LOCAL PLANNING APPEAL TRIBUNAL

James Dick Construction Limited has appealed to the Local Planning Appeal Tribunal under subsection 17(40) of the Planning Act, R.S.O, 1990, c. P.13, as amended, regarding the failure of the County of Wellington to announce a decision respecting Proposed Official Plan Amendment No. OP-2016-09;
O.M.B. File No. PL 170688

And, under subsection 34(11) of the *Planning Act*, R.S.O. 1990, c. P.13, as amended, regarding the refusal or neglect of the Township of Guelph/Eramosa to enact a proposed amendment ZBA 06/16 to Zoning By-law No. 40/2016 to rezone lands in Part Lot 6, Concession 1, Guelph Eramosa from Agricultural/Hazard to M3 - Extractive Industrial to permit the establishment of a commercial quarry.
O.M.B. File No. PL 170472

At the request of James Dick Construction Limited, the Minister of Natural Resources has referred to the Ontario Municipal Board under section 11(5) of the *Aggregate Resources Act*, R.S.O. 1990, c. A.8, as amended, an application for new Category 2 licence (quarry below water table) for the removal of aggregate from lands in part of Lot 6, Concession 1, Guelph Eramosa.
O.M.B. File No. MM150034

WITNESS STATEMENT OF

William Hill, P. Eng.
William Hill Mining Consultants Ltd.
PO Box 482, Eramosa 6th Line
Rockwood ON N0B 2K0
519-856-4253
jandwhill@gmail.com

Qualifications:

1. I am a registered Professional Engineer and a designated Consulting Engineer in the Province of Ontario. I hold a B.A.Sc. Degree in Mining Engineering from the University of Toronto (1958).
2. I have worked continuously in the mining industry since 1949 (with the exception of 1950) to the present. During my mining career I have gained significant experience as:
    - Miner
    - Operator of open pit mines
    - Mine Manager
    - Mining Contractor
    - President of Mining Corporations
    - Mining Consultant to banks, the United Nations, the World Bank, and numerous mining companies
    - A Director of several mining corporations
3. In 1966 I co-founded the company Minera Del Hill (MDH), which is still in production, having produced more than 300,000 ounces of gold in 2015.
4. My area of expertise is open pit mining, based on my work involving at least fifteen open pit mines worldwide, which had production rates ranging from 200 to 500,000 tonnes per day and total production exceeding one billion tonnes during my active career.
5. My residence is on Eramosa 6th Line, approximately 1000 metres north of the proposed Hidden Quarry site.
6. I am co-Chairman of CRC Rockwood Inc.

Summary of Evidence:

7. During the period March 2013 to 2017, I provided information via delegations and reports to the Guelph Eramosa Township Council reflecting the identification of potential issues arising from the below water blasting operations proposed by the applicant. These issues included vibration levels transmitted to various receptors within range of the quarry site; the risk of flyrock ejection to nearby structures and the major area thoroughfare, Highway 7; and the ability of the proposed perched Tributary B and adjacent wetlands to maintain their structural integrity when subjected to blasting vibration.

8. I have reviewed the applicant's three Blast Impact Analysis reports with the original dated November 19 2012, a first revision dated September 5 2014, and a second revision dated February 12 2019, all by Explotech Engineering Ltd. I also reviewed a report submitted by the applicant by Golder Associates dated October 1 2014, identified as a Peer Review of the Explotech Blast Impact Analysis Reports.
9. On behalf of Concerned Residents Coalition Rockwood Inc., I submitted the following reports to Guelph Eramosa Township:
    - October 21 2013 – *Appraisal of the Mining Aspects of Reports*
    - December 10 2013 – *Dangers Posed to Highway 7 by Hidden Quarry Flyrock*
    - January 31 2015 – *An Appraisal of the Peer Review By Golder Associates of Two Reports Titled Blast Impact Analysis, James Dick Hidden Quarry, by Explotech Engineering Ltd.*
    - March 9 2017 – *Critical Assessment of Blast Impact Predictions*.

    The January 31 2015 report reflects my review of the applicant's blasting impact analysis up to and including the 2014 revision.
10. The March 9 2017 report presents my further research into blast impact modelling. In part my research was based on other Blast Impact Analysis reports prepared by the proponent's consultants, Explotech Engineering Ltd. (EEL) and Golder Associates (GA), namely:
    - August 1998 – *Blast Impact Analysis, Tamagami [sic] Traprock Quarry, Best Township, Ontario*, EEL
    - April 2007 – *Blast Impact Analysis, Miller Braeside Quarry*, EEL
    - August 2008 – *Peer Review of Miller Braeside Quarry Blast Impact Analysis*, GA
    - November 2008 – *Blasting Impact Assessment, Dufferin Aggregates Acton Quarry Proposed Extension*, GA
    - February 2009 – *Blasting Impact Assessment*, Lafarge Dundas Quarry, EEL
    - June 2009 – *Blasting Impact Assessment*, Simpson Subdivision Land Use Compatibility, EEL
    - April 2011 – *Proposed Giofam Sebright Quarry, City of Kawartha Lakes, Ontario*, EEL
    - June 2011 – *Blast Impact Analysis*, Dewdney Mountain Farms Ltd. Quarry, EEL
    - May 2012 – *Blasting Impact Analysis*, Fairbank Quarry, EEL
    - February 2014 – *Blast Impact Analysis, Freymond Quarry*, EEL
    - March 2017 – Blast Impact Analysis, Rockridge Quarry, EEL
    - July 27 2017 – *Blast Impact Analysis, McClintock Quarry*, EEL
    - November 2017 – *Blast Impact Analysis*, Fleming Quarry Extension, EEL
    - June 2018 – *Blast Impact Analysis*, Reid Road Reservoir Quarry, EEL

    This report also relies on information obtained through an FOI application to the Ontario Ministry of Environment and Climate Change (at that time) regarding a conviction rendered by the Ministry for a flyrock incident.

11. As a reference case for underwater blasting in dolostone, I cited experience in a dolostone quarry operation in Miami-Dade County near Miramar City Florida:
    - May 31 2000 – *Blast Vibration Damage Assessment Study and Report*, Miami-Dade County Blasting Task Force.
12. In summary, my view is that the Blasting Impact Analysis reports submitted by the proponent do not adequately attend to the risk of flyrock ejection to adjacent properties and Highway 7; and that by the application of arbitrary and invalid blasting vibration prediction parameters to the Hidden Quarry site, they underestimate vibration levels at sensitive receptors.

Issues:

I will address the following issue from the Consolidated Issues List, which is relevant to my area of expertise:

Noise and Blast/Vibration.

29. Has there been an appropriate risk assessment for flyrock considering the karst geology and are proposed setbacks from structures, roadways, and people consistent with good industry practice? Has it been demonstrated that, in the absence of seismic testing, prediction of vibration levels arising from blasting are reliable? Will the proposed quarry result in any unacceptable impacts from blasting, including noise, vibration, flyrock, or other impacts?

Flyrock Ejection Risk

13. *Definition*: Flyrock in open pit mines is the propulsion of rocks through the air as a result of blasting, and their trajectory ending beyond the confines of the normal blasting area. As determined by the Supreme Court of Canada (*Castonguay Blasting Ltd. v. Ontario (Environment)*), under the Ontario EPA, any flyrock discharge that results in adverse effects on the natural environment is regarded as discharge of a contaminant. Flyrock is generally caused by natural variations in the geology and particularly by imperfections such as faults, cavities, fractures, water passage opening, etc. The Hidden Quarry site is characterized by such variations. It can also be the consequence of human error through overloading with explosive and mistakes in blast design.
14. *Safe Distance Setback*: the two most widely accepted industry standards for defining "safe distance" for blasting setback are the US Bureau of Mines model, "a quantitative definition of blasting area for normal shots", described in their report **A Model for the Determination of Flyrock Range as a Function of Shot Conditions,** and a predictive model developed by Terrock Consulting Engineers (TCE) and described in the Richards and Moore paper, **Flyrock Control – By Chance or Design**. In the case of the Hidden Quarry, it is benchtop flyrock, as opposed to the under-water face flyrock, that represents a risk.

    The USBOM maximum range prediction model is:

$$L_m = V_0^2/g$$

Where L_m = maximum flyrock range, ft. or m
V_0 = initial velocity, ft/s or m/s
g = acceleration due to gravity, 32 ft/s^2 or 9.8 m/s^2
For limestone and granite, $V_0 = 180[(s/W)^{1/3}]^{0.79}$ where
W = weight of explosive, lb. or kg
s = depth to top of explosive, ft. or m

EEL made use of this USBOM formula in a BIA dated 1998 for the Temagami Traprock Quarry (TTQ) prepared by EEL Engineer Dan Corkery, now employed by Golder Associates. Their estimates, based on 76 kg of explosives per drill hole, indicated that the flyrock from bench tops would have a maximum range (Lm) of 422 m. Based on the same formula, the HQ with a minimum of 150 kg explosive per drill hole would have a range in excess of 550 m. Four residences are located as close as 150 m from blasting and a total of 19 buildings fall within a 500 m radius. The site abuts the area's major thoroughfare, Provincial Highway 7, of which approximately 1.5 km falls within 500 m.

15. *HQ Setback Estimates and TCE Model*: The applicant's February 12 2019 Blast Impact Analysis report specifies separation distances between sensitive receptors and blasting as low as 70 m. No reference is made to benchtop flyrock. However, a 150 m buffer zone is specified without justification. A letter from Explotech to JDCL dated April 10, 2014 states that it has based its justification on a model developed by TCE. The acceptance of the model is reinforced by Dan Corkery of Golder in his Email correspondence to JDCL dated April 2, 2015: "The letter from Explotech, dated April 10, 2014 describes the approach widely used by industry to estimate flyrock range from quarry bench blasts that has been described in the published paper by Richards and Moore (2002). We agree with the approach and flyrock range estimates contained in the letter report. The presence of water within the quarry will restrict the face burst flyrock from below the water table and not that from bench top cratering." However, the TCE report continues beyond the basic calculation with the statement: "the range of maximum throw distances can be determined with reasonable accuracy; however, they have no safety margin . . . . it is considered reasonable that the maximum throw distances be **doubled** to determine the minimum clearance distances to plant and equipment and this **doubled again** to determine minimum clearance distances for personnel." **In other words, the TCE model employed by the proponent recommends the use of a safety clearance distance for personnel of four times greater than the results obtained by applying their equation, or 516 m rather than 129 m**.

    EEL's consideration of flyrock has evolved in these revisions of the Blasting Impact Assessment from specifically citing the TCE model for setback calculation, to using the TCE model without citing its source in the 2019 revision.

16. *Flyrock Risk for HQ Site*: Risk is commonly defined as Risk = Probability X Loss, or the product of probability of the event occurring and the consequences of the event should it occur. In most cases, the probability of flyrock is low, but the loss or consequences can be very large, even catastrophic. At least four residences are located as close as 150

m from blasting and a total of 19 buildings fall within a 500 m radius. Furthermore, the proposed HQ site abuts the area's major thoroughfare, Provincial Highway 7, of which approximately 1.5 km falls within what could be deemed a reasonable exclusion zone from the excavation sites.

Blasting Vibration

17. *Definition*: Vibration arising from blasting is predicted as a "peak particle velocity (PPV)" generally by means of the US Bureau of Mines prediction formula given below:

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

Where, PPV = the predicted peak particle velocity (mm/s)
k, e = site-related constants
d = distance from receptor (m)
w = maximum explosive charge per delay (kg)

In Ontario, MOECP suggests a limit to ground-borne vibration of 12.5 mm/sec PPV to avoid damage to residences.

The critical issue in the use of this formula is the values assigned to the site-related constants, *k* and *e*, and therefore the validity of the predicted PPV values. The September 5 2014 Blasting Impact Analysis report submitted by the applicant sets parameter values of *k* = 5175 and *e* = -1.76, "based on monitoring performed in an [un-named] Ontario quarry with similar material characteristics" which enables the prediction of PPV values within the Provincial guidelines.

EEL notes in all of its BIA reports, "The value of k is highly variable and is influenced by many factors (i.e. rock type, geology, thickness of overburden, etc.)" It follows that similar or identical values of *k* suggest strong similarities in the characteristics of the quarries.

18. *Basis for and validity of the postulated* k *and* e *values*: I have studied the EEL Blast Impact Reports for the Freymond Quarry (Hastings County, 2014), Miller Braeside Quarry (Renfrew County, 2007), Giofam Sebright Quarry (Kawartha Lakes, 2011) and the Temagami Traprock Quarry (1998) to assess EEL's methodology for vibration prediction and to compare it to that applied to the Hidden Quarry. The Table 1 summarizes my findings for Freymond and Braeside in comparison to the Hidden Quarry.

Table 1: Comparison of HQ, FQ and MBQ Characteristics

	HQ	FQ	MBQ
ROCK TYPE	DOLOMITE	METASEDIMENT	LIMESTONE
GEOLOGY	SEDIMENTARY EVAPORITES	MASSIVE GRANITIC	SEDIMENTARY EVAPORITES
OVERBURDEN	Approx. 8 m	ALMOST BARE	?
WATER	WATER-FILLED	DRY	DRY
AGE OF ROCK YEARS	Approx. 450 MILLION	Approx. 3 TO 4.5 BILLION	Approx. 450 MILLION
TERRAIN	FLAT	80 m HILL	FLAT
DEPTH OF ROCK CUT	27m	10m	15m
k	5175	5175	7025
e	-1.76	-1.76	-1.85

Freymond uses the same un-named Ontario quarry as the basis for employing the same *k* and *e* values as in the Hidden Quarry. Braeside and Sebright use another un-named "Eastern Ontario" region site as the basis for the second set of parameters used there.

The use of the same arbitrary set of parameters from the un-named reference site for Freymond and HQ is unwarranted in light of the lack of any commonality in material conditions. The attenuation rate of vibration indicated by the *e* value greatly depends on the extent to which water is present in the surrounding rock. In addition to the difference in rock type, because the HQ is to be water-filled whereas the Freymond Quarry is dry, the draw-down characteristics of the surround water tables are decidedly different. The result is that attenuation should be significantly lower for HQ than for Freymond, but EEL applies the same rate.

The Miller-Braeside case also demonstrates the unreliability of the modelling done by EEL. In that case records of more than 60 blasts are reported by EEL of which at least 15 included complete data on distance from the blast, weight of explosive, and the recorded PPV measurement taken for each. A peer review of the Miller-Braeside blast impact analysis produced by Golder Associates (August 2008) reports that that the actual PPVs of 11 blasts measured were almost double the magnitude of those based on EEL's prediction equation.

19. *The Miramar – Dade County Florida Reference Case*: The applicant has cited the Miramar case as a basis for stating that below-water blasting and extraction is not new and has been used successfully (March 2013 public meeting). However, the quarries in Dade County and Miramar City have a long history of problems, as recorded in the press over at least 20 years particularly with respect to shock waves. These issues continue to the present time even though almost all blasting is now carried out at a distance of well over one kilometer from any significant receptor. As summarized in Table 2, the HQ and Miramar have many similarities:

Table 2: Comparison of HQ and Dade County Quarry Characteristics

	HQ	Dade County
Under water	Yes	Yes
Rock type	Dolomite *	Limestone *
Depth of pit	27 m	Approx. 30 m
Topography	Flat	Flat
Overburden	6 to 8 m	Shallow
Water table	Close to surface	Close to surface
Homes within 1000 m	Approx. 50 - 75	None
Distance to closest home	150 m	>1000 m

*Dolomite and limestone are quite similar as both are bedded evaporates. Dolomite is slightly denser and harder than limestone, and thus a better conductor of pressure waves.

There is also a great deal of empirical seismic data for Miramar, reported in the 2000 Miami-Dade County report **Blast Vibration Damage Assessment Study and Report** and I have used it for comparison to the HQ vibration prediction model employed by the applicant. Table 3 summarizes the comparison:

Table 3: Miramar City Seismic Data from US Corps of Engineers Study

	1040 to 1600 m	2000 to 2800 m
Number of observations	17	5
Weight of explosives	156 kg	156 kg
Average distance from blast	1450 m	2500 m
Highest actual PPV mm/sec	5.1	4.1
Average actual PPV mm/sec	3.6	3.3
EEL estimated PPV mm/sec	1.26	0.48
Actual / EEL estimate	2.9 : 1	6.9 : 1

The EEL equation grossly understates the magnitude of the shock waves by an average factor of 2.9 at up to 1600 m range, 6.9 between 2000 and 2800 m range.
The Miami-Dade County report concludes that the *e* value from measured seismic data is -1.2, and applying this in the USBOM prediction model, *k* is calculated to be 2650. Using these parameters for the HQ vibration prediction model for 425 m range gives an estimated PPV value of 37 mm/sec rather than the predicted 10.1 mm/sec estimated by the applicant, or almost four times the EEL estimate. Also, the closest home to the HQ, at a distance of 150 m from the pit limit walls, would be subject to vibrations of over 10 times the MOECC maximum allowable.

20. *Impact on Brydson Creek fish habitat*: The Brydson Creek, which flows through the quarry site, supports a viable brook trout population and spawning habitat approximately 300 m from the site. The estimated PPV at 300 m based on this same

prediction formula would be 58.4 mm/s. According to the Blast Impact Analysis report done by Golder for the Dufferin Acton Quarry, the DFO guideline limit for peak ground vibration levels in fish habitat is 13 mm/s.

Documents to be Referenced:

Richards, Alan B. and Moore, Adrian J. **Flyrock Control – By Chance or Design,** Paper Presented at ISEE Conference, New Orleans, 2002. Terrock Consulting Engineers.

Explotech Engineering Ltd., **Blast Impact Analysis – Hidden Quarry**, James Dick Construction Ltd., November 16, 2012.

Golder Associates, **Technical Peer Review – Blast Impact Analysis for Hidden Quarry**. October 1, 2014.

Explotech Engineering Ltd., **Blast Impact Analysis – Miller Braeside Quarry**, April 2007.

Ontario Ministry of Environment, News, **Burlington Firm fined $130,000 for Arnprior Blasting Offences**. April 30 2014.

Roth, J., Management Sciences Associates. **A Model for the Determination of Flyrock Range as a Function of Shot Conditions**. US Bureau of Mines, 1979

Explotech Engineering Ltd., **Blast Impact Analysis - Proposed Tamagami [sic] Traprock Quarry, Best Township Ontario**. Blackstone Development Inc. August 24, 1998.

Explotech Engineering Ltd., **Blast Impact Analysis – Freymond Quarry**, February 18, 2014

Miami-Dade County Blasting Task Force, **Blast Vibration Damage Assessment Study and Report**. May 31, 2000.

Golder Associates Ltd., **Blasting Impact Assessment – Dufferin Aggregates Acton Quarry**. November 2008.

Conclusions

21. The proximity of the proposed quarry site to sensitive receptors, including the heavily travelled Highway 7 thoroughfare, dictate that the risk to health and safety and the potential damage to structures resulting from the ejection of flyrock is significant. The omission of any consideration of this risk in the Hidden Quarry Blast Impact Analysis is unacceptable.
22. According to both industry standards, the TCE and USBOM range prediction models, the potential range of flyrock based on the minimum explosive weight stated by the proponent is 550 m. Approximately 1500 m of Highway 7 lies within this range, as do 19 structures including those that are inhabited.

23. The application of a 500 m exclusion zone would necessitate either the re-routing of approximately 1500 m of Highway 7 or stoppage of access to that stretch of thoroughfare whenever blasting is being carried out.
24. The parameters used by the proponent in the US Bureau of Mines vibration prediction equation, which are acknowledged to be sensitive to site conditions, are arbitrarily adopted from an un-identified site for which no characteristics are provided. It is therefore impossible to validate their applicability to the Hidden Quarry.
25. The same vibration prediction parameters used for the Hidden Quarry are used by the proponent's blasting consultant for the Freymond Quarry. The Freymond Quarry and the Hidden Quarry have significant dissimilarities in characteristics. The arbitrary application of parameters in the vibration prediction model provides unreliable results.
26. The Miramar Florida quarry has characteristics that are similar in many ways to those at the Hidden Quarry site. It is concluded, therefore, that the blast vibration impact is also likely to be similar. Using the prediction parameters for the Miramar case gives vibration levels at sensitive receptors for the Hidden Quarry that exceed those predicted by the proponent as well as allowable limits by factors as high as 10.
27. Based on the Miramar reference case, the PPV that would be produced in the location of the Brydson Creek brook trout habitat located 300 m from the quarry site would be 58.4 mm/s, well in excess of the DFO guideline limit of 13 mm/s.
28. The combination of flyrock risk and excessive blast vibration levels alone are reasons to deny the application for an aggregate extraction licence for the Hidden Quarry.
29. My answers to the specific questions raised in Issue 29 are:
    a. The applicant has not followed good industry practice for the determination of safe setbacks for the protection of structures, roadways and people against the risk of flyrock. The proper use of either the TCE model or USBOM model for setback calculation results in a setback approximately 4 times that determined by the applicant.
    b. The applicant's prediction of vibration levels arising from blasting depends on parameters for other sites that do not have similar geology to the Hidden Quarry site. In the absence of seismic testing, this prediction is not reliable.
    c. My conclusion is that the proposed quarry will result in significant risk of unacceptable vibration and flyrock risks to structures, roadways, people and nearby aquatic environments.

Curriculum Vitae

William Hill – B.A.Sc. P. Eng.

Personal data

- 1958: B.A.Sc. University of Toronto in Mining Engineering
- Registered Professional Engineer in Ontario since 1969

Employment and Professional History

- 1949 – 1957: summer employment in the mining industry
- 1958 – 1963: Mine Manager of the Cerro de Pasco open pit, a multi-metal producer in Peru producing 3,500 tonnes per day of ore and close to 5,000 tonnes per day waste.
- 1963 – 1965: Mine Manager of the Santa Fe Mining Company in Chile, an iron ore producer shipping 5,000,000 tonnes of product from 6 mines by rail to 3 ports with owned and contracted ships Europe, Japan, and several other countries.
- 1965 – 1969: cofounder of Compania Minera Del Hill S. A. in Peru; the company is engaged in contract mining, tunneling, diamond drilling and operates several mines in Peru with 2015 production over 300,000 ounces of gold. Continuing non-active interest since 1969.
- 1969 to present: formed own consulting practice later operating under the name of William Hill Mining Consultants Ltd. (HMC)
- 1969 – 1990: had a close relationship to Atlas Consolidated Mining and Development Ltd. in the Philippines which involved almost half the practice time for almost 22 years. Directed all the mining operations including expansion of the production rate from 35,000 tpd to over 110,000 tpd by means of two new large open pits and a gold mine.
- 1969 to present: consulting for many clients and involving work in over 40 countries on varied projects. The list of clients includes:
  - The International Finance Corporation – Washington DC ,
  - Asamera Minerals, USA,
  - Echo Bay Mines Ltd. Lupin Mine,
  - Toronto Dominion Bank various financing projects,
  - Northgate Exploration Ltd, Canada,
  - Curragh Resources Inc, Canada,
  - Government of Canada
  - Royal Bank of Canada
  - Codelco, Radomiro Tomic Mine, Chile
  - Falconbridge Ltd Collahuasi Mine, Chile
  - Empresa Minera Mantos Blancos - Santa Barbara Mine, Chile
- 1969 to present director of many mining Companies