EX # 161-9

GRASSROOTS JOURNALS
ISSN 2564-016X | December 2022

JOURNAL OF ENVIRONMENTAL LAW & POLICY | 02:03 DECEMBER 2022
Published by The Grassroots Institute, in partnership with Yaroslav Mudriy National Law University of Ukraine, and in collaboration with Northern Institute of Minority & Environmental Law, University of Lapland. Website: http://grassrootsjournals.org/jelp

OPEN ACCESS Freely available online

M – 00310 | Analytical Article

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Land Use Department

BLASTING QUARRY OPERATIONS: LAND USE COMPATIBILITY ISSUES AND POTENTIAL PROPERTY VALUE IMPACTS

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Received: 30 October 2022 | **Accepted:** 30 November 2022 | **Published:** 28 December 2022

ABSTRACT

Aggregate resources are essential for road and building construction. In 2019, the US domestic production reached 1.53 billion tons of crushed stone valued at $18.7 billion produced by an estimated 1,430 companies operating 3,440 quarries, according to the U.S. Geological Survey (USGS) Mineral Commodity Summaries. But, it is also recognized that a quarry blasting below the water table is one of the most noxious, toxic and destructive uses of land, with no reasonable prospect of post-extraction-rehabilitation. If permitted and established in the wrong geographic location, a blasting quarry operation can result in significant deleterious impacts on the environment and local inhabitants and can disrupt short and long-term land use planning objectives. Because a quarry can remain operational for 100+ years, impacting five or more generations; quarries have the potential to cause permanent environmental degradation, destabilize communities, damage, sterilize or diminish the use and enjoyment of residential and non-residential properties, and reduce property values. Blasting is the preferred method of extracting rock in a quarry operation, the consequences of which can lead to environmental and property damage, and to injury or death of human and non-human life. In North America, licensing and operational oversight of a pit or quarry are primarily controlled by the individual states, territories and provinces, and address matters of compliance, while issues related to land use planning and zoning are entirely within the jurisdiction of the local municipalities, counties or regions. Accordingly, this research paper seeks to inform land use planners of the importance of protecting the environment and its inhabitants from the adverse effects, including the diminution in property values, associated with aggregate extraction operations generally and blasting quarries specifically, through the use of permanent onsite setbacks and offsite separation distances to avoid land use incompatibility and sensitive land uses.

Keywords: Quarry; Blasting; Mining; Environmental degradation; Legislation; Reclaim

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How to cite this paper: Tony Sevelka, 'Blasting Quarry Operations: Land Use Compatibility Issues and Potential Property Value Impacts' (2022) 02 (03) Journal of Environmental Law & Policy 1-78 <https://doi.org/10.33002/jelp02.03.01>

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Blasting Quarry Operations: Land Use Compatibility Issues and Potential Property Value Impacts

1. INTRODUCTION

Blasting quarry operations are a visual disamenity, and, in proximity to sensitive land uses such as settlement areas or rural clusters, have the potential to not only diminish property values, but also to destabilize existing communities, impact the environment and raise health and safety concerns that, collectively, can be effectively avoided or eliminated by imposing permanent onsite *setbacks* and offsite *separation* distances based on the principles of sound land use planning.[1]

As noted by the judge in *Davis v. L & W Construction Company, Inc.*, (1970),[2] it is a matter of common knowledge that the use of dynamite or other explosives is a hazardous activity likely to damage others, for which there are legal consequences, as mentioned below:

> *"Surely it is a matter of common knowledge, and we accord judicial notice to the fact that blasting, by use of dynamite or other explosives, is a hazardous activity and as such likely to damage others.*[3]*...[I]f one engages in an activity on his own land of such hazardous nature as to involve risk of harm to the person, land or chattels of neighboring parties, he is liable for the consequences proximately resulting therefrom without regard to degree of care, scientific manner in which done, purpose or motive."*[4]

Lafarge, a major owner of pits, quarries and cement plants worldwide, readily admits that residents of any development within 500 metres of the Seebe Quarry in Alberta (Canada) would experience a number of adverse effects, which effectively constitute *nuisance* and *trespass*. Lafarge expects neighbouring residents to run for cover to avoid injury or death whenever Lafarge decides to initiate blasting. Lafarge has no legal authority to force residents to leave their homes and evacuate when Lafarge blasts, nor does it have a legal right to prevent or sterilize the use and enjoyment of neighbouring third-party properties.

Blasting is an ultrahazardous activity and any damage, direct or indirect, caused by quarry operations to third-party personal or real property is held to strict liability regardless of whether blasting has been conducted within regulatory limits. The adverse effects that neighbouring residents are expected to endure from Lafarge's Seebe Quarry operations over the anticipated life of the quarry are posted on its website:[5]

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1 A permanent onsite setback (blast exclusion zone) of appropriate width along the perimeter of the site protects quarry employees from the impacts of blasting such as noise, dust, toxic fumes, airblast, subsidence, flyrock, etc., all of which are to be confined onsite. Externally, an offsite separation distance protects against the blasting quarry operation from adversely impacting existing and future incompatible or sensitive land uses and preserves third-party property values.

2 *Davis v. L & W Construction Company, Inc.*, 176 N.W.2d 223 (1970), <https://scholar.google.com/scholar_case?case=13093628744042978336&q=quarry+blasting+concussion&hl=en&as_sdt=2006&as_vis=1>.

3 See *Boyce v. United States*, D.C., 93 F.Supp. 866, 868; 31 C.J.S. Evidence § 9, page 226 824; and 29 Am. Jur. 2d, Evidence, section 23, page 60.

4 *Watson v. Mississippi River Power co.*, supra, at 174 Iowa 29-31m 156 N.W. 188; *Davis v. Georgia-Pacific Corporation*, Or., 445 P.2d 481; Harper and James on the Law of Torts, section 14.6, page 815; and Restatement, Torts, section 520.

5 <https://lafargeexshaw.ca/yamnuska-and-seebe-quarries/> Retrieved on 20 September 2022.

> *"The sandstone and shale quarries are active and have approval to operate with industrial lighting 24 hours a day, seven days a week. Lafarge has no plans to close or reclaim these quarries in the short or medium term and expects to use the quarries beyond 2070 to support Lafarge's modernized, Exshaw Cement Plant."*

This means that residents can expect:

- Noise and vibration [and flyrock[6]] caused by regular blasting activity
- Noise from breaking material and equipment operations
- Up to 100 trucks a day leaving and then returning to the quarries each day[7]
- Airborne dust from quarry operations.

2. EVACUATION POTENTIAL DURING BLASTING

The proposed development area near Seebe is within 500 m of Shale Quarry operation. For any blasting that takes place, Lafarge employs a 500 m exclusion zone to the front of the blast and 200 m zone to the side of the blast. Considering the location of this proposed development, there is a possibility that the area would have to be evacuated for safety during blasting. When evacuation is not required, residents can expect to feel vibration and airblast from the blasting due to the saturated nature of the ground surrounding the [B]ow [R]iver.

Braddock Park Homes entered into an agreement with Cheryl Lloyd Humphrey Land Investments (CLHLI) on February 28, 2014, to purchase 41 acres at $85,000 per acre, with a "free look" option to purchase an additional 5.5 acres (Phase II) immediately adjacent to a blasting quarry operation. Resco Products Inc. and Piedmont Minerals Company Inc., owners of the quarry, objected to the second phase of the town home development proposed by Braddock making various representations to the Town of Hillsborough, North Carolina, regarding the dangers to the health, safety and welfare of future residents posed by flyrock, air blasts, and ground

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6 Flyrock is an inevitable by-product of blasting rock. According to the application (DP 15/22) for the residential development to which Lafarge objects, "blasting has the potential of launching debris and that is why there is an exclusion zone" and "nuisances are continuing…year-round [p. 13]," <https://www.mdbighorn.ca/AgendaCenter/ViewFile/Minutes/03162022-563>. Retrieved on 20 September 2022.

7 Neelawala, P., Wilson C. and Robinson, T., "What impact does an announcement of a quarry road have on property values? Evidence from Queensland Australia," paper presented at the 85th Annual Conference of Western Economic Association International, 29 June – 03 July 2010; Hilton Portland & Executive Tower, Portland, Or. "This study extends from a large data base of previously done research that used the hedonic price model to assess the ex-post impact of environmental dis-amenities on property values. Rather, this paper differs as it provides an ex-ante analysis on the effects of an announcement of a proposed haul route to a quarry on nearby residences. 'The results of the regression analysis suggest that the marginal willingness to pay to be farther from the proposed road route is 4.92 per cent per kilometer," equating to a substantial amount in monetary terms. This seems to be an excellent study that not only grants consideration of the proximity of residences to the quarry but also implicates transportation externalities associated with quarrying." *Source*: online Annotated Bibliography, Wisconsin-Madison University, undated, <https://buffalo.extension.wisc.edu/files/2011/12/Annotated-Bibliography-mining.pdf>, retrieved on 8 November 2022.

vibrations from blasting at the quarry. Braddock Park Homes then decided not to exercise the option for the purchase of the Phase II land citing "dangers of foundation damage to homes, fly rock from blasting and nitrogen dangers to future inhabitants."[8] CLHLI has been left holding the 5.5 acre parcel, the utility and value of which have been significantly diminished.

The owner of the adjoining blasting quarry operation was prepared to acquire the 5.5 acre parcel abutting the quarry, but only at a price significantly less than market value of $85,000 per acre. The…[owners of the quarry] were required by their September 11, 2013 Permit to take measures to prevent physical hazard to any neighboring dwelling house if their mining excavation came within 300 feet [91.44 metres] thereof, regardless of the cost of doing so. Subsequent to the town's approval of the Town Home Project, the…[quarry owners] did in fact offer to purchase the 5.5 acre tract located adjacent to its Hillsborough Mine far below the fair market value [of $85,000 per acre] for the Property.

In *Opal v. Material Service Corp* (1956),[9] over a period of five years and at "great distances" from the quarry, "the plaintiffs charged that their homes were shaken, jarred and damaged, and their lives made highly uncomfortable by vibrations caused by blastings of rock at the quarry, that the blastings cast stones [flyrock debris] upon the lands of some of them, endangering the safety of the persons thereon, and that their peace and comfort were disturbed and their health affected by the noises occasioned by blastings, etc." While the owner of a licensed quarry possesses a legal right to conduct quarry operations, that right must give way to the neighbouring homeowners' right to the uninterrupted use and enjoyment of their properties, when in conflict, as cited by the court in *Blackford v. Heman Construction Co.*, 132 Mo. App. 157, 112 S.W. 287:

> *"Although defendants have, beyond a doubt, the right to quarry stone on their property, the plaintiff enjoys the right to the undisturbed possession of his home. If these rights conflict, the right to operate the quarry must yield to the latter, which, in the eye of the law, is the more important of the two…"*

In *Hardee County v. FINR II, Inc.*, (2017),[10] the Supreme Court of Florida overruled the Court of Appeal decision, which had allowed FINR to proceed with a $38 million lawsuit against the County under the "Harris Act" (Private Property Rights Protection Act) for reducing a setback requirement on the adjoining phosphate mining operation of CP Industries from a quarter mile (402 metres) to as little as 150 feet (46 metres) from "Rural Centers". The adjoining 872 acre property, owned by FINR, is classified as a "Rural Center" on the County's "Future Land Use Map," allowing for a "mixed-use"

[8] *Cheryl Lloyd Humphrey Land v. Resco*, 831 SE 2d 395 – NC: Court of Appeals 2019, <https://scholar.google.com/scholar_case?case=13037728438594285878&q=Cheryl+Lloyd+Humphrey+Land+Investments+v.+Resco+Products&hl=en&as_sdt=2006>.

[9] *Opal v. Material Service Corp*, 9 Ill. App. 2d 433 (1956) 133 N.E. 2d 733, <https://scholar.google.com/scholar_case?case=14340402992959791589&q=vibration+damage+from+blasting&hl=en&as_sdt=2006>.

[10] *Hardee County* v. *FINR II, Inc.*, 221 So. 3d 1162 (2017), <https://scholar.google.com/scholar_case?case=19049623234121156 59&q=Finr+II,+Inc.+v.+County+of+Hardee&hl=en&as_sdt=2006>.

development consisting of 900 multi-family dwelling units, 60,000 square feet of general commercial, 175,000 square feet of office, a 200-room hotel, a 200-bed hospital and a 1,030-bed expansion (FINR's existing neurological rehabilitation centre). Although the County was not held financially responsible, their action of reducing the setback requirement to permit CP Industries to mine more of its property and enhance profits came at the expense of FINR, the adjoining property owner, and the environment. In this context, the FINR alleged:

> *"...that CF Industries' mining activity resulted in excessive noise, vibration, and dust that precluded the use of FINR's property as a rehabilitation facility for the care and treatment of patients with traumatic brain injuries and that the new mining operations on the abutting property owned by CF Industries had decreased the fair market value of FINR's property by $38 million. FINR alleged that the mining relegated the highest and best use of FINR's property to merely agricultural and recreational land."*[11]

Establishing setbacks and separation distances are quintessential land use planning functions implemented by local governments to prevent land use conflicts or incompatibility, reduce environmental impacts, and preserve property values. Land use policies are also enacted as a proactive and precautionary measure to preclude a blasting quarry operation (and other types of mining operations) from locating near land zoned or slated to permit future incompatible or sensitive land uses (e.g., residential).

3. LAND USE REGULATION PURSUANT TO POLICE POWER

Prior to the implementation of zoning laws in North America, land use conflicts were not only resolved by actions seeking the common law remedy of nuisance, but also regulated through building and fire codes and established minimum standards for construction and access.[12] In 1887, the United States Supreme Court recognized that the police power could control how property was used, remarking as follows:

> *"[A]all property in the country is held under the implied obligation that the owner's use of it shall not be injurious to the community [para. 666]."*[13]

In 1926, this principle was adopted by the Supreme Court of Virginia and affirmed by the Supreme Court of the United States (1927),[14] which held that the "legislature may, in the exercise of the police power, restrict personal

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11 *FINR II, Inc. v. Hardee County*, 164 So. 3d 1260 (2015), <https://scholar.google.com/scholar_case?case=5185726016736546861&q=FINR+II+Inc+v.+County+of+Hardee&hl=en&as_sdt=2006>.

12 *American Law of Zoning*, § 1.13 and 1.16, Patricia E. Salkin, 5th ed. 2011.

13 *Mugler v. Kansas*, 123 US 623 – Supreme Court 1887, <https://scholar.google.com/scholar_case?case=12658364258779560123&q=Mugler+v+Kansas&hl=en&as_sdt=2006>.

14 *Gorieb v. Fox*, 145 Va. 554, 560, 134 SE 914, 916 (1926), affirmed 274 U.S 603, 47 S. Ct. 675 (1927), <https://scholar.google.com/scholar_case?case=14014953836361410547&q=Gorieb+v+Fox&hl=en&as_sdt=2006>. In Ontario, Canada, similar police power is found in Sections 10, 11, 128 and 129 of The Municipal Act, 2001, as amended, <https://www.ontario.ca/laws/statute/01m25#BK13>.

and property rights in the interest of public health, public safety and for the promotion of the general welfare." The issue in dispute was the passing of an ordinance by the city of Roanoke, Virginia, that imposed a building setback of 34⅔ feet from the street, to which the property owner objected while seeking to construct a building up to the street line. The Supreme Court of the United States ruled that:

> *"Since upon consideration we are unable to say that the ordinance under review is "clearly arbitrary and unreasonable, having no substantial relation to the public health, safety, morals, or general welfare," we are bound to sustain it as constitutional" (Euclid* v. *Ambler Co., supra,* p. 395)

Accordingly, the power of local government to regulate the use of land through zoning and other regulations arises from its police power to protect the public health, safety and welfare. A present, necessity need not exist before a municipality uses its police power in anticipation of the problem in order to prevent it.[15] The evolution of police powers of municipal councils is described by McQuillan, in *Municipal Corporations,* 3rd ed. Revised, vol. 6, § 24.08:

> *"Without doubt, the police power is sufficiently comprehensive to embrace new subjects and new or revised measures as exigencies and changing conditions require. In other words, the police power is capable of development and modification within certain limits, so the power of governmental control may be adequate to meet changing social, economic, and political conditions. Thus, the power is not confined with respect to the subjects upon which it operates by narrow limits of precedents based on conditions of a past era, rather, it is sufficiently flexible to meet changing conditions that call for revised or new regulations to promote health, safety, morals, or welfare [para. 15]."*[16]

For example, in *City of Carmel v. Martin Marietta Materials,* (2008),[17] the Indiana Supreme Court upheld an ordinance passed by the City of Carmel in 2005 in response to a growing number of complaints lodged with the City as residential development increased near Martin Marietta's decades-old operation consisting of a quarry, an underground mine, and sand and gravel pits. The preamble of the Ordinance sets out the following purposes for its enactment:[18]

> *"Whereas, mining and the processing of mineral resources should give due regard to (1) the protection of the health, safety and general welfare*

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15 <https://www.albemarle.org/Home/ShowDocument?id=3071#:~:text=675%20(1927)%20(zoning%20ordinance,public%20health%2C%20safety%20and%20welfare>.

16 *Fountainhead Fun Centres Ltd. v. Montreal (City)*, 1981 CanLII 2710 (QC CA), <https://canlii.ca/t/gdlmb>, retrieved on 2022-11-15.

17 *City of Carmel v. Martin Marietta Materials,* 883 NE 2d 781 – Ind: Supreme Court 2008, <https://scholar.google.com/scholar_case?case=6868528804354099380&q=quarry+blasting+damage&hl=en&as_sdt=2006>.

18 "The substantive sections of the Ordinance are consistent with the preambles' stated intent. Among many other regulations, the Ordinance addresses water and air pollution…, lateral support to prevent collapse of underground tunnels…, uncontrolled movement of loose material…, perimeter fencing and the handling of explosives to minimize the risk of injury or property damage…"

> *of the people, (2) the prevention of erosion, stream pollution, water, air and land pollution; and (3) the prevention of negative impact to the City's water supply and other injurious effects to persons, property, wildlife and natural resources;"* and
>
> *"Whereas, the Common Council of the City of Carmel finds that, for the protection of the public health, safety and welfare of the citizens of Carmel, to mitigate the negative impacts of mining and processing of mineral resources on those citizens who reside adjacent to or near such operations, and to maintain an environmentally sound and stable mining and processing industry, it is reasonable and necessary to regulate mining operations as provided in this Ordinance."*

In summary, the City of Carmel enacted the Ordinance as a general exercise of its authority to *"regulate conduct, or use or possession of property, that might endanger the public health, safety, or welfare"* as authorized by I.C. (Indiana Code) § 36-8-2-4[19] without complying with the special requirements applicable to zoning ordinances mandated by the 600 Series Procedures [para. 785].[20]

4. PLANNING AND ZONING: PRESERVATION OF PROPERTY VALUES AND SEPARATION OF INCOMPATIBLE LAND USES

It was through the land use theories advanced by Olmsted (1870)[21] and Howard (1902)[22] that zoning and city planning could produce wealth, health, and prosperity. In 1916, New York City adopted the first zoning resolution in the United States.[23] The following statement reflects the broad objectives of municipal planning:

> *"Property owners and land developers realized Olmstead's predictions in their broader sense and urged city politicians to protect and enhance the value of their assets by separating uses, and regulating the density, shape, and size of buildings in order to secure higher land values and to preserve the local tax base. Areas with good access to public amenities not only gain better land value,[24] but also attract a larger portion of new*

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19 <https://iga.in.gov/legislative/laws/2018/ic/titles/036#36-8-2-4>.

20 Article 7 of title 36 of the Indiana Code governs the exercise of a local government unit's planning and development process powers, including zoning. City zoning ordinances (and amendments to them) adopted under article 7 are subject to special procedures set forth in I.C. (Indiana Code) § 36-7-4601 to 616 (2004 & Supp. 2007) ("600 Series Procedures").

21 Frederick Law Olmsted, "Public Parks and the Enlargement of Towns" in *American Social Science Association* 1870 (reprinted: Michael Larice & Elizabeth Macdonald, eds, *The Urban Design Reader*, 2d ed [New York: Routledge, 2013] 36).

22 Sir Ebenezer Howard, *Garden Cities of To-Morrow* (Cambridge: MIT Press, [1902] 1965).

23 New York's pioneering 1916 Zoning Resolution established height and setback controls and separated what were seen as functionally incompatible uses – such as factories – from residential neighborhoods. The ordinance became a model for urban communities throughout North America. See Chapter 2, The Origins of the Zoning Power, *The Albemarle County Land Use Law Handbook*, Kamptner/July 2015, <https://www.albemarle.org/Home/ShowDocument?id=3071#:~:text=675%20(1927)%20(zoning%20ordinance,public%20health%2C%20safety%20and%20welfare>.

24 Eugene F Brigham, "The Determinants of Residential Land Values" (1965) 41 Land Economics 325.

> *development.*[25] *It has also been established that high environmental standards and good access to facilities and services have a direct, positive impact on quality of life."*

Municipalities enjoy broad powers to implement land use controls in response to undesirable encroachments on the quality of life.[26] The following statement narrates the spirit of control:

> *"The power of local governments to zone and control land use is undoubtedly broad and its proper exercise is an essential aspect of achieving a satisfactory quality of life in both urban and rural communities [para. 68]."*[27]

In the following words, the Land Use Law Centre at Pace University describes the land use powers that have been *delegated* to local governments:[28]

> *"Perhaps the most significant land use power that the state legislature has delegated to local governments is the authority to adopt zoning laws. These laws divide land within a municipality into zones, or districts, and prescribe the land uses and the intensity of development allowed within each district. This delegated authority is found in the provisions of the Town, Village and General City Law known as zoning and planning enabling acts. The enabling statutes require land use regulations to be "in accordance with a comprehensive plan" or "in accordance with a well-considered plan." Planning "is the essence of zoning", says the judiciary in New York State. Comprehensive planning is society's insurance that the public welfare is served by land use regulation."*

According to *Rogers* in *Canadian Law of Planning and Zoning*[29], the principal purpose of zoning regulations, as with restrictive covenants, is to preserve property values by prohibiting uses believed to be deleterious to neighbourhoods mainly residential in character. People living in an area of single-family dwellings want the same type of homes in the district, that is, a use that is compatible. They want to preserve the amenities of their locality. Thus, from the standpoint of ratepayers it is the status quo that is sought to be maintained and built-up residential areas, which are figuratively rimmed with "keep out" signs. Industry, an unwelcomed intruder in a residential community, also favours a zoning wall that bars residential and other incompatible encroachments. The notional route is segregation of people and the uses they make of their land. Density and development standards control

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[25] *E.g.*, Amy Armstrong et al., *State of New York City's Housing and Neighborhoods* (New York: Furman Center, NYU, 2009) 15.

[26] The World Health Organization (WHO) defines "Quality of Life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relations to their goals, expectations, standards and concerns."

[27] *Schad v. Borough of Mount Ephraim*, 452 U.S. 61, 68, 101 S. Ct. 2176, 2182 (1981), <https://scholar.google.com/scholar_case?case=19823328698738316l5&q=schad+v+mount+ephraim&hl=en&as_sdt=2006>.

[28] Land Use Law Center, Pace University School of Law, n. d., <https://law.pace.edu/sites/default/files/LULC/LandUsePrimer.pdf>.

[29] *Service Corporation International (Canada) Inc. v. Burnaby (City of)*, 1999 CanLII 7012 (BC SC), <https://canlii.ca/t/1d45r>, retrieved on 2021-12-09. I. M. Rogers in *Canadian Law of Planning and Zoning* (Toronto: Carswell, 1973).

the costs of the dwelling placed on the land and a latter determines the economic (and usually the social) position of those who live in them. Ghettos are created for the rich as well as the poor by walls of exclusionary restrictions. Land values are thus preserved by keeping out undesirable uses and consequently undesirable people. The preservation of property investment is the prime motive underlying many bylaws although they do not always clearly articulate this policy [para. 113].

And, as noted in *Saint-Romuald (City) v. Olivier*, 2001,[30] private law and municipal land use controls protect adjoining owners in the enjoyment of their indoor and outdoor amenity space[31] and promote separation of incompatible land uses to avoid *adverse effects* (e.g., nuisance and trespass), as described below:

> *"Private law has long protected adjoining owners in the enjoyment of the amenities of their land. Article 947 of the Civil Code of Québec, S.Q. 1991, c. 64, protects that enjoyment, as does the tort of nuisance at common law. Thus neighbours obtained an injunction in nuisance against a tobacco factory that emitted "noxious odours" in Appleby v. Erie Tobacco Co. (1910), 22 O.L.R. 533 (Div. Ct.), and on the same basis successfully opposed the establishment of a dog hospital in a residential area in Macievich v. Anderson, 1952 CanLII 206 (MB CA),* [1952] 4 D.L.R. 507 (Man. C.A.). *The doctrine of Rylands v. Fletcher (1868), L.R. 3 H.L. 330, imposes virtually absolute liability on owners who bring on their land "anything likely to do mischief if it escapes" and causes damage to a neighbour, unless the escape was due to the neighbour's default (pp. 339-40). These private law remedies were designed, in a general sense, to protect neighbourhood amenities."*
>
> *"An Act Respecting Land Use Planning and Development, R.S.Q., c. A-19.1, authorizes Quebec municipalities to regulate the use of land by dividing their territories into zones to which are allocated various groups and classes of uses. This is to be done:... "based on common characteristics of land occupation relating to volume, nuisance, compatibility, use and aesthetics" (s. 16 of the new zoning by-law). The impact of a particular land use on neighbouring lands is clearly a key concern, which is shared by common law jurisdictions. The loss of amenities by noise*[32] *and air pollution, increased traffic, increased demands on municipal services, or other disruptions, may conveniently be referred to as "neighbourhood effects". The minimization of such*

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30 *Saint-Romuald (City) v. Olivier*, 2001 SCC 57 (CanLII), [2001] 2 SCR 898, <https://canlii.ca/t/51z2>, retrieved on 2021-12-09.

31 The City of Toronto defines "amenity space" as indoor or outdoor space on a lot that is communal and available for use by the occupants of a building on the lot for recreational or social activities. (Zoning By-law 569-2013, as amended, Chapter 800.50 (15).

32 "...[N]oises that are too loud, or are loud and long-lasting, can damage our ears and cause noise-induced hearing loss. (NIHL). Noise is something you don't want to hear. Sound is the vibration reaching your ears. An increase of sound by 10db means that the sound is10 times more intense or powerful, so to your human ears it sounds 2X as loud. Therefore, 70db is twice as loud as 60db, and 80db is twice as loud as 70 db. The decibel (db) scale, which is used to measure the sound around us, utilizes a hearing threshold as a point of reference starting at 0db. Think silence." "[Decibel levels] involves weather, noise, sound, vibration, dust, quality of life, property values, industry and more." https://patch.com/georgia/cumming/whats-all-the-noise-about.

> *adverse effects on surrounding owners or the community as a whole is one of the principal objectives of zoning controls."*

Conversely, poor planning policies can negatively impact some residents' quality of life, use and enjoyment of indoor and outdoor amenity space, and the value of their properties in a manner that is inequitable with the community at large.[33] A planning practice may be considered as creating inequality or unfair treatment if those targeted by harmful regulation such as expropriation or condemnation or the geographic location of unattractive or undesirable uses, are systematically different from the community as a whole.

Planning decision-making often focuses on the *mere process* rather than on the substantive content of planning within an ethical framework built on fairness and long-term sustainability.

Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987)[34]. As noted by the Canadian Institute for Environmental Law and Policy, there is significant public resistance to aggregate extraction operations in populated areas due to the short-term and long-term adverse effects associated with aggregate extraction, some of which are permanent or irreversible:

> *"The nature of the aggregate extraction makes operating a pit or quarry in populated areas without impacting local communities or causing some level of land use conflict highly difficult. There is evidence to support this internationally as quarries are almost unanimously met with public resistance in most jurisdictions where they occur."*[35]

There is also the problem of cumulative effects associated with clustering of major industries such as aggregate extraction, which has the

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[33] In *Antrim Truck Centre Ltd. v. Ontario (Transportation)* [2013], MTO expropriated the land of others for the Highway 417 alignment. By doing so, MTO reduced the volume of customer vehicular traffic along existing Highway 17 in the hamlet of Antrim, where Antrim operated a Truck Stop. Antrim argued that the interference with its business was "both substantial and unreasonable," and resulted in business losses of $58,000 and diminished the market value of its property by $335,000 or 35.8%, from $935,000 before to $600,000 after the Highway 417 alignment. The Supreme Court of Canada ruled in favour of Antrim, overturning the decision of the Ontario Court of Appeal denying Antrim's nuisance claim, and reinstated the Ontario Municipal Board's (OMB's) award, deciding the case on the basis that the judgment of unreasonability must be based on whether the interference suffered by the claimant is unreasonable, not whether the nature of the defendant's conduct is unreasonable. "Once a claimant passes the threshold test of showing harm that is substantial in the sense that it is non-trivial, there ought to be an inquiry into whether the interference is unreasonable, regardless of the type of harm involved." Although it was found that some degree of "give and take" is justified in bearing interferences or temporary annoyances as the cost of living in organized society, the defining question in cases between citizens and public authorities is whether it would be unreasonable to expect the claimant to bear the interference without compensation. *Antrim Truck Centre Ltd. v. Ontario (Transportation)*, 2013 SCC 13 (CanLII), [2013] 1 SCR 594, <https://canlii.ca/t/fwdn1>, retrieved on 2022-09-29.

[34] Report of the World Commission on Environment and Development: Our Common Future (Brundtland Report, United Nations, 1987.

[35] *Aggregate Extraction in Ontario: A strategy for the future*, Executive Summary, Canadian Institute for Environmental Law and Policy, March 2011, p. 6. <http://cielap.org/pdf/AggregatesStrategyExecSumm.pdf>.

potential to undermine environmentally sound and sustainable development, as noted by the government of British Columbia:[36]

> *"Cumulative effects are changes to environmental, social and economic values caused by the combined effect of past, present and potential future human activities and natural processes."*
>
> *"Cumulative effects assessment enables an understanding of the condition of selected values and estimates the changing risk to achieving desired levels of condition for each value being assessed."*

Accordingly, it is inappropriate for a municipality to permit a blasting quarry operation to locate geographically in proximity to existing and future incompatible or sensitive land uses as it is not uncommon for a quarry, once established, to remain in operation for 100 years or more, and expose five or more generations to the anticipated and unanticipated operational adverse impacts.

Governmental agencies characterize aggregate extraction as a "temporary" or "interim" use, and mandate "rehabilitation" for an after-use. Unfortunately, a quarry that blasts below the water table has no reasonable prospect of reclamation or rehabilitation[37] to an economic use, as post-extraction usually results in a dangerous and lifeless crater allowed to fill naturally with rainwater once mechanical pumping has stopped (during quarry operations water is pumped perpetually to maintain a dry working quarry floor), and a scarred and interrupted landscape which interferes with species movement and migration. Fragmentation of the land base also precludes application of an integrated, comprehensive and sustainable approach to land use planning.

As of 2016,[38] some 500,000 abandoned hardrock mines have been identified in the United States, and between 1998 and 2007, $2.6 billion of taxpayer money was spent cleaning up abandoned hardrock mines (Government Accountability Office), with estimated clean-up costs possibly as high as $54 billion.[39] Abandoned mines and quarries are extremely dangerous having accounted for 278 deaths, including 201 deaths from

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[36] Addressing Cumulative Effects in Natural Resource Decision-Making: A Framework for Success, *CEF Overview Report February 2014*. <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/overview/overview_report_addressing_cumulative_effects_2__cef_framework.pdf>.

[37] "…[R]eclamation isn't easy. Fully rehabilitating mining sites requires replacing soil, preventing pollutants from inhibiting plant growth, correcting the flow of water into and out of a quarry, and reversing species loss caused by decades of mining—essentially, making a poisoned piece of land pristine again….Bill Langer, a geologist and quarry reclamation consultant who worked for more than four decades with the U.S. Geological Survey, says years of blasting can fracture underground caverns, rerouting natural water systems and displacing local species. The soil and water in quarries are often left thick with iron, manganese, and phosphorus, making most former quarry sites hostile to vegetation…" Carey, Mac, "When a Quarry Closes Can Its Damage Be Undone?", *Texas Monthly*, May 5, 2022, https://www.texasmonthly.com/news-politics/quarry-reclamation-lime-creek/.

[38] "*Abandoned Mines*," October 2016, <https://naturalresources.house.gov/imo/media/doc/Abandoned%20Mines.pdf>.

[39] A water-filled abandoned quarry can become an attractive nuisance to children and threaten them with harm if left physically unsecured.

drowning, during the period of 2001 to 2017.[40] In Canada, there are over 10,000 abandoned mines, with around 5,700 located in Ontario, Canada's most populated province.[41]

Creating public awareness and understanding of the adverse impacts (e.g., nuisance, trespass, health, safety, quality of life, property damage, etc.) of a blasting quarry operation, described as follows, provides the necessary context for an analysis of land use compatibility from planning and valuation perspectives:

- The extraction of aggregate resources significantly and permanently alters the natural environment. Operators of pits and quarries remove virtually all vegetation, topsoil and subsoil to access the resource. In doing so, they remove any natural habitat that may have been on site and disrupt pre-existing stream flows .... [I]mpacts on surface and groundwater are one of the major concerns regarding aggregate operations. The extraction of aggregate resources changes the slope of the land and alters water drainage patterns. As well, aggregate deposits act as underground water reservoirs; once the aggregate is excavated, their water storage capacity is lost.[42] Aggregate operations are also characterized by the release of significant amounts of particulate matter (i.e., dust) and noise pollution from extraction and processing activities as well as smog precursors and greenhouse gases from the operation of heavy equipment and machinery. The heavy truck traffic to and from aggregate sites is often a serious hazard and nuisance affecting people over wider areas and is a significant source of air pollution itself[43] (Pembina Institute, 2005)[44]
- Blasting may result in adverse impacts on the environment, infrastructure, and the health and safety of people, livestock, pets and wildlife in surrounding communities. Some of the undesirable impacts of inefficient or negligent blasting include excessive ground

[40] Hobart M. King, 'Abandoned Mine and Quarry Accidents Claim Several Lives per Year', *Geology.com*, n.d., <https://geology.com/articles/abandoned-mines.shtml>.

[41] India, Berry. Top 5 locations with Abandoned Mines, *Mining*, November 26, 2021. <https://miningdigital.com/top10/top-5-locations-abandoned-mines>.

[42] Environmental Commissioner of Ontario. *2003. 2002-2003 Annual Report.* Toronto, Environmental Commissioner of Ontario, pg. 30.

[43] Assuming 35 tonne trucks, aggregate transportation consumes 0.56 litres of fuel, and results in the release of 1.5 kilograms of greenhouse gases per kilometer Clayton Research and MHBC Regional & Urban Planning & Resource Development. 2004. *The Implications of Restricting Aggregate Supply in the GTA*, pg. 13.

[44] Winfield, Mark S. and Taylor, "Rebalancing the load: The need for an aggregates conservation strategy for Ontario," *The Pembina Institute*, January 25, 2005. <https://www.pembina.org/reports/Aggregatesfinal-web2.pdf>.

vibrations, air blast, flyrock, noise, and toxic fumes[45], which can lead to property damage, injury or death (Mpofu et al., 2021).[46]

In a practical sense, there is little distinction between property impacts caused by ground vibrations, air blast or flyrock debris that emanate from the same event – quarry blasting -- and whether the invasion is direct (as in flyrock debris) or indirect (as in ground vibrations and air blast). The following case held that all three impacts from blasting should be held to strict liability:

> *"Physical invasion of the property of another does not necessarily imply an actual breaking and entering of plaintiff's close by the wrong doer in person, or casting upon his premises any particular thing or substance [e.g., ground vibrations, air blast or flyrock debris]. Employment of force [i.e., blasting] of any kind which, when so put in operation extends its energy into the premises of another to their material injury…is as much a physical invasion as if the wrong doer had entered thereon in person… (Watson v. Mississippi River Power Co., 174 Iowa 23, 156 N. W. 188 (1916))"*

The consequences of blasting are unpredictable and potentially so severe that the courts have deemed blasting an ultrahazardous activity subject to the legal principle of strict liability. Following observation should be noted:

> *"Blasting is considered intrinsically dangerous; it is an ultrahazardous activity…since it requires the use of high explosives and since it is impossible to predict with certainty the extent or severity of its consequences….Blasting operations are dangerous and must pay their own way….The principle of strict or absolute liability for extrahazardous activity thus is the only sound rationalization. (Guilford Realty & Insurance Co. v. Blythe Brothers Co., 260 N.C. 69, 131 S.E.2d 900 (1963))"*

4.1 Definition of Blasting Quarry

A blasting quarry is defined as follows:

> *"Quarry" means land under water from which consolidated aggregate is being or has been excavated, and that has not been rehabilitated, but does not mean land or land under water excavated for a building or structure on the excavation site…[and usually involves blasting to break rock]. (Ontario Aggregate Resources Act, as amended). "Quarry" – An open or surface mine used for extraction of rock such as limestone, slate, building stone, etc.*[47]

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45 Richard J. Mainero, Marcia L. Harris, and James H. Rowland III, "Dangers of Toxic Fumes from Blasting," *33rd Annual Conference on Explosives and Blasting Technique, Nashville, TN, ISEE*, 2007; 1: 1-6, <https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/dotff.pdf>. Retrieved on September 24, 2022.

46 Mpofu, M. et al., "The influence of stemming practice on ground vibration and air blast," (2021) 121 *The Journal of Southern African Institute of Mining and Metallurgy* 1-9. <https://www.saimm.co.za/Journal/v121n01p1.pdf>.

47 Ludwiczak, James T., *The Blasting Primer, Second Edition* (Blasting and Mining Consultants, Rogers Printing Group, 2002).

4.2 Definition of Designated Blast Area (Danger Zone)

The designated blast zone or blast area is confined within the lot boundaries of a quarry operation, and is defined as follows:

> *"designated blast area" includes the danger area, which is the zone in which there exists a possibility of hazard to a person or property from flyrock, fume, air blast or ground vibrations, and is the area where the blaster has made arrangements to evacuate all persons whose safety might be threatened by the blasting operation (Province of Newfoundland and Labrador, Department of Natural Resources)*[48].

5. ADVERSE EFFECTS AND DANGERS OF BLASTING QUARRIES NOT COMMON KNOWLEDGE

The general public as well as most planners, appraisers, realtors and mortgage lenders are unaware of the numerous and often irreversible adverse effects, including potential property value impacts, and the potentially deadly consequences of a blasting quarry operation on nearby communities. One of the least disclosed and dangerous adverse effects of a blasting quarry operation is flyrock, which is described as follows in the May 31, 1994 decision of the Vermont Environmental Board in the Land Use Permit Application (#1R0589-3) of J.P. Carrara & Sons, Inc. seeking approval of a blasting quarry:

> *"Flyrock is the name given to unnecessary or unintended stone which is cast away from the detonation site. Flyrock is a potential cause of death, serious injury, and property damage, and is the most hazardous effect of blasting. Flyrock distances can range up to one mile [1,609 metres] beyond the quarry limits."*[49] *[para. 22].*

"Flyrock," the most dangerous aspect of a blasting quarry operation, is seldom mentioned or addressed in a meaningful fashion in a proponent-driven Blast Impact Assessment (BIA) prepared by an explosive engineer as part of an application for a blasting quarry operation. According to *Loeb*, as described below, blasters, consultants and inspectors complain that *flyrock* is treated with indifference and not taken seriously by blasting companies (Loeb, 2012):[50]

> *"It is the general consensus among blasters, consultants and inspectors alike, that blasting companies are not taking the necessary precautions to prevent flyrock, and are pushing the blasters to conduct their work too cheaply. This in turn causes larger holes, wider spacing on blast hole patterns, and less regard for safety from flyrock. Due to the manner in which the regulations are written, the blaster is essentially a scapegoat, and the company simply hires a new blaster and continues business as usual [p. 48]".*

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[48] <https://www.gov.nl.ca/iet/files/Quarry-Permit-Standard-Terms-Conditions.pdf>.

[49] J.P. Carrara & Sons Inc. Land Use Permit Application #1R0589-3-EB (Revised), Vermont Environmental Board. May 31, 1994. <https://nrb.vermont.gov/sites/nrb/files/documents/1r0589-3-eb-rev-fco.pdf>.

[50] Loeb, Jeffrey Thomas, "Regulatory mitigation of the adverse environmental effects of urban blasting," Thesis, 2012, University of British Columbia. <https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0050876#downloadfiles>.

6. FLYROCK STATISTICS CITED BY DIFFERENT SOURCES

Flyrock is one of the most contentious issues in blasting, as it has the potential to cause fatalities and severe injuries.[51] Flyrock, arising from open-pit blasting, continues to elude explosives engineers, despite a reasonable understanding of throw (p. 660). According to Raina et al. (2015), the amount of research conducted on flyrock is "abysmal,"[52] and the percentage of accidents occurring due to flyrock justifies its importance irrespective of the fact that the problem is seldom reported.[53] The underreporting of flyrock incidents was identified by Dataphyte in connection with its 2021 investigation of blasting quarry operations in Nigeria:

> *"[A 2021 investigation by] Dataphyte reviewed that globally, the majority of flyrock incidents go unreported or unnoticed, and in most jurisdictions, incidents of flyrock that do not leave the blast area or that do not cause injury or death within or outside the blast area are not officially reported."*[54]

As shown in table 1, over various timeframes, the percentage of injuries attributed to *reported* flyrock incidents by the following authors ranges from 19.05% (Verakis and Lobb)[55] to 68.20% (Little),[56] as reported by Raina, et al. (2015. p. 661).[57] In terms of the number of *reported* blasting injuries, they varied from 18 (2010-2011) as reported by Verakis to 412 (1978-1998) as reported by Little. Other examples of the incidence of flyrock are listed below:

- According to Dyno Nobel Americas, which participated in a 2008 "Blast Service Management" presentation, in one year they fire "approximately 100 blasts per day" and reports "approximately 150 [customer] flyrock incidents annually," while conceding that "many [flyrock] incidents are not reported." In 2007, Dyno Nobel

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51 Raina, A. K., Murthy, V. M. S. R. and Soni, A. K., "*Flyrock in surface mine blasting: understanding the basics to develop predictive regime,*" (2015) 108 (4) Current Science 25, <https://www.currentscience.ac.in/Volumes/108/04/0660.pdf>.

52 Raina, A. K., Soni, A. K. and Murthy, V. M. S. R., "*Spatial distribution of flyrock using EDA: An insight from concrete model tests. In Rock Fragmentation by Blasting* (eds Singh, P. K. and Sinha, A.)," Taylor and Francis, London, 2013, pp. 563–570.

53 Davies, P. A., "*Risk based approach to setting of flyrock danger zones for blasting sites,*" May–August 1995, Trans. Inst. Mines Met. 96–100.

54 Samad Uthman, "Into the 'cracks' Land (1): RCC Blasts Rocks for Lagos-Ibadan Road Construction, But Ogunmakin Suffers the Injury," (November 12, 2021) Dataphyte. <https://www.dataphyte.com/latest-reports/climate/into-the-cracks-land-1-rcc-blasts-rocks-for-lagos-ibadan-road-construction-but-ogunmakin-suffers-the-injury/>.

55 Verakis, H. and Lobb, T., "*Flyrock revisited an ever-present danger in mine blasting,*" 2007 <http://docs.isee.org/ISEE/Support/Proceed/General/07GENV1/07v109g.pdf>.

56 Little, T. N., "*Flyrock risk*". In Proceedings of EXPLO Conference, Wollongong, NSW, 3–4 September 2007, pp. 35–43, <https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT>.

57 Avtar K. Raina, V.M.S.R. Murthy and Abhay Soni, "Flyrock in surface mine blasting: Understanding the basics to develop a predictive regime," (2015) 108 (4) Current Science 660-665.

Americas had 32 flyrock incidents for 30,021 quarry blasts or 1.07 flyrock incidents per 1,000 blasts.[58]

- According to Mr. Gill, an engineer employed by Consbec Inc., the company responsible for blasting at the Parker Mountain Aggregates quarry in Granville, Nova Scotia, the incidence of flyrock may occur in five percent of the cases where explosives are used.[59]
- During the two months prior to December 19, 1983, flyrock occurred in about 90% of the blasts at No. 21 Surface Mine (Hobet Mining & Construction Company) in Madison, Boone County, West Virginia.[60]
- During 2019, the Tennessee State Fire Marshal's Office received 302 blasting complaints, of which 14 were for flyrock, accounting for 5% of the blasting complaints.[61]
- The Magazine of Mining Health and Safety (1978) reported that of 34 quarry accidents 28 or 82% were attributed to flyrock.[62]
- Davis (1995) considers under-reporting is responsible for five to ten times the actual number of flyrock incidents.[63]
- Generally, blasts are expected to generate some amount of flyrock, and each mining operation has a "normal" flyrock range, according to Mishra and Rout.[64]
- Reports of flyrock incidents at stone quarries are a fairly common occurrence, and there have been cases of flyrock debris causing injury, according to the district manager of the Mining Safety and Health Administration in Warrendale, PA (2018).[65]

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[58] Blast Service Management, <https://www.911metallurgist.com/blog/wp-content/uploads/2016/01/Blast-Service-Management.pdf>.

[59] *Parker Mountain Aggregates Limited*, 2007 CanLII 91661 (NS OHSAP), <https://canlii.ca/t/j7q8f>, retrieved on 2021-12-11.

[60] *Secretary of Labor, Mine Safety and Health Administration (MSHA) v. Hobet Mining & Construction Company*, Nov 6, 1985, Docket No. WEVA 84-209, A.C. No. 46-04670-03520. On December 19, 1983, Bart Lay, a mine employee, was struck by flyrock at a distance of 1,115 feet (340 metres) from the blast and sustained serious injuries and is paralyzed from the chest down.

[61] 2019 Annual Report on Blasting Fines in Tennessee, <https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/2019-BLASTING-COMMISSIONERS-REPORT.pdf>.

[62] MESA, 'Magazine of Mining Health and Safety, United States Department of the Interior', (December/January 2021) 2 (6) MESA Magazine, <https://play.google.com/books/reader?id=SwNl7rxA5ugC&hl=en&pg=GBS.PA1>.

[63] Little, T. N., "*Flyrock Risk*," EXPLO Conference, Wollongong, NSW, 3-4 September 2007, <https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT>.

[64] Mishra, A. K. and Rout, M., "Flyrocks – Detection and Mitigation at Construction Site in Blasting Operation," (2011) 1(1) World Environment 1-5.

[65] Tom Mitchell, "Quarry blast sends slate pieces into nearby yards," *Rutland Herald*, October 17, 2018, <https://www.rutlandherald.com/news/quarry-blast-sends-slate-pieces-into-nearby-yards/article_258669ca-9aa6-566b-9ca3-e21dab8328d1.html>.

- The West Virginia Department of Environmental Protection (WVDEP) failed to investigate 32 of 36 flyrock incidents reported to the agency during the period of January 2004 to December 2007.[66]
- After a flyrock incident at an Indian quarry that killed a person at a distance of 620 metres from the blast site, a study was carried out in 2005 by Rathore & Jain[67] to determine the root cause of the flyrock, which travelled beyond the government prescribed 500-metre onsite exclusion zone. A review and analysis of 10 other known flyrock incidents at quarries in India indicated travel distances of 30 metres to 210 metres from the blast site.
- During 2007, the Commonwealth of Kentucky had 13 known flyrock incidents on surface coal mining sites, including one that resulted in death, and in the first six months of 2008, there were 9 known flyrock incidents, one resulting in minor injury.[68]
- In 2008, the Queensland Explosives Inspectorate reported 13 known flyrock incidents, of which 10 caused property damage and one which caused injury. Flyrock distances are provided for only 3 of the incidents, two at a distance of 100 metres and one up to 230 metres from the blast site.[69]
- The Queensland Explosives Inspectorate in a 2012 presentation reported 14 flyrock incidents, launched 290 metres (951 feet) to 1,230 metres (4,035 feet) from the blast site, and that averaged 708 metres (2,323 feet).[70]
- Approximately 163 flyrock incidents were identified from various public sources at blasting quarries in various geographic locations, of which 26 (16%) resulted in the loss of 29 lives (killing onsite quarry employees, offsite residents while in or outside their homes, off-site employees and customers in places of business, children in schools, pedestrians while walking near quarries, and occupants in vehicles on roads near quarries), and an additional 36 people were injured in the same 26 flyrock incidents, which reached a known maximum distance of 700 metres from the blast site.[71]

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66 Ken Ward Jr., "Have a blast: OSM finds WVDEP lax in policing flyrock," (August 17, 2009) Clarkson Gazette-Mail, <http://blogs.wvgazettemail.com/coaltattoo/2009/08/17/have-a-blast-osm-finds-wvdep-lax-in-policing-flyrock/>.

67 Rathore, S.S. and Jain, E.S.C., "Studies on flyrock at soapstone quarry for safe working," 2007 Vienna Conference Proceedings 2007, European Federation of Explosives Engineers.

68 Carl E Campbell, "Kentucky Energy and Environment Cabinet Department for Natural Resources, Reclamation Advisory Memorandum RAM #140, *July 18, 2008*, <https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf>.

69 Queensland Government Explosives Inspectorate, "Significant explosives accidents and incidents," for 2008, <https://www.rshq.qld.gov.au/__data/assets/pdf_file/0013/1512040/significant-incident-reports-2008.pdf>.

70 "Explosives Inspectorate OCE Seminars," The State of Queensland, Department of Natural Resources and Mines, 2012, Slide 17, <https://www.resources.qld.gov.au/?a=298324>.

71 Tony Sevelka, "Preventing the Potentially Deadly Consequences of Flyrock: Mandatory Minimum Setbacks Required (Revised 31-Oc-2021." Research paper submitted as part of Witness Statement of Bill Hill, an explosives engineer, at the Ontario Land Tribunal (OLT) hearing of *Fowler Construction Company Ltd. v. Ramara Township*, March 2022 (Case No: PL190391).

- Documented incidents of flyrock uncovered from various public sources resulted in a finding of approximately 30 operational blasting quarries that have experienced two or more known flyrock incidents.
- In *M & N Materials, Inc. v. Town of Gurley, Alabama, et al.*, (2015),[72] in connection with a proposed blasting quarry operation on 266 acres, Jim Ludwiczak, an explosives expert, testified that "within a reasonable degree of blasting and geologic certainty" flyrock is *likely to occur* and will be *difficult to control*." He also stated that he had "seen flyrock occur in hundreds of other cases where conditions were similar to those encountered on Gurley Mountain."

  "[According to Jim Ludwiczak] some of these flyrock occurrences had some of the best blast designs I have ever seen, but flyrock still occurred. In some of [those] cases, flyrock traveled as far as 3,000 feet [914 metres], and frequently traveled 2,000 feet [610 metres] [p. 51]."
- In *Lee Lime Corp v. Massachusetts Turnpike Authority*, (1958)[73], part of a 100-acre lime plant and quarry operation was condemned (expropriated), consisting of two contiguous strips totaling 3 acres, for the purpose of a toll express highway and the owner sought compensation for the takings. The combined 3-acre strip taking formed part of the 10 acres operated as a quarry, and, as noted below, impacted an area where 5.0% of "uncontrollable" flyrock debris from blasting lands. Following fact is to substantiate:

  "There was evidence that two to four primary blasts occur annually to loosen limestone from the face of the quarry and that fragments displaced amount to 40,000 tons; these primary blastings result in the dislodging of pieces of stone of various sizes "from dust to rocks half the height of the court room and almost as square." These fragments are then reduced in size by secondary blasting so as to permit them to pass through the crusher. These secondary blasts are an indispensable part of the quarry operations and a quarry could not be conducted nor could a lime plant be conducted without them. These secondary blasts number 15,000 to 20,000 a year and five per cent will throw stones for a distance of about 800 to 850 feet [244 to 259 metres] and are likely to reach the new highway. There was also evidence that "the fly rock" is uncontrollable and results in making unavailable a large area of the petitioner's land by its inability to conduct blasting operations within 800 feet [244 metres] of the new turnpike."
- According to the National Institute for Occupational Safety and Health (NIOSH), flyrock at surface mining operations in the United

[72] *M & N Materials, Inc., v. Town of Gurley, Alabama*, 2015, United States District Court. <https://lanierford.com/images/NewsPDFs/federal-court-decision-gurley-alabama-quarry-case.pdf>.

[73] *Lee Lime Corp. V. Massachusetts Turnpike Authority*, 337 Mass. 433 (1958) 149 N.E.2d 905, <https://scholar.google.com/scholar_case?case=8453729559483718978&q=flyrock&hl=en&scisbd=2&as_sdt=2006#p434>.

States has killed or injured 311 people from 1978 to 2004.[74] NIOSH defines flyrock as:

> *"any debris that lands outside the designated blasting area. It can vary in mass from marble-sized to car-sized and can be incredibly dangerous and potentially fatal."*

Table 1: Accident statistics of reported flyrock cited by different authors

Reference	*Period*	*Blasting injuries*	*Percentage of flyrock injuries in blasting related accidents*
Mishra and Mallick[75]	1996-2011	30	24.19
Verakis[76]	2010-2011	18	38.00
Bajpayee et al.[77]	1978-1998	281	40.57
Verakis and Lobb[78]	1994-2005	168	19.05
Little[79]	1978-1998	412	68.20
Kecojevic and Radomsky[80]	1978-2001	195	27.69
Adhikari[81]	-	-	20.00

A study of blasting flyrock risk undertaken by Zhou et al. (2009)[82] found that wind conditions can have a profound impact on the travel distance of flyrock:

> *"...[W]ind can assist in the producing of flyrock. When the wind direction is in accord with the designed throwing distance, the flyrock can travel [a] distance two times [more] than normal [p.1185]".*

Flyrock is an ever-present danger wherever rock blasting occurs, and, therefore, the prevention (or avoidance) of *flyrock* should be dealt with proactively and explicitly before approving an application to permit a blasting quarry operation. Alternative description of the flyrock is as under:

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74 Josh Cabel, "*NIOSH Offers Tips for Flyrock Safety*," (January 25, 2007) EHS Today, <https://www.ehstoday.com/construction/article/21911356/niosh-offers-tips-for-flyrock-safety>.

75 Mishra, A. K. and Mallick, D. K., "Analysis of blasting related accidents with emphasis on flyrock and its mitigation in surface mines", In *Rock Fragmentation by Blasting* (eds Singh, P. K. and Sinha, A.), Taylor and Francis, London, 2013, pp. 555-561.

76 Verakis, H., "Flyrock: a continuing blast safety threat", (2011), <htpp://docs.isee.org/ISEE/Support/Proceed/General/IIGENVI/11v161g/pdf>.

77 Bajpayee, T. S., Rehak, T. R., Mowrey, G. L. and Ingram, D. K., "Blasting injuries in surface mining with emphasis on flyrock and blast area security", 2004, 35(1) Saf. Res. 47-57.

78 Verakis, H. and Lobb, T., "Flyrock revisited an ever present danger in mine blasting, (2007), <http://dpcs/osee/prg/ISEE/Suppport/Proceed/General/07GENVI/07v109g.pdf>

79 Little, T. N., "Flyrock risk", In Proceedings of EXPLO Conference, Wollongong, NSW, 3-4 September 2007, pp. 35-43.

80 Kecojevic, V. and Radomsky, M., "Flyrock phenomena and area security in blasting-related accidents", (2005) 43(9) Saf. Sci. 739-750.

81 Adhikari, G. R., "Studies on flyrock at limestone quarries", (1999) 32 (4) *Rock Mech. Rock Eng.*, 291-301.

82 Zhou, Z., Li, X., Liu, X., Wan, G., "Safety Evaluation of Blasting Flyrock Risk with FTA Method," *School of Resources and Safety Engineering, Central South University,* Changsha 410083, Hu'nan, China. <https://miningandblasting.files.wordpress.com/2009/09/safety-evaluation-of-blasting-flyrock-risk-with-fta-method.pdf>.

> *"Accidental flyrock in blasting operations has a major impact on the external environment...due to the hazards involved and is more significant than vibrations or airblast....[E]ven if it is normal practice in these zones to take into account the impact of possible vibrations and even the effects of airblast when modeling the project, flyrock risks are not dealt with in initial studies, other than by way of integrating general safety distances. These risks are only sometimes taken into account much later in the operation and most often, following an accident or significant flyrock being recorded externally [off-site] [p. 549].*[83]*Surely it is a matter of common knowledge, and we accord judicial notice to the fact, that blasting by use of dynamite or other explosives is a hazardous activity and as such likely to damage others. See Boyce v. United States, D.C., 93 F.Supp. 866, 868; 31 C.J.S. Evidence § 9, page *226 824; and 29 Am.Jur.2d, Evidence, section 23, page 60 [para. 226]."*[84]

The majority of flyrock incidents go unreported or unnoticed, and in most jurisdictions' incidents of flyrock that do not leave the blast area,[85] or that do not cause injury inside or outside the blast area are not officially reported. An investigation of two blasting events at the Pakenham Quarry in Ontario, Canada, in July 2009, found launched flyrock debris that caused damage to three vehicles (two off-site), property (on-site scale house) and injury (worker struck at neighbouring business) over an area in excess of 300 metres from the blast site. It was concluded that the onsite "blast area" (hazard zone) should have been 500 metres (1,640 feet). Rene Morin in Explotech Report (September 25, 2009) told, *"We strongly recommend that the hazard zone be increased to 500m when firing any future blasts."*

The two flyrock incidents led to convictions for releasing contaminants (i.e., flyrock) into the environment and for failing to report the flyrock incidents to the Ontario Ministry of Environment. Neither the quarry owner nor the blasting company (Austin Powder Company Limited) were aware of the reporting requirements under the Environmental Protection Act:

> *"Statements from company officials for both Thomas Cavanagh Construction Ltd. and Austin Powder Ltd. confirmed that they did not report the said incidents, had no knowledge that fly rock constitutes a*

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[83] Blanchier, A., "Quantification of the levels of risk of flyrock," Rock Fragmentation by Blasting: The 10th International Symposium on Rock Fragmentation by Blasting, 2012 (Fragblast 10); Leiden: 549-553.

[84] *Davis v. L & W Construction Company*, 176 N.W.2d 223 (1970), <https://scholar.google.com/scholar_case?case=13093628744042978336&q=%22Surely+it+is+a+matter+of+common+knowledge%22&hl=en&as_sdt=2006>.

[85] The blast area within a surface mine is the area in which onsite equipment and personnel are to remain beyond when blasting is initiated. Ludwiczak, a geologist, explosives engineer, blaster and former Director of The Division of Explosives and Blasting for the Department of Mines and Minerals of the Commonwealth of Kentucky, has investigated numerous cases involving personal injury and damage allegedly caused by flyrock within the confines of the mining operation. According to Ludwiczak, there is a "great deal of ignorance and confusion" as to how one determines the "blast area," akin to an onsite floating setback. There is also confusion as to who makes the decision and what information is used to make the decision. "Not only are people confused as what the blasting area is, but who is the person who ultimately should determine the distances from the blast (blast area) site." James T. Ludwiczak, "The Blasting Primer," Second Edition, © 2002, *Progress Printing Company.*

contaminant or, that fly rock incidents, which may cause an adverse effect, must be reported to the Ministry of the Environment."

According to Keith Tayler, General Manager, Austin Powder Company Ltd., "90% of fly rock incidents are 'unexplainable.'" Flyrock is an unavoidable by-product of blasting rock and is an ever-present danger wherever blasting occurs. Flyrock is an accident that needs to be addressed before it happens, an approach which is consistent with the proactive and precautionary principles inherent in sustainable land use planning.[86]

A proactive and precautionary approach is fundamental to protecting health and safety. Such an approach allows for threats to be minimized, eliminated, or averted, and opportunities for improvement to be seized. The sound management of natural and human-made hazards, along with other nuisances including noise, vibration, and light emissions, is a critical component to the City's sustainability."[87]

According to Gardiner (2006),[88] the precautionary principle has three important components:

- Threat of harm
- Uncertainty of impact and causality
- Precautionary response

7. EMPIRICAL METHODS OF CALCULATING FLYROCK ARE INACCURATE

There are several empirical methods for calculating *flyrock*[89] but none are capable of accurate prediction[90] due to the complexity of flyrock analysis. Flyrock is unpredictable, both in terms of distance and direction.[91] The potentially deadly consequences of flyrock do not decrease with distance, as a 200-gram projectile can be as fatal at 20 metres as it is at 1,000 metres.[92] Listed below are the findings of various authors with respect to the unpredictability and randomness of flyrock.

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86 Taylor, A., *The Application of the Precautionary Principle in the Land Use Planning Process* [Unpublished master's thesis]. Queen's University, 2015. <https://qspace.library.queensu.ca/jspui/handle/1974/14419>.

87 Policy 8.4, Environmental Health and Safety, City of Waterloo Official Plan, updated January 2020.

88 Gardiner, S. M., "A core precautionary principle." (2006) 14 (1) The Journal of Political Philosophy 33-60. < https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9760.2006.00237.x>

89 Lwin, M Min and Aung, Z Moon, "Prediction and Controlling Flyrock due to Blasting for Kyaukpahto Gold Mine," (2019) 5 (10) International Journal of Advances in Scientific Research and Engineering. <https://pdfs.semanticscholar.org/1eb3/a776fa7caf6ff4697c85a112424b875770e6.pdf>.

90 Balakrishnan, V. and Rai, P., "An Overview of Flyrock and its Prediction in Surface Mine Blasting using Soft Computing Techniques," (2021) 2 (2) Recep Tayyip Erdogan University Journal of Science and Engineering 105-119. <https://dergipark.org.tr/en/download/article-file/1941187>

91 Rathore, S.S. and Jain, E.S.C., "Studies on flyrock at soapstone quarry for safe working," (2007) Vienna Conference Proceedings 2007, European Federation of Explosives Engineers, ISBN 978-09550290-1-1.

92 Anne C Sauvage, "Flyrock: French Experience," (2017) 61 SAFEX Newsletter, <https://ap3e.pt/wp-content/uploads/2021/03/2017-2-Newsletter-61.pdf>.

- Despite considerable efforts, [the] difficult nature of rock engineering problems has caused previously empirical methods to be not appropriate in predicting flyrock phenomenon. Most of these models have been developed based on blasthole diameter.
- Despite the considerable progress made over the last three decades, significant challenges for wholly omitting of unwanted flyrock phenomenon, injuries, and fatalities still exist.[93]
- Several authors have proposed viable solutions based on assumed causative parameters and their impact as inputs....The testing methodologies used to measure the actual flyrock distance are not scientific and are highly dependent on the scrutiny of the researcher. In order to present results that are objective and uncriticizable, an accurate, quantitative and objective method of measuring the travel distance of flyrock is required.[94]
- A problem in flyrock prediction is its random nature, as one cannot generate a flyrock while relying on chance. Modelling of random flyrock with regular variables poses a challenge to researchers. Attempts to predict flyrock using throw or heave prediction routines suffer from the perils of gross generalizations. "Since flyrock is a potential threat to property and life, one cannot risk under prediction (Raina et al., 2015)."[95]

In a case study of the July 15, 2015 flyrock incident at a construction site in Johor, Malaysia, that propelled flyrock up to a distance of 200 metres killing one worker and injuring two others, it was determined that blast design was only 69% accurate in predicting flyrock distance, and, as noted below, the empirical models could not account for uncontrollable variables:

> *"In this study five empirical models are used to compare the incidents. It was found that none of the existing formulas could accurately predict flyrock distance. Analysis shows that the gap between predicted and actual flyrock distance can be reduced by including blast design and geological conditions in forecasts. Analysis revealed only 69% of accuracy could be achieved if blast design is the only parameter to be considered in flyrock projection and the rest is influenced by the geological condition."*[96]

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[93] Hasel Amini, Raoof Gholami, Masoud Monjezi, Seyed R Torabi and Jamal Zadhesh, "Evaluation of flyrock phenomenon due to blasting operation by support vector machine," (2011) Neural Computing & Applications, <https://www.researchgate.net/publication/241039190_Evaluation_of_flyrock_phenomenon_due_to_blasting_operation_by_support_vector_machine>

[94] van der Walt and Spiteri, W., "A critical analysis of recent research into the prediction of flyrock and related issues resulting from surface blasting activities," (2020) 120 (12) Journal of the Southern African Institute of Mining and Metallurgy 701-714. <http://dx.doi.org/10.17159/2411-9717/1103/2020>, <https://www.saimm.co.za/Journal/v120n12p701.pdf>.

[95] Avtar K. Raina, Murthy, V. M. S. R. and Abhay K. Soni, "Flyrock in surface mine blasting: understanding the basics to develop a predictive regime", (2015) 108 (4) Current Science 660-665. <https://www.jstor.org/stable/24216626?read-now=1&seq=6#page_scan_tab_contents>.

[96] Edy T Mohamad, Chang S Yi, Bhatawdekar Murlidhar, Rosli Saad, "Abstract: Effect of Geological Structure on Flyrock Prediction in Construction Blasting," (2018) 4 Geotechnical and Geological Engineering.

The aggregate industry's claim that flyrock is a rare occurrence is not borne out by the research conducted, nor has it been demonstrated that flyrock can be confined to a floating onsite blast area arbitrarily defined on an ad hoc basis by the blaster-in-charge[97] before every quarry blast. The designated onsite blast area is the zone in which there exists a high probability of hazard to quarry personnel from flyrock, fumes, air blast or ground vibrations, and is the area where the blaster is to make arrangements to evacuate all persons (e.g., quarry personnel) whose safety and health is threatened by the blasting operation. During the period of 1978-2003, onsite blast area security accounted for 89 accidents or 41% of all blasting related injuries reported by surface mines in the United States.[98] According to a 2008 Reclamation Advisory issued by the Kentucky Department for Natural Resources, reported incidents of flyrock debris were not confined to the onsite area of the blast site:

> *"Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'...prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and the destruction of property [p. 1]".*

8. VIBRATIONS RULED A PUBLIC NUISANCE

In *Fraser (Re)*, 2018 NSUARB 74,[99] the Board ruled that *vibrations* are a public nuisance. Murphy, an engineer, went on to explain the causation of some of the damage attributed to vibration and his reliance on the *Vibration Guidance Manual of the California Department of Transportation (Caltrans)*:

> *"When analyzing distance from the source of the vibrations to a house, the composition of the soil and ground through which the waves must travel is significant to the readings that are achieved at various distances. In every single case, it may be different because of the different subterranean composition. Consequently, distances that have been created in a laboratory do not necessarily work in the real world unless one can exactly duplicate the subterranean composition and the specific house structure [para. 184]...[Murphy] stated every experiment is specific to the facts of that soil composition and the specific house structure [para. 185]. ...[T]here's so many factors that go into vibration and the effects on a structure. It's impossible to duplicate those in a scientific setting, to duplicate them all [para. 185]. Caltran's noted vibrations can cause damage to structures....[para. 170] The damage they can cause is dependent upon the structure (J. Pistrol, F. Kopf et. al, Ambient Vibration of Oscillating and Vibrating Roller: Apart from the Characteristics of the excitation (duration,*

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97 In Ontario, Canada, under the Aggregate Resources Act, as amended, a blaster does not require a licence.

98 *Mine Blasting*," 1980. <https://vibrationmonitoringcourse.com/wp-content/uploads/sites/7/2014/03/RI-8507-Blasting-Vibration-1989-Org-Scanned-Doc.pdf>.

99 *Fraser (Re)*, 2018 NSUARB 74 (CanLII), <https://canlii.ca/t/hrg94>, retrieved on 2021-05-09.

> *frequency, magnitude, etc.) the immission on buildings highly depends on the type of structure, material properties, stiffening elements, inherent damping, natural frequencies and other building parameters [para. 171]. And now there's some jurisdictions that have determined that – with experience, that there has been – damage has occurred at the 5 millimetres per second, [0.2 inches per second] and so they're saying – they're picking that as a safe threshold and then – but basically what they're saying is you've got to do monitoring and you have to do pre-condition surveys. These are the ways that the municipality, the province, the state – you know, that's the way they're going to have to try to ensure that things are dealt [with] fairly." [Board's emphasis]*

9. DAMAGE FROM LOW FREQUENCY BLASTING AND REPEATED BLASTING ALMOST AN ABSOLUTE CERTAINTY

According to Dr. Kiger, former Dean of Engineering at the University of Missouri, vibration damage from blasting is almost an absolute certainty.[100] Sam Kiger…was the expert for the Bim blasting case, which was tried in court in Boone County in March 1999. Kiger is an international expert in protecting federal buildings from blasting damage. After examining 6,000 blasting logs, he testified that there is about a 95 percent chance of damage at a vibration limit of .5 inches/second [12.7 mm/sec], if you count each of the holes shot (50 on average) as a separate vibration. In the Bim case, he also testified that low-frequency waves (2 Hz-11 Hz) generated by some blasts can be more damaging. The frequencies can match that of a house and amplify the shaking [p. 16]. Kiger concedes that all homes undergo daily and seasonal dimensional changes due to things like humidity variations and changing temperatures. For example, a "sticking" door that will not close or open during certain times of the year. The environmental effects will cause strains in the walls, ceilings, structural framing, the covered surfaces, etc.

These strains are known by engineers as prestrains, that is strains that exist before an event like a blast-induced ground vibration. The prestrain condition may be such that a very small vibration will push the item, like a wall panel, a framing connection, or piece of tile, over its strain limit and result in a crack or loosening of a structural frame connection. Once a crack is initiated the crack will grow at a much lower level of vibrations than was required to initiate the crack. This is because of the stress concentration that exists at the crack tip, envision for example a small crack in an automobile windshield where even a small bump from one's hand can cause the crack to grow. Thus, even low levels of repeated occurrences of blast induced ground vibrations can cause significant damage to a visible damage and cracks in masonry. For example, the German vibration standard is 0.16 ips

[100] Vivian Stockman, Ohio Valley Environmental Coalition, <https://www.c-span.org/person/?108142/VivianStockman>

[inches per second] [4.06 mm/sec] for buildings with visible damage and cracks in masonry.[101]

The fact that these prestrain conditions can produce a condition in the home such that damage to a home will occur at even very low levels of vibrations is acknowledged in BOM [Bureau of Mines] RI 8507[102] in their Conclusion 7 [p. 68]...This conclusion, agreed to by the 4 experts that authored RI 8507 [Siskind et al, 1980], clearly states that "*...there may be no absolute minimum vibration damage threshold...*," that is, when inevitable prestrain conditions are present in a home, any blast induced ground vibrations might cause damage to the home.

All homes eventually crack because of a variety of environmental stresses, including humidity and temperature changes, settlement from consolidation and variations in ground moisture, wind, and even water absorption from tree roots. Consequently, there may be no absolute minimum vibration damage threshold when the vibration (from any cause, for instance slamming a door) could in some case precipitate a crack about to occur.[103]

The size of the blast induced ground vibration waves shaking the homes are large in comparison to the footprint dimensions of a typical home. The length of the ground vibration wave train is the duration of the blast induced ground vibration shaking at homes, typically about 3 to 4 sec, times the speed of the ground wave, typically about 800 ft per sec [244 metres per sec]. Thus, for a typical blasting event with multiple individual explosions the ground vibration wave train is about 3,000 ft [914 metres] long. These ground vibrations at long distances, i.e. more than 1,000 ft, [305 metres] have a dominant frequency of the ground vibration equal to about 8 to 10 Hz (cycles per sec); for a frequency of 10 HZ a single cycle of the ground shaking is 80 ft [24 metres] in length (one cycle is up down and back up) so that the leading edge of the home is picked up then pulled down while the back of the home is being picked up; this up and down of the front and then back of the house occurs repeatedly for the full 3 to 4 second duration of the ground vibration; in this example that would be about 30 to 40 complete cycles (10 cycles per second for 3 or 4 seconds). When these repeated distortions of the house match the natural frequency of the house, the motions will be amplified and damage to the house will be significantly increased.[104]

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[101] See for example Table 1 in Konon and Schuring, "Vibration Criteria for Historic and Sensitive Older Buildings" by Konon and Schuring, ASCE Preprint 83-501; American Society of Civil Engineers (ASCE), Houston Texas, October 17-19, 1983.

[102] US Bureau of Mines RI 8507, "*Structural Response and Damage Produced by Ground Vibration From Surface Mine Blasting*," 1980. <https://vibrationmonitoringcourse.com/wp-content/uploads/sites/7/2014/03/RI-8507-Blasting-Vibration-1989-Org-Scanned-Doc.pdf>.

[103] In Bureau of Mines RI 8507 they suggest a maximum allowable ground vibration peak particle velocity (PPV) of 0.5 inches per second (ips) or 12.7 mm/sec at which there is a 0.5 percent probability of damage, However, the standards in many other countries are much lower. For example, regulatory agencies in Leicestershire County, UK, have established the upper limit on allowable PPV as 0.24 ips (6.1 mm/sec). In Australia, the common PPV limit is 0.2 ips (5.08 mm/sec) and it is 0.001 ips (0.2 mm/sec) for historical buildings and monuments for frequencies less than 15 Hz. Frequencies less than 15 Hz are very likely in blast induced ground vibrations at large distances from the blasts.

[104] *Fontaina Scott v. Mountaineer Grading Co.*, Putnam Co. Vir. Act. No. 09-C-286.

Freda Harris reached a similar conclusion finding that geological "hot spots" in a community can make vibrations from blasting worse:

> *"Freda Harris, who had a blasting case with a mine in Indiana, gathered many documents during the case and subsequent FOIAs of OSM [Office of Surface Mining]. She wrote a manual for Citizens Coal Council.*[105] *One of her most intriguing findings was that there can be "hot spots" in a community where the geography can make blasts worse. She emphasizes that damage and vibrations can feel worse if a house's natural frequency is approximately between 4 Hz and 12 Hz. The above-ground part of the house often vibrates more than the ground outside and the foundation. Yet, the DEP [Department of Environmental Protection]/OSM standard is based on ground vibration [p. 16]."*

An often-quoted blasting study conducted by Siskind (1994)[106] arguing that a vibration limit at 0.5 in/sec (12.7 mm/sec) constitutes a safe blasting limit has been criticized by other experts and successfully challenged in the courts:

> *"Most of the blasting studies of the Bureau of Mines were done by David Siskind. The FOIAs provided much correspondence between Siskind and other experts, some of it quite critical. A top official of Vibra-Tech, a leader in designing blasting technology, said: "Any criteria…which ignores the frequency of a structure, and the frequency content of the ground motion is overly simplistic…Your criteria, as proposed, will neither protect the interest of the citizen and the homeowner, nor will it protect the blaster from alleged damage claims [p. 16]."*[107]
>
> *"After the Bureau of Mines was shut down by Congress [in 1996], Siskind became a private consultant. He testified for the coal company that lost the Bim case. The majority of the blasting cases have overturned his studies, and thereby the limits used by DEP and OSM. As he wrote an OSM official on June 17, 1997: "The battles I am now seeing are not 0.5 in/sec [12.7 mm/sec] versus 1.0 in/sec [25.4 mm/sec]. Complainants are trying to dismiss all the science as biased, wrong or nonapplicable. For the most part, they are succeeding in ways that pay off [p. 16]."*
>
> *"Evans [an expert blaster and regional manager of explosives firm Dyno-Nobel in southwestern Virginia (1982-2002)]*[108] *said they concentrate much more on the effects of the low frequencies than on per particle velocity [PPV]. The per-particle [velocity] reading almost*

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[105] Freda Harris and Will Collette, "*The People's Guide to Blasting: How to Protect Your Home, Family and the Environment*," 1999, <https://www.crmw.net/files/Blasting_Summary.pdf>.

[106] "Investigation of Damage to Structures in the McCutchanville-Daylight Area of Southwestern Indiana, *Office of Surface Mining Reclamation and Enforcement Technical Report/1994*, Volume 2 of 3, <https://www.osmre.gov/resources/blasting/docs/OSMREReports/McCutchanville-DaylightIN/M-DPart1CompositeReport.pdf>.

[107] Vivian Stockman, Ohio Valley Environmental Coalition, <https://www.c-span.org/person/?108142/VivianStockman>

[108] Subsequently, Evans founded Geoscan Seismic Services Inc. and is only one of four people in Kentucky currently approved to teach Basic Blaster 30-hour class, which is required by law prior to blasting on surface mines in Kentucky (Source: Geoscan Seismic Services Inc. website).

> *never goes higher than .3 inches [per second] [7.62 mm/sec], well below the regulatory limit of 1 inch per second [25.4 mm/sec]. However, just as Sam Kiger and Freda Harris determined, the low frequencies are bothersome [p. 18]".*

Interestingly, the DEP "Surface Mine Blasting Study Guide" acknowledges that the response of the human body is greater at lower frequencies: *"This explains why people file complaints even when the blasting is conducted at safe (no damage) levels [p. 17]."*

The amplitude of the structure response to ground vibrations and resultant strains within building components are also dependent on the efficiency of energy transfer from the foundation to the framework and wall components. The efficiency of energy transfer increases significantly when the natural frequency of the ground vibrations matches the natural frequency of the structure [Siskind et al., p. 103]"[109]

According to Dr. Kiger, there is an extremely high probability of certainty of damage to neighbouring structures (e.g., homeowners' property) resulting from repeated blasting, even at low ground-vibration levels. The following is worth mentioning:

> *"The explosive most often used [in blasting] is ANFO (Ammonium Nitrate and Fuel Oil). When the explosive is detonated a detonation wave moves through the explosive at a speed of about 18,000 feet per second [5,486 metres per second] changing the solid material to a gas at a very high rate. This detonation wave and rapidly expanding gas will create a cavity, crushing, cracking and moving the surrounding material. It will also introduce 2 types of waves into the earth around the explosion. First a surface, or Rayleigh wave, that will damp out and disappear in a relatively short distance. And second a body wave that will travel great distances in the bedrock (under any barrier). It is this body wave that will move through the bedrock and cause the earth above the bedrock to vibrate and shake homes, even at large distances from the explosions. There is no way to mitigate or block the movement of these body waves. [evidence presented by Dr. Kiger in connection with an Application for Rezoning and Special Use Permit for a proposed Granite Quarry in Alvaton, Meriwether County, GA]"*[110]

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[109] OSMRE: Investigation of Damage to Structures in the McCutchanville-Daylight (M/D) Area of Southwestern Indiana; M/D Part 1 (Indiana) Composite Report Technical Report/1994, Volume 2 of 3, https://www.osmre.gov/resources/blasting/docs/OSMREReports/McCutchanville-DaylightIN/M-DPart1CompositeReport.pdf.

[110] On October 23, 2018, the Meriwether County Board of Commissioners (CBC) denied the request to rezone the property and grant a special use permit for a blasting quarry. The appeal of the CBC ruling to deny the rezoning was upheld by the Superior Court in *Luther H. Randall, III, et al., v. Meriwether County, Georgia, et al.* File No. 18CV0270 [May 1, 2019]. In upholding the decision of the Board of Commissioners, the Superior Court made a number of observations as to the significant potential adverse impacts, including the following: "(e) blasting at the quarry has a high likelihood of damaging many of the more than 100 residential structures within one to two miles [1.609 to 3.219 kilometres] of the proposed granite pits over the life of the proposed operation and will significantly degrade the quality of life for those residents affected; [p. 9-11]." https://flintriverkeeper.org/wp-content/uploads/2019/05/Randall_etal_v_Meriwether_County_etal_Final_Order.pdf.

> *"In the…1980 report [prepared for the US Bureau of Mines] by Siskind et al,*[111] *the authors establish 0.5 in/sec (12.7 mm/s) as the "threshold" for damage to structures, and they define "threshold" as a 5% probability of cosmetic damage. The probability of damage to a home may be relatively small in any single blasting event. However, numerous opportunities for an unlikely occurrence (like damage to the home) will result in a very likely occurrence of damage. For example, if the probability of damage (P_d) in any single blasting event is 0.05, or 5 percent, then the probability of not being damaged (P_u) is 95 percent. One can use the probability law of independent events to calculate the probability of damage occurring at least once in 100 events….*[112] *Thus, assuming the probability of damage is the same for each event, 0.05, then the probability of not being damaged at least once in 100 events is: $P_{u\text{-}100} = (0.95)^{100} = 0.006$."*

And, in the review of the August 2018 application for a proposed 778-acre granite quarry in Alvaton, Meriwether County (Georgia, USA), Dr. Kiger pointed out the misleading nature of the use of seismometers[113] in connection with blasting quarry operations. It is sometimes suggested that dropped weights, door slams, or foot falls will generate a ppv [Peak Particle Velocity] of 1.0 ips [25.4 mm/sec] as recorded by a nearby seismometer. While it is true that the recorded ppv may be similar to the ppv recorded for a blast generated vibration wave; the effect of these vibrations on people or homes is in no way equivalent. In fact, suggesting that vibrations created by these methods are similar to those created by a quarry blast event are very misleading and are unconvincing to any individual knowledgeable about vibration effects. While it is true that using an instrument like a seismograph to measure the peak velocity near the point of impact of a dropped weight will likely record a peak velocity similar to the peak velocity produced by quarry blast at a distant location; these vibrations are not equivalent in their effects. The ground waves generated by the quarry explosions are hundreds of feet in length and will move entire buildings as described above. The vibrations generated by dropping a weight, slamming a door, or stepping on the floor are very short in duration and in length. The localized vibrations generated by a dropped weight, door slam, or foot fall generate wave with much higher in frequency and smaller length dimensions than a building and have far too low an energy level to excite an entire building. If the front door slams very hard you might hear it in the back bedroom, but the entire house will not shake.

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[111] Siskind, D.E., Stagg, M.S., Kopp, J.W. and Dowding, C.H., "Report of Investigations 8507: Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting," (1980), prepared for US Bureau of Mines. <http://www.osmre.gov/resources/blasting/docs/USBM/RI8507BlastingVibration1989.pdf> [RI 8507].

[112] For example, see Henry L Alder and Edward B Roessler, *Introduction to Probability and Statistics*, Third Edition (W.H. Freeman and Company, 1964).

[113] Seismograph (Seismometer) is an instrument that measures and supplies a permanent record of earthborn vibrations induced by earthquakes, and/or blasting (also called a blast monitor). Refer James T. Ludwiczak, *The Blasting Primer*, Second Edition (International Society of Explosives Engineers, 2002).

According to the Surface Mining Control and Reclamation Act (SMCRA) and F-SMRCA, low frequency blasting is problematic, and can cause structural damage, as found in *Jarrett v. DNR and Amax Coal Company* (1992).[114] The following statement should be considered:

> *"113. As with all other structures, homes have one or more natural (or harmonic or resonant) frequency. The mathematical effect of a natural frequency is that induced vibrations which are the same frequency as a natural frequency will cause vibrations to increase with time rather than decrease with time. As a practical matter, this means the midwall response of a home subjected to vibrations from a blast (or any other source) could be a displacement of up to four times the displacement at the foundation. It can also cause "racking" or shaking of the structure."*
>
> *"114. When such a phenomenon occurs, it clearly places considerable stress on the mortar between bricks, plaster walls and corners of a structure."*
>
> *"115. ...OSM report RI 8507, indicates natural frequency of wood frame structures is in the 5-10 Hz range for racking. Natural frequencies of one story homes can be as high as 18 Hz, but of course the initial displacement at 18 Hz is only 1/2 of the displacement of a 9 Hz frequency for the same peak particle velocity [PPV]. This study concludes that frequencies below 10 Hz are the most serious ones."*

Quesne (2001)[115], as cited by Svinkin (2004)[116] and Sayed-Ahmed and Naji (2006),[117] reported a case of ground and house exterior wall vibrations measured at distances of approximately 1.6 to 6.4 km (1 to 4 miles) from a blast site. Peak particle velocities (PPVs) were below the 0.5 ips (12.7 mm/sec), and in accordance with R1 8507, which asserts no possibility of structural damage at this level. However, amplification factors of wall vibrations were found from 4x to 9x as high as vibration measured at the ground and resulted in numerous cracks in the different house structures. According to Svinkin (2004), there are no unified or widely accepted criteria for the safe limits of ground vibrations. It is not the soil PPV that matter, but it is the structural response to the ground vibration. All blast-vibration complaints are actually due to the structure vibration not the ground vibration (Sayed-Ahmed & Naji, 2006). The following statements are pertinent in this regard:

- The level of the resulting ground vibration and the structural response depends on the explosive type and weight, delay time, blasting technology, soil properties, distance between the structure

[114] *Jarrett v. DNR and Amax Coal Company*, 5 CADDNAR 265 (1992), <https://www.in.gov/nrc/decision/89-106r.v5.html>.

[115] Quesne, J.D., 'Blasting vibration from limestone quarries and their effect on concrete block and Stucco homes', (2001) Vibration Problem. Geo-Discussion Forum.

[116] Mark R. Svinkin, "Drawbacks of Blast Vibration Regulations," (2004) VibraConsult, <https://vulcanhammernet.files.wordpress.com/2017/01/blst-crt.pdf>. Retrieved on April 23, 2022.

[117] Sayed-Ahmed, E.Y. and Naji, K.K., "Residential Houses Cracking Due to Nearby Subsurface Construction Blasting: Critical Review of Current Safe Limits", Civil Engineering Department, University of Qatar, Doha, Qatar, 1st International Structural Specialty Conference, Calgary, Alberta, Canada, Mar 23-26, 2006, <https://www.researchgate.net/publication/280530625_Residential_Houses_Cracking_Due_to_Nearby_Subsurface_Construction_Blasting_Critical_Review_of_Current_Safe_Limits>

and the blasting centre, susceptibility ratings of the adjacent and remote structures, and the age and type of structure...and stress history (Sayed-Ahmed & Naji, 2006).

- Low-rise buildings have a natural frequency in the order of 4-12Hz (Mendearis 1977; Sinkind 1980; ISEE 1988). However, the structures and their parts (e.g., floor, walls, etc.) respond differently to ground vibration as they have different natural frequencies. For example, the natural frequencies are 12-20 Hz for interior walls' horizontal vibrations and 8-30 Hz for floors vertical vibrations. Mid-walls' vibrations cause residential buildings to "rattle" making vibration more noticeable and aggravate human response to annoyance from ground vibration. It is difficult, if not impossible, to follow a uniform standard to reduce the human perception of vibration due to subsurface blasting (Baliktsis 2001).[118]

A 2012 study of current practices to address construction vibration and potential effects to historic buildings adjacent to transportation projects found that as the vibration frequency increases, building elements are better able to withstand higher levels of vibration, but, according to the author, this phenomenon would require a rather lengthy discourse on structural dynamics. "Suffice it to say that the reason has to do with the movement of main building elements (primarily walls) when subjected to base excitation:"[119]

> *"At lower frequencies, walls tend to deform more (the relative movement of different points on the wall), thus subjecting the brittle materials (in the case of masonry construction) from which they are made (such as brick and mortar) to higher stresses and strains. Based on the research, it would appear that using a frequency-based limit is probably the most reasonable approach. The German standard DIN 4150-3 [0.12 in/sec (3 mm/sec) to 0.40 in/sec (10 mm/sec) for short term vibrations depending on the frequency range] is a good example of this approach."*
>
> *"Swiss standard SN 640 312 recommend 0.12 in/sec [3 mm/sec] for continuously occurring vibration (machines and traffic) and 0.30 in/sec [7.62 mm/sec] for blasting unless the frequency of the blasting vibration is between 60 and 90 Hz. The higher criteria are in general for impulsive type vibration such as from blasting and pile driving."*
>
> *"In New York the limit for historic buildings is 0.5 inches/sec, which Hammarberg et al. point out may not be sufficient to avoid damage to fragile historic buildings....[T]he authors note the vibration limits derived from research conducted by the U.S. Bureau of Mines on the effects of blasting on residential structures are the least appropriate standards for protection of historic structures."*

[118] Baliktsis, E.K., "Blasting vibration limits to prevent human annoyance remarks from some case studies", (2001) 10 (1) Mineral Resources Engineering 71-81.

[119] NCHRP 25-25/Task 72, Current Practices to Address Construction Vibration and Potential Effects to Historic Buildings Adjacent to Transportation Projects, Wilson, Ihrig & Associates, Inc., ICF International, and Simpson, Gumpertz & Heger, Inc., September 2012, <https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(72)_FR.pdf>.

Comision Pastoral Paz y Ecologia and Unitarian Universalist Service Committee, Guatemala, in 2007, started monitoring, investigating and analyzing damage to several buildings in villages immediately surrounding the Marlin mine (owned by Goldcorp, Inc., headquartered in Vancouver, B.C.), and compared the condition of buildings in two similar control villages on the opposite side of the Tzala River valley and more than five kilometers (>3.11 miles) from the mine and outside the impact of the mining operation.[120] Buildings in the two villages near the mine have more cracks than the buildings in the two control villages, and the villages surrounding the Marlin mine are becoming destabilized by the surface mining operation. Expert reports exclaim:

> *"A total of 33 damaged buildings [1 to 4 kilometers from the mine and within 300 metres of the nearest road] were observed in the villages surrounding the Marlin mine. Generally, the damage ranges in severity from buildings having one or more cracks with no displacement to buildings with cracks displaced far enough that light can be seen through one or more of the cracks. One building…is severely damaged."*
> *"Land instability, seismic activity, damage due to underlying soil types, and to faulty construction were eliminated as likely causes of the structural cracking. The type and pattern of most cracks were determined to be those caused by ground vibrations. Vibration monitoring results were not conclusive as to the damage being caused by ground vibrations, but no other possible causes are identified. By a process of elimination, the most likely cause of the building damage is ground vibration. There are no sources of vibrations in the area except those resulting from mine blasting and heavy truck traffic; therefore, it is very highly likely that the damage in local villages is caused by the mining activity and associated truck traffic." [emphasis added]*
> *"Protests against the mine are becoming larger and more frequent. Conflicts between mine workers and other residents are on the rise. People are leaving the area in growing number, some saying that they can no longer live in this situation of conflict. The engineering team also suffered from the unrest. One member of the team was attacked and injured by mine workers during the November 2008 field trip."*

A case study of the Metlaoui Mining Basin, Southwestern Tunisia, undertaken by Aloui et al. (2016)[121] concluded that both *ground vibration* and *airblast* from blasting can cause structural damage, and are a nuisance to the inhabitants of populated areas in proximity to the surface mines. The authors reiterated the following:

> *"The measured event frequencies of blast induced ground vibrations represent high-potential damage risk due to resonance effects. However, the frequency interval of 1-5 Hz that has higher damage risk constitutes the majority of all shots. These low frequencies are very critical to*

[120] Preliminary Investigation and Analysis of Building Damage, 1 November 2009, <https://www.giscorps.org/wp-content/uploads/2017/01/Report_and_Figures.pdf?189db0&189db0>.

[121] Aloui, M., Bleuzen, Y., Essefi, E., Abbes, C., "Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia," (2016) 5 J Geol Geophys 247. <https://doi.org/10.4172/2381-8719.1000247>

> *residential structures because they are in the range of their natural frequencies. The measured values frequency are near the natural frequency of residential structures (<20 Hz) [and] is the most dangerous because it causes amplification of ground vibration [p. 7]."*
> *"Air blast represents an undesirable and unavoidable output of blasting technique. The air blast damage and annoyance may be influenced by numerous factors such as blast design, weather, field characteristics, and human response. Air blast disturbances propagate as compression wave in air. Under specific weather conditions and poor blast designs, air blast can travel for long distances [11] [p. 2]."*
> *"All frequencies of induced air blast monitoring recorded were less than 20 Hz…, which increases risk of damage. In fact, air blast is considered as an ever-annoying phenomenon in Metlaoui Mine and mostly propagates in low frequencies (<20 Hz), and causes perceptible rattling of windows easily in the building [p. 7]."*

According to Loeb (2014),[122] *ground vibration* from blasting is unavoidable, and can cause damage to neighbouring structures, including residences. "Neighbouring structures, including residential homes can sustain damage during blasting due to [1]

- permanent ground deformation due to heave or gas pressures,
- vibratory settlement of a building foundation, and
- direct vibratory cracking in a building due to ground vibrations

Whether damage to nearby home[s] occurs because of blasting depends on the magnitude of the induced vibrations and the quality and type of home construction [p. 1].

In 2009, Lafarge Aggregates reached a settlement with Forsyth County agreeing to pay $3.7 million for land disturbance from blasting that caused damage to county infrastructure, including roads and water tanks, during the period of December 2005 through to February 20, 2009. Shifting ground beneath the northwest section of the quarry forced the relocation of two nearby residents and closed a mile-long stretch of road for several months. Approximately 11 acres (4.452 hectares) were impacted by the blasting, and the ground was reported to be moving as fast as 4 inches (101.6 millimetres) in 24 hours on certain parts of the property, where it began to shift into the quarry.[123]

An investigation of a 1.2-square mile (3.108 km^2) area that contained a trailer park, houses, farmland, and the Vulcan Materials marble quarry, in which 210 people resided, was undertaken by the South Carolina Water Resources Commission (SCWRC). The following complaints from citizens about wells drying up and having poor water quality due to blasting at the

[122] Jeff Loeb and Dwayne D Tannant, "Urban Construction Blasting in Canada – Complaints and Associated Municipal Bylaws," (2014) 2 (1) Civil Engineering Architecture, 1-10, <https://www.hrpub.org/download/20131215/CEA1-14801317.pdf>.

[123] Frank, R., "Deal struck in lawsuit over land disturbance near quarry," *forsythnews.com*, March 25, 2009, <https://www.forsythnews.com/local/local-government/deal-struck-in-lawsuit-over-land-disturbance-near-quarry/>.

Vulcan Materials marble quarry in Cherokee County, South Carolina are worth noting:[124]

- The geology of the area is characterized by intensely folded and faulted rocks, which greatly influence ground water properties. Wells are generally of medium to low yield and water quality is generally good.
- The Piedmont SCWRC Office set out on the following objectives: (1) To identify problems that local residents are experiencing; (2) To evaluate the extent of the problems; (3) To determine the cause(s) of these problems;
- Water levels were measured in 31 wells during March of 1986 to construct a water table map. Automatic data recorders were installed on two deep wells to monitor water levels continuously. Blasting records and other information were obtained from the quarry.

The following conclusions were reached:

- Problems: Several residents complained that, after blasting at the quarry, their wells would dry up temporarily or the water would become silty or have an "iron taste". A more common complaint was that of ground vibration from the blasting, in some cases, causing structural damage to houses and/or wells.
- Extent: An estimated 60 families live in the general area and 37 of these were contacted by the SCWRC. Fifty-four (54) wells were inventoried, and descriptions of problems were taken from residents. Of the wells inventoried, 59 percent have had water problems. Of those wells with problems, drilling new wells solved 19 percent or installing water filters. Of the seven families still having problems, five have water quantity and quality problems while two have only water quality problems.

Causes of hydrologic problems:

- Topographic and drainage modifications by the quarry resulted in lowering of the water table and a reduced ground-water recharge area. These changes proved critical for wells upgradient from the quarry.
- Water quality has been adversely affected in ungrouted wells that allow loose material along the wellbore to travel down the outside of the well casing and enter the well hole after blasting or rainfall.

In *Koeman v. Pacific Blasting & Demolition Ltd.*, 2003,[125] drilling and repeated blasting between 1999 and 2001 at an adjacent real estate development was found to be the cause of damage to the Koeman's home, in which the Koemans had lived for 24 years. [4] The plaintiff complains of

[124] Joffre Castro, et al., "Investigation of Ground-Water Problems Near Vulcan Materials Marble Quarry, Cherokee County," South Carolina, Hydrology – Open-File Report 19, <https://hydrology.dnr.sc.gov/pdfs/reports/SCWRC_Open-File_Report_19.pdf>.

[125] *Koeman v. Pacific Blasting & Demolition Ltd.*, 2003 BCPC 147 (CanLII), <https://canlii.ca/t/5b7k>, retrieved on 2021-03-15.

drilling and repeated blasts of explosives (168 blasts) [sic should read 188] with cumulative effect which he lists as:

- The noise and dust, vibrations and shocks have been severe.
- The complete house shakes and vibrated during many blasts.
- The engineer from Metro Blasting said that the shaking of the drilling is even worse than the blasting for damage
- Consistently my wife has a headache because of noise. And me too.
- Her nervous system is also affected by the blasts.
- Pictures just about daily have to be straightened out.
- Stuff falls of[f] the selves
- Dirt and dust are everywhere
- If I am on the phone in my study, I sometimes have to hang up because the noise makes it impossible to hear the other party.
- Even in the middle of a beautiful day all doors and window[s] must be kept closed.
- On weekdays it is impossible to sit outside on many of my patios or decks.
- In my wine cellar 35 bottles of wine that were sitting against the concrete wall popped of which, except for the last item, these are substantially matters of nuisance.

The Court ruled in favour of the homeowners, concluding as follows:

> *"[21] This Court is satisfied that there is damage to be found in the claimant's home much as he described and some of which can probably be attributed to repetitive blasting. This Court is satisfied that there was repetitive blasting in the vicinity of his house."*
>
> *"[22] This Court concludes that in all probability no individual blast had sufficient concussive force, either by air pressure or ground wave, to cause damage. However, there are numerous blasts set off over time, each with measurable force, most of which could probably be detected at the claimant's residence."*
>
> *"[23] The total effect could have resulted in cracks to the house, mostly in a high wall which was without much in the way of lateral support."*
>
> *"[24] The loss of bottles of wine poses an interesting question that is, how did the bulk of the stock of wine remain unaffected while only 35 bottles in a very localized area pop?"*
>
> *"35[b]ottles from a fairly large stock of wine were lost during the time period in question. They were first described as broken, then as having their corks pop out. This point raises some question of the reliability of the evidence as it relates to the wine. Nevertheless, it is not in dispute that the wine was lost. It does not seem contrary to probability that repeated vibration of stacked bottles of wine would be vulnerable to damage. And in this, that is accepted."*

While damage caused by flyrock debris is self-evident and difficult to refute, quarry operators routinely deny damage caused by airblast and vibrations arguing that the blasting is occurring within regulatory limits and that there is no possibility of damage. In *Dykes, et al. v. Peabody Shoreline*

Geophysical, (1985),[126] three homes were damaged by vibrations from blasting, and the defense of "scientific impossibility," used with minimal success in other blasting cases, was rejected. "...Peabody offered the argument of "scientific impossibility." This consisted of testimony by an expert in explosives and stress analysis who holds degrees in mathematics and physics. The witness purported to show by mathematics and scientific calculations, that it was a total impossibility for the explosion to have caused the damage. This defense has been used before in blasting cases, with minimal success. Given the choice between an obvious fact and a technical, scientific denial of that fact, our courts have refused to accept the denial." [citation omitted]

In *Wiley, et al.*,[127] *v. Pittsburg & Midway Coal Min. Co.*, (1987),[128] the Missouri Court of Appeals acknowledged that when property is damaged by *concussion* or *vibration* from blasting, there is liability for the invasion irrespective of negligence. Damage to property by *concussion* or *vibration* from blasting must be demonstrated by circumstantial evidence because the concussions or vibrations that travel through the air or the earth cannot be seen.[129] From cases such as Summers v. Tavern Rock Sand Co., 315 S.W.2d 201 (Mo.1958), it appears that a submissible case for damages caused by blasting may be made on testimony that vibrations were felt coincidentally with the detonation of the explosive and that physical evidence of structural damage was observed thereafter. Thus, in the present case, plaintiffs' testimony of the vibrations sensed, corroborated by the calendar diaries, and the perceived cracks in walls and floors was enough at least to survive a motion at the close of plaintiffs' evidence.

In *Clay v. Missouri Highway & Transportation Commission*, et al. and Max Rieke & Brothers, Inc., (1997),[130] the Clays' property, located some 0.85 miles (1,368 metres) from where 'controlled' blasting of rock for the sides of a highway was taking place, suffered damage. The blasting affected the quality and quantity of the water coming from the aquifer, and that due to cracks caused to the aquifer from blasting, sediment such as sand and oil contaminated the aquifer and, ultimately, the Clays' well-water. The water level of their well dropped, and the water flow in their well was drastically reduced. The Clays had to haul two six-gallon cans of water per day from the day the water was polluted in February 1990 until city water was

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[126] *Dykes, et al. v. Peabody Shoreline Geophysical*, 482 So.2d 662 (1985), <https://scholar.google.com/scholar_case?case=10693979160760880282&q=quarry+blasting&hl=en&as_sdt=2006>.

[127] "A number of other plaintiffs were in the case at trial. Some who received smaller judgments have been paid." [Footnote 1]

[128] *Wiley v. Pittsburg & Midway Coal Min. Co.*, 729 S.W.2d 228 (1987), <https://scholar.google.ca/scholar_case?case=16844615106345768138&hl=en&as_sdt=2005&sciodt=2006>.

[129] *Donnell v. Vigus Quarries, Inc.*, 526 S.W.2d 314, 316 (Mo.App.1975); *Poston v. Clarkson Construction Co.*, 401 S.W.2d 522, 525 (Mo.App.1966).

[130] *Clay v. Missouri Highway and Transp. Com'n*, 951 S.W.2d 617 (1997), Mo. Court of Appeals, Western Dist., <https://scholar.google.com/scholar_case?case=6636206402696025097&q=clay+v+missouri+highway+and+transp+com%27n&hl=en&as_sdt=2006>.

installed in October 1994. The appeal court acknowledged the damage sustained by the Clays, commenting as follows:

> *"This type of damage is equally serious and equally likely to affect the value of property as is damage caused by vibrations or concussions on the property. We find the Clays' proof of damage was sufficient to support strict liability for blasting..."*

The damages awarded the Clays against either MHTC or Rieke were $19,640 for the diminution in the value of the Clays' property, with the award for *loss of use* damages of $2,700 recoverable only from Rieke.

In *Associated Contr. Stone v. Pewee Val. San. & Hosp.* (1963),[131] the Kentucky appellate court upheld the lower court's injunction preventing a proposed quarry from being established a short distance southeast of the City of Pewee Valley, in a rustic neighborhood with no industry and no public water supply. The suit to prevent operation of a blasting quarry was brought by over 50 parties, with proof clustered along three salient issues:

1) Lowering of the "water table" likely to result from drainage of underground waters, by force of gravitation, to and out of the face of the quarry when the rock formations are cut open;
2) Damage to the natural water supply through disturbance, by the use of explosives at the quarry, of underground barriers that now serve to impound the water; and
3) Disruption of the peace and quiet by vibrations from blasting.

Apart, however, from the water phase of the case, there is other and more positive proof that the operation of the quarry will materially affect the peace and quiet of the neighbors in the enjoyment of their homes. It so happens that before the institution of this proceeding the defendants set off at the quarry site a 2,000-lb.[907-kilogram] test charge of dynamite, a quantity they admit having been substantially smaller than they expect to use routinely. This blast was heard, and the tremor felt by several of the plaintiffs in their homes nearby. One said that his television set, the chimney, and "every window in the house" shook. Another said the noise caused his wife to jump up and scream and the concussion "actually blew the curtains out." Some of the plaintiffs live directly across the road from the quarry property. If their homes were shaken by the test shot, it is certain that they would be repeatedly shaken by the larger shots expected to be used in the regular course of business. We think this is an interference they should not be forced to suffer.

...[B]y their own stipulations and admissions during the course of trial the defendants left no room to suppose that they could or would conduct their operations in any manner or on any scale that would not involve a shaking of the environs occupied by the plaintiffs. Their case was honest and forthright. They made no pretense that this particular result would not be a necessary incident of their business as they intended to operate it.

[131] *Associated Contr. Stone v. Pewee Val. San. & Hosp.*, 376 SW 2d 316 (1963), https://scholar.google.ca/scholar_case?case=5042499607404372 94&q=%22quarry%22+and+%22concussion%22&hl=en&as_sdt=2006. Rehearing denied March 20, 1964.

The evidence established with reasonable certainty that the dwellings of at least some of the plaintiffs would be subjected for an unlimited period in the future to the process of being shaken to such a degree as to constitute a material and continuing annoyance. This is no less real, no less unreasonable, and no less wrongful an invasion than a direct trespass. The distinction between a nuisance and a trespass in this respect is without substance or justifiable effect. Cf. Bartman v. Shobe, Ky. 1962, 353 S.W.2d 550, 555. The chancellor's finding that a nuisance necessarily would result was not clearly erroneous.

As noted in the Northern Kentucky Law Review (Vol. 8/323),[132] in reference to an Ohio case involving damage caused by blasting, that blasting was conducted with "due care" and in a "scientific manner" is no defense and offers no comfort to the owner or tenant whose property has been damaged. It reads:

> *"If the means employed [blasting] will, in the very nature of things, injure and destroy his neighbor's property, notwithstanding the highest possible care is used in handling of the destructive agency, the result to the adjoining property is just as disastrous as if negligence had intervened. If one may knowingly destroy his neighbor's property in the improvement of his own, it is little consolation to the neighbor to know that his property was destroyed with due care and in a scientific manner [p. 334]."*

In *R. v. Chenard*, Ontario Court of Justice, (2005),[133] *vibration* that escaped from a blast site was held to be a contaminant, pursuant to Section 1(1) of the EPA, which had the potential to cause an *adverse effect* (Section 14(1)). The appeal court found that the Justice of the Peace failed to consider the words "or was likely to cause an adverse effect" or to consider "the accumulative effect of all 32 blasts" in determining whether the contaminant *vibration* from blasting rock was the cause of the *adverse effect*:

> *"Based on the evidence that was adduced during the course of the four-day trial, it is evident to me that the Justice of the Peace did not consider the words "or was likely to cause an adverse effect" or to consider the accumulative effect of all 32 blasts, including those on 6th of September 2001 [para.43]"*

In *SDI Quarry v. Gateway Estates Park Condominium Association*, (2018),[134] repeated blasting at the only quarry in the area at a distance of 7,000 feet (2,134 metres) from man-made South Lake, which forms part of a mobile home condominium, was found by the Florida appeal court to be the cause of the damage to the South Lake shoreline collapsing 3.5 feet (1.07 metres). The community was exposed to an average of 20 blasts a year from the quarry, and each blast was monitored, and the vibrations recorded. All were within lawful levels established by state law (peak particle velocity (PPV) of 0.5 inches per second (12.7 mm/sec), and none of the blasts exceeded 0.2

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[132] <https://chaselaw.nku.edu/content/dam/chase/docs/lawreview/v8/nklr_v08n2.pdf>.

[133] *R. v. Chenard*, 2005 ONCJ 501 (CanLII), <https://canlii.ca/t/1mfqs>, retrieved on 2022-02-03

[134] *SDI Quarry v. Gateway Estates Park Condominium Association*, 249 So.3d 1287 (2018), <https://scholar.google.com/scholar_case?case=5383564357932576454&q=SDI+v+Gateway&hl=en&as_sdt=2006>.

in/sec (5.08 mm/sec) PPV at South Lake, with most being 0.1 in/sec (2.54 mm/sec) PPV. No damage to South Lake was evident for five to six years of blasting until 2011, when its shore first began to show signs of destabilization. "That the blasts were all within state standards...doesn't negate potential liability." Blasting continued without interruption, and between July 1, 2015, and October 17, 2016, there were 25 blasts. Based on this figure the judge inferred that the number of historical blasts that had impacted the South Lake shoreline was 200 to 250 and ordered the quarry operator to pay $840,000 to repair the damage to the shoreline. The judge observed the following:

> *"In 2011, about five or six years after Appellee began its blasting activities soil at the edge of the lake began to slough and slump into the water. This opened up fissures in the slope, which undermined the upward bank. In time, holes appeared in the bank, and pieces of the once level surface fell off, resulting in a narrowing of the horizontal area from roughly five feet [1.524 metres] to about a foot and a half [0.457 metres]. Respondents observed the ground falling into the water in close temporal proximity to the blasting."*

10. QUARRY OPERATIONS GENERATE PUBLIC COMPLAINTS

Land uses and developments that are planned and designed to avoid incompatibility with their surroundings, now and in the future, prevent or minimize conflicts and avoid dangers to the public health, safety and welfare, and the environment. Aggregate extraction is a destructive and noxious use of land that is notorious for generating public complaints, with the frequency of complaints increasing with the scale and intensity of operations. As the scale and intensity of aggregate operations become increasingly larger, there is a corresponding increase in the short- and long-term adverse impacts, the duration of public complaints, and potential lawsuits. Santa Clara County compiled and issued the review of violations taking place at the Lehigh property, a cement plant and quarry operation on 900 acres (364.217 hectares), in unincorporated Cupertino, California. The Housing, Land Use, Environment and Transportation (HLUET) Committee reviewed the May 19, 2022, report, and forwarded the report to the Board of Supervisors for its consideration.[135] The report says:

> *"The report reviewed records from 15 local, state and federal agencies, as well as the record of pending and past litigation, between Jan. 1, 2012, and Dec. 31, 2021. More than 2,135 violations resulting in millions of dollars in fines and penalties were identified."*

A general list of concerns and complaints expressed by residents adversely impacted by blasting quarry operations compiled by the San

[135] "Report reveals more than 2,100 violations at Lehigh quarry," *Town Crier Report*, Jun 14, 2022, <https://www.losaltosonline.com/news/report-reveals-more-than-2-100-violations-at-lehigh-quarry/article_409c869a-db51-11ec-9093-2b46c9b2d896.html>.

Diego Union-Tribune (Oct 18, 2009)[136] is reproduced below followed by an analysis of five formal surveys of residents in other jurisdictions impacted by aggregate extraction operations.

- They [quarry operators] destroy communities;
- They cause nervous, health, and sleep disorders in their communities;
- People move away. Good luck selling your seriously depreciated house, though—to whom?... [unsuspecting home buyers are often unaware or uninformed about the adverse effects of residing near a blasting quarry operation, and overpay];
- They are fined constantly by authorities. Sort of like a parking ticket. It's just a minor cost of business;
- They poison groundwater supplies with the deadly benzene runoff from the ammonium nitrate explosives;
- They damage houses with the blasts: e.g., cracked plaster, structures shifting off foundations (...[N]ote that in the Massachusetts Web site..., the insurance companies won't cover the tens of thousands of dollars' damage from nearby mining companies.); [and]
- Huge pieces of "flyrock" (isn't that a quaint new term!?) land as far away as three miles [4.828 kilometres] from the mine blasting, terrorizing residents and damaging houses (amazingly only one killed so far). Check the Nashville, Tenn., Web site for flyrock details of several nearby interstate highways closed down after huge boulders land on the road. The death was in West Virginia, of a little boy killed in his bed by flyrock smashing through his bedroom window.

10.1 Survey One

As referenced in the July 2014 Department of State Development *Resource Area Management and Planning Final Report*,[137] the *Urban Growth Management for Metropolitan Adelaide* report discusses the findings of complaint data received by quarry operators, the EPA, PIRSA (Department of Primary Industries and Regions), and the City of Tea Tree Gully with regards to excavation activity within and adjacent metropolitan Adelaide, and indicates average distances of around 500 to 700 metres (1,640 to 2,297 feet) "capture" the majority of complaints for hard rock quarries. The inferences drawn are:

- The majority of complaints received were in relation to blasting activities, with the average distance for these complaints occurring at 489m [1,604'] from the mine/quarry. [2.3.2, p. 20]

[136] Biddle Jr Nicholas, "Forum: National anti-quarry 'tea party' blasting across Web," <https://www.sandiegouniontribune.com/sdut-forum-national-anti-quarry-tea-party-blasting-2009oct18-story.html>.

[137] Department of State Development, *Resource Area Management and Planning Final Report*, July 2014, <https://energymining.sa.gov.au/__data/assets/pdf_file/0020/240662/2014-07-22_DSD_Resource_Area_Management_and_Planning.pdf>.

- Dust was also a common complaint, the average complaint distance relating to dust from hard rock quarries occurred at a distance of 690m [2,264']...indicating that blasting activity is likely to cause dust to travel further distances. [p. 20]
- The average distance for noise complaints for hard rock quarrying was 675m [2,215']...[p. 20]
- The highest frequency of complaints for hard rock quarries occur between 500m and 550m...[p. 20]"

The findings of the Adelaide study show that while 60% of blasting complaints were received at a distance of 500 metres or less, noise complaints from blasting quarries occurred at an average distance of 675 metres. This suggests that a separation distance of at least 675 metres (2,215') is needed from a blasting quarry operation to reduce complaints from nearby residents. (p. 20).

10.2 Survey Two

Pursuant to Interim Control By-Law No. 05-15 passed by the Township of Zorra, which placed a one-year freeze on new aggregate extraction operations, Oxford County, in 2015, undertook a survey of County residents with the intent to develop recommendations for appropriate amendments to the County Official Plan and the Township of Zorra Zoning By-law with respect to aggregate extraction operations.[138] A total of 67 survey responses were received from residents with 83.6% residing either in the Township of Zorra or the Town of Ingersoll. Most of the residents indicated that they were usually at home during the day. The findings from the residents surveyed are summarized as follows:

- 60% of respondents who described themselves as living within 1,000 metres of a pit or quarry indicated that they moved to their current location before operations began.
- 64% of respondents stated that there were no benefits to living within 1,000 metres of an existing or rehabilitated aggregate operation.
- 52.2% of respondents, in response to an open-ended question, attributed pit/quarry operations to negative impacts, including property values, road safety, road infrastructure, property damage, health impacts and other (dust, noise, landfill, trespass, visual, non-adherence to haul route, agricultural productivity).
- Residents consistently attributed pit/quarry operations to negative impacts on the ability to enjoy personal outdoor amenity space (i.e., backyard/nature) and driving (due to road safety and infrastructure damage attributed to pit/quarry trucks).
- Resident respondents identified most frequently being 'very concerned' with the potential impact pit/quarry operations have on ground water quality.

[138] Aggregate Policy Review Study, Resident and Operator Survey Results, *Oxford County*, 2015,

The Oxford resident survey has a number of shortcomings in that no distinction is made between the 77 licensed pits and 2 licensed quarries, the latter of which has the potential for significantly more adverse effects on the environment and the surrounding communities. There are only two blasting quarry operations within Oxford County (Lafarge and Carmeuse), one of which is in a remote location. Therefore, the resident survey essentially addresses complaints related only to the operation of *pits*. Given the greater number of adverse effects associated with a *blasting quarry operation*, more than 1,000 meters might be necessary to separate incompatible land uses and to reduce the number of resident complaints.

10.3 Survey Three

A questionnaire sent by Adelola and Nenuwa (2017)[139] to 150 residents residing in proximity to 3 different quarries in Nigeria resulted in 127 responses regarding the adverse impacts from quarry blasting. The respondents most severely impacted by the blasting quarries reside within 2 kilometres of each of the three quarries, and the responses to the questionnaire were analyzed using percentage distribution with respect to complaints of shock wave (ground vibrations), dust, noise, blown roof, wall crack, window shatter and landslide:

- The Ikere community is the most affected by shock wave [ground vibrations] as 73.7% agreed that it is common, at Ikole community, 31.3% complained of shock wave while at Igbemo, 46.3% confirmed the incidence of shock wave. According to these group of people shock wave is usually felt by the human body whenever there is blasting at the quarry. The shock waves [ground vibrations] travel through the earth and cause the ground to vibrate which constitutes nuisance to the environment and sometimes lead to restiveness of the human body. The situation is similar to the circular ripples produced on the surface of a pool of calm water when it is struck by a rock....The aged members of the communities are more adversely affected by the shock wave.
- At Ikere-Ekiti, 44.7% of the respondents said that dust is one of the effects of ground vibration, at Ikole-Ekiti 52.1% agreed to this fact, while 41.5% said dust problem is more severe when the level of ground vibration is high. Dust problem is experienced more during the dry season than rainy season, high temperature will aid vibration and consequently loose soil particles will be suspended in the air. Most of the people affected by dust are those who reside very close to the quarry site.
- Noise effect is highest at Ikole-Ekiti as 52.1% agreed that ground vibration is accompanied by noise, 18.4% said noise is one of the effects of ground vibration at Ikere-Ekiti, while 26.8% of the

[139] Adetiloye Adeola and Nenuwa Olushola B., 'An Investigation of the Effect of Ground Vibration during Blasting Operation in some Selected Quarries in Ekiti state, Nigeria', (2017) 6 (8) International Journal of Engineering and Science 41-47. <https://doi.org/10.9790/1813-0608024147>

residents at Igbemo_Ekiti complained about the problem of noise. Some waves usually escape in the form of noise, although this phenomenon is not significant in two of the study area (Ekere-Ekiti and Igbemo-Ekite).

- The incidence of blown roof...in the study areas...[is] 21.1% complained about at Ikere-Ekitit, 31.3% at Ikole-Ekiti and 12.2% at Igbemo-Ekiti. Majority of those who complained about blown roof are artisans who owned small sheds or shops and elderly respondents who live in very old houses, some of the houses, shops and sheds in these communities are old and the roofing materials are very weak. These roofs are more weakened by shock waves received from ground vibration and they are usually blown off by winds or rainstorms.
- The case of wall crack was observed at Ikere-Ekiti by 31.6% of the respondents; at Ikole-Ekiti by 41.7% of the respondents and 26.8% of the respondents at Igbemo-Ekiti said wall crack is a ground vibration problem. Although vibration damage usually first appears as extensions of old cracks, the plaster which is the weakest material in the building is the first material to form new cracks.
- Window shatter was observed by 36.8% of the respondents at Ikere-Ekiti, 10.4% of respondents at Ikole-Ekiti agreed that window shatter is caused by ground vibration while 17.1% of respondents at Igbemo-Ekiti confirmed the statement. Ground vibration during blasting releases shock waves which cause sudden expansion and contraction of windowpanes, this leads to shattering of the windows. This occurrence is common when there are old cracks on such windowpanes.
- Although landslide is not commonly experienced in the study areas, few respondents still believed ground vibration during blasting is responsible for earth movement which have led to some cases of rock falls, deep failure of slopes and shallow debris flows and bench collapse in and around the quarry areas. 7.9% of respondents at Ikere-Ekiti agreed to this fact. 18.8% at Ikole-Ekiti agreed while just 2.4% of the respondents from Igbemo-Ekiti believed landslide is one of the effects of ground vibration during blasting. Landslides occur when the slope changes from a stable to an unstable condition. A change in the stability of a slope can be caused by ground vibration during blasting.

10.4 Survey Four

A survey undertaken by Oluwatofunmi and Bibilari (2018)[140] of 90 residents randomly selected and residing in proximity to two blasting quarries disclosed significant concerns over a number of environmental impacts, with the scale and intensity of quarry operations being a significant

[140] Akinwamide D Oluwatofunmi and Idris O Bibilari, "Locational Effect of Quarry Sites on Residents' Satisfaction and Environment if Proximate Residential Neighborhood in Akure," (2018) 4 (3) Journal of Environment Protection and Sustainable Development, 38-45.

factor in determining the level of environmental pollution. Environmental pollution, which is a health, safety and environmental concern, remained extremely high within a distance of 2 kilometres from the two blasting quarries:

i. Degradation of farmland and roads,
ii. River siltation/farm flooding,
iii. Noise from quarry operations
iv. Vibrations from rock blasting,
v. Air pollution/dust generation and
vi. Destruction of biodiversity

The 90 residents surveyed were divided into 6 groups each with 15 residents at half-kilometre intervals from the quarry starting from 0.0 km to 0.5 km to beyond 2.5 km. Following observations were recorded:

- Within 0.5 kilometres 100% of the 15 residents experienced "very high" or "high" levels of environmental pollution.
- Within 0.6-1.0 kilometres 100% of the 15 residents experienced "very high" or "high" levels of environmental pollution.
- Within 1.1-1.5 kilometres 86.7% (13 residents) of the 15 residents experienced "very high" or "high" levels of environmental pollution.
- Within 1.6-2.0 kilometres 60.0% (9 residents) of the 15 residents experienced "very high" or "high" levels of environmental pollution
- Within 2.1-2.5 kilometres 63.3% (8 residents) of the 15 residents experienced "very high" or "high" levels of environmental pollution.
- Beyond 2.5 kilometres 26.6% (4 residents) of the 15 residents experienced "very high" or "high" levels of pollution

Overall, within 1 kilometer (0.621 miles) of the blasting quarry operations 100% of the 30 residents experienced "very high" or "high" levels of environmental pollution; and within two kilometres (1.243 miles) 52 of the 60 residents or 86.7% experienced "very high" or "high" levels of environmental pollution.

10.5 Survey Five

In December 2020, Jefferson M. Domingues et al. had the results of a survey questionnaire analyzing the impact of quarrying operations on the health and perception of neighbouring communities in the city of Lavras, Minas Gerais, Brazil, published in the Journal of Environmental Science and Sustainable Development.[141] Data from 177 residents were analyzed with logistic regression models, with distance from the quarry and length of residency used as covariates in the logistic models to quantify residents' satisfaction with and perception of quarrying activity intensity and its

[141] Jefferson M Domingues, Vania F L Miranda, Denise C Rezende, Yar S Lares, "Statistical Modeling of Quarrying Activities and Their Impact on Residents' Satisfaction," (2020) 3 (2) Journal of Environmental Science and Sustainable Development 416-429. <https://scholarhub.ui.ac.id/cgi/viewcontent.cgi?article=1062&context=jessd>.

impact. Residences in proportion to their population were distributed based on proximity to a quarry operation, resulting in three equally distant radii: Area I (closest to the quarry at 630 metres are 32 houses); Area II (730 metres with 64 houses); and Area III (farthest from the quarry at 830 metres are 81 houses). The sample size was calculated by setting the confidence level at 95% and a maximum error of 5%, and included qualitative variables in response to the following questions:

- *Do you think the quarrying activities cause damaged to your house?* Compared to residents in Area III (farthest from the quarry at 830 metres), the odds of residents believing that quarrying can cause damages to their homes are seven times higher for residents in Area 1 (closest to the quarry at 630 metres) and five times higher for the residents in Area II (730 metres from the quarry).
- *Do quarrying activities cause any kind of nuisance (noise, quakes, dust)?* In Area I, experiencing nuisances, the odds are more than 18 times those for Area III, and regardless of the area, nuisances increase as the length of residency increases.
- *Do you think your house is affected by the blasting of rocks?* Several respondents reported cracking after long periods of repeated detonations, and residents complained of discomfort during detonations and associate cracking and cracking problems caused by quarry activities. The odds of Area I residents believing their home is affected by blasting may be 10 times higher than those of the residents in Area III, and for the residents in Area II, the odds maybe five times higher than for those residents of more distant areas. The odds of obtaining unfavourable responses from residents to quarry blasting also increase as the length of residency increases.
- *Do you think your house falls within the high-risk area?* The odds of Area I residents believing their home is in a high-risk area are approximately seven times higher than those of the Area III residents.
- *Are you satisfied with the presence of the quarrying company?* In determining residents' satisfaction, the odds of Area I residents being indifferent or satisfied with the presence of the quarry operation are approximately a third of the odds of the Area III residents.

The relocation or turnover rate indicated by the average length of residency of 2.22 years for Area I, the area closest to the quarry and most adversely affected, is approximately 1.8 times more frequent than the average length of residency for Area II (4.02 years) and 2.4 times more frequent than the average length of residency for Area III (5.28 years), the area farthest from the quarry.

11. EXAMPLES OF COMMUNITIES DESTABILIZED BY BLASTING QUARRY OPERATIONS

In one of the most disturbing examples of a community decimated by the operations of a surface coal mine, complaints from homeowners about blasting, dust and flyrock became of such concern, the mine owner (Arch Coal) hired land agents and embarked on a plan to buyout nearby residents in the Town of Blair, West Virginia.[142] The details associated with the destabilization of the community are summarized as follows:

- Between 1990 and 1993, four families who lived in the Blair area sued Dal-Tex, the then owner of the mine, for blasting damage, loss of well water, and dust and noise nuisances. Three of the cases settled out-of-court, with the terms of the settlement never disclosed, and in the fourth case a local judge dismissed the allegations against Dal-Tex.
- According to the 1997 article "Shear Madness," (U.S. News & World Report), subsidiaries of Arch Coal purchased more than half of the 231 homes in Blair. "Vacated and stripped, at least two dozen have been burned down by arsonists," Subsequently, the elementary school and the town's only grocery stores closed.

Blair residents who wanted the company to buy their property had to sign agreements that they would never again protest a strip mine and were required to promise not to live or own property in a 25-square-mile area around Arch Coal's mining operations. One of the families (the Moores), who had lived in Blair for six years, got tired of the blasts that shook their home and rattled windows, and the dust that aggravated their son's asthma, but the Moores refused to sell their property to the companies affiliated with Arch Coal. In 1997, the Moores commenced an action against the companies alleging that the companies "conspired with each other to operate and implement what they have identified as a 'target property acquisition' program which was intended to force and coerce [the Moores] and other families residing near the Dal-Tex complex to move forever' from their homes in the Blair area." Arch Coal settled the case and paid the Moores $225,000, of which $35,000 was paid for their three-quarter-acre lot and the mobile home that sat on it.[143]

In another example of a destroyed community, residents near the Malartic open pit mine in Quebec filed a $70 million class action suit for the impacts on 700 houses and 1,400 people located closest to the blasting quarry operation. The class action suit, launched on August 1, 2016, aimed to

[142] Ken Ward Jr., "Buying Blair: Arch Coal found way to move residents away", (Oct 25, 2017) Charleston Gazette-Mail, Updated. <https://www.wvgazettemail.com/news/special_reports/buying-blair-arch-coal-found-way-to-move-residents-away/article_c9999d45-538b-56cb-9300-aa5894c048cf.html>.

[143] Ken Ward Jr., "Buying Blair: Arch Coal found way to move residents away", (Oct 25, 2017) Charleston Gazette-Mail, Updated.

compensate damages related to *dust, noise* and *daily blasts*.[144] In this effect, the following points are important:

- The company itself admitted the impacts of its mine on local community members and has agreed, on 1 September 2016, to offer $50 million relocation and compensation package for the 3500 residents of Malartic, some of whom live up to about 2-2.5km [1.24-1.55 miles] away from the mine site at the city limits....
- The Canadian Malartic gold mine is currently the largest urban mine in operation in Canada. Despite having spent millions to date in mitigation measures and using best available practices, the mine is incapable of meeting regulated levels and has incurred some 4000 environmental infractions since construction started in 2009 [and mining started in 2011]. The mine is now seeking an expansion permit which would increase the length of the open pit from 2.5km to 3.5 km [1.55 to 2.17 miles], and nearly double the total volume of rocks extracted.
- Community members also launched an injunction asking the court to order the company to respect laws and regulations at all time from now on.

Court documents offer insight into the establishment and operation of the Malartic open pit, and its adverse impacts on the community, which preceded the Class Action Lawsuit.[145] The court observed that:

> *"Mining started in 2011 and is scheduled to end in 2028. Its activities are a source of various troubles and inconveniences for its neighbors [para. 4]... Conscious of these repercussions, the Respondent invited members of the community to participate in a working group (Working Group). Its mandate is to "develop a document with the local community to equip itself with a framework and guidelines in order to cancel, mitigate and/or compensate for the impacts generated by the operations of the mine."*

The Working Group was made up of twelve members, i.e. three representatives of the Respondent, three representatives of the City of Malartic, three representatives of the Monitoring Committee and three representatives of the Citizens Committee of the southern zone of the Malartic railway (Citizens Committee). The latter, however, withdrew after a few working meetings and are today at the origin of collective [class] action [para. 5]. The Working Group finalized the Guide to cohabitation aimed at mitigating and compensating for impacts and the acquisition of properties in Malartic (Guide) following a period of 15 months of analysis, writing and phased consultation between May 2015 and August 2016, before the application for authorization to exercise collective action from 1st *August 2016. The Guide* entered into force on 1st September 2016, before the decision

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[144] Ajax Mine, "Miningwatch Predicts $100 Million in Compensation," (October 25th, 2016). http://www.kapa-kamloops.ca/stop-ajax/blog/miningwatch-predicts-100-million-in-compensation.html.

[145] *Trottier v. Canadian Malartic Mine*, 2018 QCCA 1075 (CanLII), < https://canlii.ca/t/hsqwn >, consulted on 2021-05-02. Also see *Lemire v. Canadian Malartic*, 2019 QCCS 849 (CanLII), <https://canlii.ca/t/hz4rq>, consulted on 2 May 2021.

of authorization "bring the class action, dated May 5, 2017 [para. 6] [footnote omitted]

The Guide includes a program to compensate residents and owners of Malartic for past and future inconveniences suffered as a result of mine activities.... It offers compensation for material impacts, inconvenience and inconvenience caused by dust, vibrations from blasting, noise, air quality, loss of enjoyment, stress and fatigue. The targeted territory is divided into three zones, circumscribed according to "the impacts measured on noise, dust and blasting" [para. 7]. The Guide proposes indemnities payable by periods, at the end of these periods. The first two periods ranging from 1st July 2013 to 30 June 2016 and 1st July 2016 to 31 December 2016. Subsequent annual periods from 1st January to 31 December each year. The compensation amounts are adjusted on 1st July of each year from 2017, according to the consumer price index for Quebec established by Statistics Canada [para. 8]. [footnote omitted]

For the first two periods expiring on December 31, 2016, a very large majority of residents and owners of the Town of Malartic, that is to say 83% of the members of the group targeted by the collective action, took advantage of the Guide. They asked for compensation, and they received the compensation payable. The Guide foresees an application until 2028, which corresponds to the end of the planned activities of the mine [para. 9]. In the authorization judgment of May 5, 2017, the judge assigned the appellant the status of representative for the exercise of the class action, and he defined the group as follows:

> *"All persons who, since 1st August 2013, are owners, tenants or residents, or are owners, tenants or residents of buildings in the center districts, East and Laval of the town of Malartic, bounded by the...railway to the north, by chemin du Lac Mourier to the west, by the mine to the south and by avenue Champlain to the west, in addition to the residents of chemin des Merles in Rivier-Heva, including the owners of the buildings included in this area, even if they do not live there, as well as tenants of commercial buildings [para. 10]"* [footnote omitted]

An October 15, 2019 news release[146] reported that Canadian Malartic Mine Corporation reached an out-of-court settlement with the defined group in the Class Action lawsuit, which the court confirmed on December 13, 2019:

> *"This agreement includes additional compensations for the residents located closest to the mine site, within 800m (2,625') of the pit edge,"* stated Ugo Lapointe of Coalition Quebec Meilleure Mine and MiningWatch Canada....

Although out-of-court settlements are almost always the results of compromises between divergent interests, the groups recognize the following benefits to the affected citizens:

- ending years of litigation and avoiding a four-month long, costly hearing...[scheduled for] 2020;

[146] Mining Watch, "Largest Gold Mine in Canada Settles with Affected Citizens Out of Court," (October 15, 2019) Mining Watch.

- retroactive compensation for the years 2013 to 2018;
- additional compensation of up to $1.7 million for house retrofitting and renovation for all the property owners; and
- no legal fees or costs for the citizens.

12. QUARRY BLASTING IMPACTS UNIQUE TO EVERY RESIDENTIAL PROPERTY

In *Frieman v. San Rafael Rock Quarry Inc.*, (2004),[147] pursuant to a June 2001 Marin County (California) Grand Jury report,[148] which was critical of the county's handling of complaints against the 750-acre San Rafael Rock Quarry and recommended the district attorney institute a nuisance abatement action against the quarry, the homeowners were unsuccessful in their motion for a class action. The nuisances identified in the Grand Jury's report consisted of *dust, noise, blasting* and *truck traffic* attributed to a substantial unlawful expansion of the quarry in 1986 without permits, including unlawful construction of office buildings. The appellate court upheld the trial court's refusal to certify the class action for the group of homeowners residing within five square miles (12.95 km^2) of the quarry, which sought non-economic and economic damages based upon allegations of "public nuisance for annoyance, inconvenience, and discomfort."

In denying the motion for class certification, the trial court stated, "common questions of law or fact do not predominate," and that "special injury" involves another element where proof would vary significantly between the estimated 11,075 class members within five square miles (12.95 km^2) of the quarry. The trial court's ruling was supported by two reports prepared on behalf of the quarry owner, both of which acknowledge that the noise and vibration impacts experienced by each class member would vary considerably depending on a number of environmental and property-specific locational and physical factors:

- ...[T]he Salter report found that "[t]he variation in noise is due to the wide range of distances between the noise sources and homes and shielding of the noise provided by natural terrain, intervening homes and vegetation. Because of these factors, in many locations, neighbors within a few hundred feet of each other have dramatically different exposure." The report notes that noise exposure also varies inside of individual homes due to the orientation of rooms, nature of furnishings, size and construction of windows and whether windows are open or closed.
- The...report, prepared by Blast Dynamics, Inc., analyzed how blasting at the Quarry affected neighboring residents. This report identified a number of variables in the way that different residents

[147] *Frieman v. San Rafael Rock Quarry, Inc.* 10 Cal.Pptr.3d 82 (2004) 116 Cal.App.4th 29, <https://scholar.google.ca/scholar_case?case=7418002689018790095&q=san+rafael+rock+quarry+inc&hl=en&as_sdt=2006>.

[148] "Who's Minding The San Rafael Rock Quarry?." June 2021, <https://www.marincounty.org/-/media/files/departments/gj/reports-responses/2000/srrqrept.pdf>. Retrieved on September 24, 2022.

would experience vibration from blasting. These variables include the presence of rock or soil formations that alter the frequency of blast waves, the natural or "resonant" frequencies in each structure that changes the response to vibration, distance from the blast site and differences in the duration of the blasts. The report included a geologic map of the area showing a combination of soil, rock, sandstone, artificial fill, bay mud and marshland under the relevant area. The report noted that soil typically filters out high frequency energy, while rock transmits it. Test blasts were detonated at the Quarry and instruments were placed at various locations to evaluate the differing effects. The results of the velocity measurements showed a decrease in impact with distance from the blast site, but the frequency measurements showed no consistent pattern. The report concluded that: "[t]he test data shows that it is unreasonable to expect that any two sites will experience the same blast related vibration...."

13. SEPARATION DISTANCES IN VARIOUS JURISDICTIONS

Ramara Township, in Ontario, Canada, has 14 licenced Quarries and 8 licensed Pits that produce about 3 million tonnes of aggregate annually on 1,660 hectares (4,102 acres). Thirteen of the 14 licensed quarries are located within areas identified as High Potential Mineral Aggregate Resource Areas (HPMARAs) in its Official Plan. The identified HPMARAs account for about 12,560 hectares (31,036 acres) and represent 30% of Ramara's total land area. The boundary of the HPMARA is located a minimum of 1,000 metres (3,281 feet) from existing and planned Sensitive Land Uses such as designated Settlement Areas, designated Shoreline Residential Areas, First Nation Reserve Lands, and Provincially Significant Wetlands. The separation distance of 1,000 metres in Ramara Township prevents or minimizes adverse impacts to *sensitive land uses*, now and in the future, while ensuring the long-term protection of aggregate resources. Ramara has also expressed concern over the issue of *flyrock* from quarry blasting operations, an undefined term in the Ontario *Aggregate Resources Act*:[149]

> *"Fly Rock discharge from a quarry blasting is a contaminant and it is likely to cause an adverse effect under the Environmental Protection Act.... Currently, there is no provincial policy, regulation or guideline that protects the environment, people, property and natural heritage features on land and in the air and water from the discharge of fly rock from a quarry [p. 6]."*
>
> *"14. The Township of Ramara recommends that the MECP [Ministry of Environment, Conservation and Parks] should modify the proposed Guideline to include land use compatibility provisions to adequately protect the environment beyond quarry sites from the possible adverse*

[149] Mark L Dorfman, "Proposed Land Use Compatibility Guideline Ministry of Environment, Conservation and Parks (MECP)", report addressed to the Township of Ramara Committee of the Whole, June 21, 2021, <https://www.northkawartha.ca/en/our-council/resources/09-07-Council-Package/CA_5_c_Mark-L.-Dorfman-Planner-Inc._Redacted.pdf>.

> *impacts of fly rock during blasting operations."* [emphasis in original]

A similar approach with respect to land use incompatibility has been adopted by Algonquin Highlands, Ontario, Canada, to protect the environment and the community from the potential adverse effects of blasting quarry operations. A new Aggregate Quarry requiring an amendment to Algonquin Highland's Official Plan (section 4.3.8.10)[150] shall be limited to areas:

- Farther than 1,000 metres from a residential land use;
- Farther than 1,000 metres from a boundary of a Settlement Area; and
- Farther than 1,000 metres from the Waterfront designation.

Algonquin Highlands also requires that all extraction operations be undertaken in a manner that reduces impacts on the physical environment and adjacent land uses after issues of public health, public safety and environment impacts have been addressed (section 4.3.8.11). The Town of Holyrood (Newfoundland and Labrador) Development Regulations (2014-2024, Gazetted: February 27, 2015)[151] has a similar provision which specifically addresses *aggregate extraction involving blasting*, and imposes a separation distance of 1,000 metres from existing or proposed *residential development*:

> *"Minimum Distance of Quarry Workings from existing or proposed Residential Development where blasting is involved [is] 1000 metres [p.71]."*

Nigeria's Environmental (Quarrying and Blasting Operations) Regulations, 2013, are more stringent when it comes to protecting the environment and the public from a blasting quarry operation, as a minimum safe distance of three kilometres (3,000 metres) or 1.864 miles (3,281 yards) is mandatory:[152]

> *"20 A person shall not locate a quarry or engage in blasting within three kilometres (3km) of any existing residential, commercial or industrial area."*

In response to an application for a proposed limestone quarry, accompanied by blasting below the water table, on a 524-acre site, a Prohibition Ordinance was passed in 2014 by the Board of Commissioners of Teppecanoe County, Indiana, prohibiting new quarries on any site in the county which has 100 or more residential homes within a two-mile (3.219-kilometre) radius. The proponent appealed the Prohibition Ordinance, and the Prohibition Ordinance was ruled invalid by the Court of Appeals of

[150] <https://www.algonquinhighlands.ca/deptdocs/Official%20Plan%20OFFICE%20CONSOLIDATION%2001-Jan-2019.PDF>.

[151] <https://www.gov.nl.ca/mpa/files/registry-community-holyrood-files-holyrood-dr.pdf>.

[152] <https://standards.lawnigeria.com/2020/08/21/national-environmental-quarrying-and-blasting-operations-regulations-2013/>.

Indiana (2016)[153] because it was not enacted in accordance with Indiana's zoning statutes. The court made the following observation:

> *"Because the Prohibition Ordinance, even more clearly than the ordinances in Town & Country and Pro-Eco, purports to dictate what type of land use is permitted and where, it is a zoning ordinance under our Supreme Court's analysis in Martin Marietta. As such, the County was required to comply with the 600 Series Procedures [Indiana Code §.36-7-4-600 (2019)]. Since it did not, the ordinance is invalid and unenforceable, and Rogers Group is entitled to summary judgment on this issue."*[154]

Additional examples of separation distances between a blasting quarry operation and sensitive or incompatible land uses imposed by other jurisdictions are listed as follows:

- 1,000 metres from planned maximum extent of quarry operations to any sensitive use where regular blasting takes place (Tasmania, EPA 6.1.2)[155]
- 800 metres (2,625') separation from the foundation or base of a structure located off site measured from the working face and the point of blast (Nova Scotia Environment and Labour)[156]
- 600 metres (1,969') minimum separation between a new quarry and territory zoned by municipal authorities for residential, commercial or mixed purposes (commercial-residential) (Quebec Environment Quality Act, Q-2, r.7, Section 10)
- 500 metres (1,640.4') minimum separation between licensed boundary and a Sensitive Land Use (Municipality of Trent Lakes Zoning By-Law B2014-070, Section 4.34.1)
- >500 metres (>1,640.4') separation between licensed boundary and lands zoned Residential, Institutional, Commercial, Environmental Conservation or Open Space; or an existing residential dwelling located in a Rural Zone (Township of Douro-Dummer Zoning By-Law 2020-74, Section 3.43.2)

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[153] *Rogers Group, Inc. v. Tippecanoe County*, 52 N.E. 3d 848 (2016), <https://scholar.google.com/scholar_case?case=10399870508009400527&q=Tippecanoe+County+Board+of+Commissioners+and+Quarry&hl=en&scisbd=2&as_sdt=2006>.

[154] Focusing on our Supreme Court's statement in *Martin Marietta* that a zoning ordinance "dictates what type of land use is *permitted* and where," 883 N.E.2d at 787 (emphasis added), the County suggests that the Prohibition Ordinance cannot be a zoning ordinance because it would *prohibit* mining in certain areas, not *permit* mining in certain areas. This is an arbitrary distinction that has no basis in the actual holding in *Martin Marietta*. The ordinances in *Town & Country* and *Pro-Eco* were also prohibitive, not permissive, and our Supreme Court did not hesitate to conclude that they were zoning ordinances.

[155] "New quarries should not be located close to existing residences or other sensitive uses. Similarly, proposals to locate new residences adjacent to existing quarries should be discouraged, if possible, to reduce the potential for environmental nuisance [6.1.2]. <https://epa.tas.gov.au/Documents/Quarry%20Code%20of%20Practice%20May%202017%20-%20web.pdf>.

[156] <https://novascotia.ca/nse/issues/docs/Pit_and_Quarry_Guidelines.pdf>.

14. INCOMPATIBLE LAND USES OR SENSITIVE RECEPTORS IMPACTED BY BLASTING QUARRY OPERATIONS

Sensitive existing or permitted uses of land under a zoning by-law (ordinance) or Official Plan (Master Plan) are to be avoided for the anticipated life of a new blasting quarry operation or expansion (extension) of an existing aggregate operation. In the following cases, the courts held that the quarry operator must provide the necessary setback (buffer) and refrain from using third-party property to mitigate or avoid deleterious effects of blasting quarry operations and not cast the burden on the properties of adjoining neighbours:

- *Kozesnik et al. v. Township of Montgomery et al*, 24 N.J. 154 (1957) 131 A.2d 1[157]
- *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51[158]
- *Eastman et al. v. Dewdney Mountain Farms Ltd.*, (2017), ONSC 5749[159]
- *Miller Paving Ltd. v. McNab/Braeside (Township)*, (2015), CanLII 70369 (ON LPAT)[160]

Where a nuisance or trespass results from an incompatible use of land (e.g., a proposed blasting quarry operation), it is no defense that the zoning by-law or ordinance has authorized the operation. If a zoning by-law or ordinance expressly said that a property owner may not improve his land within a given distance of a quarry or processing plant, the appropriation (or de facto taking) of their property for the benefit of the quarry operator would be obvious.[161] The following inferences should be noted:

- Principle is no less offended when the ordinance purports to place the burden upon the quarry operator but as a practical matter transfers it to neighboring owners who, while ostensibly permitted to utilize their properties, must provide their own setbacks or experience an exposure capable of hindering their [use and] enjoyment. Whatever the reasonable distances may be, they should be measured from adjoining property lines whether or not the parcels are now improved [para. 177].[162]
- Kozesnik complains that his property [20 acres or 8.094 hectares] cannot be put to the single authorized use since he cannot associate

[157] *Kozesnik v. Township of Montgomery*, 24 N.J. 154 (1957), <https://scholar.google.com/scholar_case?case=8002546886091518038&q=Kozesnik&hl=en&as_sdt=2006>. *Affirmed* by the Supreme Court of New Jersey, 29 N.J. 584 (N.J. 1959) 151 A.2d 537.

[158] Leave to appeal to the Supreme Court of Canada denied. Supreme Court of Canada Summary 32302 *City Sand and Gravel Limited, et al. v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs 2008* (Newfoundland & Labrador) (Civil) (By Leave), CanLII 1399 (SCC), <https://canlii.ca/t/1vgkt>, retrieved on 2022-12-15

[159] *Eastman, Johnson, Klein and Pillsworth v. Dewdney Mountain Farms Ltd.*, 2017 ONSC 5749 (CanLII), <https://canlii.ca/t/h6fbf>, retrieved on 2022-09-22.

[160] *Miller Paving Ltd. v McNab / Braeside (Township)*, 2015 CanLII 70369 (ON LPAT), <https://canlii.ca/t/glwwn>, retrieved on 2022-04-27.

[161] *Raskin v. Town of Morristown*, 21 N.J. 180 (1956) 121 A.2d 378.

[162] *Kozesnik et al. v. Township of Montgomery et al*, 24 N.J. 154 (1957) 131 A.2d 1.

it with a quarrying operation in Hillsborough and hence the ordinance is invalid as to his property. That a restraint against all use is confiscatory and beyond the police power and statutory authorization is too apparent to require discussion [citations omitted] [para. 183].

- ...[A] permit may not issue for quarrying unless the applicant holds 200 contiguous acres [80.937 hectares]..., but it is stipulated that 200 acres could not be assembled. In short, only 3M can quarry and the remaining acreage could so be utilized only if sold to 3M. If the design were to compel a sale [of the Kozesnik property] the invalidity of the ordinance would be indisputable. But although the mentioned facts invite circumspection, yet the reasonableness of the acreage requirements were not challenged by any proof, and we cannot reject the affirmative evidence that they are intended to safeguard the public. [para. 175]

A quarry owner or proponent of a quarry application has a legal responsibility to confine all potential adverse effects (noise, airblast, vibrations, flyrock, toxic fumes,[163] dust, etc.) within the boundary limits of their own property, and to not damage or disrupt the use and enjoyment of privately owned third-party neighbouring properties. Quarry operators are not entitled to the free use of adjoining property, whether improved or unimproved, and for which the owners of the adjoining properties are obligated to pay property taxes.

15. BENEFITS OF MANDATORY FIXED MINIMUM SETBACKS AND SEPARATION DISTANCES APPLIED TO BLASTING QUARRY OPERATIONS

Appropriate mandatory fixed minimum setbacks and separation distances imposed on applications for new or expanding blasting quarries protect onsite quarry equipment and personnel, and eliminate the potential for damage to offsite private third-party personal and real property from vibration, airblast and flyrock, and eliminate or reduce other adverse impacts to a "trivial" level over the anticipated life of the quarry operation[164] with respect to:

- neighbourhood character
- visual incompatibility with surrounding land uses
- soil stability (subsidence and sinkholes)
- the natural environment (e.g., air, water and land)
- underground and aboveground infrastructure (e.g., gas lines, electric power transmission lines and poles)

[163] "Between 1992 and 2002, there were 8 events with one fatality in the US involving post-blast NO_x poisoning (Explosives Inspectorate, 2011). And more generally, from 1978 to 2003, 8.5% of blasting injuries reported in the US were due to fumes (Bajpayee, et al., 2005)" (Taylor, 2015, p. 19).

[164] In some jurisdictions such as Ontario, Canada, once a licence to extract aggregate is issued under the Aggregate Resources Act, the quarry operation can remain operational effectively forever or until the quarry owner concludes the quarry operation is no longer feasible.

- the quantity and quality of private third-party domestic well water of current and future generations[165]
- the health and safety of human and non-human life
- the quality of human and non-human life
- the productivity of agricultural lands (e.g., mainstream crops, specialty and organic crops, livestock)
- the use and enjoyment of private third-party real property (e.g., residences, farms, businesses)
- the use and enjoyment of public property (e.g., parks, campgrounds, trailways, bike routes, roads/highways)
- the value of private third-party real property (e.g., residences, farms, businesses)
- the growing 24-hour stay-at-home live and work economy occasioned by the coronavirus (COVID-19). A January 2022 survey conducted by Pew Research Center of 5,889 workers surveyed, found that 61% of people working from home say they're not going into the workplace because they choose not to.[166]
- the number of public complaints and lawsuits (e.g., trespass, nuisance, negligence, emotional distress) from nearby homeowners and business owners, which would only increase as more people are forced or choose to work from home

As blasting is the most dangerous aspect of operating a quarry, a generous fixed *setback* (onsite extraction limit[167]) and *separation* distance are warranted as part of any planning approval to protect quarry workers and the general public. When establishing onsite setbacks and external separation distances from populated areas or areas of human activity, the setbacks and separation distances should reflect worst case scenarios, and allow for human error (overloading with explosives and mistakes in blast design). According to a past president of the International Society of

[165] In *Federation of Tiny Township Shoreline Associations v. Ontario (Environment, Conservation and Parks)*, 2021 CanLII 34308 (ON ERT), the Ontario Environmental Review Board ruled that "precautionary water conservation and protection measures have not been applied and that current and future generations have not been considered in a manner that is consistent with the principles of sustainable development [para. 46]. Based on the evidence and submissions before it, the Tribunal finds that it appears that there is good reason to believe that no reasonable person, having regard to the MECP's SEV [Statement of Environmental Values] on sustainable development principles, could have made the decision to issue the Permit [to Take Water from a source pond] [para. 46]." *Federation of Tiny Township Shoreline Associations v Ontario (Environment, Conservation and Parks)*, 2021 CanLII 34308 (ON ERT), <https://canlii.ca/t/jflwk>, retrieved on 2022-11-04.

[166] Rachel Minkin, "COVID-19 Pandemic Continues To Reshape Work in America," (February 16, 2022) Pew Research Center, <https://www.pewresearch.org/social-trends/2022/02/16/covid-19-pandemic-continues-to-reshape-work-in-america/>.

[167] A municipality can impose "Setback Limits" on a Pit or Quarry. Pursuant to Section 124(1) of the *Ontario* Municipal Act S.O. 2001, c. 25, the Corporation of the United Townships of Dysart, Dudley, Harcourt, Guilford, Harburn, Bruton, Havelock, Eyre and Clyde passed By-law No. 2003-95, "A By-law to Regulate the Operation of Pits and Quarries," The "Setback Limits" in the By-law, "Excavation Setback Area" means the area within the setbacks for a pit or quarry established by the Municipality's Comprehensive Zoning By-law, and no person shall excavate aggregate within the "Extraction Setback Area" of a site. <https://www.dysartetal.ca/en/municipal-government/By-Law%20Enforcement/By-Law%202003-95%20Pits%20and%20Quarries.pdf>.

Explosives Engineers (ISEE), when it comes to protecting the public from the adverse effects of blasting quarry operations, there are only two choices:

> *"Don't blast in a location that threatens public safety or adopt the safety measures required [i.e., impose adequate setbacks and separation distances on the quarry operation]."*[168]

16. COURT RECOGNITION OF POTENTIAL PROPERTY VALUE IMPACTS FROM QUARRY OPERATIONS

Courts have recognized the traditional role and power of municipalities to protect its residents' economic interests, preserve the community's tax base, and protect the health, safety and welfare of the public. Some cases are explained as under:

- In *Red Wing Properties, Inc.*, Interim Decision of the Commissioner, January 20, 1989, in declining to consider property value and tax diminution in the context of a sand and gravel mine, the Commissioner stated that it is local government's prerogative to protect the community's property values through local zoning. Local zoning may restrict the activity that may cause a decline in property values. The MLRL [Mined Land Reclamation Act] amendments of 1991 explicitly retained local governments' authority to enact laws of general applicability - zoning - while restricting their power and reclamation standards. The role of local governments in protecting the property values and tax base of the community through zoning has been affirmed in subsequent commissioner's decisions, as well as by the courts (*See, Matter of Dailey*, Interim Decision of Commissioner, May 14, 1992; *Matter of Kearney Gravel*, Interim Decision of the Commissioner, September 28, 1992)[169]
- In *Rockford Blacktop Construction Company v. County of Boone,* (1994),[170] the Appellate Court of Illinois ruled that the diminution in property values is one of many proper factors to consider when assessing land use compatibility of an application for a blasting quarry permit, citing *Lambrecht v. County of Will* (1991): [171]

  > *"...[T]he diminution of property values within a neighborhood is a proper factor for the trial court to consider. [citations omitted] "[t]he rights of adjacent and abutting property owners are to be considered".*

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[168] Fischenich, M., "Expert: Flyrock from any blast 'unacceptable', (Oct 21, 2017) The Free Press, <https://www.mankatofreepress.com/news/local_news/expert-flyrock-from-any-blast-unacceptable/article_8ad31cf8-b5cf-11e7-bf58-c3cdd328cf7f.html>.

[169] Final Environmental Impact Statement, County Line Stone Co., Inc., Akron Quarry, Towns of Newstead and Pembroke Erie and Genesee Counties, New York DEC No: 9-1456-00004/00013, June 18, 2019, p. 4.

[170] *Rockford Blacktop Construction Company v. County of Boone*, 635 N.E.2d 1077, 263 Ill. App.3d 274, 200 Ill. Dec. 738, <https://scholar.google.ca/scholar_case?case=2890919888892488582&q=quarry+blasting+lambrecht&hl=en&>.

[171] *Lambrecht v. County of Will*, (1991), 217 Ill. App. 3d 591, 594, 160 Ill. Dec.464, 577 N.E. 2d 789, <https://scholar.google.ca/scholar_case?case=13855044279831539095&q=quarry+blasting+lambrecht&hl=en&as_sdt=2006>.

> *Moreover, regardless of the merits of the distinction drawn by Gorte [county planner] between people who build their homes near existing quarries and those who buy their homes and "then have a quarry put in [their] back yard", there is nothing in the record to suggest that the trial court based its decision on, or was even influenced by, a similar concern."*

- In 2012, the proponent of a 32-acre (12.95-hectare) quarry application in the City of Westbrook (2012 Pop. 17,501), Maine, in a Consent Order[172] willingly agreed to purchase homeowners properties within a half-mile (805 metres) of the proposed quarry for their market value. The measure requires the quarry proponent to meet with the owners of the homes and discuss purchasing their homes for its fair market value as of the date of the Consent Order based on a written appraisal prepared by a Maine licensed appraiser and submitted by the property owner.[173]

On its face, and in the absence of appropriate separation distances and setbacks, the buyout by the quarry proponent of properties within a half-mile (805 metres) of the quarry at market value appears to be a practical solution for the preservation of homeowner equity, but the stipulated distance is unlikely to capture all of the impacted properties, and, depending on the number of properties involved, it could destabilize or effectively destroy the community.[174]

- In 2019, residents of Kyaggundal Village, Nigeria, affected by flyrock debris from a nearby 15-acre (6.07-hectare) quarry, and residing within a radius of 500 metres were being compensated by the quarry owner to temporarily relocate to safer places and return after 24 months.[175] According to village residents:

> *"A Chinese firm, Hunan Road and Bridge Construction Group Companies Ltd, which is managing the quarry, last week [August 2019] started compensating about 80 residents with plots of land and houses within 500 metres radius from the stone quarry to enable then to relocate to safer places and return after 24 months."*

- In *Parker Mountain Aggregates Limited v. Nova Scotia (Ministry of Environment)*, (2010),[176] the court found that it was not speculation

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[172] A Consent Order is generally a voluntary agreement worked out between two or more parties to a dispute. It generally has the same effect as a Court Order and can be enforced by the court if anyone does not comply with the order. See <https://definitions.uslegal.com/c/consent-order/#:~:text=A%20consent%20order%20is%20governed,not%20comply%20with%20the%20orders>.

[173] Westbrook Planning Board Minutes, September 25, 2012, <https://www.westbrookmaine.com/ArchiveCenter/ViewFile/Item/239>.

[174] Acquisition by the quarry owner of 13 residences, as far as approximately 1,509 metres from the excavated area of the blasting Acton Quarry operation, has effectively obliterated any sense of community life along Third Line, <https://files.secure.website/wscfus/6880241/28362475/adverse-effects-13-homeowners-bought-out-by-quarry-owner-jan-21.pdf>.

[175] "Residents reject cash to abandon stone quarry site," *Monitor*, September 4, 2019, <https://www.monitor.co.ug/uganda/news/national/residents-reject-cash-to-abandon-stone-quarry-site-1846128?view=htmlamp>.

[176] *Parker Mountain Aggregates Limited v. Nova Scotia (Minister of Environment)*, 2010 NSSC 277 (CanLII), <https://canlii.ca/t/2bjb4>, retrieved on 2022-01-20.

that homeowners within 1,000 metres of a quarry would experience a decline in the value of their properties. "Such a decline will be the direct result of the development and operation of the quarry [para. 16]."

- In *Verbillion et al. v. Enon Sand & Gravel, LLC*, 2021,[177] the Ohio Court of Appeals upheld the lower court's ruling in which the trial judge concluded that property owners whose properties bordered the proposed quarry expansion, exposed to truck traffic (100 trucks per day), would be damaged in a manner not experienced by the general community; and that their wells would be adversely affected. It was also noted that the trial judge took "'judicial notice'[178] that adjoining property values would be diminished if blasting occurred [para. 47]." Following observations in this context are important:

  "[Previously,] [i]n December 2020, the citizens group [CAM] celebrated another win – a private lawsuit settled in favor of five neighbors of the mine [Enon Sand and Gravel] who successfully argued that mining could damage their property values and private wells."

  "Another outcome of the December [2020] decision was the judge's determination that area neighbors have standing to challenge the mine based upon health and safety issues. While the company had argued that the interests of neighbors had been settled by the settlement with the county commissioners, the judge saw private property owners as having their own interests with regard to the project." [179]

- In *Troy Sand & Gravel Co., Inc., et al. v. Fleming, et al.*, (2017),[180] the appellate division of the Supreme Court of New York upheld the ruling of the lower court that denied an application to permit a quarry on a 214-acre (86.603-hectare) parcel, scheduled to remain operational for approximately 150 years, in the Town of Nassau. The quarry application was denied by the Town of Nassau for a host of reasons including concerns related to blasting (fugitive dust, vibration, noise, flyrock) and the impact of the proposed quarry on property values. The quarry application failed to meet a standard that "the nature and intensity of intended operations shall not discourage the appropriate development and use of adjacent land and buildings nor impair the value thereof" (Local Law No. 2 [1986] of the Town of Nassau. A comprehensive Value Impact Analysis prepared on behalf of the Town of Nassau concluded,

[177] *Verbillion, et al. v. Enon Sand & Gravel, LLC*, 2021-Ohio-3850, <https://scholar.google.com/scholar_case?case=7412176152641197603&q=%22quarry%22+and+%22property+value%22&hl=en&scisbd=2&as_sdt=2006>. Appeal to Review denied. *Verbillion v. Enon Sand & Gravel*, 181 N.E. 3d 1209 (2022) 166 Ohio St.3d 1414 2022-Ohio-554, Supreme Court of Ohio.

[178] "Judicial notice" is a judge's recognition of a fact without requiring a party to prove it.

[179] Bachman, M., "A win for quarry opponents", (February 11, 2021) YSNES.com, <https://ysnews.com/news/2021/02/a-win-for-quarry-opponents>.

[180] *Troy Sand & Gravel Co., Inc., et al. v. Fleming, et al.* 156 A.D.3d 1295 (2017), 68 N.Y.S.3d 540, <https://scholar.google.com/scholar_case?case=6635546804191739814&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cproperty+value%E2%80%9D&hl=en&scisbd=2&as_sdt=2006>.

unequivocally, that the proposed quarry "would have a deleterious financial effect on existing homeowners in the surrounding area and could result in a significant decrease in neighboring property values."[181]

- In *McLean Lake Residents' Association v. City of Whitehorse and Yukon Government Department of Energy, Mines and Resources*, [2007],[182] involving an application to rezone 14 hectares (34.6 acres) to permit a quarry with a life expectancy of 50 years, the Supreme Court of the Yukon Territory rejected the argument that property values are outside the scope of the *Environmental Assessment Act*:

  "I do not necessarily agree with the statement in the Screening Report that property values are outside the scope of the Environmental Protection Act. Surely, the definition of "environmental effect" is broad enough to include property values. Obviously, if there is a significant negative impact on the property values, that would be a significant finding to be taken into consideration [para. 43]."

- The Yukon Supreme Court also took exception to the notion of aggregate quarries in the Industrial Service areas being perceived as "interim uses" pursuant to Section 8.6(3) of the City of Whitehorse Official Community Plan. The Court observed that:

  "Policy 8.6(3) states that the aggregate quarries in the Industrial Service areas along McLean Lake Road may continue but they are over time to be redeveloped to other industrial uses, thereby being "perceived" as "interim uses." If the proposed quarry development is captured by this policy it is clearly not in conformance as it has a 50-year life expectancy which is anything but an "interim use."

- In *Warren Tp. v. Suffness, et al.*, (1988),[183] the appellate division of the Superior Court of New Jersey upheld the Tax Court's decision to apply its own judgment to valuation data submitted by experts in order to arrive at true (market) value for three contiguous properties, by deducting 25% from the land value estimate and 25% from the estimated cost of the improvements for the impacts of the nearby blasting quarry. In other words, the value of both the *lot* and *improvements* were equally impacted by the abutting blasting quarry operation. The Court observed the following:

  "With regard to the quarry operated on the October 1, 1980 valuation date, the Tax Court Judge found that the "dwelling house" on each lot had been affected by the noise and dust caused by the quarry operation, and cracks had occurred in each house as a result of quarry blasting operations. The Tax Court Judge had the right to apply his own judgment in making an independent assessment of the true values. His

[181] See Resolution of the Town Board of the Town of Nassau Decision on the Troy Sand & Gravel Special Use Permit Application, Resolution No. 17, September 1, 2015.

[182] *McLean Lake Residents' Association v. City of Whitehorse*, [2007], <https://www.yukoncourts.ca/sites/default/files/documents/en/mclean_lake_v_city_of_whitehorse_and_ytg_2007yksc44.pdf>.

[183] *Warren Tp. v. Suffness*, 225 N.J. Super. 399 (1988) 542 A.2d 931, <https://scholar.google.ca/scholar_case?case=10694856670601680060&q=%E2%80%9Cquarry+blasting%E2%80%9D&hl=en&scisbd=2&as_sdt=2006>.

deduction [of 25%] from the value of each lot's improvements to account for the adverse effect of the lot's proximity to the quarry in the absence of expert evidence to support such a deduction is sustainable because it is so clearly logical and reasonable that the value of the improvement will be affected by the adverse quarry condition [para. 415]."

- In *Sand Springs Material LLC* (SSM)*v City of Sand Springs* (City), (2010),[184] the Court of Civil Appeals of Oklahoma upheld the City's decision to refuse to permit SSM to operate a 515-acre (208.413-hectare) blasting quarry on a number of grounds, including concerns expressed by 150 property owners that property values will be adversely affected, with the appeal court commenting as follows:

  "[para. 15]...[E]vidence was presented that a potential buyer decided not to pursue the purchase for fear that the quarry would be approved, and his property value would diminish. SSM argues that "One citizen's decision to no longer buy a home in this area is hardly evidence that property values will be adversely affected." Therefore, SSM concludes that the "fears" of 150 property owners that their property values would decline should be disregarded pursuant to Volunteers[185] because there is no actual evidence property values will decline. In essence, SSM argues that until the quarry is in operation and is shown to adversely affect property values, the quarry must be approved. Volunteers requires evidence supporting a landowner's "fears" that property values will decline. It does not require evidence that property values have actually declined before a proposed use can be denied."

  "[para. 16]...[I]t was the opinion of SSM's expert that blasting operations would not physically damage nearby residential structures, he also stated that there was "no doubt" that occupants would feel the vibrations caused by the proposed blasting. A home owner is qualified to testify regarding the value of owner's property [citation omitted]. SSM cannot simply dismiss, as unsubstantiated fears, the evidence provided by 150 property owners."

17. PROPERTY VALUE IMPACTS OCCASIONED BY AGGREGATE EXTRACTION OPERATIONS

Market Value is the standard measure of the value of property exchanged in an open, active and transparent market, and assumes that the buyer is well-informed or well-advised in making the purchase. Real estate agents, most of whom have little or no understanding of the externalities occasioned by the aggregate industry, and the sellers they represent are seldom in the habit of disclosing the adverse effects of an aggregate

[184] *Sand Springs Materials LLC v. City of Sand Springs*, 243 P.3d 768 (2010) 2010 OK CIV APP 128, <https://scholar.google.com/scholar_case?case=5244406433361108630&q=ssm+llc+v+city+of+sand+springs&hl=en&as_sdt=2006>.

[185] *Application of Volunteers of America v. Curtis M. French*, 749 P.2d 549 (1988), Supreme Court of Oklahoma,

operation for fear of having to discount the asking price of their property. The argument often presented by the aggregate industry in refusing to acknowledge the detrimental effects that an aggregate operation has on the value of nearby residential properties is premised on the implicit, but unrealistic, assumption that a prospective purchaser has an understanding of the adverse impacts to which they will be exposed. ...[T]he aggregate industry] should not realistically expect a purchaser to check the county clerk's office, the planning and zoning commission files, the Army Corps of Engineers, the United States Geological Society, the state geologist, other agencies and the internet, prior to purchasing a house, much less bringing a building inspector, hydrologist, geologist and meteorologist to the site [p. 41].[186]

In the application of a hedonic pricing model by Guignet (2011)[187] designed to measure the impact of an environmental disamenity on house prices found that if the sellers and buyers were unaware of the presence of a leaking underground storage tank (LUST), there was no measurable impact on house price. It was stated that:

> *"Overall, in my hedonic application I find LUSTs [leaking underground storage tanks] generally have little effect on the local home values. I believe this is because buyers and sellers (at least in these housing markets and during this period) are typically unaware of the disamenity. I do, however, find a significant depreciation at homes where I know households are well-informed, as well as in the preference studies, where respondents are explicitly informed as part of the study design."*

As important value-influencing information is usually asymmetrical, resting solely with the seller, prospective purchasers overpay for properties impacted by aggregate operations or other disamenites/negative externalities.[188] An internet search related to the potential impact of aggregate operations on the value of residential properties in proximity produced the following Proximity Studies:

17.1 Proximity Study One

In a large-scale peer-reviewed study of the impact of rock mines (quarries) on residential property prices, the first of its kind,[189] Malikov, et al (2018), documented a sample of 5,500 house sales that took place in Delaware County, Ohio, during the 2009-2011 period (roughly two years). Within the

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[186] Demos Binder, "The Duty to disclose Geologic Hazards in Real Estate Transactions," (1998) 1 (13) Chapman Law Review 13-56. <https://www.chapman.edu/law/_files/publications/CLR-1-denis-binder.pdf>.

[187] Dennis B Guignet, "What Do Property Values Really Tell Us? Evidence From Revealed and Stated Preference Studies," Doctoral dissertation University of Maryland, College Park, 2011

[188] Neelawala, S.N.S.L.H.P., "Asymmetric Information Between Buyers and Sellers in the Residential Property Market, A Hedonic Property Valuation Approach," PhD diss. Queensland University of Technology, 2014. <https://eprints.qut.edu.au/76412/5/S.N.S.L.H.P%20Neelawala%20Thesis.pdf>.

[189] Emil Malikov, Yiguo Sun and Diane Hite, "(Under)Mining Local Residential Property Values: A Semiparametric Spatial Quantile Autoregression," (June 22, 2018) Journal of Applied Econometrics 82-109. <https://onlinelibrary.wiley.com/doi/epdf/10.1002/jae.2655>.

County are four surface rock (limestone) mines (quarries), three of which are no longer operational. The only operational quarry (state mine: Del-5), at 510 acres, also happens to be the largest and is subject to blasting, which creates a far greater nuisance (hazard) than other types of surface mines. It was said explicitly:

> *"Given that the other mines in the county were no longer in operation by the period of our study and hence did not generate noise, dust and traffic, in our analysis we focus solely on the operational Del-5 mine, which is not only very large but is also located in an area of high urban development."*

Standard software was used to calculate straight-line distances from each property (sale) to the mine centroid of Del-5. The study found statistically significant property-suppressing effects of being located near an operational rock mine (quarry), which gradually decline to near-zero at roughly a 10-mile (16.093-kilometre) distance. For residential property in the middle of the price distribution (r = 0.50), our estimates suggest that, between two identical houses, the one located a mile closer to a rock mine is predicted to be priced, on average, at about 3.1% discount.[190] The analogous average discounts for houses in the first and third quartiles of price distribution are around 2.3% and 3.4%, respectively. For an upscale property in the 0.95th quantile [$552,500 average house price], it is at an astounding 5.1%. This is rather expected because of income sorting whereby higher-income households have higher ability to pay for better environmental quality: in this case, distance from a disamenity. Conversely, households with lower incomes and less expensive homes are perhaps more willing to substitute environmental quality for other, more necessary, house characteristics such as easier access to employment, including jobs in the environmental-externality-generating rock mining industry itself."[191]

As a back-of-the-envelope welfare calculation using unconditional sample quantiles of house values corresponding to the fitted quantile functions,[192] the above discount estimates imply the average loss in property value associated with the house being located a mile [1.609 kilometres] closer to a rock mine ranging from $3,691 to $10,970 for houses within the interquartile range of price distribution. For more expensive neighborhoods in the 0.95th quantile, such losses can be, on average, as high as $28,410. A July 9, 2018 Supplementary Appendix[193] of the study includes the following statement:

> *"Our estimates suggest that, all else equal, a house located a mile [1.609 kilometres] closer to a rock mine is priced, on average, at about 2.3–*

[190] 5.28 thousand feet [one mile] times the mean estimate of 0.58% per 1,000 feet. The average discount estimates for other quantiles of house price are obtained similarly.

[191] Cohen and Coughlin (2008) discuss such positive employment accessibility effects associated with environmental disamenities which may counteract negative externality effects in the context of a noise-generating airport.

[192] And assuming a constant marginal willingness to pay [footnote 18].

[193] <http://qed.econ.queensu.ca/jae/2019-v34.1/malikov-sun-hite/Malikov-Sun-Hite-Mining-Property-Values-Appendix.pdf>.

5.1% discount, with more expensive properties being subject to larger markdowns."

17.2 Proximity Study Two

Professor Hite undertook a study in 2015 that analyzed the property value impacts of rock and gravel mines on house prices in Upstate New York. The study used a large data set of MLS realtor-negotiated house sales (18,941) covering the period of January 1, 2000 to May 7, 2015, with all sales adjusted to current 2015 dollars based on the House Price CPI, in areas surrounding three stone quarries and one sand/gravel pit in Columbia, Saratoga and Rensselaer Counties. The sales surrounding the four mines are from Capital Region Multiple Listing Service (MLS) data, and, according to Hite, use of only Realtor mediated sales in Hedonic Price Models consistently demonstrate lower impacts of disamenities than do those that include all house sales (Jauregui and Hite, 2009);[194] "thus estimates of impacts in the current study should be considered underestimates of the true impacts of mines [by about 3.0%]."

Hite's study, which was relied upon by the Town of Nassau, New York, in its 2015 review of Troy Sand & Gravel Co., Inc.'s application to permit a blasting quarry with an expected life of 150 years on 89 acres (36.017 hectares) of a 216-acre (87.412-hectare) parcel, concluded that:

- Mine operations are a disamenity that would have a negative impact on property values ranging from a 7.5% to 36% discount. Related to these discounts, she concluded (page 12)[195] that 'These discounts are statistically significant at the 99+% level; such a high degree of significance leads us to conclude that, without a doubt, the quarry Troy Sand & Gravel Co., Inc., proposes to develop and operate in the Town of Nassau, Rensselaer County, New York, will have a deleterious financial effect on existing homeowners [emphasis in original].'
- ...[T]here are 293 residential parcels within 1 mile [1,609 metres] of the [proposed] mine site, equating to about 750 people (293 residences at 2.6 persons per household as per US Census Data). That equals about 15% of the Town [of Nassau] population. The Town does not consider this a remote location [p.35].
- To most people, it makes intuitive sense that an operation like a mine – which creates traffic, noise, and dust and that is highly unattractive – would result in nearby house prices being depressed. Statistically based studies have borne out this intuition, and the current study scientifically conservatively demonstrates these impacts....Dr. Hite's 1998 article in Land Economics[196] found that individuals who were aware of the existence of a disamenity (in this

[194] Jauregui, A. and Diane Hite, "The Impact of Realtors on House Prices near Environmental Disamenities", (2009) 20 (2) Housing Policy Debate 295-316.

[195] Diane Hite and Derrick Robinson, "The Impact of Hard Rock and Gravel Mines on House Prices in Upstate New York", June 23, 2015.

[196] Hite, Diane, "Information and Bargaining in Markets for Environmental Quality," (1998) 74 (3) Land Economics 303-316.

> case, landfills), bid down the prices of houses within 3 miles [4.83 kilometres] by an average of 10.65% as compared to individuals who did not know about the disamenity. The same group of people received further discounts as high as 20% based on how close the homes sought to be purchased were to the disamenity. In addition, because house prices are influenced by comparable sales, even individuals without knowledge of the disamenity received discounted house prices [p.12].[197]

Because uninformed buyers overpay for property impacted by a quarry operation, an acknowledged disamenity, these transactions taint the data pool of comparable sales if they are relied upon by realtors setting asking prices or real estate appraisers estimating market value.

17.3 Proximity Study Three

Erickcek's 2006 study[198] of the economic impact of the proposed 853-acre Stoneco Gravel Mine (Pit), when in full operation, concluded that residential property values in Richland and Richland Township, Michigan, would be reduced by $31.5 million, adversely impacting the value of 1,400 homes, which represent over 60 percent of the Richland Residences, with residential properties declining 20% within a half-mile (805 metres) to 4.9% within 3 miles (4,828 metres):

> *"A residential property located a half mile (805 metres) from the gravel mine (pit) would experience an estimated 20 percent reduction in value; one mile [1,609 metres] from the mine, a 14.5% reductions; 2 miles [3,219 metres] from the mine, an 8.9% reduction; and 3 miles [4,828 metres] from the mine, a 4.9 percent reduction. These estimates are similar to estimates published in academic journals on the effects of landfills on nearby property values [p.5]."*
>
> *"The loss in property value results from the negative consequences of the mining operation and reflects the deterioration in the area's quality of life due solely to the operation of the gravel mine. In other words, the loss in house value is a way to quantify in dollars the deterioration in quality of life, as capitalized in the price of the house. It captures the price reduction the homeowner would have to offer to induce a new [informed] buyer to purchase the property. Even if homeowners do not move as a result of the gravel mine, they will lose homeowner equity as the potential sale price of their house is less. Therefore, regardless of whether or not a person actually sells their property, it measures the adverse effects in their quality of life in being subjected to the disamenities introduced into the area by the gravel mine [p.6]."*

The "hedonic pricing model" relied upon by Erickcek was developed by Professor Hite, Auburn University, based on detailed transactional data

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[197] Diane Hite and Derrick Robinson, "The Impact of Hard Rock and Gravel Mines on House Prices in Upstate New York," June 23, 2015.

[198] Erickcek, G., "An Assessment of the Economic Impact of the Proposed Stoneco Gravel Mine Operation on Richland Township," *W.E. Upjohn Institute*, 2006, <https://research.upjohn.org/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1225&context=reports>.

from Delaware County, Ohio, for the initial purpose of studying land use planning issues (Erickcek, 2006):

> *"Hite examines the effects of distance from a 250-acre gravel mine [i.e., blasting limestone quarry] on the sale price of 2,552 residential properties from 1996 to 1998. Her model controls for a large set of other factors that determine a house's sale price, including number of rooms, number of bathrooms, square footage, lot size, age of home, sale date, and other factors specific to the locality, so that she can focus solely on the effect of proximity to the gravel mine [i.e., blasting quarry] on house values. She finds a large, statistically significant effect of distance from a gravel mine [i.e., blasting quarry] on home sale price: controlling for other determinants of residential value, proximity to a gravel mine reduces sale price. Specifically, Hite reports that the elasticity of house price with respect to distance from a gravel mine [i.e., blasting quarry] is .097, implying that a 10 percent increase in distance from the gravel mine is associated with slightly less than a 1 percent increase in home value, all else the same.*[199] *Conversely, the closer the house to the proximity to the mine, the greater the loss in house value."*

According to Professor Hite, model results presented in elasticity form are particularly difficult for lay people to understand. As a result, Erickcek transformed the elasticity model into a graph that calculates property discounts associated with the estimated model demonstrating that the reduction in house values shown on the graphic (page 5) due to the mine (pit) ranged from 30% adjacent to the mine (pit), to about 5% at 3 miles (4,828 metres) from the mine (pit). While the Hite study relied upon by Erickcek pertains to a blasting quarry, Erickcek justified and explained his reliance on the Hite study to measure the impact of a proposed gravel pit, as if fully operational, on area property values in his December 20, 2006, addendum. The following points are notable in this context:

- Hedonic pricing models have been the standard research technique for evaluating property value impacts for decades.
- The Upjohn report based its estimates of property value impacts for Richland using model estimates from Professor Hite's research because her research was based on high quality data. In addition, hers was the only study we knew of at the time that used hedonic pricing models to estimate residential property value impacts of mines. Since conducting the study, we have become aware of another study that uses hedonic pricing models, and we have conducted our own analysis based on data for an area gravel mine supplied in an industry consulting report [Sustaining A River: An Economic Impact Study of the Lower Great Miami River Segment

[199] This estimate is based on a constant elasticity model specification. At the Upjohn Institute's request, At the Upjohn Institute's request Professor Hite tested the sensitivity of these findings to model specification, and in all specifications finds a large, statistically significant negative effect of proximity to gravel pit on house prices. The simulations for Richland Township reported below are based on the estimates from the constant elasticity specification and yield slightly lower estimated negative property value impacts than those based on models using other functional forms. We consider this number to be a conservative estimate.

Improvements, by Radha Ayalasomayajula, Fred Hitzhusen and Pierre Wilmer Jeanty].

This study used a hedonic price model similar to that used in Professor Hite's study to estimate the impact of gravel mining operations near the Great Miami River in Butler and Hamilton counties, Ohio. The sample contained sales data on only 119 homes - far fewer than the 2,552 homes Professor Hite had in her sample. The model used in this study accounted for structural characteristics of the individual homes including number of baths, living area, age, number of bedrooms and whether they had a fireplace. In addition, it included the distance from a gravel mine and distance to the closest urban area. The study found that, on average, property values increased by $1,675 per every 1/10th mile [161 metres] the home was away from the mining operation. In other words, the value of a home one mile [1,609 metres] away from the gravel mine would be worth $16,725 more than the identical house located at the mouth of the mine. The study's analysis limited its impact to only a one-mile radius.[200]

Although Professor Hite's data set is ideal for studying these property value impacts, we were uncomfortable basing the Upjohn report on her initial analysis. Professor Hite agreed to do additional work for the Institute [without seeking compensation].... [T]his involved running checks on the data and variable construction, adding control variables, and testing the robustness of her results to model specification. The simulations presented in the Upjohn report were based entirely on new work performed by Hite for the Upjohn Institute and show somewhat lower property value impacts than in her initial report....Professor Hite's interest in this project is solely to produce high quality research that is publishable in a peer-reviewed, scholarly journal.[201]

As pointed out by Professor Hite, pits and quarries have a number of operational similarities:

> *"I would like to emphasize that the two types of gravel operations [pits and quarries] are very similar in that, like landfills, they both involve increased truck traffic, noise, and dust and the destruction of large tracts of land....[T]he main difference is that gravel produced at a limestone quarry requires significantly more blasting. To the extent that blasting results in higher average noise or dust levels for area residents, these operations may have larger adverse effects on nearby property values. The adverse property effects from limestone quarries in my study are very large...and...it is improbable that all of these adverse property effects are the consequence of blasting."*

Erickcek also took into account an assessor's testimony at an August 9, 2006, public hearing held in Howard Township in Cass County on Moose Lake Aggregate's Application for a Conditional Use Permit, confirming that the assessments on 13 residences near the Moose Lake Gravel Mine were

[200] The study's analysis was not as sophisticated as Hite's model in that it generated a strictly linear estimate of the negative impact of the mining operation on housing prices. Hite's model generates a more realistic "curved" estimate that declines first at an increasing rate and then at a decreasing rate.

[201] Professor Hite received no compensation for her work, despite the fact that is was fairly extensive.

reduced by 30% based on his expertise. The estimated 30% reduction in the assessments of these 13 properties is nearly identical to the estimates in the Upjohn Institute study. Later the township assessor revised the negative impact to only 10 percent; however, upon the protest of two of the homeowners of the impacted properties, the assessor increased the negative impact of the mining operation back up to 30 percent of the property's original SEV. The two owners had their properties independently appraised and the Township assessor agreed: "I believe that if I had the appraisals before...that I probably would have left everbody's at 70 percent, but I didn't have any knowledge of that." [footnote omitted]

In addition to the obvious adverse impacts (nuisances) of dust and noise generated by the operations of an active gravel pit, which decline with distance from the gravel pit, three other adverse or negative impacts that would not decline so quickly with distance are traffic congestion and traffic accidents, town or community reputation and uncertainty about future development or land use plans, all of which result in a negative impact on residential property values. These are described as below:

- *Road Congestion*: Still, township residents who do not live along potential truck routes or who reside far enough away from the mine to avoid its dust and noise, will face increased road congestion [and traffic accidents] due to the truck traffic generated by the mine. Gravel trucks can be slow-moving and difficult to pass. Also, due to the lack of sidewalks, the trucks will have to share the road with pedestrians and bicyclists. In addition, while the proposed truck route for the gravel mine stays clear of the Village of Richland, independent truck contractors would be allowed by state law to drive through the Village on M-43 and/or M-89. For some instances, this could prove to be the low-cost route for the independent haulers. If this occurs, it will have a negative impact on the Village's environment, which would be shared by most all of the township residents.
- *Reputation of the area:* Just as amenities such as a good school system can improve a town's reputation and improve property values, the introduction of a disamenity such as a gravel mine can harm the reputation of the area [community], in turn depressing property values.. As George Tolley of the University of Chicago writes "people living away from the area, who are not directly affected by the disamenities, view the area as undesirable."[202]
- The operation could also alter future development plans for the township. In real estate, uncertainty only decreases land values. Once the mining operation is in place, it can ease the allowance of other heavy industry uses to occur in the township. In short, the gravel mine could open the door to other heavy primary industries. This is the "blight-begets-blight" principle. In fact, one argument cited in defense of having trucks use 24th Street is that it was used

[202] George S. Tolley, *Effects of the Proposed Indeck Facility on Property Values, Land Use and Tax Revenues.* May 2000, unpublished paper, page 6.

before for heavy trucks going to a now closed landfill. In short, this will raise uncertainty about the allowance of other noisy, heavy industries into the region.

17.4 Proximity Study Four

In 2020, Kolala et al.[203] undertook a study employing the Hedonic pricing method (Rosen, 1974)[204] to quantify the impact on residential property values in proximity to the Fimiston super pit (quarry) in Western Australia, which measures 3.5 km in length, 1.5 km in width and 360m in depth. Kalgoorlie-Boulder has an estimated population of about 32,000, and the main economic actively is mining, followed by agriculture, manufacturing and processing activities. The most common complaints from residents residing in proximity to the super quarry relate to blasting, noise and dust. To estimate the "dis-amenity impact" of the open pit gold mine on residential property values in the community, sales data for 21,850 residential properties sold in Kalgoorlie-Boulder, between 1990 and 2018, were analyzed, and adjusted to 2012 values using the consumer price index (CPI). The average house sale price in the sample of 21,850 house sales is AU$250,000, in 2012 prices; has a 700 square metre (7,535 sf) lot, three bedrooms, and one bathroom; and is located 3 km (1.864 miles) from the super-pit, 2.5 km (1.553 miles) from the CBD, 1 km from the nearest school, and 0.5 km (0.311 miles) from the nearest park.

The distance between the super quarry and the first street with residential properties is less than 200 metres (656 feet), and the maximum distance to the quarry to residential homes is just under 7 kilometres (4.35 miles). The data set contains information on the sale price, location, and sale date; as well as house features such as the number of bedrooms, bathrooms, lot size, type of roofing, wall construction material, and the year the property was built. The initial data contained over 30,000 sales records, but after data checking and restricting the observations to single-family houses and units within the Kalgoorlie-Boulder metropolitan area, ...21,850 complete records [remained]. The maximum distance from a residential home to the super pit is just under 7 km.... Cadastral data were obtained from Landgate, the Western Australian Land Information Authority....[T]he distance of each house to relevant neighbourhood amenities, (schools, parks, sports facilities and central business district) and dis-amenities (super-pit and the airport) using ArcMap 10.5. Model estimation was... performed [in] R (R Core Team 2019)).[205]

The study found that residential properties within 2 km (1.243 miles) of the Fimiston super-pit (quarry) trade at a 20% to 30% discount to similar residential properties located at least six to 7 km (4.35 miles) from the super pit. It was also concluded that the results of the study provide valuable

[203] Kolala, C., Polyakov, M., Fogarty, J. "Impacts of mining on property values in Kalgoorlie_Boulder, Western Australia," (2020) 68(C) Resources Policy.

[204] Rosen, S., "Hedonic prices and implicit markets: product differentiation in pure competition", (1974) 82 (1) J. Polit. Econ. 34-55.

[205] R: Core Team, "R: a language and environment for statistical computing", (2019) Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

information for planners seeking to set appropriate buffer zones (separation distances) around mining operations to avoid land use conflicts, while protecting residential property values.

17.4 Proximity Study Five

In *M & N Materials, Inc. v. Town of Gurley, Alabama, et al.*, (2015),[206] the United States District Court issued summary judgment in favour of the Town of Gurley, upholding the Town's April 13, 2004 decision to annex a quarry operator's 266 acres (107.65 hectares), and to prevent quarrying based on a number of potential adverse effects on the environment and the community related to *health, safety, morals* and *general welfare* of the Town's residents. On the issue of property value impacts, Key, a member of the Appraisal Institute, prepared a Proximity Study involving small samples of grouped sales. Key's Proximity Study grouped sales of modest detached single-family dwellings within 875 feet (267 metres) of the lot boundaries of a quarry that was operational when the sales occurred, compared to a group of sales located beyond 875 feet of the lot boundary of the operational quarry (i.e., the control group). Both groups of sales are from the same subdivision. The purchase price of each sale in both groups of sales were *time-adjusted* to the effective date of appraisal (November 23, 2004), and relied upon to isolate the impact, if any, the proposed quarry in the Town of Gurley would have on the value of nearby residences within 875 feet (267 metres) of the boundary limits of the proposed 266-acre quarry. Combined, the house sales in both groups ranged in price from $82,000 to $125,000.

Based on the *distance* parameter of the Proximity Study, Key concluded that residences within 875 feet of the boundary limits of the proposed quarry would sustain an estimated 12.2% diminution (loss) in value, a rate that falls within the 10% to 15% discount suggested by two knowledgeable local realtors. The risk factors associated with a quarry operation to which homeowners are exposed, as identified in Key's study, include the following:

- Quiet Enjoyment : Noise issues
- Trespass : Dust and airborne particles
- Structural Damage : Blasting
- Ongoing Monitoring : Determining change of structural damage
- Market Resistance : Proximity issues resulting in a diminution in value

The Proximity Study does not indicate the distance from the actual quarry activity (mining and blasting), a point that is more distant than the 875 feet (267 metres) measured from the boundary limits of the quarry. Likewise, the distance from the planned quarry activity (mining and blasting) to its boundary limits of the proposed quarry is not specified. Furthermore, the Proximity Study does not disclose whether the purchasers

[206] *M & N Materials, Inc. v. Town of Gurley, Alabama, et al*, United States District Court, Northern District of Alabama, Northeastern Division, November 13, 2015, <https://lanierford.com/images/NewsPDFs/federal-court-decision-gurley-alabama-quarry-case.pdf>.

in both groups of sales were aware of the potential hazards of flyrock, as identified by Ludwiczak, the blasting expert whose testimony in this case was also accepted by the court.

Purchasers relocating from major urban centres to a rural community like the Town of Gurley (2004 population: 874) are unlikely to fully grasp the deleterious effects associated with residing in proximity to a blasting quarry operation, including the dangers of flyrock, which is the ultimate adverse effect due to its potential for injury or death of human and non-human life. If the purchasers in both groups of sales were not fully aware of, or well-advised as to the adverse effects of residing near a blasting quarry, the loss in property value would be expected to be higher. Buyers given the choice of selecting between two homes at the same price and similar in age, quality of construction, building materials, utility and lot size, would avoid choosing the one in proximity to a blasting quarry (or non-blasting quarry).

18. CONCLUSION

While aggregate resources are essential for road and building construction, the process of extracting aggregate involves the inevitable destruction of the land from where the aggregate resources are extracted. There are always adverse impacts on the environment occasioned by the processes and operational aspects involved in aggregate extraction, impacts that are magnified as the scale, intensity and duration of aggregate operations increases. The most destructive and dangerous form of aggregate extraction involves quarries that blast rock below the water table, and which have no realistic prospect of rehabilitation. Blasting generates toxic fumes, airblast, ground vibrations and flyrock, an unavoidable by-product of blasting. Repeated blasting has been documented as causing structural damage at a considerable distance from the blast site, despite blasting being conducted within regulatory limits, and despite the aggregate industry's constant claims to the contrary.

When a blasting quarry operation is permitted to be established in the wrong geographic location, and the adverse impacts on the environment and surrounding community cannot be mitigated to a "trivial" level, the negative externalities, financial and otherwise, associated with the quarry operation are borne by the public and innocent third parties. Not only is the health, safety and welfare of the community compromised, but numbers of comprehensive proximity studies have also concluded that residential properties within a certain radius of blasting quarry operations, as well as pits, are less marketable and sustain a significant loss in property value or home-owner equity. Upscale homes sustain larger losses than more modestly priced homes equally distant from an aggregate operation.

Land use planners acting on behalf of a municipality, county or region, engaged in the processing of applications to permit aggregate extraction have statutory and common law obligations to protect the *health, safety* and *welfare* of the communities under their jurisdiction, including the residents' rights to the uninterrupted use and enjoyment of their properties and to

preservation of their property values (e.g., home-owner equity). A permanent mandatory minimum onsite setback of 500 metres to protect quarry employees, coupled with a minimum offsite radius separation distance of 1,000 metres between the boundary of a quarry and sensitive land uses or activities, existing or proposed, would reduce, but not necessarily eliminate all adverse effects. Other environmental considerations could necessitate enhanced setbacks and separation distances. All other things equal, the more geographically distant a quarry operation is from sensitive or incompatible land uses, deleterious impacts are reduced, including losses in property value.

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AUTHOR'S DECLARATION AND ESSENTIAL ETHICAL COMPLIANCES

Authors' Contributions (in accordance with ICMJE criteria for authorship)
This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

Funding
No funding was available for the research conducted for and writing of this paper.

Research involving human bodies (Helsinki Declaration)
Has this research used human subjects for experimentation? No

Research involving animals (ARRIVE Checklist)
Has this research involved animal subjects for experimentation? No

Research involving Plants
During the research, has the author followed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora? Yes

Research on Indigenous Peoples and/or Traditional Knowledge
Has this research involved Indigenous Peoples as participants or respondents? No

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
Has author complied with PRISMA standards? Yes

Competing Interests/Conflict of Interest
Author has no competing financial, professional, or personal interests from other parties or in publishing this manuscript.

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