisheries and Oceans Canada
 - ECA - Environmental Compliance Approval
 - BMP - Best Management Practices Plan
 - PTTW - Permit to Take Water
 - MASL - Metres above sea level
 - TCPL - Trans Canada Pipeline
 - ROW - Right of way
 - HMA - Hot mix asphalt
 - PWQO - Provincial Water Quality Objectives
 - MISA - Municipal Industrial Strategy for Abatement
 - TSS - Total Suspended Solids

Site Plan Amendments

No.	Date	Description	By

Site Plan Revisions (Pre-Licensing)

No.	Date	Description	By
1	January 2022	Revised note C.1 and hatched watercourse realignment area.	C.P.
2	August 2023	Update site plan to incorporate JART and MNR comments.	C.P.

MHBC
PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE
113 COLLIER STREET, BARRE, ON, L4M 1H2 | P: 705.728.0405 F: 705.728.2010 | WWW.MHBCPLAN.COM

MHBC Stamp

Debra Walker
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 2.2(3)(f) of Ontario Regulation 244/97 to prepare and certify site plans.

Christopher Poole
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 2.2(3)(f) of Ontario Regulation 244/97 to prepare and certify site plans.

Applicant

walker aggregates
Walker Aggregates Inc.
2800 Thorold Townline Road
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Project
Upper's Quarry

MNDMNR Licence Reference No. / **Applicant's Signature**

Plan Scale: 1:3000 (Arch E) / **Date:** October 2021

Drawn By: C.P. / **File No.:** 9811V

Checked By: D.W.

File Name: Extraction Sequence

Drawing No.: 3 of 6

File Path: N:\09\9811V - Walker Upper Quarry Drawings\Site Plan\CAD\9811V - Site Plan.dwg

A. Acoustic Assessment

- 1. Minimum 3 metre tall acoustic berms shall be constructed in the locations shown on the plan view.
2. The acoustic berms shall be constructed during site preparation and prior to extraction.
3. The primary crusher shall stay within 30 metres of the working face to maximize shielding effect of the quarry terrain, except when extraction is in the South Extraction Areas as per note A.4 below.
4. Material extracted from the South Extraction Area shall be processed in the Mid Extraction Area.
5. While processing in Phase 4, the licensee shall maintain an 8 metre tall barrier at a radius of 40 metres to the southeast of the processing plant's secondary crushers (see plan view for location). The barrier can be material stockpiles, noise walls, or a combination of both. The barrier shall extend long enough to shield receptors R4 and R5 (see plan view) from the secondary crushers.
6. All construction equipment shall meet the sound emission standards defined in MECP Publication NPC-115.
7. The following best practice measures shall be undertaken to minimize the potential for construction noise impacts related to site preparation, berm creation and rehabilitation but not related to extraction and processing activities:
a. Construction will be limited to time periods allowed by the City of Niagara bylaws. If construction activities are required outside of these hours, the licensee will seek permits / exemptions directly from the City in advance.
b. All internal combustion engines will be fitted with appropriate muffler systems.
c. The licensee's operating procedures will contain a provision that any initial complaint will trigger verification that the general noise control measures agreed upon on this Plan are in effect.
d. In the presence of persistent noise complaints, all construction equipment will be verified to comply with MECP's NPC-115 guidelines.
e. In the event of verified noise complaints, alternative noise control measures may be required where reasonably available. In selecting appropriate noise control and mitigation measures, consideration will be given to the technical, administrative and economic feasibility of the various alternatives.

B. Air Quality

- 1. The licensee shall apply water or another provincially approved dust suppressant to internal haul roads and processing areas, as necessary to mitigate dust.
2. Processing equipment shall be equipped with dust suppressing or collection devices, where the equipment creates dust and is operating within 300 metres of an air quality sensitive receptor (as set out in the Air Quality Impact Assessment).
3. The licensee shall obtain an environmental compliance approval under the Environmental Protection Act where required to carry out operations at the quarry.
4. The site will operate in accordance with the Best Management Practices Plan (BMP) for Fugitive Dust Emissions. The BMP may be amended from time to time, considering actual impacts and operational considerations. The recommendations in the BMP are based on the maximum daily production rates. All production rates, the control measures specified in the BMP can be reduced accordingly, provided dust remains mitigated on site.
5. The following mitigation measures shall be incorporated into the BMP:
a. Blasting operations occurring within 300 metres of a residential receptor shall have a smaller blast area, not exceeding 200 m² in area.
b. Aggregate extraction, processing and shipping does not exceed 9,000 tonnes per day.
c. Under dry conditions, the capacity to apply water on an hourly basis to all traveled haul routes within the licence boundaries.

C. Archaeology

- 1. Areas identified as "Archaeological Site - Protected Areas Requiring Further Archaeological Assessment" on this drawing reflect areas that require further archaeological assessment and are protected by a 20 to 30 metre protective buffer. A 50 metre monitoring buffer is also identified on this drawing.
2. No ground alterations including overburden stripping and excavation, or development of any kind shall occur within areas identified as "Archaeological Site - Protected Areas Requiring Further Archaeological Assessment" and their respective protective buffers until:
a. the required investigations are completed in accordance with the Stage 1 and 2 Archaeological Assessment prepared by Archaeological Research Associates Ltd. (April 2020),
b. any recommendations that the respective site(s) has no further cultural heritage value or interest are made as a result of completing further investigations, and,
c. the associated reports are entered into the Ontario Public Register of Archaeological Reports and copies are provided to the MNRF.
3. Until rule C.2 has been satisfied, a temporary barrier shall be established around the perimeter of each "Archaeological Site - Protected Areas Requiring Further Archaeological Assessment" identified on this drawing as part of site preparation and in advance of extraction ground alteration.
4. All soil disturbing activities within the 50 metres monitoring buffers shall be monitored by a licensed archaeologist to ensure the effectiveness of the avoidance strategy. The archaeologist shall ensure that the temporary barrier is in the appropriate location and shall be empowered to stop construction if there is a concern for impacts to an archaeological site. No go instructions shall be issued to all work crews for the protected areas, and the locations of the protected areas shall be shown on all appropriate control drawings. The protected areas shall be inspected by a licensed archaeologist once the strategy is no longer required, and the effectiveness of the strategy shall be reported to the MHSTCI.
5. Immediately upon issuance of the Licence, and once the construction schedule has been finalized, a licensed archaeologist will be retained by the licensee so that monitoring can occur where required. The remaining archaeological fieldwork will be completed upon issuance of the licence by the MNRMNR.
6. Should deeply buried archaeology remains be found during the course of site preparation and/or extraction related activities, the MHSTCI shall be notified.
7. In the event that human remains are encountered during quarry or extraction activities, the licensee shall immediately contact both the MHSTCI and Registrar or Deputy Registrar of the Consumer Services Division of the Ministry of Government and Consumer Services (MGCS).

D. Blasting

- 1. An alteration study shall be undertaken by an independent blasting consultant during the first 12 months of operation in order to obtain sufficient quarry data to confirm the initial guideline parameters and assist in refining future blast designs.
2. All blasts shall be monitored for both ground vibration and overpressure at the closest privately owned sensitive receptor adjacent to the site, or closer, with a minimum of two (2) instruments - one installed in front of the blast and one installed behind the blast.
3. Blasts shall be designed to maintain vibrations below 13mm/s at the location of the closest identified active spanning beam as per DFO guidelines. When blasting during active spanning season, a minimum of one supplemental vibration monitor shall be installed on the spanning beam to monitor the vibration levels.
4. The guideline limits for vibration and overpressure shall adhere to standards as outlined in the Guidelines For the Use of Explosives in or Near Canadian Fisheries Waters (1996) or any such document, regulation or guideline which supersedes this standard.
5. All blasts shall be monitored for ground vibration at the adjacent Trans Canada Energy High Pressure Natural Gas Pipeline when blasting within 100m of the pipeline or when calculations suggest vibrations at distance of 35mm/s.
6. Blasts shall be designed to maintain vibrations at the transmission towers in the Hydro One Corridor below 50mm/s or any such document, regulation or guideline which supersedes this standard.
7. Blasts shall be designed to maintain vibrations at the 4832 Thorold Townline Road utility buildings below 50mm/s. When vibration calculations suggest vibrations at the utility buildings may exceed 35mm/s, the buildings shall be monitored for ground vibration.
8. The guideline limits for ground vibration and air overpressure shall adhere to standards as outlined in the Model Municipal Noise Control By-law publication NPC 119 (1978) or any such document, regulation or guideline which supersedes this standard.
9. Orientation of the aggregate extraction operation shall be designed and maintained so that the direction of the overpressure propagation will be away from structures as much as possible.
10. Blast designs shall be continually reviewed with respect to fragmentation, ground vibration and overpressure. Blast designs shall be modified as required to maintain compliance with current applicable guidelines and regulations.
11. Detailed blast records shall be maintained in accordance with current industry best practices.

E. Natural Heritage

- 1. General
a. Existing vegetation within the setbacks shall be maintained except where berms, haul roads and conveyors are required.
b. New vegetation shall be maintained in accordance with note G.5 on this drawing.
c. Silt fencing shall be installed at the eastern limit of Phases 1A and 2A where field drainage enters the existing watercourse. Silt fencing will serve to demarcate the limit of protected area until the watercourse is diverted.
d. Stockpiling of all excavated material shall be in accordance with note H.7 on drawing 2 of 6.
e. Topsoil and overburden stockpiles shall be maintained in accordance with the Best Management Practices for the Protection, Creation and Maintenance of Bank Swales in Ontario (MNRF 2017). Stripped overburden and topsoil for rehabilitation shall be utilized in accordance with notes E.4, E.5 and E.6 on drawing 2 of 6.
f. Dust control will be implemented in accordance with Section B on this drawing.
g. Fuel storage shall be in accordance with the notes under Section K on drawing 2 of 6.
2. Natural Channel Design
a. The existing watercourse will remain open (not culverted) where it enters the south limit of the South Extraction Area.
b. Where the watercourse exits the North Extraction Area, a culvert will be installed to maintain the watercourse while allowing an acoustic berm to be constructed. As part of final rehabilitation, the berm and culvert shall be removed to allow for the watercourse to be open.
c. As part of site preparation, a compensation pond will be constructed in the Watercourse Realignment Transition Area within Phase 2B, in accordance with the Natural Channel Design Report (Stantec 2021). The compensation pond will be excavated to a maximum depth of 1.4 m in this area and in accordance with DFO authorization. No drilling or blasting shall occur in this Transition Area.
d. As extraction is completed in Phases 1B and 2B, these areas will be filled with clay overburden material to an elevation ranging between 173 to 178 masl. In accordance with the Natural Channel Design Report (Stantec 2021), a new watercourse channel will be constructed, vegetated and designed in these areas and will include the following design elements:
0.1. Floodplain wetlands
0.2. Fish habitat ponds, including new pike spawning habitat as well as foraging, spawning and rearing habitat for other fish species
0.3. Creek sections
0.4. Wood debris toe protection and wood reinforced banks
0.5. Log sills
0.6. Augmented riffle.
e. Culverts will be installed under Upper's Lane and the unopened road allowance.
f. 2:1 side slopes shall be established on the east side of the new watercourse channel down to the quarry floor.
g. Once the realigned watercourse channel has been constructed in Phases 1B and 2B and adequate vegetation to mitigate potential erosion has been established (as confirmed by an ecologist), water from the existing watercourse will be excavated to a maximum depth of 1.4 m in this area and in accordance with DFO authorization. A fish rescue will be undertaken prior to dewatering and culvert relocation. A Licence to Collect Fish for Scientific Purposes will be obtained for the fish rescue.
3. Woodland and Terrestrial Habitat Enhancement
a. The 2.0 ha woodland situated on the east side of Thorold Townline Road shall be removed during the advancement of operations in Phase 1A/1B. Tree clearing in the woodland shall be undertaken outside of the breeding bird period and the active bird season from March 23 and August 08.

F. Wetlands

- a. Wetlands along the existing watercourse will be maintained until the watercourse has been diverted to the watercourse realignment channel.
b. Once the watercourse has been diverted, the created wetlands in the watercourse realignment channel shall be maintained.

G. Monitoring Program

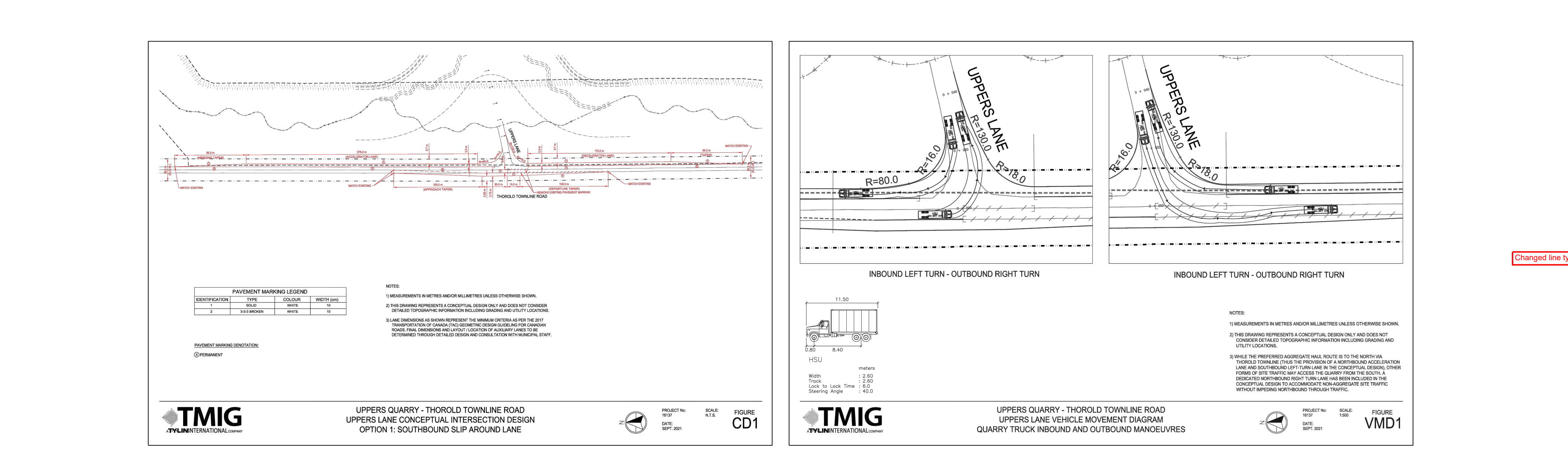
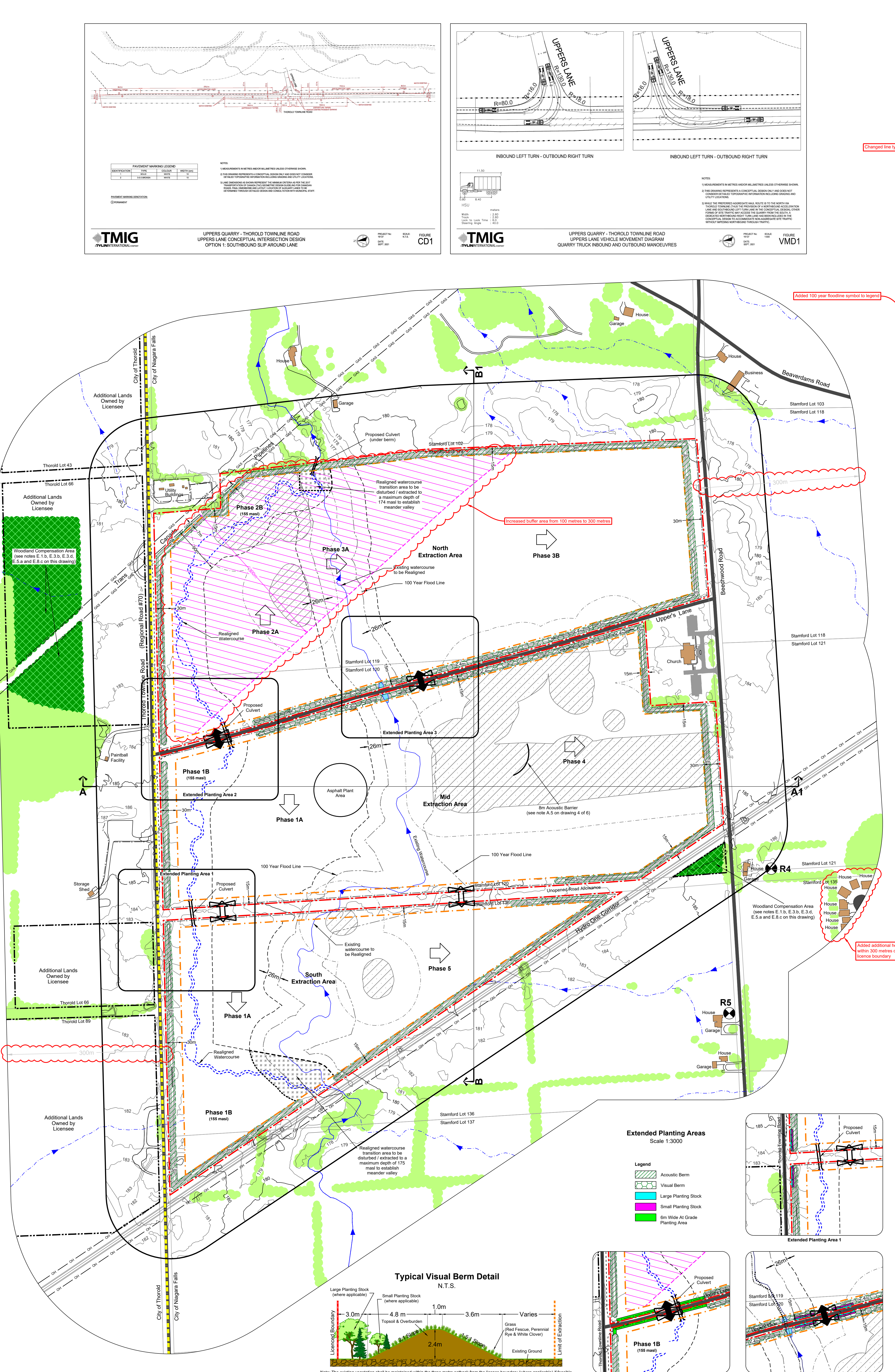
- a. A monitoring plan shall be prepared in consultation with regulatory authorities to assess the performance of the watercourse realignment channel and to confirm that impacts to off-site wetlands are not occurring as a result of dewatering.
b. A monitoring program of compensation planting shall be prepared in consultation with regulatory authorities to confirm stable conditions have been established.
c. A trigger mechanism and contingency plan, as detailed in WSP's Water Study Report, shall be implemented upon licence approval to proactively ensure natural habitat features and their functions are maintained (i.e. fish habitat, watercourse downstream and at 604 Beechwood Road, and woodlands) during operational and rehabilitation phases.

H. Water Supply

- 1. A long-term monitoring program will be implemented during the quarry operational and rehabilitation phases, until stable conditions are observed after quarry decommissioning.
2. In the event of a well interference claim is received, the licensee shall implement the following mitigation plan to protect the local groundwater users.
a. Prior to extraction, landowners shall be provided with a copy of the water well interference plan as well as the contact information for the licensee and MECP (Wells Help Desk 1-888-396-9355 or email wells@helpdesk(ontario.ca)).
b. If a water well interference claim is received by the licensee the following actions shall be taken:
b.1. The licensee shall immediately notify MNRMNR and MECP of the complaint.
b.2. The licensee shall contact a well contractor in the event of a well malfunction and residents will be provided a temporary water supply within 24 hours, if the issue cannot be easily determined and rectified.
c. The well contractor shall contact the resident with the supply issue to rectify the problem as expeditiously as possible, provided landowner authorization of the work.
d. If the issue raised by the landowner is related to loss of water supply, the licensee shall have a qualified hydrogeologist / well contractor determine the likely causes of the loss of water supply, which can result from a number of factors, including pump failure (owner's expense), lack of well maintenance / well cleaning (owner's expense) or lowering of the water level in the well from the quarry development (licensee's expense). This assessment process shall be carried out at the expense of the licensee and the results provided to the homeowner.
e. If it has been determined that the quarry caused the water supply interference (i.e., lowering of the water level), the licensee shall continue to supply water at their expense until the problem is rectified. The following mitigation measures shall be considered, and the appropriate measure(s) implemented at the expense of the licensee:
e.1. Adjust pump pressure;
e.2. Lowering of the pump to take advantage of existing water storage within the well;
e.3. Deepening of the well to increase the available drawdown, if the well deepening changes the water quality a water treatment shall be provided;
e.4. Widening of the well to increase the available storage of water;
e.5. Relocation of the well to another area on the property; or
e.6. Drilling multiple wells.
f. If the issue raised by the landowner is related to water quality, the licensee shall have a qualified hydrogeologist / well contractor determine the likely causes of the change in water quality, and review monitoring results at the quarry and background monitoring results from the baseline well survey to determine if there is any potential correlation with the quarry. If it has been determined that the quarry caused a water quality issue, the licensee shall continue to supply water at their expense until the problem is rectified. The licensee shall be responsible for restoring the water supply by reducing the well or providing a water treatment system. The licensee is responsible for the expense to restore the water quality.
3. A spill action plan shall be carried out in accordance with the notes in Section N Spills Plan on drawing 2 of 3.
4. A trigger mechanism and contingency plan as set out in WSP's Level 2 Water Study Report shall be implemented.

I. WSP's Water Study Report

WSP's Water Study Report confirms that drawdown points do not extend to areas identified in the Niagara Peninsula Source Protection Plan as Intake Protection Zones.



Legal Description: Part of Lots 119, 120, 136 & 137 City of Niagara Falls (Geographic Township of Stamford) Regional Municipality of Niagara. Legend: Licence Boundary, Limit of Extraction, Additional Lands Owned by Licensee, Municipal Boundary, Contours with Elevation, Public Road, Fence, Watercourse, Surface Drainage Feature, Watercourse - Realigned, 100 Year Floodline, Water Feature, Wooded Area, Watercourse Realignment Transition Area, Woodland Compensation Area (Off-site), Archaeological Site, Archaeological Offset. Site Plan Acronyms: 1. ARA - Aggregate Resources Act, 2. MNRMNR - Ministry of Northern Development, Mines, Natural Resources and Forestry, 3. MHSTCI - Ministry of Heritage, Sport, Tourism and Culture Industries, 4. MECP - Ministry of the Environment, Conservation and Parks, 5. MGCS - Ministry of Government and Consumer Services, 6. DFO - Department of Fisheries and Oceans Canada, 7. ECA - Environmental Compliance Approval, 8. BMP - Best Management Practices Plan, 9. PTTV - Permit to Take Water, 10. MASL - Metres above sea level, 11. TCPL - Trans Canada Pipeline, 12. ROW - Right of Way, 13. HMA - Hot mix asphalt, 14. PWDO - Provincial Water Quality Objectives, 15. MISA - Municipal Industrial Strategy for Abatement, 16. TSS - Total Suspended Solids.

Site Plan Amendments table with columns: No., Date, Description, By. Site Plan Revisions (Pre-Licensing) table with columns: No., Date, Description, By.

MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE. MHBC Stamp: Debra Walker, Christopher Poole. Applicant: Walker Aggregates Inc. Project: Upper's Quarry. MNDMNR Licence Reference No., Applicant's Signature, Plan Scale: 1:3000 (Arch E), Date: October 2021, Drawn By: C.P., File No.: 9811V, Checked By: D.W., File Name: Report Recommendations, Drawing No.: 4 of 6, File Path: N:\08\9811V - Walker Upper Quarry Drawings\Site Plan\CAD\9811V - Site Plan.dwg

PROGRESSIVE REHABILITATION

- A. General
1. Area calculations:
a. Licenced area 103.6 ha
b. To be extracted 89.1 ha
c. Final rehabilitation within licence (total) 103.6 ha
...
d. To be rehabilitated outside of licence: 4.7 ha

- 6. The monthly sump discharge sample results shall be compared with the background conditions in the Existing Watercourse (station SW3) and Beaverdam Creek (station SW1) ...
7. If weekly sampling is required for a period of more than four (4) weeks, contingency measures shall be implemented to reduce concentrations in the quarry discharge ...
8. At existing pits and quarries within southern Ontario, hydrogen sulphide is typically not routinely included in the trigger mechanism ...

FINAL REHABILITATION

- G. General
1. All equipment and buildings/structures shall be removed from the licenced areas.
2. A Field/property access points entrance shall remain ...
3. The long term average surface water and lake level elevation is estimated to be approximately 175.15 masl.

Table 1: Deciduous Woodland Planting List

Table with 3 columns: % Botanical Name, Common Name. Lists trees like Acer saccharum, Fraxinus americana, etc.

Planting Notes:

Trees - wooded density 2,000/ha
Shrubs - 3:1 shrubs to trees - 3000/ha
Ground Cover - application rate 25kg/ha

Table 2: Treed Deciduous Swamp Planting List

Table with 3 columns: % Botanical Name, Common Name. Lists trees like Acer spicatum, Populus nigra, etc.

Planting Notes:

Trees - densely treed deciduous swamp 1,200/ha
Shrubs - 3:1 shrubs to trees - 3000/ha
Ground Cover - application rate 25kg/ha

Table 3: Swamp Thicket / Marsh Meadow Planting List

Table with 3 columns: % Botanical Name, Common Name. Lists trees like Cornus amomum, Silybium laciniatum, etc.

Planting Notes:

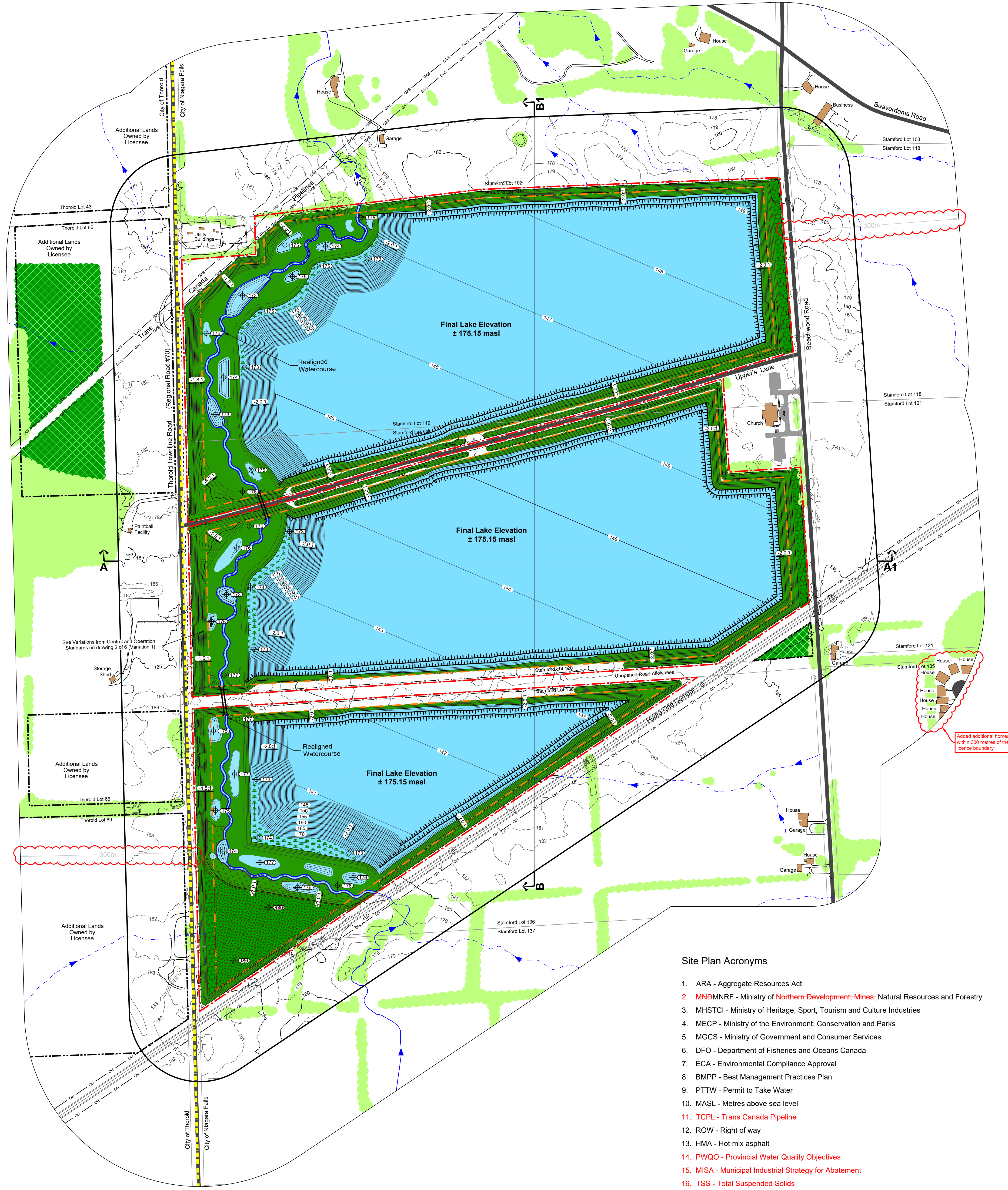
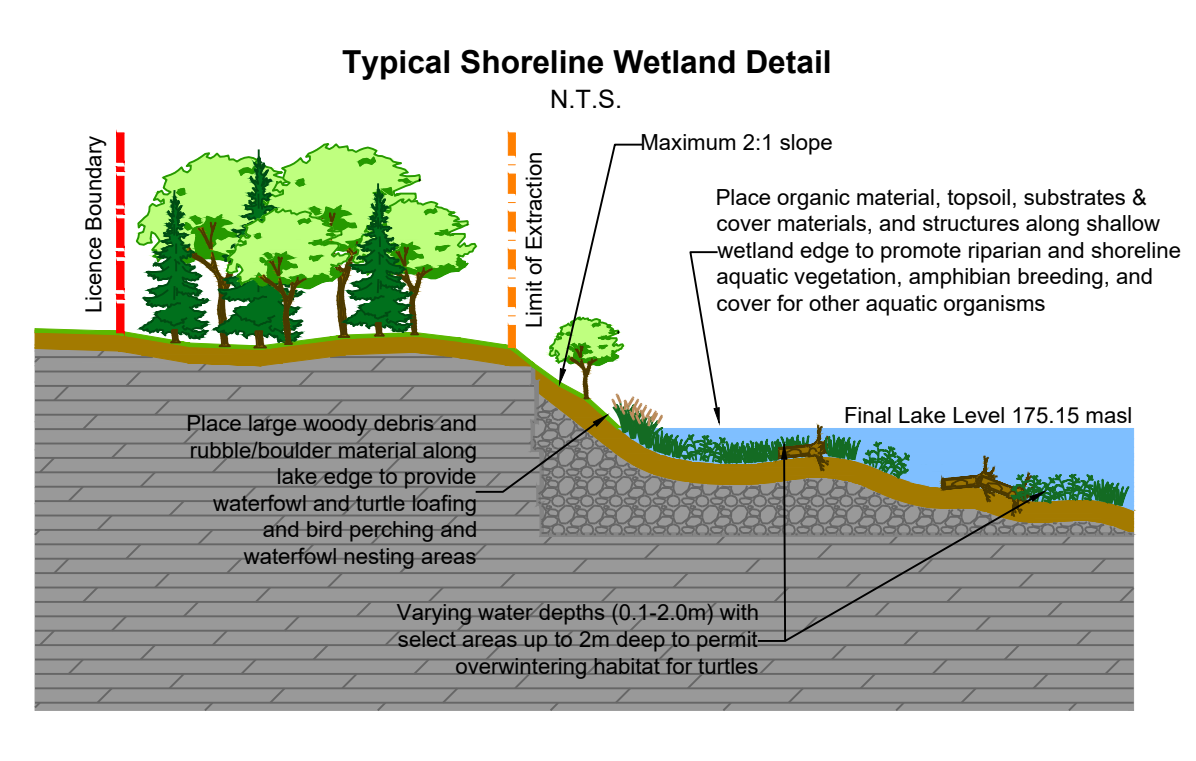
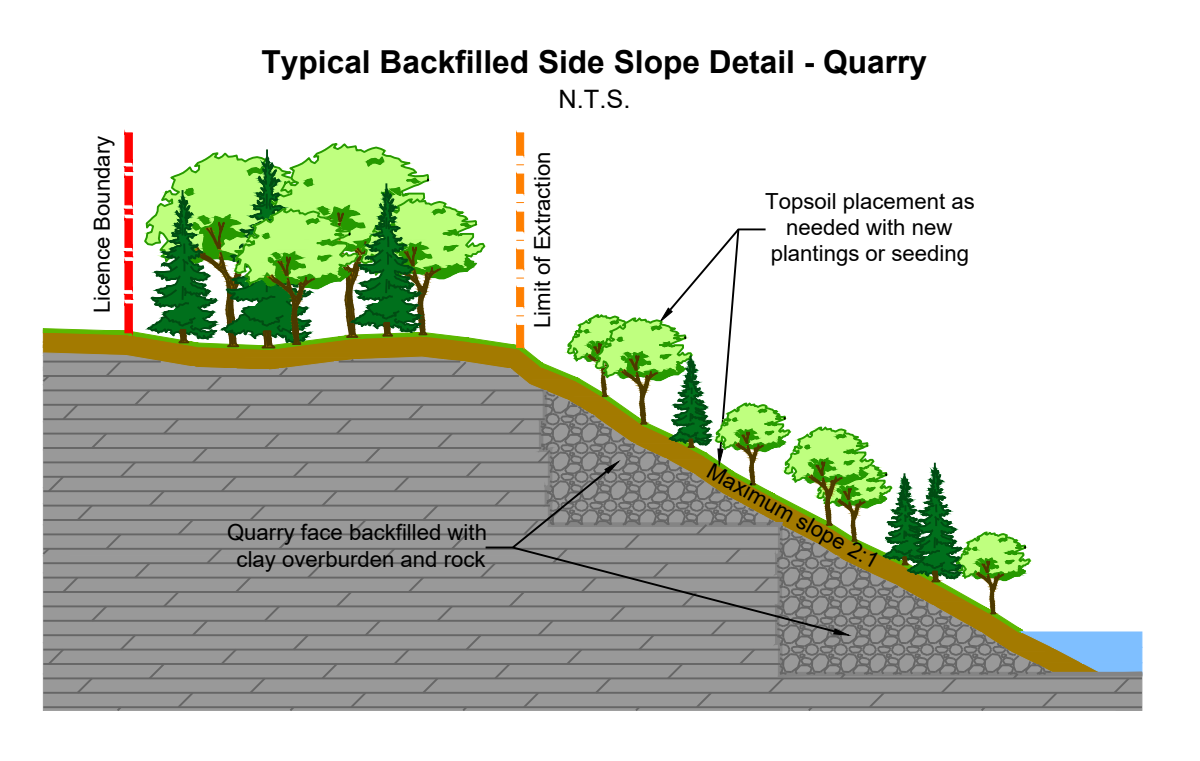
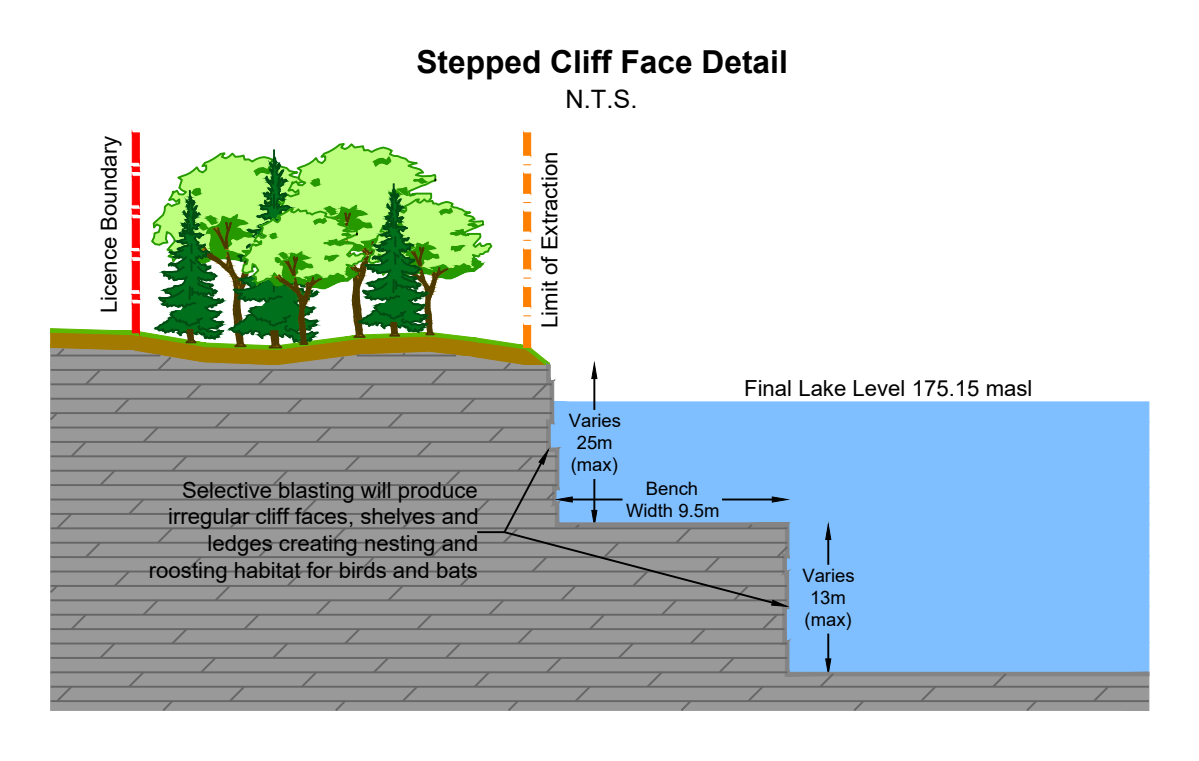
Shrubs - Thicket Shrubs - 3000/ha
Ground Cover - application rate 25kg/ha

Table 4: Riparian Planting List

Table with 3 columns: % Botanical Name, Common Name. Lists trees like Salix viminalis, Populus nigra, etc.

Planting Notes:

Plugs - 2 rows each with linear spacing of 30 - 50 cm



Legal Description
Part of Lots 119, 120, 136 & 137
City of Niagara Falls (Geographic Township of Stamford)
Regional Municipality of Niagara
Legend
Licence Boundary
Limit of Extraction
Additional Lands Owned by Licensee
Municipal Boundary
Watercourse
Surface Drainage Feature
Watercourse - Realigned
Waterbody
Shoreline Wetland
Terrestrial Habitat
Deciduous Woodland
Treed Deciduous Swamp
Swamp Thicket and Marsh Meadow
Woodland Compensation Area (Off-site)
Wooded Area

Legend - Cross Sections
Licence Boundary
Limit of Extraction
Existing Grade - Undisturbed
Existing Grade - Removed / Altered
Maximum Predicted Water Table
Quarry Floor / Face
Backfilled
Lake or Pond
Hydro Corridor

Site Plan Amendments table with columns: No., Date, Description, By.

Site Plan Revisions (Pre-Licensing) table with columns: No., Date, Description, By.

MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE
113 COLLIER STREET, BARRIE, ON, L4M 1H2

MHBC Stamp
Debra Walker
Christopher Poole
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry

walker aggregates
Walker Aggregates Inc.
2800 Thorold Townline Road
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Project: Upper's Quarry
MNDNR Licence Reference No.
Applicant's Signature: Christopher Poole
Date: October 2021
Plan Scale: 1:3000 (Arch E)
Drawn By: C.P.
Checked By: D.W.
File No: 9811V

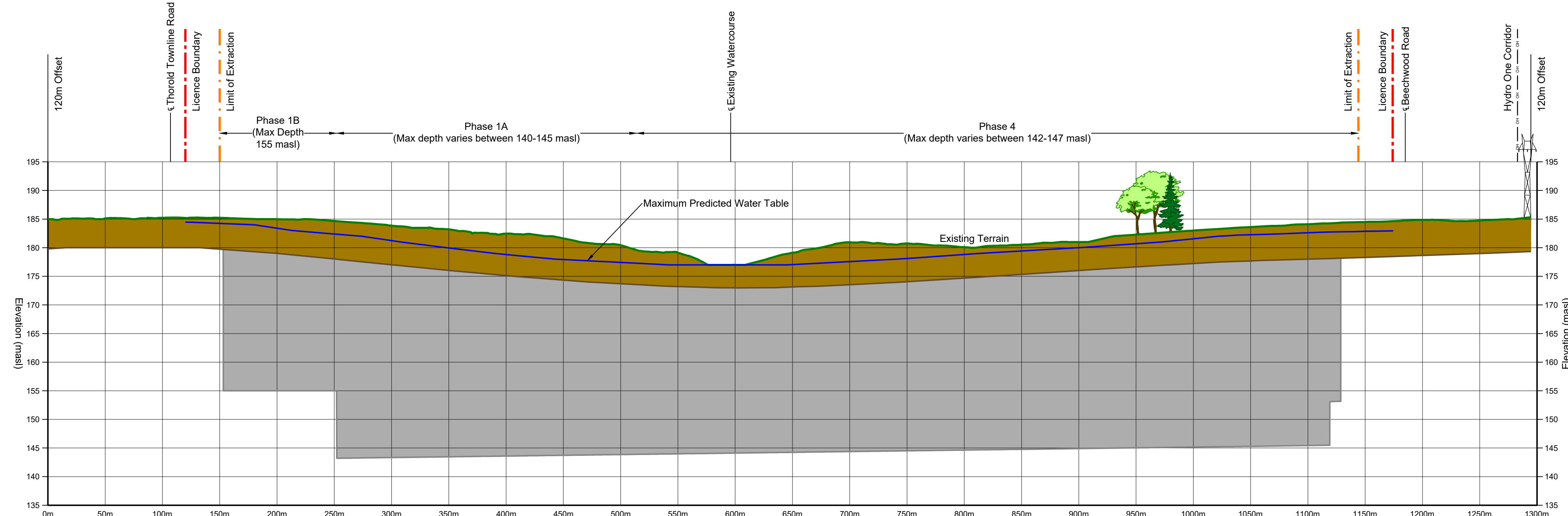
Rehabilitation Plan
Drawing No. 5 of 6
File Path: N:\8049811V - Walker Upper Quarry\Drawings\Site Plan\CAD\811V - Site Plan.dwg

Table with 3 columns: Parameter, Proposed Trigger Mechanism, Applicable Standard. Lists pH, TSS, Hydrogen Sulphide, Total Oil and Grease.

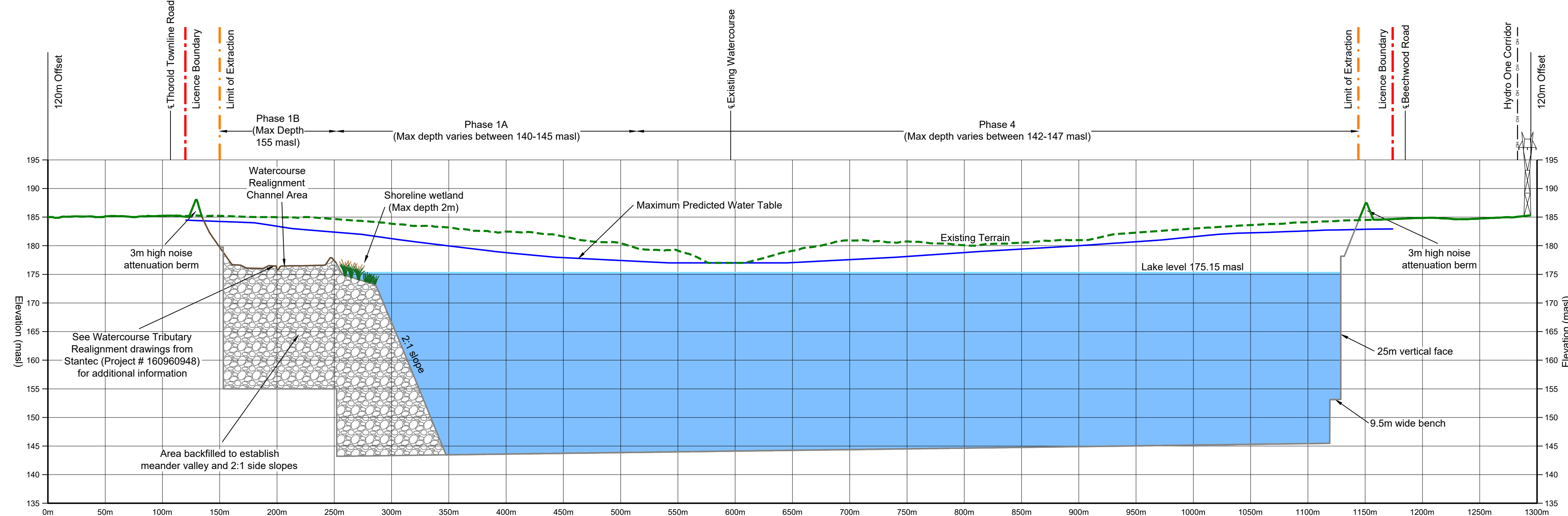
- 4. The shallow bedrock aquifer groundwater is more mineralized / harder than the surface water in the vicinity of the Site ...
5. The Municipal Industrial Strategy for Abatement (MISA) was also considered, as such, pH, total suspended solids (TSS) and total oil and grease have also been included in the trigger mechanism.

Site Plan Acronyms

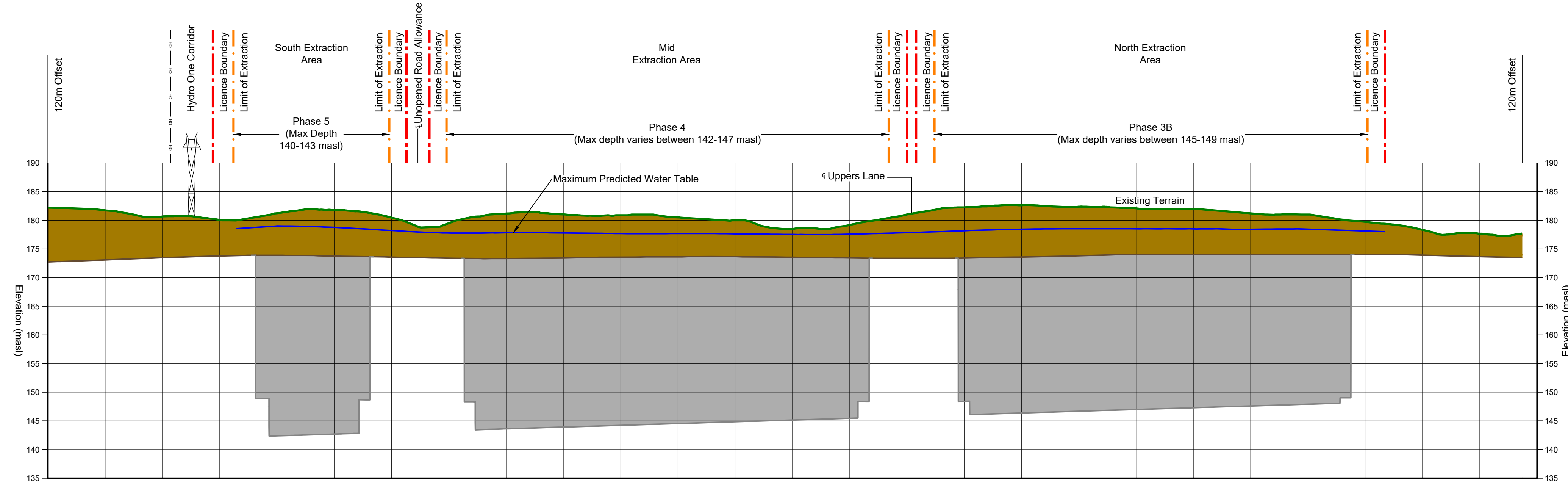
- 1. ARA - Aggregate Resources Act
2. MNDNR - Ministry of Northern Development, Mines, Natural Resources and Forestry
3. MHSTCI - Ministry of Heritage, Sport, Tourism and Culture Industries
...
16. TSS - Total Suspended Solids



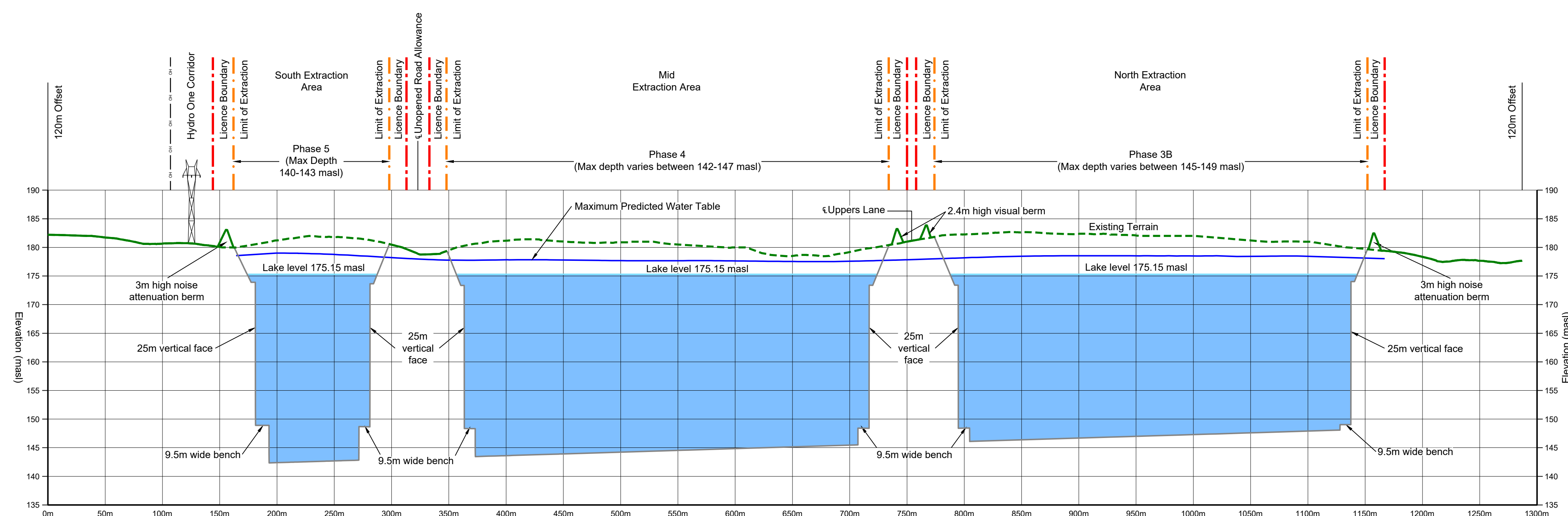
Section A-A' - Existing
Horizontal - 1:2500
Vertical - 1:500



Section A-A' - Rehabilitation
Horizontal - 1:2500
Vertical - 1:500

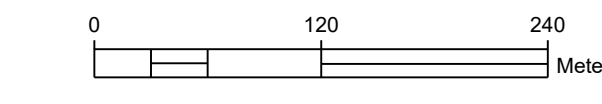


Section B-B' - Existing
Horizontal - 1:2500
Vertical - 1:500



Section B-B' - Rehabilitation
Horizontal - 1:2500
Vertical - 1:500

Cross Section Key Map
Scale 1:4000



- Legal Description**
Part of Lots 119, 120, 136 & 137
City of Niagara Falls (Geographic Township of Stamford)
Regional Municipality of Niagara
- Legend**
- Licence Boundary
 - Limit of Extraction
 - Additional Lands Owned by Licensee
 - Municipal Boundary
 - 120m Offset From Licence Boundary
 - Public Road
 - Trans Canada Pipeline Easement
 - Hydro One Easement
 - Cross Sections

- Legend - Cross Sections**
- Licence Boundary
 - Limit of Extraction
 - Existing Grade - Undisturbed
 - Existing Grade - Removed / Altered
 - Berm
 - Maximum Predicted Water Table (See note A.2 on drawing 5 of 6)
 - Quarry Floor / Face
 - Topsoil and/or Overburden
 - Aggregate Available for Extraction
 - Backfilled
 - Lake or Pond
 - Hydro Corridor

Site Plan Amendments

No.	Date	Description	By

Site Plan Revisions (Pre-Licensing)

No.	Date	Description	By
1	January 2022	Updated site plan per feedback from MNDMRF and completed minor housekeeping	C.P.
2	August 2023	Update site plan to incorporate JART and MNR comments	C.P.

MHBC
PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE
113 COLLIER STREET, BARRE, ON, CAN. L4G 1H2 | P: 705.728.0040 F: 705.728.2010 | WWW.MHBCA.COM

MHBC Stamp
Debra Walker
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 2.2(3)(f) of the Planning Act, R.S.O. 1990, c. P.22 to prepare and certify site plans.

MHBC Stamp
Christopher Poole
Is authorized by the Ministry of Northern Development, Mines, Natural Resources and Forestry pursuant to Subsection 2.2(3)(f) of the Planning Act, R.S.O. 1990, c. P.22 to prepare and certify site plans.

Applicant
walker aggregates
Walker Aggregates Inc.
2800 Thorold Townline Road
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Project
Upper's Quarry

MNDMRF Licence Reference No.

Applicant's Signature

Plan Scale: (Arch E)
Horizontal 1:2500
Vertical 1:500

Date October 2021

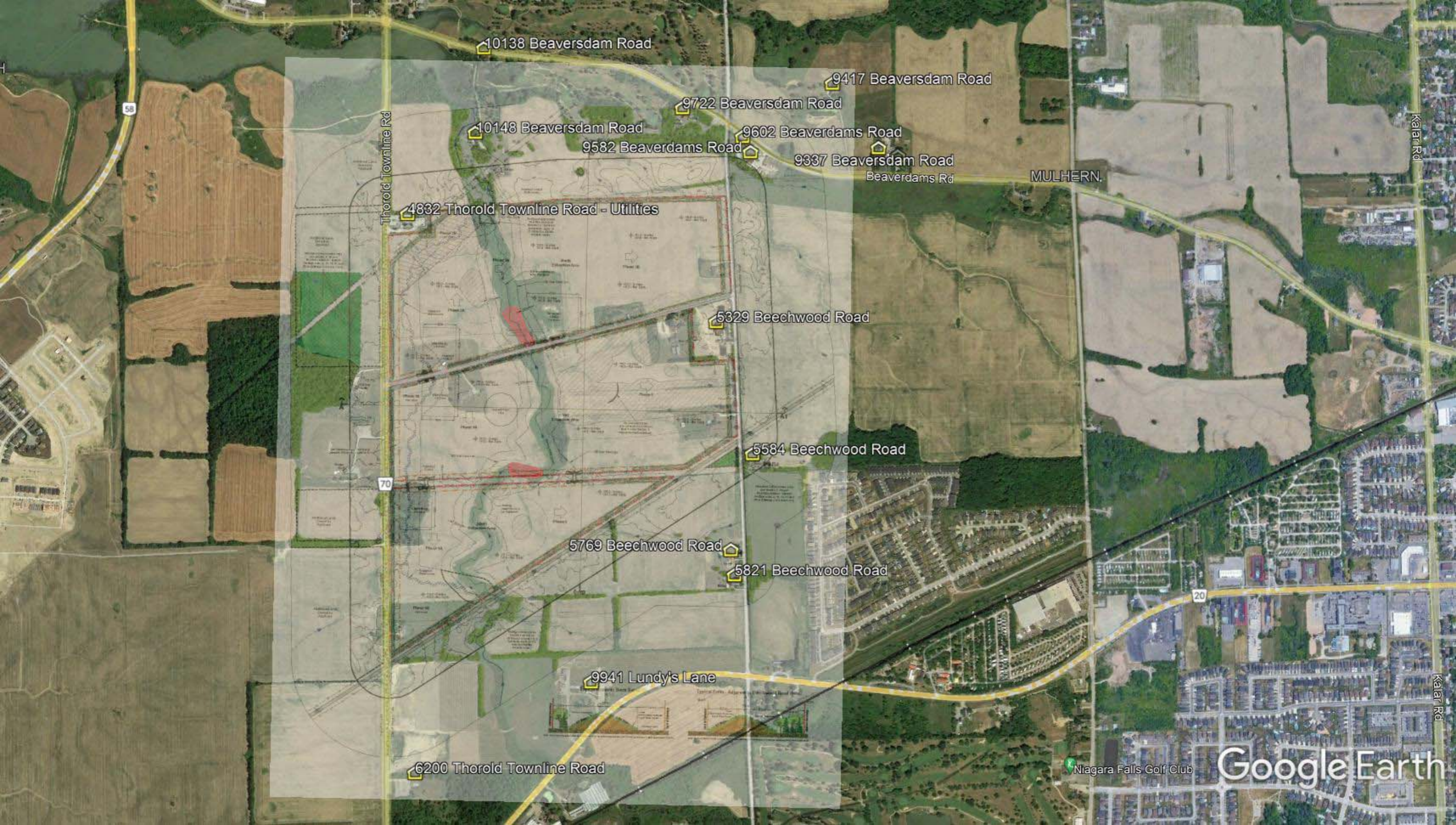
Drawn By C.P. **File No.** 9811V

Checked By D.W.

File Name **Cross Sections**

Drawing No. **6 of 6**

File Path N:\9811V - Walker Upper's Quarry Drawings\Site Plan\CAD\9811V - Site Plan.dwg



10138 Beaversdam Road

9417 Beaversdam Road

9722 Beaversdam Road

10148 Beaversdam Road

9602 Beaversdam Road

9582 Beaversdam Road

9337 Beaversdam Road

Beaversdam Rd

MULHERN.

Thorold Townline Rd

4832 Thorold Townline Road - Utilities

5329 Beechwood Road

5584 Beechwood Road

5769 Beechwood Road

5821 Beechwood Road

9941 Lundy's Lane

6200 Thorold Townline Road

58

70

20

Niagara Falls Golf Club

Google Earth

Kalar Rd

Kalar Rd

Appendix B



Uppers Quarry

PREVAILING METEOROLOGICAL CONDITIONS

Medians provided by Environment Canada
Canadian Climate Normals 1981-2010
St Catherines – Municipal Airport

Date	Wind Direction	Max Hourly Wind Velocity Km/h	Temperature (Deg Celsius)
January	SW	89	-3.8
February	E	63	-2.9
March	SW	74	1.1
April	SW	74	7.4
May	SW	65	13.7
June	SW	65	19.0
July	SW	63	21.9
August	W	59	20.8
September	W	53	16.6
October	SW	63	10.4
November	SW	70	4.6
December	SW	70	-0.9

Appendix C

Ground Vibrations

Imperial Equations				
Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
Oriard 50% Bound (2002)	Oriard 90% Bound (2002)	Typical Production Blast (Bulletin 656 – 1971)	Typical limestone Quarry (Pader report – 1995)	Typical Coal Mine (RI8507 1980)
$v = 160 \left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 242 \left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 182 \left(\frac{D}{\sqrt{W}}\right)^{-1.82}$	$v = 52.2 \left(\frac{D}{\sqrt{W}}\right)^{-1.38}$	$v = 133 \left(\frac{D}{\sqrt{W}}\right)^{-1.5}$

Metric Equations			
Equation 1	Equation 2	Equation 3	Equation 4
DuPont General (1968)	Construction Blasting (Dowding 1998)	Agg. Quarry Blasting (Explotech 2005)	Agg. Quarry blasting (Explotech 2003)
$v = 1140 \left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 1326 \left(\frac{D}{\sqrt{W}}\right)^{-1.38}$	$v = 5175 \left(\frac{D}{\sqrt{W}}\right)^{-1.76}$	$v = 7025 \left(\frac{D}{\sqrt{W}}\right)^{-1.85}$

D (m)	W (Kg)	PPV1 (mm/s)	PPV2 (mm/s)	PPV3 (mm/s)	PPV4 (mm/s)	PPV5 (mm/s)	PPV1 (mm/s)	PPV2 (mm/s)	PPV3 (mm/s)	PPV4 (mm/s)
710	118	1.4	2.2	0.5	1.4	1.9	1.4	4.1	3.3	3.1

Air Overpressure

Imperial Equations			
Equation 1	Equation 2	Equation 3	Equation 4
USBM RI8485 (Behind Blast)	USBM RI8485 (Front of Blast)	USBM RI8485 (Full Confined)	Construction Average
$P = 0.056 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.515}$	$P = 1.317 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.966}$	$P = 0.061 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.96}$	$P = 1 \left(\frac{D}{\sqrt[3]{W}}\right)^{-1.1}$

Metric Equations		
Equation 1	Equation 2	Equation 3
Ontario Quarry (Explotech 2013)	Limestone (Explotech 2011)	Ontario Quarry (Explotech 2012)
$P = 159 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.0456}$	$P = 206 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.1}$	$P = 1222 \left(\frac{D}{\sqrt[3]{W}}\right)^{-0.669}$

D (m)	W (Kg)	OP1 (dB)	OP2 (dB)	OP3 (dB)	OP4 (dB)	OP1 (dB)	OP2 (dB)	OP3 (dB)
710	118	119.3	123.6	97.3	114.4	126.7	125.3	126.8

Appendix D

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Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Robert J. Cyr, P. Eng.
Principal, Explotech Engineering Ltd.

EDUCATION

Bachelor of Applied Science,
Civil Engineering, Queen's University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
Association of Professional Engineers and Geoscientists of BC (APEG)
Association of Professional Engineers, Geologists and Geophysicists of Alberta
Association of Professional Engineers and Geoscientists of New Brunswick
Association of Professional Engineers of Nova Scotia
Association of Professional Engineers and Geoscientists Manitoba
Professional Engineers and Geoscientists Newfoundland and Labrador
Northwest Territories and Nunavut Association of Professional Engineers (NAPEG)
International Society of Explosives Engineers (ISEE)
Ontario Stone Sand & Gravel Association (OSSGA)
Surface Blaster Ontario Licence 450109

SUMMARY OF EXPERIENCE

Over thirty five years experience in many facets of the construction and mining industry has provided the expertise and experience required to efficiently and accurately address a comprehensive range of engineering and construction conditions. Sound technical training is reinforced by formidable practical experience providing the tools necessary for accurate, comprehensive analysis and application of feasible solutions. Recent focus on vibration analysis, blast monitoring, blast design, damage complaint investigation for explosives consumers and specialized consulting to various consulting engineering firms.

PROFESSIONAL RECORD

2001 – Present	-Principal, Explotech Engineering Ltd.
1996 – 2001	-Leo Alarie & Sons Limited - Project Engineer/Manager
1993 – 1996	-Rideau Oxford Developments Inc. – Project Manager
1982 – 1993:	-Alphe Cyr Ltd. – Project Coordinator/Manager

EXPLOTECH ENGINEERING LTD.

Ottawa ♦ Sudbury ♦ Toronto ♦ Halifax

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1-866-EXPLOTECH



Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Mitch Malcomson, P.Eng.
Consulting Engineer, Explotech Engineering Ltd.

EDUCATION

Bachelor of Engineering,
Civil Engineering with Concentration in Business Management,
Carleton University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
Association of Professional Engineers and Geoscientists of BC (APEG)
International Society of Explosives Engineers (ISEE)
Ontario Stone Sand and Gravel Association (OSSGA)

SUMMARY OF EXPERIENCE

A Consulting Engineer and Project Manager for Explotech Engineering Ltd., Mitch holds a Bachelor of Engineering degree from Carleton University in Civil Engineering with a Concentration in Business Management. Mitch has strong analytical, technical, business and leadership skills. As a Project Manager, Mitch is responsible for operational strategies, scheduling and contract procurement. As a Consulting Engineer, the technical responsibilities include detailed blast designs, blast investigations and reviews, implementation of vibration monitoring programs, development of monitoring equipment/ technologies and building assessments for construction and the drilling and blasting portions of mining, quarrying and construction projects across Canada.

PROFESSIONAL RECORD

2008 – Present - Consulting Engineer / Project Manager, Explotech Engineering Ltd.



Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Andrew Campbell, P.Eng.
Explotech Engineering Ltd.

EDUCATION & QUALIFICATIONS

Bachelor of Engineering,
Mechanical Engineering, Carleton University

Advanced and Expert (Industry) CadnaA Modelling
DataKustik, Mississauga, Ontario

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
International Society of Explosive Engineers (ISEE)

SUMMARY OF EXPERIENCE

An engineer working for Explotech Engineering Ltd., Andrew holds a Bachelor of Engineering degree in Mechanical Engineering and has strong analytical, technical, and interpersonal skills. A proven leader in collaborative environments, Andrew is comfortable managing projects, specifying details, and communicating internally and externally. With a focus on blast designs, blast impact analyses, noise monitoring and modelling, damage complaint investigations, vibration analysis, and blast monitoring, Andrew has applied these skills across Canada.

PROFESSIONAL RECORD

- 2018 – Present - Engineer, Explotech Engineering Ltd.
- 2013 – 2018 - Technician / EIT, Explotech Engineering Ltd.
- 2012 – 2012 - Ride Technician, Canada's Wonderland



Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Michael Tobin, P.Eng.

Explotech Engineering Ltd.

EDUCATION

Bachelor of Applied Science,
Geological Engineering, Queen's University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
International Society of Explosives Engineers (ISEE)

SUMMARY OF EXPERIENCE

An engineer working for Explotech Engineering Ltd., Michael holds a Bachelor of Applied Science degree from Queen's University in Geological Engineering. Michael has strong analytical, technical, and interpersonal skills. Recent projects have focused on blast monitoring, vibration analysis, job estimation, damage complaint investigation and blast design.

PROFESSIONAL RECORD

2021 – Present - Engineer, Explotech Engineering Ltd.
2017 – 2021 - Technician, Explotech Engineering Ltd.

Appendix E



Blasting Terminology

ANFO:	Ammonium Nitrate and Fuel Oil – explosive product
ANFO WR:	Water resistant ANFO
Blast Pattern:	Array of blast holes
Body hole:	Those blast holes behind the first row of holes (Face Holes)
Burden:	Distance between the blast hole and a free face
Column:	That portion of the blast hole above the required grade
Column Load:	The portion of the explosive loaded above grade
Collar:	That portion of the blast hole above the explosive column, filled with inert material, preferably clean crushed stone
Face Hole:	The blast holes nearest the free face
Overpressure:	A compressional wave in air caused by the direct action of the unconfined explosive or the direct action of confining material subjected to explosive loading.
Peak Particle Velocity:	The rate of change of amplitude, usually measured in mm/s or in/s. This is the velocity or excitation of the particles in the ground resulting from vibratory motion.
Scaled distance:	An equation relating separation distance between a blast and receptor to the energy (usually expressed as explosive weight) released at any given instant in time.
Sensitive Receptor:	Sensitive land use may include recreational uses which are deemed by the municipality or provincial agency to be sensitive; and/or any building or associated amenity area (i.e. may be indoor or outdoor space) which is not directly associated with the industrial use, where humans or the natural environment may be adversely affected by emissions generated by the operation of a nearby industrial facility. For example, the building or amenity area may be associated with residences, senior citizen homes, schools,

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day care facilities, hospitals, churches and other similar institutional uses, or campgrounds.

Spacing:	Distance between blast holes
Stemming:	Inert material, preferably clean crushed stone applied into the blast hole from the surface of the rock to the surface of the explosive in the blast hole.
Sub-grade:	That portion of the blast hole drilled and loaded below the required grade
Toe Load:	The portion of explosive loaded below grade



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