

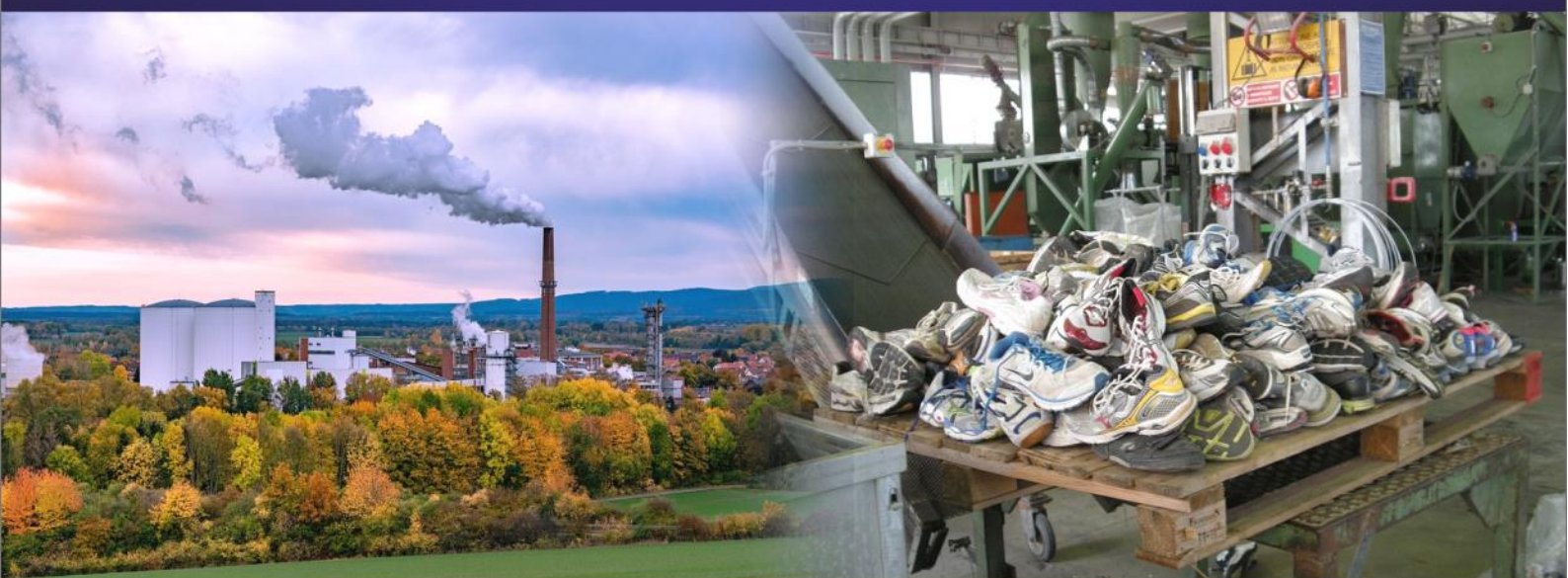
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TABLE OF CONTENTS

M-00310	BLASTING QUARRY OPERATIONS: LAND USE COMPATIBILITY ISSUES AND POTENTIAL PROPERTY VALUE IMPACTS <i>By Tony Sevelka</i>	1-78
M-00311	ENDING GAS FLARING IN THE NIGERIAN OIL AND GAS INDUSTRY: THE NEED FOR STRICT REGULATORY ENFORCEMENT <i>By Dandy Chidiebere Nwaogu, Theresa Uzoamaka Akpoghome</i>	79-101
M-00312	DEMAND-PULL INSTRUMENTS TO SUPPORT THE CIRCULAR ECONOMY: A GLOBAL PERSPECTIVE <i>By Eleanor Mateo, Topi Turunen, Joonas Alaranta</i>	101-138
M-00313	PROSPECTS AND CHALLENGES TO PROVE ENVIRONMENTAL HARM IN LITIGATION: STATUS QUO IN NIGERIA <i>By Awodezi Henry</i>	139-153



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

Tony Sevelka

International Valuation Consultants Inc., Suite 38, Matheson Mews, 2601 Matheson
Boulevard East, Mississauga, Ontario L4W 5A8 Canada. E-mail: info@intval.com
ORCID: <https://orcid.org/0000-0002-2210-421X>

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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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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

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+conclusion&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.

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

“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 flyrock⁶] 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 day⁷
- 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

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.

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

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=1904962323412115659&q=Finr+II,+Inc.+v.+County+of+Hardee&hl=en&as_sdt=2006>.

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

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]ll 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

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>>.

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

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 34 $\frac{2}{3}$ 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

¹⁵

<[¹⁶ *Fountainhead Fun Centres Ltd. v. Montreal \(City\)*, 1981 CanLII 2710 \(QC CA\), <<https://canlii.ca/t/gdlmb>>, retrieved on 2022-11-15.](https://www.albemarle.org/Home/ShowDocument?id=3071#:~:text=675%20(1927)%20(zoning%20ordinance,public%20health%2C%20safety%20and%20welfare>.”</p></div><div data-bbox=)

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...”

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

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) § 36-8-2-4¹⁹ 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 Olmsted'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

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](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.

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

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

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=1982332869873831615&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).

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

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 space³¹ 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

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 is 10 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>.

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

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

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>>.

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

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 rehabilitation³⁷ 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

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.

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

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 itself⁴³ (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>>.

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

vibrations, air blast, flyrock, noise, and toxic fumes⁴⁵, 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

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).

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

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].”

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>>.

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

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

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.

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

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

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=SwNI7rxA5ugC&hl=en&pg=GBS.PA1>>.

⁶³ Little, T. N., "Flyrock Risk," EXPLOR 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>.

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

- 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 & Jain⁶⁷ 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

⁶⁶ Ken Ward Jr., “Have a blast: OSM finds WVDEP lax in policing flyrock,” (August 17, 2009) *Clarkson Gazette-Mail*, <<http://blogs.wvgazette.com/coalattoo/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-Oct-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).

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

- 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>.

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

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:

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), <<http://docs.isee.org/ISEE/Support/Proceed/General/IIGENV1/11v161g/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/Support/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>>.

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

*“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

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*.

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

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 prediction⁹⁰ 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.

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>>.

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

- 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

⁹³ Hasel Amini, Raof 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, Bhatwdekar Murlidhar, Rosli Saad, "Abstract: Effect of Geological Structure on Flyrock Prediction in Construction Blasting," (2018) 4 Geotechnical and Geological Engineering.

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

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-charge⁹⁷ 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. Pistol, F. Kopf et. al, Ambient Vibration of Oscillating and Vibrating Roller: Apart from the Characteristics of the excitation (duration,

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.

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

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>>

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

[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 8507¹⁰² 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

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.

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

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

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).

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

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

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_et_al_v_Meriwether_County_et_al_Final_Order.pdf.

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

"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: $P_{u-100} = (0.95)^{100} = 0.006$."

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 seismometers¹¹³ 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.

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).

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

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://vulcanhammer.net.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>

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

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](https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(72)_FR.pdf)>.

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

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>>

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

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 km²) 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/>>.

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

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.

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

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*

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

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

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>.

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

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=504249960740437294&q=%22quarry%22+and+%22concussion%22&hl=en&as_sdt=2006. Rehearing denied March 20, 1964.

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

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

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>.

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

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>.

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

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>.

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

- 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,

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

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>>

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

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-Ekiti, 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.

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

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>>.

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

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 I (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.

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

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.wvgazette.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.

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

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

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.

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

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 release¹⁴⁶ 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.

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

- 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 km²) 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 km²) 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.

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

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>.

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

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 Tepecanoe 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/>>.

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

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)

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>.

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

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 1¹⁵⁷
- *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51¹⁵⁸
- *Eastman et al. v. Dewdney Mountain Farms Ltd.*, (2017), ONSC 5749¹⁵⁹
- *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.

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

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 operation¹⁶⁴ 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.

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

- the quantity and quality of private third-party domestic well water of current and future generations¹⁶⁵
- 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 limit¹⁶⁷) 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.dysart.ca/en/municipal-government/By-Law%20Enforcement/By-Law%202003-95%20Pits%20and%20Quarries.pdf>>.

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

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".

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=289091988892488582&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>.

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

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 Order¹⁷² 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 them 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

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.

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

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>.

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

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>.

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

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,

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

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 disamenities/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

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>>.

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

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 Appendix¹⁹³ 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>>.

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

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.

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

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 study¹⁹⁸ 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

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>>.

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

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.

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

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 it was fairly extensive.

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

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 everybody'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.

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

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 activity 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/>>.

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

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>>.

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

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

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

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

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ENDING GAS FLARING IN THE NIGERIAN OIL AND GAS INDUSTRY: THE NEED FOR STRICT REGULATORY ENFORCEMENT

Dandy Chidiebere Nwaogu

Department of Jurisprudence and International Law, Faculty of Law, University of Benin, Benin City, Nigeria. Email: dandy.nwaogu@uniben.edu,
ORCID: <https://orcid.org/0000-0002-6672-8761>

Theresa Uzoamaka Akpoghome*

Department of Public Law, Faculty of Law, Benson Idahosa University, Benin City, Nigeria. E-mail: teremajor@gmail.com, takpoghome@biu.edu.ng
ORCID: <https://orcid.org/0000-0002-9296-0134>

**Corresponding author*

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ABSTRACT

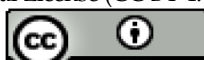
Environmental pollution arising from gas flaring constitutes a major concern among the international community, particularly as a result of the negative impact it brings to society, environment, and economy. In the last 60 years, multinational oil companies operating in Nigeria have consistently flared associated natural gas. This paper critically examines the extant legal frameworks for regulating gas flaring within the Nigerian oil and gas industry, as well as other efforts made by the federal government towards ending gas flaring in the country. The effects of gas flaring on the inhabitants of the Niger-Delta region of Nigeria (human and environment) are discussed, then an overview of the challenges militating against ending the menace of gas flaring is provided. The paper contends that unless there is strict enforcement of anti-gas flaring regulations by the regulating agencies of government with stiff punishments and fines for erring oil companies, gas flaring will not abate. Recommendations are, therefore, proffered for combating gas flaring in the country.

Keywords: Gas flaring; Regulations; Effects; Punishment; Challenges; Enforcement

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Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

1. INTRODUCTION

Started by early 20th century, oil and gas production has been the major means of economic advancement for many oil producing countries of the world, including Nigeria.¹ The Nigerian state is currently counted amongst the top 10 countries rich in natural gas globally. Nigeria has massive natural gas reserves close to 159 trillion cubic feet², out of which about 2.5 billion cubic feet is said to be vented by the multinational oil companies operating within the Nigerian oil fields.³

Oil exploration in any oil producing country has both positive and negative effects of such exploration. Gas flaring constitutes a major negative effect in the communities where oil and gas is produced and processed.⁴ In Nigeria, the Niger Delta region is the primary location where oil and gas operation take place at large volumes. The inhabitants of this region rely heavily on their natural environment for daily survival. Therefore, the local people of the region look up to their farmland and water for sustenance.⁵ As a result, the huge venting of gas during oil production by the international oil companies caused heavy pollution in the environment within the region, thus making life difficult for the inhabitants.⁶ Despite the fact that oil exploration has consistently been carried out in the Niger Delta area since 1956 after oil was discovered in Nigeria, the region has been left poor and undeveloped by the federal government of Nigeria and the operating oil companies.⁷

Gas flaring refers to the act of burning off into the atmosphere the additional natural gas attached to crude oil at the point of drilling the oil out of the ground.⁸ Gas flaring is often carried out by the multinational oil companies for economic and other purposes. The multinational companies believe that processing of natural gas or embarking on re-injection plan is more expensive as compared to flaring such natural gas. The attraction to flare gas in Nigeria is attributed partly to the lack of adequate incentives for acquisition of gas infrastructural equipment, the absence of gas storage facilities⁹, and the persistent low market for natural gas in the country. Arguably, gas flaring remains a persistent environmental and health challenge in Nigeria owing to lack of well-developed gas policy and inadequate enforcement of extant legislations on the part of government agencies.

¹ Ibrinke Odumosu, 'Transferring Alberta's Gas Flaring Reduction Regulatory Framework to Nigeria: Potentials and Limitations', (2007) 44 (4) *Alberta Law Review* 863.

² Olujobi Joshua Olusola, 'The Appraisal of the Legal Framework Regulating Gas Flaring in Nigeria, Upstream Petroleum Sector: How Efficient?' (2019) 10 (3) *International Journal of Advanced Research in Engineering and Technology* 235.

³ *Ibid.*

⁴ Ibrinke, *supra* 1, p. 864.

⁵ Eghosa Ekhatior, 'Public Regulation of the Oil and Gas Industry in Nigeria: An Evaluation' (2016) *XXI Annual Survey of International Comparative Law* 77.

⁶ *Ibid.*

⁷ *Ibid.*

⁸ Factsheet: Global Flaring Reduction Partnership, <<https://www.worldbank.org/ggfr.site>> accessed 12 September 2022.

⁹ Olusola Joshua *supra* 2 p. 236.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

These and other issues are examined in this paper. For effective elucidation of the topic under study, this paper is divided into 9 parts including the introduction. Part II discusses the historical perspective of gas flaring. This is to show that the practice has been on-going for quite a while. Part III examines the effect of gas flaring on man and the environment. A study of areas in Nigeria where gas is flared has revealed some adverse effect of gas flaring on man and the environment. Part IV and V present and discuss the international and regional regulations and frameworks on gas flaring. The essence is to help the readers understand the role of laws and to determine the adequacy of the laws and the gaps that will lead to the solutions in addressing the menace of gas flaring. Part VI presents a comparative analysis of the practice in Nigeria and Saudi Arabia. This analysis is key as Saudi Arabia is a leading producer of oil and gas in the world. It is expected that the study of Saudi Arabia practices will reveal lessons that Nigeria can learn from to improve on the existing practice at home in order to bring it up to global best practices. Part VII discusses the challenges in curbing or combating gas flaring in Nigeria. Part VIII presents the recommendations based on the findings of this paper, while Part IX concludes the paper.

2. HISTORICAL PERSPECTIVE OF GAS FLARING IN THE NIGERIAN OIL AND GAS INDUSTRY

The venting of gas started in Nigeria as soon as oil was discovered in commercial volumes in early 1956 in Oloibiri, Balyasa State, in the Niger Delta region of Nigeria.¹⁰ The first discovery of crude oil in Nigeria was made by Shell British Petroleum (which was known as Royal Dutch Shell). After the discovery was made by Shell BP, other multinational oil companies such as Total, Chevron, EXXonMobil (formerly Mobil Oil Producing Unlimited), have joined in exploring for oil in Nigeria.¹¹ Gas as a natural energy resource was found in Nigeria in the process of crude oil exploration.¹²

However, it was in 1963 when Nigeria started to develop its gas industry along with marketing natural gas to factories located within gas fields in Ughelli in Delta State and Abia State¹³. Thus, the excess gas produced in the industry was vented or flared.¹⁴ From that time onwards, multinational oil companies carrying out oil exploration in the country have not stopped flaring gas within the oil producing areas in Nigeria. Subsequently, an oil and gas processing plant was built in Okpau-Kwale by Agip Oil Company, and later in 1987, it inaugurated the gas recovery and utilization scheme in line with the Nigerian government's Gas Re-injection Act.¹⁵

¹⁰ ERA, Gas Flaring in Nigeria, 'A Human Rights, Environmental and Economic monstrosity' (2005) Environmental Rights Action (Friends of the Earth) 1-5.

¹¹ Uwem Udok and Enobong Akpan, 'Gas flaring in Nigeria: Problems and Prospects' (2017) 5 (1) Global Journal of Politics and Research 2.

¹² *Ibid.*

¹³ *Ibid.*

¹⁴ *Ibid.*

¹⁵ *Ibid* p. 3.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

It must be stated that the Nigerian gas industry having only a recent origin does not enjoy the same level of patronage and development as the Nigerian oil industry. The oil industry being in operation for well over 60 years has served as the mainstay of the Nigerian economy and infrastructural development.¹⁶

The leadership of General Yakubu Gowon in 1969 took steps to end gas flaring with a policy compelling multinational oil companies to secure relevant equipment that will aid the storage and utilization of gas products. The above directive was to be carried out within the period of 5 years by the oil companies. This directive was never carried out by the oil operators because the time given was short to acquire such expensive equipment for gas storage.¹⁷ When that failed in 1983, however, a new date was given to end the scourge of gas flaring this time with stiff sanctions for non-adherence. The date was similarly changed in 1984 by the government, and later moved to 1 January 2008 as the new date to ending gas flaring in the country with an assurance to close any oil producing company that violates this order of the government.¹⁸

To deter oil companies from flaring gas, the Government of Nigeria have over the years imposed and, subsequently, increased the fees paid by the multinational oil companies having violated the law.¹⁹ The fees were as follows:

1. 2 kobo²⁰ per million standard cubic feet (mscf) prescribed by the Associated Gas Re-injection Amendment Decree 7 of 1985 on companies that flared gas without obtaining Ministerial approval. This very fee was later increased to 50 kobo in 1990.
2. N10 (\$0.0224) per million standard cubic feet in 1998 prescribed by the 1998 Budget.
3. \$3.50 per million standard cubic feet (mscf) in 2011 prescribed by the Ministerial Directive of 2011.²¹

In 2018, the Nigerian President in his capacity as the Minister of Petroleum Resources issued "Regulation 2018"²² as part of the means to protecting the environment against the effects of gas flaring and further preventing the waste of natural gas and creating some economic benefits to Nigeria from gas flaring.²³ Prohibiting gas flaring, the regulation imposes much higher charges as follows:

- a) \$2.00 USD per 28.317 standard cubic meters (1000 standard cubic feet) of gas flared shall be charged as payment to the federal government for gas flaring by a producer from any oil mining lease

¹⁶ Lawrence Atsegbua, 'Oil and Gas Law in Nigeria, Theory and Practice' 4th Edition, (Benin Four Pillars Publishers 2021) 307.

¹⁷ *Ibid.*

¹⁸ *Ibid.*

¹⁹ Oludamola Adewumi, "Gas Charges in Nigeria" (Mondaq Nigeria, 20 November 2018), <<https://mondaq.com/Nigeria/oil-gas-electricity/756460/gas-flaring-charges-in-nigeria>> accessed 18 October 2022.

²⁰ The Nigerian currency is denominated in naira and kobo just as the United States currency is denominated in Dollars and cents.

²¹ *Ibid.*

²² The Flare Gas (Prevention of Waste and Pollution) Regulation 2018.

²³ *Ibid.*

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

area or marginal field that produces 10,000 barrels or more of oil per day.

- b) \$0.05 cent per 28. 317 standard cubic meters (1000 standard cubic feet) of gas flared shall be charged as payment to the federal government for gas flared by the producer of any oil mining lease area or marginal field that produces less than 10,000 barrels of oil per day.²⁴

Despite the charges imposed on oil producers by the government to deter them from flaring gas, gas flaring has continued unabated in the country. Until the government gets serious with the enforcement of anti-flaring regulations, it is believed that gas flaring will not come to an end. This is because the oil operators find it convenient to pay charges and flare gas than embark on gas storage and re-injection projects, which in the long run serves more benefits to the country and help protect human lives and the environment.

This paper argues that gas flaring or venting has remained a recurring decimal in the Niger Delta region of the country owing to the inability of government to import the necessary technology and equipment that can help the country to make use of the excess gas rather than flaring it. This becomes important because of the negative impact that gas flaring has on economic fortune of the country, human lives and the natural environment. However, it looks like the “economic fortune” from oil and gas production is rated high above the environmental hazards and other health challenges that the after effect of such oil exploration brings to the oil host communities in the Niger Delta region of Nigeria.²⁵

3. THE EFFECTS OF GAS FLARING ON SOCIETY AND ENVIRONMENT

Gas flaring does not only constitute a huge loss of valuable resources, which could otherwise be used for national development; it is also the cause of environmental degradation as well as other serious health challenges to the inhabitants of oil host communities.²⁶ When gas is flared, different kinds of toxins and greenhouse gases are released into the atmospheric environment, thus, leading to climate change. Climate change is considered a major challenge confronting most the third world nations today, including the African countries; This is because the countries find it difficult to survive and cope effectively with some of the effects of climate change including shortage of good drinking water and food. Other challenges include quick spread of diseases and flooding.²⁷

Agricultural farmlands of oil producing host communities are equally affected by the impact of gas flaring. The rich nutrients of the soil within the Niger Delta region have been heavily reduced as a result of the acidic chemical compositions from gas flaring, therefore, resulting to the failure of

²⁴ Section 13 of the Regulations 2018.

²⁵ *Ibid.*

²⁶ Lawrence Atsegbua, *supra* 16, p. 309.

²⁷ Nii Nelson, ‘National Energy Policy and Gas Flaring in Nigeria’, (2015) 5 (14) *Journal of Environmental and Earth Science* 59.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

crops or low crop production. The consequence of this on the oil-bearing host communities includes scarcity of food and intense hunger.²⁸

Gas flaring negatively impacts the health of the inhabitants of Niger Delta region of Nigeria. The carbon monoxide released in the atmosphere causes a serious health problem to human lives, impacting on the reproductive ability in man. It is said to be the leading cause of reproductive toxicity.²⁹ The emission of carbon monoxide into the atmosphere during gas flaring is proven to be dangerous to the human reproductive organs³⁰; for the women, it can lead to complicated menstrual challenges, like dysmenorrhea and menorrhagia, meaning painful and heavy periods. It could also lead to prolonged pregnancy. Whereas the usual period of pregnancy for women is nine months, but the negative impact of carbon monoxide can lead a pregnant woman into premature labour and delivery. Invariably, women go into labour between six to eight months of pregnancy.³¹

For most women living within oil producing communities there is evidence of alteration in menopause. This stage sets in for women between 40 to 50 years, respectively. But consistent exposure to carbon monoxide from gas flaring can call in this stage in a woman earlier than the time stipulated by nature. Women also suffer unexpected miscarriage where they are exposed to intense carbon monoxide.³²

The male reproductive system is equally affected; they often suffer fertility challenges such as low sperm count, chest pain and connected heart diseases, cancer and skin diseases.³³ Other effects include noise pollution and reduction in life expectancy for inhabitants of the Niger Delta of Nigeria as compared to persons living in other parts of the country.³⁴ Gas flaring does not only constitute wastage of useful economic resources, but it further results to serious health and environmental problems. Several million tons of carbon dioxide released into the air from year to year in Nigeria from gas flaring without doubt cause unbearable hardship and disaster to human life, plant, and animal life, especially in the oil producing regions of Nigeria.³⁵

Arguably, the attitude of the Nigerian government to gas flaring in the country has not helped in fighting against the menace. The government focuses its attention more on the economic benefits from oil and gas production rather than developing the willpower to end gas flaring in Nigeria. Thus, over the years the government has been unable to sanction the multinational oil companies for their failure to comply with directives meant to end gas flaring.³⁶ The exemption of certain oil wells from compliance with the provisions of the law, together with the imposition of

²⁸ *Ibid.*

²⁹ Kwame Sekyi, 'The Impact of Gas Flaring on Man and His Environment', (2017) 2 (3) International Journal of Engineering and Management Science 87.

³⁰ *Ibid.*

³¹ *Ibid.*

³² *Ibid.*

³³ *Ibid.*

³⁴ Hakeem Ijaiya, Mutiat Abdulsalam, and Maryam Jimoh, 'Institutional and legal Control of Gas Flaring in the Niger Delta Region of Nigeria', (2018) 5 (1) Brawijaya Law Journal 32.

³⁵ *Ibid.*

³⁶ Eghosa Ekhator, *supra* 5, p. 80.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

low fines as penalties, plus the consistent shifting of the dates and deadlines to end gas flaring cannot really be explained.³⁷

Despite the high level of environmental pollution in the oil producing regions, the Nigerian Courts, to comply with anti-flaring legislations in the country, have refused to give orders compelling multinational oil companies whose activities are responsible for such environmental degradation.³⁸ The quest to increase financial revenue and to retain the multinational companies seems to override the need to adequately protect human lives and the environment.³⁹ According to Ekhaton, this kind of dependent relationship existing between the Nigerian government and the oil operators is traceable to the inability of the Nigerian government to control oil and gas industry.⁴⁰

The reluctant attitude of the Nigerian courts toward granting redressal for environmental degradation is clearly demonstrated in the cases of *Shell v. Ambah*⁴¹ and *Ogiale v. Shell*.⁴² In both the cases, the applicants brought an action for compensation arising from the oil exploration activities of the multinational companies within their community, their claims were to compensate the loss of their incomes from their farmland and crops, contamination of drinking water, and injury caused to their health as a result of pollution from oil exploration. The court declined issuing the necessary orders towards the compensation for the damages caused to the health of inhabitants and their environment.

4. REGULATING GAS FLARING IN NIGERIA

This section of the paper focuses on the various international and national legislations as part of the efforts made by both the international community and the Nigerian government over the years to combat the scourge of gas flaring.

4.1 International Legal Frameworks on Gas Flaring

The United Nations Declaration on Human Environment (The Stockholm Conference, June 16, 1972)

The conference was aimed at addressing the problem of degradation of the ecosystem by anthropogenic activities. It urged States to carefully ensure that operations within its national boundaries do not cause harm to the environments of surrounding States. It further provides that States have the right to use their natural resources in such a way as to protect the environment and the lives of the inhabitants.⁴³ States are also required to pay compensation for harms caused by associated flaring and other

³⁷ *Ibid.*

³⁸ Ebeku, K., 'Judicial Attitudes to Redress for Oil Related Environmental Damages in Nigeria', (2003) 12 (2) RCIEL 208.

³⁹ *Ibid.*

⁴⁰ Ekhaton *supra* 5 p. 5.

⁴¹ *Shell v. Ambah* (1999) 3 NWLR (Pt. 593) 1.

⁴² *B.E.O. Ogiale and Ors v Shell Petroleum Development Company Nigeria Limited* (1996) 1 NWLR (Pt. 480) 148.

⁴³ Olusola Joshua, *supra* 2 p. 238.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

environmental injuries caused by their conduct within their states.⁴⁴ This type of declaration within the field of International Law is regarded as soft law, which is considered not mandatory, but basically declarative in nature; in other words, they are international norms that are deliberately not binding yet they have legal relevance.⁴⁵ In recent times, the declarations have been made to apply to domestic laws as well.⁴⁶ It is important to note, however, that the 'no harm' rule has been applied by the International Court of Justice in the *Corfu Channels Case*⁴⁷.

*The Vienna Convention on the Protection of the Ozone Layer*⁴⁸

The Convention urged States to cultivate ways of protecting the health of citizens as well as its environment from harmful activities in the ozone layer. Thus, a responsibility was placed on States to protect the ozone layer to protect human lives and by extension protect the environment from other harmful consequences capable of affecting the operations of man.⁴⁹ In addition to the Vienna Convention, the Montreal Protocol was made⁵⁰ to specifically state the substances that are capable of destroying the ozone layer. The protocol urges State parties to put measures in place to desist or reduce the level of substances which diminish the ozone layer in order to protect human lives and the environment.

*The United Nations Framework on Climate Change*⁵¹

This framework is foisting towards the proper management or reduction of gas flaring into the atmosphere, and as well to ensure a healthy and clean habitual environment. The Kyoto protocol is said not to have enjoyed effective compliance within the international community because at the time it was adopted, it did not encompass the world's largest economies, and it excluded most developing countries including the People's Republic of China and Africa from binding effects. Again, the United States of America failed to sign up.⁵² Thus, the protocol lacked an effective enforcement mechanism and support from several countries.⁵³

*The African Charter on Human and Peoples' Rights*⁵⁴

Article 24 of the Charter provides for the right to a healthy environment, and, therefore, places responsibility on members of the African

⁴⁴ *Ibid.*

⁴⁵ Arif Ahmed and Jahid Mustofa, 'The Role of Soft Law in Environmental Protection: An Overview', (2016) 4 (2) Global Journal of Politics and Law Research 2.

⁴⁶ *Ibid.*

⁴⁷ International Court of Justice, *Corfu Channel* (United Kingdom of Great Britain and Northern Ireland v. Albania), <<https://www.icj-cij.org/en/case/1>> accessed December 18, 2022.

⁴⁸ This Convention entered into force in 1988.

⁴⁹ Hakeem, Mutiat and Jimoh *supra* 33 p. 37.

⁵⁰ It came into force in January 1989.

⁵¹ Also known as the Kyoto Protocol, it came into force in February 2005.

⁵² Edith Forsyth & Kimberly Winston, 'Kyoto Protocol Overview, Pros & Cons', <<https://study.com/learn/lesson/kyoto-protocol-overview-pros-cons.html>> accessed 20 October 2022.

⁵³ *Ibid.*

⁵⁴ This Charter was adopted in 1981 by the Organization of African Unity, now known as the African Union (AU).

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

Union to ensure the provision of a healthy and clean environment. It is important to note that Nigeria has adopted this provision of the Charter through the act of domestication.⁵⁵ The Charter is now part of Nigerian Law, this is by virtue of the African Charter on Human and Peoples' Rights (Ratification and Enforcement Procedure) Act Cap A9 LFN 2004.

Article 24 states that 'All peoples shall have the right to general satisfactory environment favourable to their development'. With the adoption and domestication of the law, African Charter fully becomes an integral part of the Nigerian law.⁵⁶ Thus, the inconsistency requirement in Section 6 (6) (c) of the Constitution have not been violated.⁵⁷ Section 20 of the 1999 Constitution provides that 'the State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife. Although the right to environmental protection is guaranteed in the constitution, sadly, the above provision is not enforceable before the Nigerian courts. This is because section 20 of the constitution falls under Chapter II referred to as "Fundamental Objectives and Directives Principles of State Policy". All matters in this chapter of the constitution are not justiciable. Meaning that aggrieved citizens of the country whose fundamental rights have been violated upon cannot seek redressal at the court of law.

According to *Emejuru*, since the African Charter on Human and Peoples has been domesticated and now is the part of domestic law, the Nigerian Courts certainly assume jurisdiction to apply provisions of the Charter.⁵⁸ Thus, a citizen who feels his/her rights under the provisions been breached should be able to get redressal in the Nigerian courts.⁵⁹ For the citizens of the country to fully enjoy the environmental rights provided in Section 20 of the Constitution, this section on the environment should be removed from Chapter II of the Constitution through an amendment in order to protect, improve and safeguard the citizens' right to clean environment.

Arguably, these international instruments on environmental protection have not significantly helped in combating environmental challenges within the international community as a result of the lack of enforcement at national level. The absences of a known monitoring body to ensure compliance together with no judicial institution on environment have made it difficult to enforce compliance of the international conventions on the environment. The authors argue that for there to be a quick end to gas flaring and other environmental challenges, the international community need to go beyond the adoption of international conventions and protocols on environment, to taking more proactive steps. In this regard, the following suggestions are proffered:

⁵⁵ Referred to as the African Charter on Human and Peoples' Rights Ratification Act, Cap. A9, Laws of the Federation of Nigeria 2004.

⁵⁶ Emejuru Emenike, Ebikaka Nwanyanwu & Chukwuma Ajie, 'Right to a Healthy Environment in Nigeria and Other Jurisdictions: A Legal Assessment' (2020) 8 (3), *Global Journal of Politics and Law Research* 9.

⁵⁷ *Ibid.*

⁵⁸ *Ibid.*

⁵⁹ *Ibid.*

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

- i) The creation of a powerful international monitoring body on environment to ensure full compliance with the conventions as adopted.
- ii) The establishing of an International Judicial Institution (Court) on Environment for quick trial and prosecution of offending States, multinational oil companies. The Court could also serve as inter-states environmental disputes resolution mechanism. This can be achieved by incorporating environmental crimes into already existing judicial institutions both at the international and regional levels.

4.2 National Legislations for Arresting the Scourge of Gas Flaring in Nigeria

Acknowledging the negative effects of gas flaring on human lives and the environment, the Nigerian government had at different times made efforts to combat gas flaring. The first regulation in this regard was the promulgation by the government of the Associated Gas Re-injection Act 1979.

Associated Gas Re-injection Act 1979

Thus, in 1984, the Associated Gas Re-injection (Continued Flaring of Gas) Regulation was subsequently promulgated. The purpose of this piece of legislation was to compel the multinational oil companies to conserve the huge gas reserves of Nigeria, develop and process natural gas for domestic and industrial usage.⁶⁰ Section 1 of the Act ensures that oil companies can only flare gas from specific oil fields on satisfying the under listed requirements:

- i) In the event that above 75 percent of the gas produced has been conserved.
- ii) Where in the process of utilization or conservation equipment in use failed, provided that such equipment failure does not occur frequently.
- iii) Where oil is produced from an oil well which does not meet the requirement stated in the guiding laws.⁶¹

The implication of this therefore, is that the Minister of Petroleum Resources can legitimately under the present legal regime authorize the flaring of gas into the atmosphere where the oil companies have met the above stipulated conditions.⁶² Arguably, this is done undermining the health and environmental impacts of the inhabitants of the Niger Delta region of Nigeria.⁶³ However, the Associated Gas Re-injection (Continued Flaring of Gas) Regulations failed to realize its purpose of ending gas flaring, because

⁶⁰ Lawrence Atsegbua *supra* 16 p. 307.

⁶¹ Eghosa Ekhaton, *supra* 5 p. 5.

⁶² *Ibid.*

⁶³ Section 3(2) (a) of the Associated Gas Re Injection Act (Amendment) 2004. This section of the Act allows the oil companies to flare gas with the permission of the Minister of Petroleum. The Act directs the Multinational Companies to provide plans for the utilization of gas. The author argues that the minimal sanctions provided by the AGRA has not in any way deterred the oil companies from ending the menace of gas flaring.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

the multinational oil companies considered it attractive and cheaper to vent gas than to embark on gas re-injection scheme that they saw as very expensive in terms of acquiring the needed storage equipment.⁶⁴ Sadly, the oil companies have refused to comply with government deadlines and directives to end gas flaring and this could be attributed to the fact that the government lacks the will power to enforce compliance and adequately sanction the multinational companies.

Sections 33 (1) and 34 (1) 1999 Constitution as Amended

This represents another major legislative effort in fighting against gas flaring in Nigeria. These provisions of the Constitution guarantee the right to life, and dignity to humans. The enjoyments of the above listed rights, therefore, are predicated on the availability of clean and healthy environment. However, under the present constitutional arrangement, these rights are not justiciable as earlier observed, because Chapter 2 of the 1999 Constitution, particularly Section 20, makes it unenforceable against the government in the event of its failure to protect the environment from harmful effects.⁶⁵ Thus, the 1999 Constitution does not offer individuals or groups any form of redressal or remedy for breach of their environmental rights.⁶⁶

The Flare Gas (Prevention of Waste and Pollution) Regulations 2018

This was also enacted to stop gas emissions that is, the venting of natural gas in the country. The essence of this regulation was basically to implement the polluters pay principle, wherein the oil companies were to pay with carbon tax. The Regulation also seeks to increase the fine payable by the defaulting companies. Under the Regulation, oil companies were directed to disclose the exact figure of gas flared, they were similarly mandated to grant undeniable access to specific sites of the flare.⁶⁷ Failure to comply with the above directives could mean either suspension or termination of license of such erring multinational oil company. It could be argued that the regulation has also not been able to combat gas flaring in Nigeria for lack of effective monitoring and enforcement by the appropriate government agencies saddled with the responsibility of such enforcement.

Harmful Waste (Special Criminal Provisions) Act

Similarly, the Harmful Waste (Special Criminal Provisions) Act⁶⁸ was enacted to make it unlawful to dump all forms of harmful waste on any piece of land, air or body of waters in Nigeria without obtaining the required permission.⁶⁹ The Act provides against the acquisition, deposit or storage of toxic waste.⁷⁰ The Act prescribes life imprisonment as penalty for violating its provisions.

⁶⁴ Lawrence Atsegbua *supra* 16 p. 308.

⁶⁵ Olusola Joshua *supra* 2 p. 239.

⁶⁶ *Ibid.*

⁶⁷ *Ibid.*

⁶⁸ Harmful Waste (Special Criminal Provisions) Act 2004, Cap. HI, LFN.

⁶⁹ Eghosa Ekhaton, *supra* 5 p. 83.

⁷⁰ Section 6 of the Act.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

*The National Environmental Standard Regulation (Establishment) Agency (NESREA) Act 2007*⁷¹

The Agency was established to monitor and enforce all laws on the environment. Section 7(c) of the Act mandates it to enforce and ensure compliance with relevant international agreements on environmental preservation in line with the national policy on the environment.⁷² The Act outlaws the unlawful discharge of harmful substances into the environment without the requisite permission.⁷³ The Agency also has the responsibility to monitor compliance with stipulated standards and subsequently prosecute offenders in line with the Act.⁷⁴ The Act gives the Agency the power to set up mobile courts for the quick trial of offenders and violators of environmental laws.⁷⁵ The Act gives the Agency the power to set up departments and offices as it so desires to enable it carry out its functions seamlessly.⁷⁶

Arguably, some major flaws are identified in the NESREA Act. The Act no doubt makes elaborate provisions on environmental protection for the benefit of human beings and the environment at large; however, the Act does not give the Agency authority over matters bordering on crude oil and natural gas.⁷⁷ Thus none of the provisions of the Act directly or expressly prohibits the flaring of natural gas. Again, one wonders why the powers of the agency do not extend to hazardous wastes like gas flaring.

Other kinds of environmental pollution carried out by the multinational oil companies are similarly excluded from the operation and capacity of the agency.⁷⁸ Oil companies operating in Nigeria must be adequately and timely punished for acts of environmental pollution committed by them. These exclusions, however, are considered a serious *lacuna* in the Act, which needs an urgent amendment if the fight against gas flaring in the country will be nipped in the bud any time soon.⁷⁹

Thus, for the Agency to be able to carry out its international obligations in respect to international agreements on environment, such compliance must be subject to act of domestication in line with the practice of the National Assembly.⁸⁰

*The Petroleum Industry Act 2021*⁸¹

The signing of the Petroleum Industry Act (PIA) expectedly ends several years of efforts by stakeholders to reform the Nigerian oil and gas industry, with the purpose of creating an industry considering more

⁷¹ The agency was established on the 31 July 2007, published in the FRN Official Gazette, No.92, Vol.94.

⁷² National policy on Environment 1989.

⁷³ Section 8 (d) of the Act.

⁷⁴ Section 8 (e) of the Act.

⁷⁵ Section 8 (f) of the Act.

⁷⁶ Section 10 (5) and (6)

⁷⁷ Hakeem, Mutiat and Jimoh, *supra* 33 p. 40.

⁷⁸ Section 8 (g) of the Act.

⁷⁹ Olusola Joshua, *supra* 2, p. 241.

⁸⁰ Section 12 (1) of the 1999 Constitution as amended.

⁸¹ Signed into law on 16 August 2021 to repeal the extant Petroleum Act 2004.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

proactive and purposeful for improving the sector and addressing the agitations of the oil producing host communities. The PIA makes provision for two regulatory agencies, the Nigerian Upstream Petroleum Regulatory Commission and the Midstream and Downstream Petroleum Regulatory Authority, which will be fully responsible for the technical and commercial regulation of petroleum operations and shall also have the power to acquire, hold and dispose of property as well as sue and be sued in their own name.

The PIA creates provisions and innovations that will impact the private, public sectors and all the stakeholders in the Nigerian oil and gas industry. The Chapter 5 of the Act has as its main objectives as follows:

- i) To create effective management institutions for the petroleum industry.
- ii) To promote transparency, good governance and accountability in the administration of the petroleum industry in Nigeria.
- iii) To ensure compliance with the applicable laws and regulations governing the upstream petroleum operations.
- iv) To foster sustainable peace and prosperity within host communities and provide direct social and economic benefits from petroleum operations to host communities. etc.⁸²

The Petroleum Industry Act 2021⁸³ prohibits gas flaring and other kinds of environmental pollution. An oil and gas operator shall not flare or vent natural gas except:

- a) In the case of an emergency;
- b) In line with permission granted by the commissioner;
- c) As an acceptable safety practice under established rules.⁸⁴

A licensee or lessee intending to produce natural gas is expected to, within a period of 12 months of the effective date, submit natural gas elimination and monetization plan to the commission, which shall be prepared in line with the regulations made by the commission under the Act.⁸⁵

Such an operator is expected before beginning petroleum production to install metering equipment conforming to the specified facility from which natural gas may be flared or vented as the commission or authority may prescribe in a regulation.⁸⁶ Where a licensee, lessee, or an operator violates the provisions of the Act, such a violating operator shall pay a penalty prescribed pursuant to the Flare Gas (Prevention of Waste and Pollution) Regulations 2018.⁸⁷ This regulation aims to reduce the environmental and social impact caused by the flaring of methane or natural gas, protect the environment, prevent waste of natural resources and create economic benefits from gas flare capture. Section 2 (1) of the regulation gives the federal government ownership over associated gas and the MNCs can flare gas free of cost and without payment of royalty. By the regulations, oil producers may only flare gas as permitted under the provisions of the

⁸² Lawrence Atsegbua *supra* 16, pp. 43-45.

⁸³ Petroleum Industry Act, No.6, 2021.

⁸⁴ Section 104 (a-c) Petroleum Industry Act 2021.

⁸⁵ Section 108 Petroleum Industry Act 2021.

⁸⁶ Section 106 Petroleum Industry Act 2021.

⁸⁷ The Regulations effectively commenced operation on the 5 July 2018.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

Associated Gas Re-injection Act, as permit holders are not allowed to engage in routine gas flaring.⁸⁸ The Regulation also requires producers to provide flare gas data within 30 days upon request by the relevant agency.⁸⁹ Such oil producer is liable to penalties or possible imprisonment where incorrect data is tendered.⁹⁰ One major flaw identifiable with the Regulation is that it permits operators to flare gas due to safety reasons. This could be another open cheque for the oil companies to stylishly continue with the act of gas flaring as it would be difficult on the part of government to determine and monitor.

The commission may however, give permission to a licensee or lessee to flare or vent natural gas for a specific period of time for the purpose of facility start-up or strategic operational reasons including testing.⁹¹ It is interesting to note that a major innovation of the Petroleum Industry Act is the transfer of gas flare penalties paid by operators to oil-producing communities to solving problems of gas flaring within the communities.⁹² Thus, money received from gas flaring penalties by the commission will be used for the purpose of environmental remediation and relief for the host communities. The authors argue that if this very provision of the Act is transparently implemented, then, the agitations of the Niger Delta oil producing communities would be reasonably reduced, thereby, giving them a relief.

The PIA that represents a new regulatory framework and governance in the Nigerian oil industry has repealed the Petroleum Act of 1969. It is, however, criticized on the basis of the following provisions of the Act:

i) Section 240 (2)⁹³ reads as follows:

“Each settlor, where applicable through the operator, shall make an annual contribution to the applicable host community development trust fund of an amount equal 3% of its actual operating expenditure in the immediately preceding calendar year in respect of all petroleum operations affecting the host communities for which the applicable host community development trust was established.”

The 3% contribution to be made annually by operators to the host communities to create social infrastructure and improve their environment have been criticized and rejected by the Niger Delta oil producing region of the country for being too minimal compared to the huge mineral resources, which is extracted from their soil. Therefore, they are calling for an amendment of this section towards an increased contribution by the operators. 3% contribution to host community cannot be considered sufficient to stop agitation from a region which has suffered environmental degradation and neglect for several decades. Considering the high level of

⁸⁸ Flare Gas (Prevention of Waste and pollution) Regulations 2018, <<https://www.iaea.org/policies/8675-flare-gas-prevention-of-waste-and-pollution-regulations-2018>> accessed 20 October 2022.

⁸⁹ Section 4 (2) of the Regulation.

⁹⁰ Section 5 of the Regulation.

⁹¹ Section 107 Petroleum Industry Act 2021.

⁹² Section 104 (2) Petroleum Industry Act 2021.

⁹³ Section 240 (2) of the Petroleum Industry Act, 2021.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

environmental degradation and its impact on human lives the call for upward review of the 3% contribution to the host communities is a request in the right direction.

ii) Section 53(1),⁹⁴ provides thus:

The Minister shall within 6 months from the commencement of this Act cause to be incorporated under the Companies and Allied Matters Act, a limited liability company, which shall be called Nigerian National Petroleum Company Limited (NNPC Limited).

The import of this section is the legitimized privatization of the NNPC. The Act, therefore, commercializes the state-owned enterprise, thus converting NNPC to NNPC Limited, which is now a commercial entity. The ownership of shares shall be vested with the federal government and the Ministries of Finance and Petroleum shall hold the shares on behalf of the federal government. Arguably, conversion of NNPC into a limited liability company is considered a ploy by a few powerful individuals in the country to gather the nation's profit from the oil sector into private pockets. By this section of the Act, there has been a shift from an enterprise of public and social good to individual benefits. The authors believe that privatization of the cooperation will not be in the best interest of Nigerians, because this provision of the Act will help facilitate the robbing or stealing of the national wealth belonging to the people and legitimately hand it over to a few private individuals.

iii) Section 104 (1-2)⁹⁵ provides as follows:

"A licensee or lessee or operator shall not flare or vent natural gas except:

- i) In the case of an emergency;
- ii) Pursuant to an exemption granted by the Commission;
- iii) As an acceptable safety practice under established regulations."

By this provision of Section 104 (1) and (2), the PIA arguably has purposely opened the floodgate for the multinational oil companies to continue the act of gas flaring rather than enforcing compliance. By creating conditions under which oil companies can flare gas and pay penalties to the Midstream Gas Infrastructure Fund, the Act by this has already opened the window for the continuation of gas flaring in the country. The authors thereby advocate that this section should be expunged from the PIA. This is because it creates continuous room for gas flaring to the detriment of the Niger Delta oil producing communities.

iv) Section 257 (2)⁹⁶ reads thus:

"Where in a year, an act of vandalism, sabotage or other civil unrest occurs that causes damage to petroleum and designated facilities or disrupts production activities within the host community, the community shall forfeit its entitlement to the extent of the cost of repairs of the damage that resulted from the

⁹⁴ Section 53 (1) Petroleum Industry Act, 2021.

⁹⁵ Section 104 (1), (2) Petroleum Industry Act, 2021.

⁹⁶ Section 257 (2) of the Petroleum Industry Act, 2021.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

activity with respect to the provisions of this Act within the financial year.”

This provision of the PIA strictly imposes the responsibility to protect and secure oil and gas facilities on host communities. The provision suggests that the host communities are either responsible for vandalizing oil and gas facility or facilitates such acts. The paper argues that the destruction of oil and gas installations located within the domain of oil producing communities has always been the activities of dangerous criminals that have even subjected some of the host communities to untold terror over the years. This provision also needs to be expunged from the PIA as it is considered an easy way out to shy away from the responsibility of contributing towards the maintenance and development of the Niger Delta Region.⁹⁷

Atsegbua has argued that the laws on gas flaring have not been effective because the oil producing companies find it easy and cheap to flare gas rather than embark on a gas re-injection project, which is considered very expensive and highly technologically driven.⁹⁸ *Kachikwu*, on the other hand, has advised that for the gas re-injection scheme to effectively yield benefits, the oil operators has to be supported with attractive fiscal incentives.⁹⁹ This becomes important as the oil multinational companies have consistently argued that the biggest constraint in ending gas flaring was the shortage of financial resources to construct the needed gas re-injection plant within the spelt out period of time given by the government.

5. COMPARING THE NIGERIAN GAS MANAGEMENT AND VENTING SYSTEM WITH SAUDI ARABIA

Saudi Arabia is one of the biggest oil producers in the world, and at the same time, it is said to have the highest oil reserve. The country’s oil production rate is put at 10 million barrels in a day with about 257 trillion cubic feet of gas reserves;¹⁰⁰ making it the fourth largest country with such volume of gas reserves in the world.¹⁰¹ Aramco, which is the country’s own national oil company, produces yearly an estimated natural gas of about 109 billion cubic meters.¹⁰² Although the gas market awareness for the country is relatively a recent one with a very small consumption data base, yet its natural gas utilization level is considered very high.¹⁰³ The country’s national oil company spends huge sums of money yearly for research and acquisition of relevant equipment for natural gas reinjection projects, which ultimately translates into meaningful utilization of their natural gas.¹⁰⁴

⁹⁷ The Vanguard, 22 November 2010, available at <https://www.vanguardngr.com/2010/11/militants-plant-explosives-to-bomb-more-pipelines/> accessed 21 October 2022.

⁹⁸ Lawrence Atsegbua, *supra* 16 p. 308.

⁹⁹ Ibe Kachikwu, ‘Legal Issues in Oil and Gas Industry’ (1989) 2 (34) *Gravitas* 39.

¹⁰⁰ Olubisi Oluduro, ‘The Legal Implication of Gas Flaring on Climate Change in Nigeria’, (2014) 29 *Journal of Law, Policy and Globalization* 172.

¹⁰¹ *Ibid.*

¹⁰² *Ibid.*

¹⁰³ *Ibid.*

¹⁰⁴ *Ibid.*

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

While Saudi Arabia operates the monarchical mode of government, the country's oil and gas wealth is vested in the government.¹⁰⁵ Nigeria, on the other hand, runs a federal system of government in which the ownership of oil and gas is vested in the federal government by constitutional and statutory provisions.¹⁰⁶ Saudi Arabia's Ministry of Energy, Industry and Mineral Resources are saddled with the responsibility of developing and implementing policies relating to oil as well as the country's master gas system.¹⁰⁷

The gas project for Nigeria is implemented by the Nigeria Gas Company under the supervision of the NNPC. According to *Olusola*, the major setback for the Nigerian Gas Company has been lack of competence and corruption of its officials.¹⁰⁸ The National Oil Company of Saudi Arabia strictly carries out enforcement checks to ensure oil companies operating in the country install the needed facilities capable of preventing gas flaring.¹⁰⁹ With this facility in place, it is able to discover incidences of flared gas by the oil companies. While the daily crude oil production of Saudi Arabia is in excess of 10 million barrels, the country has continued to record very low rate of gas flaring when compared to Nigeria which merely produces 2.5 million barrels of crude oil per day.¹¹⁰

The success that Saudi Arabia has achieved in reducing the incidences of gas flaring in the country is attributed mainly to two factors; first is the fact that it has invested heavily on research, acquisition of relevant technology and effective monitoring of gas flaring preventing installations by the multinational oil companies.¹¹¹ Secondly, Saudi Arabia has put in place a good gas policy together with sound legal frameworks for combating gas flaring. The Nigeria government can do well to follow after the steps of Saudi Arabia by formulating a workable gas policy and clear legal frameworks on gas flaring. The strict implementation of the extant legal frameworks by the relevant agencies in Nigeria is also a major key in ending gas venting in the country.

There is need for adequate enforcement of gas flaring laws as well as prompt prosecution of defaulter of such laws. Saudi Arabia through relevant legislations, made it compulsory for oil companies operating in the country to engage the use of gas for electricity production and other ancillary domestic usage. Also, it has through legislation given adequate incentives to the multinational oil companies for the utilization of gas.¹¹²

¹⁰⁵ The Basic Law of Saudi Arabia (Royal Decree No. A/90 dated 27/8/1412 H of March 1st 1992, vests all of the kingdom of Saudi Arabia's oil and gas wealth in the Government <<https://www.britannica.com/topic/Basic-Law-of-Government>> accessed 21 October 2022.

¹⁰⁶ Section 44 (3) of the 1999 Constitution as Amended, and Section 1 (1) of the petroleum Act 1969, "Notwithstanding the foregoing provisions of this section, the entire property in and control of all minerals, mineral oils and natural gas in, under or upon any land in Nigeria or in, under or upon the territorial waters and the Exclusive Economic Zone of Nigeria shall vest in the Government of the Federation and shall be managed in such manner as may be prescribed by the National Assembly".

¹⁰⁷ *Olusola supra* 2 p. 19.

¹⁰⁸ *Ibid.*

¹⁰⁹ *Ibid.*

¹¹⁰ *Olubisi supra* 99 p. 172.

¹¹¹ *Ibid.*

¹¹² *Ibid* p. 10.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

6. CHALLENGES IN COMBATING GAS FLARING IN NIGERIA

One of the major challenges in arresting the scourge of gas flaring in Nigeria has been the weakness of national legislations on gas flaring and ineffective enforcement of the laws. The enforcement of oil and gas laws in the country more often than not is based on some political or economic factors. Situations where multinational oil companies are allowed to flare gas with the permission of the Nigerian government is a pointer to the weakness of our extant legal frameworks. Thus, strict enforcement and adequate sanctions are required to end gas flaring in the country. The present penalties and fines payable by defaulting oil companies in Nigeria for breach of gas flaring laws and other environmental legislations are insignificant to serve as deterrence to the oil companies who would rather prefer to pay meager fines and then flare gas.¹¹³

Another challenge militating against ending gas flaring is the lack of acquisition of relevant technology. The agencies saddled with the responsibility of regulating the gas industry lack the availability of modern equipment to ascertain the volume of gas flared and the level of environmental damage caused by the oil companies. Often, gas is flared under the guise of unavailable and expensive equipment. In this regard, the government needs to wake up to its responsibility in terms of funding and research directed towards bringing gas flaring to a quick end.

The constitutional provision making environmental breaches non-justiciable before the Nigerian courts is also considered a major challenge.¹¹⁴ Individuals lack the *locus standi* to pursue environmental rights before the courts. The right of the individual to a healthy environment needs to be protected. Environmental pollution, and by extension gas flaring can to a large extent be curtailed when the multinational oil companies consider the huge financial damages payable to individual victims and other affected entities within the Nigerian State, by so doing, there would be the need to fully comply and respect the extant laws on gas flaring and other related environmental regulations in the country.

7. RECOMMENDATIONS

To end gas flaring in Nigeria, the following recommendations are hereby proffered:

1. The various regulatory agencies in the oil and gas industry need to develop the political will to strictly enforce the extant laws and regulations in operation within the oil and gas industry. This is very important, because thus far, there is no oil and gas regulatory agency in the country that has taken steps to bring legal action whether criminal or civil against the operating oil companies for the environmental degradations caused by them to man and the

¹¹³ Olusola *supra* 2 p. 243.

¹¹⁴ Section 20 of the 1999 Constitution as amended.

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

environment particularly in the Niger Delta region of Nigerian. The lack of prosecution of defaulting multinational oil companies can be seen as giving enough impetus to the operating companies to continue to vent gas in the country.

2. Interestingly, the Federal High Court in *Jonah Gbemre v. Shell*¹¹⁵ held that the constitutional rights guaranteed by Sections 33 and 34 of the 1999 Constitution and reinforced by Articles 4, 16 and 24 of the African Charter on Human and Peoples' Rights¹¹⁶ provides rights which inevitably include the rights to a clean, poison and pollution free environment. The court declared that the action of the respondents in allowing and continuing flaring of gas in the applicant's community is a violation of their fundamental rights to clean and healthy environment. The judge further ordered the Attorney General of the Federation to ensure immediate amendment of the Associated Gas Reinjection Act bring it up to speed with Nigeria' human rights obligations under the Constitution and the African Charter.
3. There is the need to amend extant environmental laws to adequately extend to environmental degradation such as gas flaring. Example of such laws would include but not limited to the National Environmental Standards and Regulations Enforcement Agency (NESREA). This is because the Agency presently does not have enforcement powers in respect to oil and gas issues. To a large extent, this has prevented the agency from carrying out enforcement actions for environmental pollution occurring within the oil and gas industry.
4. The Petroleum Industry Act 2021, which all stakeholders have over the years anticipated as a holistic piece of legislation to bring to the fore the needed reforms in the oil and gas industry in Nigeria, needs amendment for some provisions of the Act that have been criticized for not covering the interest of certain groups in the country. Some of the affected sections include 240 (2), 53(1), 104 (1-2), and 257 9(2) these sections need to be reviewed to accommodate the agitations of the Niger Delta oil producing region of the country.
5. The Federal Government of Nigeria need to invest in research and acquisition of modern technology of international standards to enable the relevant regulatory agencies to monitor the level of gas flaring and other forms of environmental problems in the country. Gas flare meters need to be acquired and installed to enable the government take records of the amount of gas flared by the oil companies.
6. Nigeria needs an improved gas market as well as local utilization of natural gas. Efforts should be made to improve electricity generation

¹¹⁵ *Jonah Gbemre v. Shell* Suit FHC/B/CS/53/05, 14 November 2005, <<http://www.climatelaw.org/media/gas.flaring.suitnov2005/ni.shell.nov05.decision.pdf>> accessed October 11, 2022.

¹¹⁶ Ratified and domesticated by Nigeria, as Cap.A9, Laws of the Federation of Nigeria (2004).

Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict Regulatory Enforcement

- by engaging the use of natural gas; this may lead to power stabilization and increase in the financial fortunes of the country.
7. The provisions of our laws which gives permits to multinational oil companies to flare gas on certain conditions with the consent of the minister of petroleum is considered unacceptable, as it opens the floodgate for continued gas flaring in the country.
 8. All the stakeholders within the oil and gas industry should always be consulted and carried along by the government in determining the dates and deadlines for ending gas flaring in the country. Government should be firm on dates fixed for ending gas venting.
 9. Strict punishments and penalties should be enforced for non-compliance with anti-gas flaring laws, to further serve as sufficient deterrence for the oil companies. The fines payable are too minimal.

8. CONCLUSION

From the discussion thus far, gas flaring is a global environmental problem affecting most countries of the world including Nigeria. It has impacted negatively on the people of the Niger Delta area as well as their immediate environment. This paper analysed several steps taken by the Nigerian government and the international community at different times to address the scourge of gas flaring. Although there are a plethora of laws and regulations on gas flaring, the regulatory agencies in Nigeria completely lack the political will or legal backing to strictly enforce such extant laws in the oil and gas industry. This is clearly demonstrated by the fact that no relevant agency of the government has so far prosecuted any multinational oil company for violating any of laws relating to gas flaring in the country.

The authors contend that the reason for the lack of prosecution of the erring oil companies by the government is due to the fact that the government solely looks up to the oil companies to operate its oil and gas sector. Thus, The Federal Government of Nigeria must, therefore, build the requisite human capacity, invest in research and modern technology that can enable it independently control its own oil and gas industry without necessarily counting on the multinational oil companies for oil exploration.

Therefore, to end gas flaring in the country, the established regulatory authorities must be firm in enforcing anti flaring legislations without any recourse to political, economic or other considerations. Implementing total compliance with extant laws and regulations by all stakeholders is certainly the quickest way to winning the fight against gas flaring in Nigeria.

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**Ending Gas Flaring in the Nigerian Oil and Gas Industry: The Need for Strict
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DEMAND-PULL INSTRUMENTS TO SUPPORT THE CIRCULAR ECONOMY: A GLOBAL PERSPECTIVE

Eleanor Mateo*

Law School, University of Eastern Finland, Joensuu, Finland
Brussels School of Governance, Vrije Universiteit, Brussels, Belgium
Email: Eleanor.mateo@uef.fi | <https://orcid.org/0000-0003-0126-887X>

Topi Turunen

Law School, University of Eastern Finland, Joensuu, Finland
Finnish Environment Institute SYKE, Helsinki, Finland
Email: topi.turunen@uef.fi | <https://orcid.org/0000-0002-4502-8088>

Joonas Alaranta

Law School, University of Eastern Finland, Joensuu, Finland
Registry of the Board of Appeal, European Chemicals Agency, Helsinki, Finland
Email: joonas.alaranta@uef.fi | <https://orcid.org/0000-0003-3197-6594>

**Corresponding author*

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ABSTRACT

In recent years, transitioning to a more circular economy has been introduced as a policy objective in many jurisdictions across the globe with a view to achieving a sustainable society. However, the increasing attention paid to this issue has so far not led to a large-scale transformation of production processes and consumption. Instead, many circular economy innovations have remained niche and have not become the mainstream solutions. A plethora of regulatory, market, cultural and technological barriers limit the demand for, and consequently wide-scale adoption of, circular solutions. This article examines the potential offered by regulatory demand-pull instruments to overcome such barriers and to mainstream circular economy solutions. In particular, the article investigates innovative demand-pull instruments that have been used in various jurisdictions globally. This article analyses the instruments according to their types – i.e., command-and-control measures, economic incentives, information tools and public procurement – to gain a better understanding of the rationales, strengths, and limitations of these categories of instruments in creating a stable demand for the circular economy. The lessons learned from the regulatory innovations enable a more critical approach in determining the best combination of instruments and tools to implement sustainable circular solutions on a larger scale.

Keywords: Circular economy; Transition; Demand-pull instruments; Sustainability

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Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

1. INTRODUCTION

Transitioning to a circular economy (CE) is crucial to achieving a more sustainable society. The CE presents pathways to abate the critically increasing environmental impacts of material production and processing. At the same time, circular strategies are becoming increasingly relevant in an era in which materials are extracted from increasingly dispersed sources at ever-escalating economic cost.¹ The CE likewise seeks to address the need to stay within the Earth's ecological boundaries in view of the latter's finite capacity for reproduction and absorption of waste.²

Thus, transitioning to a CE has been the subject of many policy objectives in recent years. The European Union (EU), for example, has set an ambitious target to transition to a climate-neutral CE by 2050.³ Many countries have also set national targets for achieving the CE. Since 2000, Japan has legislated around the concept of a 'sound material cycle society' having many common objectives with CE.⁴ China has been promoting the CE by emphasising cleaner production and industrial parks since 2002.⁵ CE objectives and approaches have steadily but increasingly been enacted in many legislative frameworks across the globe. In most jurisdictions, however, there is no single legal framework for CE. Instead, CE objectives are being promoted in multiple substantive legal provisions (e.g., law on waste, product design, public procurements). Yet, despite the increasing attention being paid to CE, its implementation remains limited and is far from mainstream.

The barriers that hinder transitioning to CE are manifold and have been discussed in a growing body of literature. They are generally categorized as regulatory, market, cultural and technological barriers, respectively.⁶ Rules hamper the CE when they provide misaligned incentives (e.g., subsidies for fossil fuel perpetuate low price levels for virgin materials) or entrench existing paradigms (e.g., regulations that prevent the use of waste as inputs)⁷. Furthermore, high upfront investment costs, market uncertainty, strong path dependencies and lock-ins, market failure to internalize environmental costs, and asymmetric information create significant market barriers for the adoption of the CE.⁸ The

¹ Julian M Allwood and others, 'Material Efficiency: A White Paper' (2011) 55 Resources, Conservation and Recycling 362, 365-368.

² Martin Geissdoerfer and others, 'The Circular Economy – A New Sustainability Paradigm?' (2017) 143 Journal of Cleaner Production 757, 759.

³ European Commission, 'A New Circular Economy Action Plan for a Cleaner and More Competitive Europe' (Communication) COM (2020) 98 final 2.

⁴ Japan Ministry of Environment, 'Sound Material-Cycle Society' <<https://www.env.go.jp/en/recycle/smcs/>> accessed 8 July 2022.

⁵ Will McDowall and others, 'Circular Economy Policies in China and Europe' (2017) 21 Journal of Industrial Ecology 651, 652 <<https://doi.org/10.1111/jiec.12597>> accessed 22 December 2022; Yong Geng and others, 'Towards a National Circular Economy Indicator System in China: An Evaluation and Critical Analysis' (2012) 23 Journal of Cleaner Production 216, 217.

⁶ Ana de Jesus and Sandro Mendonça, 'Lost in Transition? Drivers and Barriers in the Eco-Innovation Road to the Circular Economy' (2018) 145 Ecological Economics 75; Julian Kirchherr and others, 'Barriers to the Circular Economy: Evidence from the European Union (EU)' (2018) 150 Ecological Economics 264.

⁷ de Jesus and Mendonça (n 7) 78.

⁸ Kirchherr and others (n 7) 268–269.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

artificially low cost of virgin raw materials makes secondary materials less price competitive on the market, limiting their use.⁹ Cultural barriers, in the form of consumer habits and company routines, also hinder CE implementation. Technological barriers prevent the progress of the CE.¹⁰ The lack of awareness of, and low consumer interest in, CE solutions and hesitant company culture are among the biggest barriers to CE implementation.¹¹ These barriers are interrelated and interact with each other.¹² For example, the low cost of virgin materials makes circular products more expensive, which, in turn, causes a cultural barrier (e.g., lack of consumer interest in the relevant products leads to companies failing to invest in developing them).¹³ These barriers negatively affect demand for circular products and services, limiting their diffusion. Hence, it is important to identify areas of legal intervention that could address these barriers and limit the negative chain reactions that hinder the broader CE transition.

Given the foregoing, this article investigates how different jurisdictions globally have used innovative regulatory instruments to address the lack of demand for CE solutions. The objective of this article is to gain a better understanding of the rationale, strengths, and limitations of these different approaches in mainstreaming CE to provide insights for future regulations. However, the functionality of transplanting regulatory solutions utilized in one jurisdiction into another country's legislative frameworks should always be carefully considered before such steps are undertaken.¹⁴ This is in part due to the context-specificity of the factors affecting the demand for CE solutions, as discussed in Section 3.

Regulatory innovations often imply the implementation of something new in an existing system or regulatory framework. In this article, regulatory innovations refer to new ways to intervene to promote a certain objective (in this case, the CE).¹⁵ This does not necessarily mean enacting completely new legislative approaches but may also mean adapting an existing approach to new regulatory objects or areas.¹⁶ It is possible that similar instruments (i.e., taxation) have been enacted to promote other objectives (e.g., pollution abatement), but the approaches may still be considered 'innovative' in terms of promoting the objectives of the CE.

⁹ Walter R Stahel, 'Policy for Material Efficiency—Sustainable Taxation as a Departure from the Throwaway Society' (2013) 371 (1986) *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 1, 8–9.

¹⁰ de Jesus and Mendonça (n 7) 21–22; Kirchherr and others (n 6) 268–269.

¹¹ Kirchherr and others (n 7) 267–268, 270; Felix Preston, 'Briefing Paper - A Global Redesign? Shaping the Circular Economy' (2012) *Energy, Environment and Resource Governance BP 2012/02* <<https://www.chathamhouse.org/2012/03/global-redesign-shaping-circular-economy>> accessed 31 October 2022.

¹² Kirchherr and others (n 7) 270.

¹³ *ibid.*

¹⁴ Helen Xanthaki, 'Legal Transplants in Legislation: Defusing the Trap' (2008) 57 *The International and Comparative Law Quarterly* 659.

¹⁵ James J. Patterson, *Remaking Political Institutions: Climate Change and Beyond* (1st edn, Cambridge University Press 2021).

¹⁶ Peter John, *How Far to Nudge? Assessing Behavioural Public Policy* (Edward Elgar Publishing Limited 2018); Petrus Kautto and Helena Valve, 'Cosmopolitics of a Regulatory Fit: The Case of Nanocellulose' (2019) 28 *Science as Culture* 25.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

Therefore, we adopt a dynamic notion of ‘innovative’ as being always time and place dependent.¹⁷

In this article, different types of innovative regulations that have been or are proposed to be adopted are explored using the typologies of demand-pull instruments to inform the analytical approach. Each of these typologies has its own intervention logic in addressing the underlying conditions affecting the demand (or lack thereof) for circular innovations. This allows examining critically the specific legislative features of the innovative regulations and their intervention logic in addressing these conditions. The article proceeds as follows: Section 2 revisits the rationale of demand-pull regulations in addressing the demand for CE, and its typologies. Section 3 looks at innovative demand-pull regulations across the globe to identify the specific regulatory features addressing the demand conditions for CE. Section 4 discusses the cross-cutting findings and conclusions.

2. DEMAND-PULL INSTRUMENTS FOR THE GENERATION AND DIFFUSION OF CIRCULAR INNOVATION

In order to tackle the challenge posed by resource consumption and its environmental impacts, CE innovations need to be ‘generated, bought and applied’.¹⁸ The important role of government policies is acknowledged in overcoming the various barriers to the adoption of CE innovations that affect both suppliers and consumers.¹⁹ CE innovations are here understood as products and services that have been adapted to, or created through processes that, reduce material consumption, increase recycling and use, or expand product lifetimes.

2.1 Rationale of Demand-Pull Instruments

These instruments can be broadly categorized based on their purpose, and in particular on how they stimulate innovation, either as supply-push or as demand-pull policies.²⁰ Supply-push and technology-push instruments focus on enhancing the supply of innovative technologies

¹⁷ Louise Fromond, Jukka Simila and Leila Suvantola, ‘Regulatory Innovations for Biodiversity Protection in Private Forests—Towards Flexibility’ (2009) 21 *Journal of Environmental Law* 1; Jonas Schoenefeld, Mikael Hildén and Kai Schulze, ‘Policy Innovation for Sustainable Development’ in Duncan Russel and Nick Kirsop-Taylor (eds), *Handbook on the Governance of Sustainable Development* (Edward Elgar Publishing 2022).

¹⁸ Wouter Boon and Jakob Edler, ‘Demand, Challenges, and Innovation. Making Sense of New Trends in Innovation Policy’ (2018) 45 *Science and Public Policy* 435, 436.

¹⁹ Kirchherr and others (n 7) 270; Giulio Cainelli, Alessio D’Amato and Massimiliano Mazzanti, ‘Resource Efficient Eco-Innovations for a Circular Economy: Evidence from EU Firms’ (2020) 49 *Research Policy* 103827.

²⁰ Jens Horbach, Christian Rammer and Klaus Rennings, ‘Determinants of Eco-Innovations by Type of Environmental Impact — The Role of Regulatory Push/Pull, Technology Push and Market Pull’ (2012) 78 *Ecological Economics* 112; Michael Peters and others, ‘The Impact of Technology-Push and Demand-Pull Policies on Technical Change – Does the Locus of Policies Matter?’ (2012) 41 *Research Policy* 1296; Klaus Rennings, ‘Redefining Innovation — Eco-Innovation Research and the Contribution from Ecological Economics’ (2000) 32 *Ecological Economics* 319. See also Karoline S Rogge and Kristin Reichardt, ‘Policy Mixes for Sustainability Transitions: An Extended Concept and Framework for Analysis’ (2016) 45 *Research Policy* 1620 (who included a third category as systemic instruments).

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

through factors that affect the generation of new knowledge,²¹ such as by reducing the costs of their development through subsidies on research and development and funding demonstration projects.²² Demand side policies aim to improve ‘demand conditions’ in order to generate and diffuse innovation.²³ The primary logic behind demand-pull policies is that a growing market incentivizes investment in innovation by increasing its profitability, and facilitates learning through diffusion, which, in turn, informs the innovation process.²⁴ Conversely, lack or uncertainty of demand deters investment. Thus, demand-side policies primarily aim to identify or create a need for an innovation or support the ability and willingness of potential buyers to adopt an innovation or co-produce it with suppliers.²⁵ Particular to CE-related innovations, there is growing evidence on the significant role of ‘green demand’ as a driver of innovation adoption.²⁶

Existing literature supports the importance of the role of demand in the mainstreaming of circular innovation. Depending on the industry, demand from key players in the value chain can have a significant role (even more than that of consumer demand) in influencing actors in the value chain to adopt circular innovations.²⁷ Consumer demand for circular products can also stimulate production and the potential for economies of scale, which, in turn, make take-back systems and recovery activities feasible at an industrial scale.²⁸ The discovery of new markets provides an important incentive for firms to transition from a traditional business approach to a more circular value proposition.²⁹

Recent literature has emphasized that a robust regulatory framework supporting socio-technical transitions requires a policy mix that includes a combination of supply-push and demand-pull instruments.³⁰ The analysis in this article focuses on demand-pull instruments addressing barriers that affect the demand for CE innovations, and specifically on the innovative features of these instruments.

²¹ Gregory F Nemet, ‘Demand-Pull, Technology-Push, and Government-Led Incentives for Non-Incremental Technical Change’ (2009) 38 *Research Policy* 700, 701–702.

²² *ibid.*

²³ Boon and Edler (n 19) 436. Demand conditions have been described as referring to the quantity and quality of demand for a particular innovation.

²⁴ Jakob Edler, ‘The Impact of Policy Measures to Stimulate Private Demand for Innovation’ in Jakob Edler and others (eds), *Handbook of Innovation Policy Impact* (Edward Elgar Publishing 2016).

²⁵ *ibid.* 5.

²⁶ Cainelli, D’Amato and Mazzanti (n 20).

²⁷ Maria A. Franco, ‘Circular Economy at the Micro Level: A Dynamic View of Incumbents’ Struggles and Challenges in the Textile Industry’ (2017) 168 *Journal of Cleaner Production* 833, 842.

²⁸ *ibid.*

²⁹ Amir Asgari and Reza Asgari, ‘How Circular Economy Transforms Business Models in a Transition towards Circular Ecosystem: The Barriers and Incentives’ (2021) 28 *Sustainable Production and Consumption* 566, 578 <<https://doi.org/10.1016/j.spc.2021.06.020>> accessed 22 December 2022.

³⁰ Rogge and Reichardt (n 21); Susana Borrás and Charles Edquist, ‘The Choice of Innovation Policy Instruments’ (2013) 80 *Technological Forecasting and Social Change* 1513.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

2.2. Types of Demand-Pull Instruments

The typologies developed by Hannon and others (2015) divide demand-pull instruments into four main types.³¹ The first of these involves command-and-control (CAC) instruments. These instruments stimulate demand by establishing expectations about future markets³² by defining, or setting the rules of, the market conditions for innovative products and processes.³³ They drive demand for alternative solutions by setting restrictions, standards or performance targets.

The second type refers to economic incentives. These aim to stimulate demand by lowering the entry or life-cycle costs of investments in innovations, making the latter more competitive in the marketplace.³⁴

The third type, informative instruments, drive demand by addressing different forms of information asymmetry (e.g., in terms of the relative environmental performance or quality of CE products or services) or awareness deficit (e.g., lack of awareness about or confidence in CE innovations or how they are to be used).³⁵

The fourth type of demand-pull instrument is direct public sector purchasing or public procurement. This instrument involves a public authority ordering for its own use or purpose a product or system that at times may not yet exist in the market or is still niche.³⁶ Hence, while a public procurement policy could also take the form of a CAC or information instrument, its mechanism for triggering broader demand for CE innovations is narrowly focused on using public purchasing as leverage.³⁷

Since the CE transition calls for systemic change, a combination of demand-pull instruments (both mandatory and voluntary) targeting different stages of a material's lifecycle will be necessary.

3. DEMAND-PULL POLICIES RESPONDING TO CE BARRIERS: A GLOBAL PERSPECTIVE

3.1 Command-and-Control (CAC) Instruments

CAC instruments create demand for circular products and processes by defining market conditions, for example by prescribing materials, processes or environmental performance in respect of products and services that support circular transition or by regulating user behaviour. Where users and producers resist changing consumption or production patterns, regulations may help facilitate the transition by prescribing the

³¹ See Matthew J Hannon, Timothy J Foxon and William F Gale, ““Demand Pull” Government Policies to Support Product-Service System Activity: The Case of Energy Service Companies (ESCos) in the UK” (2015) 108 *Journal of Cleaner Production* 900.

³² Jakob Edler, ‘Review of Policy Measures to Stimulate Private Demand for Innovation. Concepts and Effects’ in Jakob Edler and others (eds) *Handbook of Innovation Policy Impact* (Edward Elgar Publishing 2016).

³³ Borrás and Edquist (n 31) 1516.

³⁴ Edler (n 33) 7.

³⁵ Hannon, Foxon and Gale (n 32); Edler (n 33).

³⁶ Borrás and Edquist (n 31) 1519.

³⁷ Edler (n 33) 7.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

use of circular designs or materials through design standards or norms.³⁸ Furthermore, requiring the use of circular-based materials (e.g., minimum recycled content) could increase their availability and consequently cost-competitiveness vis-à-vis linear based materials.³⁹ Establishing circular standards and performance requirements also helps create certainty as to market expectations and produces reliable information on how products perform.⁴⁰ Thus, CAC instruments offer a means by which to overcome path dependency and technology lock-ins, create new markets, enable economies of scale and encourage further investment and innovation. This section looks at the different features of CAC instruments aimed at increasing demand for circular innovation and their implementation challenges.

3.1.1 EU Ecodesign Regulation

A substantial proportion of the environmental impacts of a product's life cycle are decided in the design phase. Therefore, regulating the design of products is an effective way of addressing how CE objectives are implemented in that life cycle. In the EU, product design is currently regulated under the ecodesign framework. This comprises Directive 2009/125/EC⁴¹ and product-specific regulations. The current regulatory framework focuses on the energy consumption of energy-intensive products. To better include CE aspects in the ecodesign regulation, the EU Commission has proposed a new Ecodesign Regulation to repeal the current Directive. The proposal significantly extends the scope of the existing regulatory framework. The proposed Regulation will apply to the broadest possible range of products and will set product-level requirements that not only promote energy efficiency but also circularity to address the most adverse environmental and climate impacts. The requirements are intended to achieve improvements in areas including product durability and reusability, resource efficiency, minimum recycled content, ease of disassembly as well as carbon and environmental footprints.⁴² The Regulation would be complemented by product-specific legislation laying down particular requirements for well-defined product groups. The proposal also includes the possibility to enact horizontal ecodesign requirements for a wider range of product groups (e.g., electronic appliances or textiles) where this is reasonable due to technical similarities etc. The methods used to assess the ecodesign requirements would be developed using the experiences from the current ecodesign framework as well as Product Environmental Footprint (PEF) method set

³⁸ Kris Hartley, Ralf van Santen and Julian Kirchherr, 'Policies for Transitioning towards a Circular Economy: Expectations from the European Union (EU)' (2020) 155 *Resources, Conservation and Recycling* 104634, 3.

³⁹ *Ibid.*

⁴⁰ *See* Edler (n 33) 8–9.

⁴¹ Parliament and Council Directive 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products [2009] OJ L 285/10.

⁴² European Commission, 'Proposal for a Regulation for the European Parliament and of the Council establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC' COM (2022)142 final art 5.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

out in Commission Recommendation (EU) 2021/2279⁴³ as well as the development of standards by international and European standardization organizations. Providing detailed technical minimum performance levels for different products has huge potential to promote the CE but is a slow measure to implement: different product groups have to be regulated individually and performance levels can only apply to new products. Therefore, even after the introduction of new requirements, it will take some time before the higher performing products conquer the market.

3.1.2 Washington Minimum Recycled Content Requirements

Legally imposed 'minimum recycled content' requirements promote the CE by increasing demand for recycled materials as a substitute for virgin raw materials. These requirements refer to an obligation to use recycled materials as inputs in the manufacture of a product. The coercive nature of the requirement can be particularly effective for materials where the demand for secondary raw materials is not automatically formed. This might be the case where the virgin raw materials have a 'price advantage', for example due to complicated recycling processes or administrative processes connected to the commodification of waste materials. In the United States, the state of Washington laid down mandates on minimum recycled content for certain household plastic products, plastic trash bags and plastic beverage containers. The requirements were included in a wider legal proposal on single-use plastics.⁴⁴ This proposal passed into law⁴⁵ in April 2021. For each product group a gradually increasing recycled content requirement is laid down ranging from 10% to as high as 50% by 2031.⁴⁶ In order for progress to be monitored, producers are required to submit an annual report. A weight-based fiscal sanction is applied to producers that do not meet the minimum requirements. The EU has adopted a similar, albeit less ambitious, requirement for beverage bottles in Directive 2019/904/EU,⁴⁷ which also concerns single use plastics. Under the Directive, producers are required to incorporate 25% of recycled plastic in covered plastic beverage bottles from 2025, and 30% in all plastic beverage bottles from 2030.⁴⁸ Moreover, in the EU the sanctions imposed on producers that do not meet these targets are determined at national level, which implies varying level of stringency.⁴⁹

⁴³ European Commission (EU) Recommendation 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations [2021] OJ L471/1.

⁴⁴ Concerning the management of certain materials to support recycling and waste and litter reduction, S.B. 5022, 67th Leg. (Washington 2021).

⁴⁵ Washington Revised Code, ch. 70A.245 (2021).

⁴⁶ Ibid at Section 3. For cleaning and personal care product containers, 15% by 2025, 25% by 2028, 50% by 2031. For plastic trash bags, 10% by 2023, 15% by 2025 and 20% by 2027. For certain plastic beverage containers, 15% by 2023, 25% by 2026 and 50% 2031. For milk containers 15% by 2028, 25% by 2031 and 50% by 2036.

⁴⁷ Parliament and Council Directive (EU) 2019/904 of 5 June 2019 on the reduction of the impact of certain plastic products on the environment [2019] OJ L155/1 [hereinafter "Directive (EU) 2019/904"].

⁴⁸ Directive (EU) 2019/904, art. 6.

⁴⁹ Directive (EU) 2019/904, art. 14.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

Minimum recycled content requirements have mostly been discussed with regard to plastics, but the idea could also be extended to other materials and several US states have, for example, introduced a minimum recycled glass content requirement. The state of New Jersey recently required manufacturers to ensure that all glass containers sold or offered for sale in the state shall contain at least 35% postconsumer recycled content, or 25% if mixed-colour cullet is used.⁵⁰ This followed a similar requirement enacted in California.⁵¹ However, the objective of increasing recycled material content should not lead to poorer product quality or the recirculation of harmful chemical substances to the detriment of human or environmental health. Thus, mixing requirements can be unsuitable for some product categories: for example, under Commission Regulation (EU) No 2022/1616⁵² only those recycled plastics that meet stringent quality requirements and recycling processes can come into contact with foodstuffs.⁵³ There is also a need to assess whether the use of recycled content for specific product categories is the most environmentally beneficial solution. For example, there are questions over whether the use of recycled glass in containers would divert its use into cement production, which could potentially have higher emissions savings.⁵⁴

3.1.3 France's Repairability Index

Product life extension has been found to be the more environmentally desirable end-of-life treatment option compared to various modes of recycling based on certain product characteristics.⁵⁵ France's Repairability Index is the first mandatory labelling regulation relating to product lifespans to be implemented in Europe.⁵⁶ It requires covered manufacturers to disclose the reparability performance of their products from a scale of 1 to 10 based on a set of reparability criteria.⁵⁷ The objective of the regulation is to nudge consumers towards preferring products with lifespans that can be extended beyond their expected service life through repair, and to encourage consumers to extend the lifetimes of their products. The law did not impose technical standards on the products themselves, rather it

⁵⁰ New Jersey Statutes Ann. 13:1E-99136-157, § 5 (Updated 2022).

⁵¹ CA Pub Res Code § 14549 (b) (2021).

⁵² Commission Regulation (EU) 2022/1616 of 15 September 2022 on recycled plastic materials and articles intended to come into contact with foods, and repealing Regulation (EC) No 282/2008 [2022] OJ L243/3.

⁵³ Topi Turunen, Milja Räisänen and Petrus Kautto, 'Need for Speed? Meeting the New Recycling Targets for Plastics' (2022) 1/2022 *Ympäristöjuridiikka* 39, 43 <<https://www.edilex.fi/ymparistojuridiikka/1000660003>> accessed 22 December 2022. The interviewees within the study agreed that recovered plastics should not be 'forced' to adopt certain purposes of use.

⁵⁴ See Dylan D Furszyfer Del Rio and others, 'Decarbonizing the Glass Industry: A Critical and Systematic Review of Developments, Sociotechnical Systems and Policy Options' (2022) 155 (111885) *Renewable and Sustainable Energy Reviews* 1, 10 (the authors discussed multiple uses of recycled glass, including construction).

⁵⁵ Frithjof Laubinger and Peter Börkey, 'Labelling and Information Schemes for the Circular Economy' 34 <<https://doi.org/10.1787/abb32a06-en>> accessed 22 December 2022.

⁵⁶ *Ibid* 39.

⁵⁷ Art. R. 541-210 C. environnement; Loi n° 2020-105 du 10 février 2020 Relative à la Lutte Contre le Gaspillage et à L'économie Circulaire (Law against Waste and for the Circular Economy) 2020 (hereinafter 'Loi n° 2020-105'), art 16.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

prescribes the information that should accompany the covered products. The law prescribes the criteria that must be considered in evaluating the reparability of products, the methodology used in carrying out such assessment, and how the information on reparability is to be communicated to consumers. The reparability criteria include the availability of technical documentation relevant for the repair of a product, availability and pricing of spare parts, ease for disassembling and product-specific criteria.⁵⁸ As from 2024, the Reparability Index will be replaced by a Durability Index, which will combine both reparability and reliability aspects of a product.⁵⁹ Aside from setting the reparability criteria, the law also specifies which product groups will have better overall environmental performance through extension of their lifespans. Currently, France's Reparability Index covers a limited number of household electronic and electrical devices.⁶⁰

Several studies have found that lifespan labelling influences purchasing decisions in favour of products with longer lifespan, although this may vary depending on the product category.⁶¹ Despite this, voluntary product labels that include reparability criteria have so far resulted in a poor adoption rate among manufacturers.⁶² The French index addresses this issue by making the use of the index mandatory for certain products. Furthermore, the French label tackles the issue of information asymmetry by prescribing a uniform criterion for product groups and by requiring the information to be set out in the form of a score. This makes the information comparable and easy for users to understand, and thus helpful in their decision-making.

However, preliminary studies after a year of implementation show that the current criteria may need to be more robust to further distinguish ratings among products. In respect of lawnmowers and washing machines, on which most manufacturers already register high scores, the criteria may need to be more ambitious to incentivize continuous improvements.⁶³ Ensuring and maintaining credibility is another important challenge for the French label. The obligation to assess the reparability of products falls on the manufacturers themselves.⁶⁴ While the law contains safeguards, in the form of the possibility to impose sanctions, against the use of fraudulent

⁵⁸ Art. R. 541-214 (I), C. environnement.

⁵⁹ Loi n° 2020-10, art 16.

⁶⁰ The list includes front-loading washing machines, smartphones, laptops, TV monitors and electric lawn mowers.

⁶¹ European Economic and Social Committee, 'The Influence of Lifespan Labelling on Consumers' (2016) <<https://data.europa.eu/doi/10.2864/29757>> accessed 22 December 2022; María Bovea and others, 'Incorporation of Circular Aspects into Product Design and Labelling: Consumer Preferences' (2018) 10 (2311) Sustainability <<https://doi.org/10.3390/su10072311>> accessed 22 December 2022.

⁶² Laubinger and Börkey (n 56) 39.

⁶³ Halte à L'obsolescence Programme, 'The French Repairability Index: A First Assessment – One Year after Its Implementation' 3 <<https://www.halteobsolescence.org/wp-content/uploads/2022/02/Rapport-indice-de-reparabilite.pdf>> accessed 22 December 2022.

⁶⁴ France, 'Notification to the Commission: Decree Relating to the Repairability Index of Electrical and Electronic Equipment' para 8 <<https://ec.europa.eu/growth/tools-databases/tris/en/search/?trisaction=search.detail&year=2020&num=468%20>> accessed 26 September 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

scores or failure to display the scores, the credibility of the index will depend on how rigorous the government is in investigating fraudulent cases and the extent to which market actors are vigilant in policing their competition.⁶⁵

3.1.4 Pros and Cons of Using CAC Instruments

CAC instruments have a high degree of efficacy because of their mandatory nature, which also entails certain challenges. From the environmental perspective, there is a need to ensure that the binding circular requirements are suitable to produce optimal environmental impacts.⁶⁶ The approaches required to determine which CE strategies will produce the desired environmental impacts vary greatly at both material and product levels. In relation to minimum recycled content, it is important to ascertain whether the policy (i.e., recycling) will promote the best circular strategy for the material, whether using it in a specific product (i.e., containers) will be the most optimal use for it, and whether such use will prevent other strategies (i.e., the use of less packaging) from being deployed. In relation to the reparability index, it is also important to assess whether promoting reparability will result in burden-shifting of the environmental impacts from the production to the use stage. As the example of the EU Ecodesign Regulation demonstrates, the foregoing requires the use of sophisticated methodologies to assess life cycle impacts under various regulatory scenarios. Furthermore, because the policy offers the least flexibility among market actors, CACs can face market resistance and accordingly demand huge political will to bring into effect. Thus, the adoption and implementation of circular CACs may be a slow process.

With a view to achieving wide adoption, CAC instruments should prescribe an ambitious level of environmental performance, but which is not impossible to achieve.⁶⁷ Further, as the French reparability index illustrates, the applicable performance standards should leave room for manufacturers to strive to improve their performance. Technology-specific

⁶⁵ In other countries, reparability is promoted via taxation. Sweden has introduced a value added tax (VAT) deduction on repairs and an income tax deduction for working costs for repairs. The VAT on repairs of, for example, textiles, shoes, leather products and bicycle is reduced from 25% to 12% and households can deduct up to 50% of the working costs of repairs on certain white goods and consumer electronics (Lag (2016:1055) om ändring i inkomstskattelagen). According to the first analyses these tax deductions have not had significant impact yet; Carl Dalhammar and others, 'Promoting the Repair Sector in Sweden' (2020) <https://lucris.lub.lu.se/ws/portalfiles/portal/77933910/Promoting_the_repair_sector_in_Sweden_2020_IIIEE.pdf> accessed 22 December 2022; Leonidas Milios, 'Towards a Circular Economy Taxation Framework: Expectations and Challenges of Implementation' (2021) 1 Circular Economy and Sustainability 477; The effectiveness of tax reductions requires further validating to what extent repair costs have a significant impact on consumers' decisions whether to repair which products.

⁶⁶ Petrus Kautto and others, 'The Circular Economy and Product Policy' (Finland Prime Minister's Office 2021) <<http://urn.fi/URN:ISBN:978-952-383-283-1>> accessed 22 December 2022; Harri Kalimo and Eleanor Mateo, 'Framing Circular Economy Laws for Sustainability' (2022) 52 Environmental Law Reporter 10922.

⁶⁷ See David Popp, Richard G Newell and Adam B Jaffe, 'Energy, the Environment, and Technological Change', in Bronwyn Hall and Nathan Rosenberg (eds), *Handbook of the Economics of Innovation* 885 (vol 2, Elsevier 2010).

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

CAC instruments could be beneficial in terms of diffusion⁶⁸, by generating market and legal certainty for suppliers, and in ensuring the availability of the product (i.e., recycled packaging) on the market. Such certainty will help hasten the market transition. However, CAC instruments need to be used cautiously as they could also lead to technology lock-ins, which might prevent other circular or more sustainable strategies from being implemented. It is, thus, important that CAC instruments are used where there are clear environmental benefits from a life-cycle perspective, i.e., where the technology and its impacts are well understood. Such clear demonstrable environmental benefits could also help generate the requisite political support for restrictive regulations. At the same time, there is a need for mechanisms to ensure dynamic efficiency so that CAC instruments do not deter further innovation once the standards or performance requirements are met.⁶⁹ CAC instruments that prescribe circular targets or standards need to be reviewed periodically to allow for upward adjustment to promote continuous market development.

3.2. Economic Instruments

From a demand-pull perspective, the main objective of using economic instruments is to make circular products more attractive (compared with their linear counterparts) in the marketplace. The demand for low-resource solutions and recovered materials is hindered by the relatively low price of virgin materials.⁷⁰ There are many factors that contribute to this. First, recycling high-quality materials requires high-level sorting. This is a labour-intensive process that renders such materials expensive.⁷¹ Second, primary production makes use of fossil-based energy, which is highly subsidized, contributing to artificially low prices.⁷² Furthermore, the pricing of raw materials often fail to internalize the environmental costs of resource extraction and use. Typically, these instruments promote the CE through financial incentives and disincentives to induce different types of economic actor to use or prefer options that reduce resource consumption and wastage. Broadly speaking, this entails increasing the costs of, or eliminating existing fiscal incentives and subsidies accorded to, resources and/or resource-intensive activities; or directly reducing the costs of circular products (e.g., durable, reused, recycled and remanufactured products) and activities. Thus, unlike conventional environmental taxes, the aim of the instruments goes beyond merely discouraging different kinds of emission, effluent and pollutive

⁶⁸ See Ángeles Pereira Santos and Xavier Vence, 'Environmental Policy Instruments and Eco-Innovation: An Overview of Recent Studies' (2015) 25 *Innovar* 65, 69-70.

⁶⁹ Pablo del Río, Javier Carrillo-Hermosilla and Totti Könnölä, 'Policy Strategies to Promote Eco-Innovation: An Integrated Framework' (2010) 14 *Journal of Industrial Ecology* 541, 548 <<https://doi.org/10.1111/j.1530-9290.2010.00259.x>> accessed 22 December 2022.

⁷⁰ See Walter R Stahel, 'Policy for Material Efficiency—Sustainable Taxation as a Departure from the Throwaway Society' (2013) 371 (1986) *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 1, 8–9.

⁷¹ *Ibid.*

⁷² Xavier Vence and Sugey de Jesus López Pérez, 'Taxation for a Circular Economy: New Instruments, Reforms, and Architectural Changes in the Fiscal System' (2021) 13 (8) *Sustainability* 1, 10 <<https://doi.org/10.3390/su13084581>> accessed 22 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

discharges.⁷³ The instruments could be linked to specific activities across the life cycle of products⁷⁴ (e.g., resource extraction, use or consumption, as well as tax on end-of-life activities) or to specific enterprise undertakings (e.g., investments in resource-efficient technologies)⁷⁵. This section investigates the various types of innovative economic instrument, their key legislative features in stimulating demand, and current challenges.

3.2.1 Swedish Virgin Material Taxes (VMT)

Sweden introduced a gravel tax in 1996 to address concerns about resource scarcity in natural sand and gravel in various parts of the country and to advance environmental protection.⁷⁶ The tax also aimed to promote substitution of natural gravel by crushed rocks and alternative recycled materials. The policy objective was to achieve a ratio of 30:70 between the use of natural gravel and substitute materials, with a 15% sub-target for the use of recycled materials.⁷⁷ The tax, which was increased over time, aimed to close the price gap between gravel and its closest substitute (e.g., crushed rock).⁷⁸ The tax increased the price of natural gravel because anyone exploiting a gravel extraction site that requires a permit under the Swedish Environmental Code⁷⁹ is obliged to pay it. According to evaluations, the tax had a modest effect in reducing the use of natural gravel. It was difficult to isolate the impact of the tax in terms of the use of substitutes.⁸⁰ Alongside and even before the imposition of the gravel tax, Sweden also implemented changes in road building material policies and tightened the permit regime. The combination of the tax, building and permit regulations, as well as procurement preferences, contributed to increasing demand for gravel substitutes.⁸¹ Despite this, however, it is unclear whether the 15% target for the use of recycled aggregates has been met.⁸² This has been attributed in part to the low replacement rates of buildings in the country, which limited the source for recycled aggregates.⁸³ In Denmark, where similar gravel taxes were imposed, the use of a waste tax and the imposition of a regulatory requirement to sort construction and demolition waste at source helped increase the availability and use of recycled aggregates in construction.⁸⁴ Furthermore, despite the Swedish VMT's success in terms of conserving natural gravel, there was also evidence showing that the use of crushed rock as an alternative had resulted in extraction processes involving greater energy use due to

⁷³ *Ibid* 7.

⁷⁴ See Milios (n 66) 480.

⁷⁵ See Vence and López Pérez (n 73) 11.

⁷⁶ Lag (1995:1667) om skatt på naturgrus (Act on Tax on Natural Gravel).

⁷⁷ European Environment Agency, 'Effectiveness of Environmental Taxes and Charges for Managing Sand, Gravel and Rock Extraction in Selected EU Countries' (2008) No 2/2008 30 <https://www.eea.europa.eu/publications/eea_report_2008_2/file> accessed 22 December 2022.

⁷⁸ Patrik Söderholm, 'Taxing Virgin Natural Resources: Lessons from Aggregates Taxation in Europe' (2011) 55 Resources, Conservation and Recycling 911, 916.

⁷⁹ Ds 2000:61.

⁸⁰ European Environment Agency (n 78) 31–32.

⁸¹ *Ibid*; Söderholm (n 79) 916.

⁸² Söderholm (n 79) 917.

⁸³ *Ibid*.

⁸⁴ *Ibid* 918.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

crushed rock requiring more energy per tonne than natural gravel.⁸⁵ However, this was partly offset by shorter transportation distances. The Swedish tax, which was imposed on the volume of gravel extracted, supported a gradual decline in the use of natural primary raw materials and increased demand for substitutes, but highlighted the need for complementary policies to bolster the supply of more sustainable alternatives.⁸⁶

3.2.2 UK Plastic Packaging Tax

The use of economic instruments to increase demand for recycled materials is increasingly prevalent in the plastics industry. The UK recently brought in a tax on plastic packaging aimed at curbing the use of new plastic materials and increasing demand for recycled plastic in the manufacture of plastic packaging. UK government estimates indicate that the tax will bolster the use of recycled plastic in packaging by up to 40%.⁸⁷ This in turn is expected to foster increased collection and plastic recycling, further contributing to the goal of diverting plastic from landfill and incineration. The tax is imposed on domestic manufacturers of plastic packaging and importers of plastic packaging.⁸⁸ Under the law, a finished plastic packaging component is taxable if it does not contain at least 30% recycled plastic by weight.⁸⁹ Chargeable plastic packaging components are taxed at a rate of £200 per metric tonne.⁹⁰ However, the ambition of the 30% recycled content threshold has been questioned given that some brands and retailers have already voluntarily pledged to reach this threshold by 2025.⁹¹ The law also aimed to narrowly target single-use packaging by carving out exemptions to exclude plastic packaging that are designed to be suitable for reuse or to fulfil functions other than packaging as well as packaging for medicinal products.⁹² Similar proposals have been advanced in Italy, Spain and the Netherlands. In Italy, a plastic tax is imposed to curb the consumption of single-use plastic manufactured goods.⁹³ The tax applies to products composed of, whether fully or partially, organic polymers of synthetic origin which have the function of containing, protecting, handling or delivery of goods or foodstuffs, and which are not

⁸⁵ Ibid 916–917.

⁸⁶ European Environment Agency (n 78) 8, 10, 30, 32, 33.

⁸⁷ ‘Policy Paper: Introduction of Plastic Packaging Tax from April 2022’ (GOV.UK, July 2021) <<https://www.gov.uk/government/publications/introduction-of-plastic-packaging-tax-from-april-2022/introduction-of-plastic-packaging-tax-2021>> accessed 23 September 2022.

⁸⁸ Finance Act 2021 (UK) section 44.

⁸⁹ Finance Act 2021 (UK) section 47(1).

⁹⁰ Finance Act 2021 (UK) section 45. The UK government preferred to use a single rate to lower the costs of compliance and administering the tax.

⁹¹ UK HM Treasury, ‘Plastic Packaging Tax: Summary of Responses to the Consultation’ para 3.12 <<https://www.gov.uk/government/consultations/plastic-packaging-tax>> accessed 23 September 2022.

⁹² Finance Act 2021 (UK) section 52. See UK Her Majesty’s Revenue and Customs, ‘Explanatory Memorandum to the Plastic Packaging Tax (General) Regulations 2022’ <https://www.legislation.gov.uk/uksi/2022/117/pdfs/ukxiem_20220117_en.pdf> accessed 23 September 2022.

⁹³ Bilancio di previsione dello Stato per l’anno finanziario 2020 e bilancio pluriennale per il triennio 2020-2022 (hereinafter ‘L 160/2019’), art 1, paras 634–58.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

intended for repeated use.⁹⁴ The tax rate is set at 0.45 Euro per kilogram of single-use plastic material contained in the manufactured goods.⁹⁵ The tax does not apply to compostable single-use plastics, medical devices and those used to contain medical formulations and those derived from recycling processes.⁹⁶

In terms of stimulating demand, a plastic packaging tax is less stringent than a minimum recycled content mandate. However, such flexibility could be beneficial when considering the industry's capacity to produce recycled plastic on an industrial scale. From the environmental perspective, one of the issues debated at EU level is that of whether chemical recycling is more environmental than other options, such as promoting the reuse of plastics.⁹⁷ Chemical recycling could have higher environmental impacts for certain impact categories (e.g. acidification) than incineration.⁹⁸ The UK tax, for example, leans heavily towards incentivizing the use of recycled plastics by basing the tax threshold on minimum recycled content, while Italy's tax appears to support broader alternatives by taxing based on the volume of single-use plastic, and exempting alternatives such as non-single use, compostable and recyclable plastics.

3.2.3 Dutch Tax Deductions

To increase the demand for environmentally friendly investments, the Netherlands has introduced tax reliefs schemes in the form of an Environmental Investment Allowance (*Milieu Investeringsaftrek*, MIA) and arbitrary depreciation of environmental investments (*Willekeurige Afschrijving Milieu-investeringen*, VAMIL).⁹⁹

Under the MIA scheme, Dutch companies may deduct a percentage (up to 45% in 2022) of eligible investment costs from their taxable profits.¹⁰⁰ This allows companies to reduce the costs of eligible investments.¹⁰¹ The level of deductions is based on (i) the environmental performance of the investment; (ii) the level of innovativeness; and (iii) the level of the price

⁹⁴ L 160/2019, art. 1, para 634.

⁹⁵ L 160/2019, art. 1, para 640.

⁹⁶ L 160/2019, art. 1, para 634.

⁹⁷ See Robert Hodgson, 'Analysis: Why Debate over Chemical Recycling of Plastic Is Heating up as Packaging Rules Take Shape' (*Ends Europe*) <<https://www.endseurope.com/article/1750004/analysis-why-debate-chemical-recycling-plastic-heating-packaging-rules-shape>> accessed 22 June 2022.

⁹⁸ Harish Jeswani and others, 'Life Cycle Environmental Impacts of Chemical Recycling via Pyrolysis of Mixed Plastic Waste in Comparison with Mechanical Recycling and Energy Recovery' (2021) 769 [144483] *Science of the Total Environment* 1, 13.

⁹⁹ Regeling van de Staatssecretaris van Infrastructuur en Waterstaat van 14 december 2018, nr. IENW/BSK-2018/261579, tot wijziging van de Aanwijzingsregeling willekeurige afschrijving en investeringsaftrek milieu-investeringen 2009 (Environmental List Adoption 2019), *Stcrt.* 2018, 69481.

¹⁰⁰ 'MIA and VAMIL' (*Rijksdienst voor Ondernemend Nederland*, 27 December 2021) <<https://english.rvo.nl/subsidies-programmes/mia-and-vamil>> accessed 22 December 2022.

¹⁰¹ Rijksdienst voor Ondernemend Nederland, 'MIA \ Vamil: Brochure en Milieulijst 2022 (Brochure and Environmental List' 7 <<https://www.rvo.nl/sites/default/files/2022-07/MIAVamil-Brochure-en-Milieulijst-2022.pdf>> accessed 22 December 2022. If your project does not generate profit, you may settle this with previous years (carry back) or upcoming years (carry forward).

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

gap against a conventional alternative.¹⁰² Costs that can be deducted under the scheme include purchase costs, production costs, modification costs, the cost of purchasing new components and the cost of environmental consultancy (only for SMEs).¹⁰³ The MIA scheme offers tax deduction for investments of at least €2,500, but not exceeding €50 million, per business asset per year.¹⁰⁴ To qualify for the preferential tax scheme, the investment must pertain to capital assets listed on the Dutch Environment List (*Milieulijst*).¹⁰⁵ The list includes assets that promote circularity:¹⁰⁶ examples are raw materials saving industrial equipment, production equipment for (products of) biobased plastics, equipment producing durable products with take back guarantees.¹⁰⁷ In parallel, eligible companies can also apply for the VAMIL scheme. The VAMIL scheme allows entrepreneurs to deduct 75% of their investment expenses and decide when exactly to write off these expenses. This offers lower interest payments and improved liquidity for the companies. The VAMIL scheme applies to the same costs eligible under the MIA. Like MIA, the VAMIL scheme also applies to capital assets from the Dutch Environment List and for purchases of at least €2,500 per year.¹⁰⁸ Both MIA and VAMIL are applied by notifying the Netherlands Enterprise Agency within three months of the purchase of the new business asset.¹⁰⁹ The scheme has had multiple effects on both the demand and supply of covered assets: the Dutch Environmental List has served as a marketing tool for covered assets, which has led to increased turnover for suppliers. This, in turn, has further encouraged suppliers to continue developing environmentally friendly equipment, particularly those aimed primarily at the Dutch market. The list has also lent credibility to the assets' environmental performance and served as an indicator of the future direction of the government's environmental policy.¹¹⁰

3.2.4 Pros and Cons of Using Economic Instruments

The regulatory examples show the nuances of using economic instruments to influence demand for circular products. While taxes can reduce the price difference between new and circular products, this does not automatically lead to substitution. Actual substitution may depend on factors such as the demand elasticity of the product or material taxed, the

¹⁰² European Commission - Environment, 'Case 6: VAMIL and MIA, The Netherlands' 6 <https://ec.europa.eu/environment/archives/sme/cases/cases06_en.htm> accessed 24 September 2022.

¹⁰³ Rijksdienst voor Ondernemend Nederland (n 91) 10.

¹⁰⁴ 'Voorwaarden MIA\Vamil' (*Rijksdienst voor Ondernemend Nederland*, 30 June 2022) <<https://www.rvo.nl/subsidies-financiering/mia-vamil/ondernemers/voorwaarden>> accessed 24 September 2022. For certain business assets, the maximum amount is set at €25 million.

¹⁰⁵ 'MIA and VAMIL' (n 101).

¹⁰⁶ Rijksdienst voor Ondernemend Nederland (n 102) 17–18.

¹⁰⁷ See 'Milieu- En Energielijst (Environment and Energy List) 2022' (*Rijksdienst voor Ondernemend Nederland*) <<https://data.rvo.nl/subsidies-regelingen/milieulijst-en-energielijst/2022?goals=32115&type=miavamil>> accessed 24 September 2022.

¹⁰⁸ 'Voorwaarden MIA\Vamil' (n 105).

¹⁰⁹ Ibid.

¹¹⁰ Robert Vergeer, Martijn Blom and Ellen Schep, 'Beleidsvaluatie: MIA\Vamil' (CE Delft 2018) <https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_7M95_Beleidsvaluatie_MIA_Vamil_DEF.pdf> accessed 22 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

availability of circular alternatives or substitutes, as well as whether the fiscal [dis]incentives are substantial enough to bring about changes in behaviour. As the Swedish VMT example shows, an economic instrument might require complementary policies, such as regulations that enable the production of circular products, to produce its intended effects. Price was not the only barrier for using recycled aggregates in Sweden, as lack of accessible sources was also a factor. The VMT was not suitable to address the latter. The importance of understanding the contextual barrier to a desired circular solution cannot be overemphasized.

The examples also show the challenge inherent in designing economic instruments that are also optimal for the environment because of their "impreciseness" in targeting the factors that affect the desired environmental objectives.¹¹¹ In the VMT and UK tax examples, the taxes had a narrow environmental focus, such as reduced use of primary materials and use of recycled substitutes. The narrow focus provided a clear signal as to the direction of government policy and eased the administrative burden, but there was a risk that the taxes might not result in optimal environmental outcome. The Dutch MIA and VAMIL show how a tax benefit can be further nuanced based on the environmental performance of assets. The foregoing highlights the need for rigorous debate on the actors and activities penalized or incentivized by the economic instruments based on their life-cycle impacts, but also on the important role of monitoring and review mechanisms.

3.3. Information Instruments

Information instruments are demand-pull policy instruments whose aim is to reduce the information asymmetries that hinder the adoption of circular innovations. The use of CE labels, information schemes and awareness campaigns could help to correct information asymmetries and ameliorate the problems caused by poor communication between users and producers. CE labels and information schemes comprise 'labels, certifications, standards of information schemes that fully or at least partially address one or more resource efficiency or circular economy elements'.¹¹² As a steering tool, information instruments do not necessarily directly impact the circularity of products. However, these instruments use different types of information to influence different CE actors, including consumers, businesses and governments. This section examines innovative information instruments in terms of the circular services covered, the kinds of information made available to users, and the mechanisms through which information is made accessible to different users.

3.3.1 Proposed EU Digital Product Passport

Digital product passports are a modern tool for information distribution, labelling and tagging which can facilitate achievement of the

¹¹¹ Söderholm (n 79); Teresa Domenech and Bettina Bahn-Walkowiak, 'Transition Towards a Resource Efficient Circular Economy in Europe: Policy Lessons from the EU and the Member States' (2019) 155 *Ecological Economics* 7, 15.

¹¹² Laubinger and Börkey (n 56) 9.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

CE objectives in many ways and have been presented as solutions for many of the CE's problems, including such matters as unique item-level identification and detection of environmental parameters¹¹³ and tracking chemicals through product life-cycle.¹¹⁴ The EU's Sustainable Product Policy Initiative¹¹⁵ proposes that digital product passport would be the norm for all product regulated under the proposed Ecodesign Regulation.¹¹⁶ The proposed digital product passport would be an important tool for making information available to actors along a product's entire life-cycle and value chain. The passport should help consumers make informed choices by improving the availability of relevant information on the product, while also allowing operators such as repairers and recyclers as well as authorities to access information on it. The Ecodesign Regulation proposal states that information about a product's durability, reliability, reusability and reparability, and the presence of substances of concern etc. could be included in the product passport. The parameters chosen to measure the performance of the product would be examined on a case-by-case basis as different parameters are relevant for different product groups. The products could only be placed on the market or put into service if a product passport were available. The proposed regulation does not prescribe an exact form for the passport. Nonetheless, the Commission has suggested that the passport should be easily accessible by scanning a data carrier such as watermark or a QR code.¹¹⁷ The Commission also suggested that the data in the digital product passport could help in setting mandatory green public procurement criteria and in preventing destroying unsold consumer products.

3.3.2 Portugal's Organized Waste Market

One way to promote the CE is by providing a supportive framework for industrial symbiosis. Portugal has enacted various instruments to promote the formulation of such a framework. One of the most distinctive instruments is the organized waste market (*Mercado Organizado de Residuo*). The Portuguese Decree Law 178/2006¹¹⁸, as amended, provides for the establishment of a voluntary online market to serve as the central platform for the buying and selling of various secondary materials. The market was established to promote the reintroduction of secondary materials into the

¹¹³ Nenad Gligoric and others, 'SmartTags: IoT Product Passport for Circular Economy Based on Printed Sensors and Unique Item-Level Identifiers' (2019) 19 (3) Sensors <<https://doi.org/10.3390/s19030586>> 23 December 2022; Thomas Adisorn, Lena Tholen and Thomas Götz, 'Towards a Digital Product Passport Fit for Contributing to a Circular Economy' (2021) 14 (8) Energies <<https://doi.org/10.3390/en14082289>> accessed 23 December 2022.

¹¹⁴ Commission, 'On Making Sustainable Products the Norm (Communication)' COM (2022) 140 final [hereinafter "COM (2020) 142 final"]; Thomas de Römph, *The Legal Transition towards a Circular Economy: EU Environmental Law Examined* (DLaw, KU Leuven 2018) 210, 371–72. See also Commission, 'European Resource Efficiency Platform: Manifesto & Policy Recommendation' (2012) 7.

¹¹⁵ COM (2022) 140 Final' (n 115).

¹¹⁶ Ibid; Commission, 'Proposal for a Regulation for the European Parliament and of the Council Establishing a Framework for Setting Ecodesign Requirements for Sustainable Products and Repealing Directive 2009/125/EC' COM (2022) 142 final.

¹¹⁷ COM (2022) 140 final (n 115); COM (2022) 142 final (n 117) recital 31.

¹¹⁸ <<https://data.dre.pt/eli/dec-lei/178/2006/09/05/p/dre/pt/html>> accessed 22 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

economy and thereby reduce the need for virgin raw materials. Sellers can post their secondary materials online, creating visibility regarding the various possible sources of secondary materials. The Portuguese law also provided for financial and administrative incentives to facilitate the use of the platform. For example, the law provides the possibility to exempt users who adhere to the conditions of the trading platform from licensing requirements for non-hazardous waste recovery operations.

It has been argued that Portugal still has strategic, technical, fiscal, social, and process gaps in its industrial symbiosis framework.¹¹⁹ These are issues that information instruments cannot resolve on its own and which require complementary approaches. At EU level, other instruments that are relevant for industrial symbiosis and are implemented in all Member States include, for example, regulation on differentiating by-products from 'waste' and regulation on industrial emissions and Best Available Techniques (BAT).¹²⁰ These latter instruments help improve the technical and process gaps in implementing industrial symbiosis. In addition, industrial symbioses may, for example, be promoted by setting out different financial incentives or indirectly encouraging market actors via land-use regulation and planning.¹²¹

3.3.3 Germany's Blue Angel Certification Scheme for Car-Sharing

The CE also includes business models that are based on providing access to users instead of transferring ownership. By utilizing operational strategies that rely, for example, on increased utility or product-life extension, these business models can promote resource efficiency while meeting a need or performing a function. However, not all access-based services result in positive environmental impacts. Hence, it is also crucial that users can distinguish and prefer those services that are circular and sustainable.¹²² In Germany, the reach of the Blue Angel certification scheme has been extended to cover car-sharing services. The environmental objectives of certification under this scheme include reducing resource use by enabling people to live without car ownership, saving space on the road while reducing air pollution, CO₂ emissions and energy consumption.¹²³ The objectives are operationalized through technical requirements imposed in respect of the car-sharing fleet. For example, any new diesel vehicle added to the fleet should comply with maximum NO_x and particulate emissions limits. The car-sharing operator must also phase out diesel

¹¹⁹ Juan Henriques, Paulo Ferrão and Muriel Iten, 'Policies and Strategic Incentives for Circular Economy and Industrial Symbiosis in Portugal: A Future Perspective' (2022) 14 (11) *Sustainability* 1, 18–20 <<https://doi.org/10.3390/su14116888>> accessed 23 December 2022.

¹²⁰ Industrial symbiosis is mentioned in Article 5 of the EU Waste Directive regarding by-products and the recitals of the 2018 amendments to the Directive; Helena Dahlbo and others, *Promoting Non-Toxic Material Cycles in the Preparatuin of Best Available Technique Reference Documents* (Finnish Environment Institute 2021) <<http://urn.fi/URN:ISBN:978-952-11-5402-7> <http://hdl.handle.net/10138/329318>> accessed 22 December 2022.

¹²¹ Suvi Lehtoranta and others, 'Industrial Symbiosis and the Policy Instruments of Sustainable Consumption and Production' (2011) 19 *Journal of Cleaner Production* 1865, 1873.

¹²² Kautto and others (n 67) 103–105.

¹²³ Blue Angel, 'Car Sharing: Basic Award Criteria' 5–6 <<https://produktinfo.blauer-engel.de/uploads/criteriafile/en/DE-UZ%20100-201801-en-Criteria-V4.pdf>> accessed 3 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

vehicles or at least ensure that all its diesel vehicles comply with the maximum NO_x emission limits by 2021.¹²⁴ Operators that have more than 50 vehicles are also subject to a requirement to increase the percentage of electric vehicles in the overall composition of the fleet, which should be charged using 100% renewable energy.¹²⁵ The label also has requirements to use compact vehicles, for example 45% of the vehicles in a fleet should be from the mini and small cars segments as defined by the German Federal Motor Transport Authority.¹²⁶ This facilitates the use of trip-appropriate, small and less material-intensive vehicles, which also contributes to reducing operational CO₂ emissions. To further support the deployment of sustainable car-sharing, the city of Bremen linked the use of the label as a condition for awarding parking privileges.¹²⁷

The Nordic Swan Ecolabel is also currently investigating how to develop ecolabels for businesses based on sharing, such as e-bike-sharing.¹²⁸ Going beyond emissions, the label is looking at whether the material efficiency criteria can be extended to require that the product (e.g., bikes) be made from recyclable or renewable components, that operators undertake to maintain, repair and reuse parts, and that discarded parts be recycled in a way that retains their highest value.¹²⁹ These two examples show how material efficiency and other environmental criteria can be combined and developed to help users identify services that are truly circular and sustainable.

3.3.4 Information Requirements on Substances of Concern – the EU’s SCIP Database

The EU has recently introduced a requirement for all companies that place articles and products on the EU market to notify the European Chemicals Agency if those articles and products contain substances that have been identified as substances of very high concern under the REACH Regulation^{130,131}. The information is published in the Substances of Concern in Products (SCIP) database, which is publicly available. Following the introduction of the SCIP database much more information on the presence of substances of very high concern in the products placed on the EU market

¹²⁴ Ibid 10–11.

¹²⁵ Ibid 11–12.

¹²⁶ Ibid 12.

¹²⁷ Kalimo and Mateo (n 67).

¹²⁸ Matthias Vang Vestergaard, Jesper Minor and Dilek Turan, ‘Ecolabel Potentials of Sharing Economy Services in the Nordics: A Study into the Potential Framework for Ecolabelling of Sharing Based Services in a Circular Economy Perspective’ (2020) Nordic Working Paper <<http://dx.doi.org/10.6027/NA2020-906>> accessed 23 December 2022.

¹²⁹ Ibid.

¹³⁰ Parliament and Council Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (as amended) [2006] OJ L 396/1.

¹³¹ Parliament and Council Directive 2008/98/EC of 19 November 2008 on waste and repealing certain Directives [2008] OJ L312/3 (as amended), art. (9)(1)(i).

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

is now available.¹³² One of the aims of the European SCIP database is to help waste operators ensure that substances of very high concern are not present in recycled materials. Secondary materials may contain chemical substances that pose risks to human health or the environment. The presence of hazardous substances in and even the mere absence of information on the chemical composition of the secondary materials can limit their use and hinder material circulation. At the same time, it would be too costly to require every batch of a potential secondary material to undergo chemical analysis.

One way to tackle the problem is to set out information and traceability requirements as regards the presence of hazardous substances in the products from which the secondary materials originate. Better information on the safety of the recycled materials is crucial to foster demand for the secondary materials as it increases market operators' confidence in using secondary materials and helps to minimize both the risks related to the safety of the materials and the related business risks. Mere uncertainty as to the possible existence of residues of hazardous substances may prevent the circulation of an otherwise useful secondary material. The SCIP database is a good first step towards achieving a better information flow concerning the presence of hazardous substances in the material circles. However, as it sets requirements only as regards substances of very high concern it covers only a small proportion of all the hazardous substances that may be present in secondary materials and is, therefore, not in itself a sufficient measure. Thus, some scholars have taken the view that the SCIP database does not provide sufficient information for recyclers, for example because the product information in the database is not specific enough and the information on the chemical composition is limited to substances of very high concern.¹³³

3.3.5 Pros and Cons of Using Information Instruments

The various examples of information instruments set out above show the broad spectrum of how they could be used to mainstream the CE. The Blue Angel example demonstrates the role of labels in creating awareness of the fact that not all circular services are sustainable, and in distinguishing those that are sustainable.

Identifying environmentally superior circular products requires the development of methodologies by which to measure environmental impacts and standards and translate this information in a way that is meaningful for the targeted actors. These could provide the basis for regulating new circular aspects and developing new demand-pull regulations. Thus, new information on CE products, materials and services can also create new regulatory objects. The information that a digital

¹³² European Chemicals Agency, '7 Million Searchable Articles in SCIP Database Improve Transparency on Hazardous Chemicals' (*European Chemicals Agency*) <<https://echa.europa.eu/-/7-million-searchable-articles-in-scip-database-improve-transparency-on-hazardous-chemicals>> accessed 26 September 2022.

¹³³ Henning Friege and others, 'The New European Database for Chemicals of Concern: How Useful Is SCIP for Waste Management?' (2021) 21 (100430) *Sustainable Chemistry and Pharmacy* 1 <<https://doi.org/10.1016/j.scp.2021.100430>> accessed 23 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

product passport scheme would make it possible to obtain could support the development of more sophisticated regulations and circular public procurement. Furthermore, information instruments can help support compliance, but also improve the monitoring of the environmental impacts of other demand-pull instruments.

Information instruments play an important role where the barriers for CE adoption are not based (at least exclusively) on economic logic, including such matters as lack of market information, technical know-how and cultural barriers. The Portuguese example of promoting the organized waste market and the SCIP database example demonstrate the importance of creating spaces, physically or virtually, where various CE actors can obtain relevant information to facilitate CE objectives. In the Portuguese example, it was information as to the availability, supply, and demand for certain waste materials to facilitate industrial symbiosis that was important, while in respect of the SCIP database the presence of information regarding the hazardous contents of products offered a means of increasing confidence in secondary materials and facilitating their use. The examples provided also hint at the need to ensure the accessibility of CE-relevant information: this entails organizing, centralizing, and linking information or databases.

The SCIP database example also shows that using information instruments to increase the demand for circular products need not necessitate the development of new regulatory frameworks. Instead, existing information infrastructure can be utilized to allow for the collection of CE-relevant information.

3.5 Public Procurement Instruments

Public procurements have significant potential as a driver of the CE transition because the volume of procurements made by different public authorities is substantial. By favouring CE solutions and products in their purchases public authorities can therefore create demand and markets for CE industry. Furthermore, by applying Circular Public Procurement (CPP) the public sector actors can lead by example and thereby also encourage private sector actors to favour circular solutions and products in their procurement.¹³⁴

CPP is a dimension of a wider green public procurement concept in which public authorities seek to procure goods, services and works that have a reduced environmental impact throughout their life-cycle when compared with goods, services and works with the same primary function that would otherwise be procured.¹³⁵ It also falls within the sustainable public procurement concept which covers environmental, social and

¹³⁴ See e.g. Mervin Jones, 'Harnessing Procurement to Deliver Circular Economy Benefits' (2017) 5 <https://sustainable-procurement.org/resource-centre/?c=search&category=tool_guidance&topic=circular_economy&p=2> accessed 23 December.

¹³⁵ European Commission, 'Public Procurement for a Better Environment (Communication)' COM (2008) 400 final 4.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

economic sustainability.¹³⁶ CPP can be defined as 'procurement of competitively priced products, services or systems that lead to extended lifespan, value retention and/or remarkably improved and non-risky cycling of biological or technical materials, compared to other solutions for a similar purpose on the market'.¹³⁷ The CE can be promoted in the context of public procurement by setting specific circularity criteria for the acquired products, by procuring services instead of products (e.g., by applying different product-service systems), by using public procurement as a platform for piloting new and innovative products, services and materials, or by promoting industrial symbiosis and circular ecosystems in the public procurement.¹³⁸ CE objectives can therefore be promoted in the public procurement as well by applying circular procurement models (e.g., renting or leasing), by setting requirements for the life-cycle of the products (e.g., take-back mechanisms and disassembly or reparability requirements), or setting requirements for the materials used (the procured product must contain recycled materials and/or the materials used must be recyclable).¹³⁹

3.5.1 Circular Public Procurement (CPP) in the Netherlands

CPP in the Netherlands has been promoted under the government-wide CE programme which aims at achieving a fully circular economy by 2050.¹⁴⁰ The Netherlands uses information-based instruments such as circular public procurement guidelines to promote CPP.¹⁴¹ This approach is similar to that taken by countries like Finland, which relies less on legislative amendments and more on informational guidance aimed at contracting authorities and bidders to promote CPP.¹⁴² The Netherlands has also launched a Green Deal for Circular Procurement. This established a network among public and private actors for them to learn about the application of circular principles in procurement and exchange best practices. It also supports innovative circular pilot projects.¹⁴³

¹³⁶ United Nations Environment Programme, United Nations Office and others, 'Buying for a Better World: A Guide on Sustainable Procurement for the UN System' (2011).

¹³⁷ Katrina Alhola and others, *Circular Public Procurement in the Nordic Countries* (Nordic Council of Ministers 2017) 12 <<https://norden.diva-portal.org/smash/get/diva2:1092366/FULLTEXT01.pdf>> accessed 5 July 2022.

¹³⁸ Katriina Alhola and others, 'Exploiting the Potential of Public Procurement: Opportunities for Circular Economy', (2019) 19 *Journal of Industrial Ecology* 96, 101-104 <<https://doi.org/10.1111/jiec.12770>> accessed 23 December 2022; Kautto and others (n 67) 103–105.

¹³⁹ European Commission, 'Circular Procurement for a Circular Economy: Good Practice and Guidance' (2017) 6 <https://ec.europa.eu/environment/gpp/circular_procurement_en.htm> accessed 23 December 2022.

¹⁴⁰ 'Circular Dutch Economy by 2050' (*Government of the Netherlands*) <<https://www.government.nl/topics/circular-economy/circular-dutch-economy-by-2050#:~:text=The%20Netherlands%20aims%20to%20have,and%20raw%20materials%20are%20reused.>> accessed 7 October 2022.

¹⁴¹ See e.g. Cecilia van Oppen and others, *Circular Procurement in 8 Steps* (Rijkswaterstaat 2018).

¹⁴² Topi Turunen, Leila Suvantola and Seita Romppanen, 'Well Defined Is Half Solved? The Regulatory Barriers for Circular Economy Business' (2021) (1) *Nordic Environmental Law Journal* 93, 108 <<https://nordiskmiljoratt.se/earlier-issues.html>> accessed 23 December.

¹⁴³ INTERREG Baltic Sea Region, 'State-of-the-Art on Circular Procurement Policy in the Baltic Sea Region' (2019) 40 <<http://circularpp.eu/wp-content/uploads/2019/06/Summary-Report-WP-2.1-State-of-the-art-of-Circular-Procurement-Policy.pdf>> accessed 22 December 2022.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

Local authorities also play an important role in using CPP to advance CE targets as they could have more ambitious targets and provide more targeted guidance than national authorities. In the Netherlands, the city of Amsterdam aims to implement 100% circular procurement by 2030.¹⁴⁴ The city uses public procurement as a way of building knowledge and technical know-how for circular solutions. It also supports innovative circular products and services by serving as its first significant or ‘launching’ customer.¹⁴⁵ Amsterdam has adopted a policy of according precedence to circular solutions such as ‘products as a service’ and the utilization of used and/or reusable and refurbishable products.¹⁴⁶ These targets are operationalized and focus on four sectors: construction, consumer goods, food and waste, which were chosen based on their economic and environmental significance to the city.¹⁴⁷

Zooming in on one of the city’s priority sectors – the built environment – the city has published a comprehensive, step-by-step guide on how to conduct circular construction procurements.¹⁴⁸ The guide used a life-cycle approach in implementing circular procurement taking into account the different stages of the construction phase.¹⁴⁹ It sets out four key principles of circular buildings that are intended to guide procuring authorities’ decision-making: (i) reduce initial demand for materials; (ii) look for synergies in the use of resources (i.e. sharing, reuse); (iii) when synergy effects are exhausted, use clean, renewable or otherwise ecologically beneficial sources; and (iv) manage the impacts by ensuring reliable feedback through transparent data and efficient information networks.¹⁵⁰ These principles underpin 32 circular criteria that may be used when designing a circular tender. The topics covered by these criteria include, for example, design for disassembly, use and capture of scarce and critical materials, and use of secondary materials for the building process.¹⁵¹ Amsterdam’s approach of learning by doing fills an important knowledge gap in the construction sector. For example, reuse of building materials has remained niche despite potential benefits simply due to lack of technical know-how.¹⁵² The city plans to evaluate the guidance based on the experienced gained from at least three tenders, as well as from transformation, renovation, and demolition projects.

¹⁴⁴ City of Amsterdam, ‘Amsterdam Circular 2020-2025 Strategy’ (City of Amsterdam 2020) 17 <https://assets.amsterdam.nl/publish/pages/867635/amsterdam-circular-2020-2025_strategy.pdf> accessed 7 October 2022.

¹⁴⁵ Ibid 52.

¹⁴⁶ Ibid.

¹⁴⁷ Ibid 8.

¹⁴⁸ City of Amsterdam, ‘Roadmap Circular Land Tendering’: An Introduction to Circular Building Projects’ (n.d.) <https://www.metabolic.nl/wp-content/uploads/2019/02/roadmap_circular_land_tendering.pdf> accessed 7 October 2022

¹⁴⁹ Ibid.

¹⁵⁰ Ibid 13.

¹⁵¹ Ibid 16-17.

¹⁵² Katrin Knoth, Selamawit Mamo Fufa and Erlend Seilskjær, ‘Barriers, Success Factors, and Perspectives for the Reuse of Construction Products in Norway’ (2022) 337 (art. 130494) *Journal of Cleaner Production* 1, 5.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

3.5.2 Circular Public Procurement in South Korea

In South Korea, circular procurement falls within the broader ambit of the country's policy of promoting green public procurement, which is tied strongly to the use of ecolabels.¹⁵³ The 2005 Act on the Promotion of Purchase of Green Products (as amended) serves as the main legislative instrument for the implementation of green public procurement. Under Article 6 of the Act, public institutions are required to purchase 'green products' unless there is a compelling reason not to do so, such as lack of availability. Under the Act, green products refer to those certified under the Korea Eco-Label or Good Recycled Mark certification, or those that meet other environmental criteria set by the Ministry of Environment, in consultation with the heads of other relevant ministries.¹⁵⁴ This is similar to Japan's approach of developing green procurement criteria based on ecolabels (e.g., Eco Mark, Green Mark and Recycle Mark).¹⁵⁵ Sector-specific requirements were introduced under the 2005 Construction Waste Recycling Promotion Act, which required the use of recycled aggregates certified either by the Korea Eco-Label or the Green Recycled Mark in the procurement of construction works.¹⁵⁶ Korea's Eco-Label System involves a third-party authority identifying products that have lesser environmental impact throughout their life-cycles.¹⁵⁷

Through its procurement policy, Korea has supported the development of the market for its ecolabelled products. During its conception, the Korea Eco-Label covered only four product categories. By 2016, the label's scope had expanded to cover 161 categories.¹⁵⁸ The market for Korea Eco-Label products has also increased tenfold from USD 3 billion in 2005 to USD 34 billion in 2013.¹⁵⁹ The South Korean example shows how public procurement can be linked with certification systems to support the market for circular products and services.

3.5.3. Pros and Cons of Using CPPs

CPP helps mainstream CE beyond establishing a market for CE products. CPP, particularly through the development of circular criteria, signals to suppliers the policy objectives and direction that the government wants to support. The Amsterdam example demonstrates how CPP can be

¹⁵³ See Harri Kalimo and others, 'Hiili- ja ympäristöjalanjälki hankinnoissa – lainsäädäntö ja mittaaminen' (Finland Prime Minister's Office 2021) 114 <<http://urn.fi/URN:ISBN:978-952-383-097-4>> accessed 23 December 2022.

¹⁵⁴ 2005 Act on the Promotion of Purchase of Green Products, art. 2.

¹⁵⁵ United Nations Environment Programme, 'Comparative Analysis of Green Public Procurement and Ecolabelling Programmes in China, Japan, Thailand, and the Republic of Korea: Lessons Learned and Common Success Factors' (2017) 40 <<https://wedocs.unep.org/handle/20.500.11822/33377>> accessed 7 October 2022. Kalimo and others (n 154) 114.

¹⁵⁶ United Nations Environment Programme, 'Green Public Procurement in the Republic of Korea: A Decade of Progress and Lessons Learned' (2019) 23 <<https://wedocs.unep.org/20.500.11822/32535>> accessed 23 December 2020.

¹⁵⁷ Korea Ministry of Environment and Korea Environment Institute, 'Eco-Label Certification System (ECS) in Korea' (2016) Korea Environmental Policy Bulletin 41, Vol. XIV Issue 1 5 <<https://me.go.kr/home/file/readDownloadFile.do?fileId=148570&fileSeq=1>> accessed 22 December 2022.

¹⁵⁸ Ibid 7.

¹⁵⁹ United Nations Environment Programme (n 157) 26.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

used as a means of building knowledge to close technological and information gaps, which could benefit the industry at large and potentially serve as the basis for future regulations.

The foregoing also validates earlier findings that using CPP to promote the CE does not necessarily require the introduction of new legislation or amendment of existing legislation. As the Netherlands example shows, increased collaboration between the procurer and potential suppliers throughout the procurement process can help facilitate circular procurement but requires mutual commitment.¹⁶⁰ This is particularly true in complex circular solutions, such as in construction, which include aspects that cannot be easily covered by ecolabels or standards. The South Korean example demonstrates how to achieve synergies with ecolabels and procurement policies to support circular products. The mandatory use of labelled products facilitated the identification and verification of environmentally superior products during the procurement process. On the other hand, South Korea's public procurement policy guarantees demand for, and encouraged suppliers to invest in the development of, circular products and services and simplified the procurement process for the staff of procuring authorities. However, exclusive reliance on ecolabels may limit the scope of products and services that could be the subject of CPP.¹⁶¹ It may also hamper suppliers' flexibility in meeting environmental requirements and hinder motivation to look for better and more innovative approaches.

Another dimension that the Amsterdam example highlights is the importance of creating priority and influencing demand for circular solutions that have better environmental impacts, for example by establishing the four key principles when procuring for construction or by adopting a policy of purchasing fewer new products. This also encourage suppliers to invest in circular strategies that are higher in the hierarchy (i.e., reduce, reuse, etc.).

Finally, the examples show the complementary roles of national and local governments in supporting circular solutions through CPP. Local governments are better equipped than national ones to understand which CE solutions need to be prioritized and in which sectors in the context of CPP from an environmental perspective. However, national CPP targets help provide regulatory certainty.¹⁶²

4. CONCLUSION: DEFINING THE ROLE OF DEMAND-PULL INSTRUMENTS IN MAINSTREAMING THE CIRCULAR ECONOMY

This article has examined the four main types of demand-pull instruments to promote the CE. It has looked at innovative examples from different jurisdictions and examined how they addressed the needs of the

¹⁶⁰ Sjors Witjes and Rodrigo Lozano, 'Towards a more circular economy: Proposing a framework linking sustainable public procurement and sustainable business models' (2016) *Resources, Conservation and Recycling* 37-44, 41-42.

¹⁶¹ United Nations Environment Programme (n 156) 63, 96.

¹⁶² Kalimo and others (n 154) 63-64.

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

CE transition. The regulatory examples were not intended to be showcased as viable solutions in all jurisdictions. Rather, the aim was to highlight the innovative elements of the various approaches and the challenges and pathways for improvement. None of the regulatory innovations discussed provide the key to the CE transition in themselves, but they can be utilized as part of the solution. However, before enacting any of the identified regulatory approaches as legal transplants in another jurisdiction, whether combined with other regulatory tools or applied for different regulatory objects, a thorough evaluation of its impacts (direct and indirect), legitimacy and applicability will be needed.

All the examples offered demonstrate that mainstreaming the CE requires the balancing of various factors. These include creating sufficient legal certainty and incentives for market operators, ensuring feasibility while supporting the possibility of further innovation as well as ensuring that the approach taken is geared to producing positive environmental outcomes. From the outset, it is important that life cycle environmental impacts inform decisions as to which CE strategies are mainstreamed¹⁶³ and through which instruments.

Furthermore, it is crucial to identify and have a holistic understanding of the nature of the barriers to the implementation of specific aspects of the CE: lack of technical and organizational know-how, socio-cultural barriers, economic and regulatory disincentives require different approaches and therefore different instruments. The presence of multiple barriers also signifies the limitations involved in using a single instrument and the need for complementary policies. Indeed, the examples show that many demand-pull instruments have in fact complementary roles and can be utilized to achieve synergies. The deployment of instruments can be phased based on technological/market readiness and availability of data, including data on environmental impacts. Information instruments, such as ecolabels, certifications, and digital product passports can be used to develop life-cycle analysis methodologies and standards that could support public procurement, or later inform CAC instruments, or as a basis for awarding economic incentives. Economic instruments can be supplemented by information and CAC instruments to overcome non-economic barriers. Information instruments and public procurement can also be used to build technical know-how and experiment with solutions to test their environmental impacts. Where the technological capability to supply circular solutions on a wider scale is relatively well developed and there is clear understanding of the concomitant environmental impacts, CAC instruments can be used to achieve more efficient adoption and mainstreaming of circular solutions. These instruments are slow to implement and are most restrictive. Hence, softer information instruments can be used to build understanding and bring about gradual acceptance to counter cultural resistance.

The discussions above also highlight that most regulatory frameworks still offer only limited examples of policies to support a shift

¹⁶³ See Kalimo and Mateo (n 67).

Demand-Pull Instruments to Support the Circular Economy: A Global Perspective

towards what Stahel labels as 'sufficiency'.¹⁶⁴ Sufficiency represents not just using less resources to produce a product, but also possibly reducing consumption itself. Examples of this approach include not replacing products until they become functionally obsolescent and shifting from products to services to reduce the material stock of a product over time. This approach requires, for example, thinking not only about how to maximize the use of recycled content in packaging but also about how to reduce the need for packaging itself.¹⁶⁵ This also presents a notable challenge when conceptualizing demand-pull instruments. Beyond information instruments, there is a need to further understand to what extent demand-pull instruments, and which types, can support 'sufficiency' approaches. What solutions, activities or alternatives promote sufficiency, and which are not linked to consumption? What role and how could regulations enable and support these innovations in consumption, and who might be the relevant actors and regulatory subjects in promoting this shift? Further research is needed to understand the suitability and design of demand-pull instruments that mainstream solutions based on non-consumption.

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¹⁶⁴ Walter Stahel, 'Sufficiency Strategies for a Sustainable and Competitive Economy Reversed and Inversed Incentives' (Proceedings Second International Symposium on Environmentally Conscious Design and Inverse Manufacturing conference, Tokyo, December 2001) <<https://ieeexplore.ieee.org/document/992428>> accessed 7 October 2022.

¹⁶⁵ Nancy MP Bocken and Samuel W Short, 'Transforming Business Models: Towards a Sufficiency-Based Circular Economy' in Miguel Brandão, David Lazarevic and Göran Finnveden, *Handbook of the Circular Economy* (Edward Elgar Publishing 2020) 254.

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Authors' Contributions (in accordance with ICMJE criteria for authorship)

<i>Contribution</i>	<i>Mateo</i>	<i>Turunen</i>	<i>Alaranta</i>
Conceived or design the research analysis	Yes	Yes	Yes
Collected the data	Yes	Yes	Yes
Contributed to data analysis and Interpretation	Yes	Yes	Yes
Wrote the article	Yes	Yes	Yes
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PROSPECTS AND CHALLENGES TO PROVE ENVIRONMENTAL HARM IN LITIGATION: STATUS QUO IN NIGERIA

Awodezi Henry

Faculty of Law, University of Delta, Agbor, Nigeria

Email: h.awodezi@unidel.edu.ng; henryawodezi@gmail.com

ORCID: <https://orcid.org/0000-0002-1179-3371>

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ABSTRACT

Environmental litigation and enforcement of environmental rights remain a global challenge to sustainability, especially in developing countries such as Nigeria. The increasing rates of industrial activities have led to increase in production of hazardous substances posing threat to lives of the inhabitants of the environment. Victims of environmental harm most times find it difficult to protect and enforce their environmental rights. Proving environmental harm such as damages to property in litigation to enforce rights of compensation or restoration for damages suffered becomes difficult due to locus standi technicalities and undue delays during trials. Sometimes victims are faced with financial constraint in pursuing the course of justice which involves retaining the services of a lawyer and expert witnesses. This paper, therefore, examines the prospects and challenges to proving environmental harm in litigation. This paper employs doctrinal legal research methodology and content analysis of both primary and secondary sources in relation to proving environmental harm in litigation. On this premise, this paper recommends the application of the principle of Res Ipsa Loquitur in trials of environmental cases. Proving environmental harm for the enforcement of environmental rights by victims, should be totally devoid of technicalities of law during trials. This will in turn promote the course of justice in cases dealing with environmental harm.

Keywords: Environmental harm; Challenges; Litigation; Compensation; Locus standi

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Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

1. INTRODUCTION

This paper discusses the prospects and challenges to proving environmental harm in litigation. It examines rights of compensation or restoration in cases of damages to land, streams, vegetation, etc. induced by anthropogenic activities. It is observed that in almost all African Countries, such as Nigeria, Ghana, Cameroon, among others, environmental harms are majorly caused by human industrial activities. This is as a result of human developmental and profit-oriented ambition superseding environmental sustainability, hence, the recurrent cases of environmental harm. In Nigeria, access to a clean environment appears to rank the least in order of environmental priorities due to an overwhelming profit and developmental interest overriding fundamental human rights to life and serene environment. These rights to life and serene environment are synonymous to healthy living.

The importance of the right to healthy living cannot be overemphasized owing to the fact that the major causes of sicknesses and diseases befalling humans are from environmental harm. Thus, right to a clean and healthy environment was defined as something of which no one may be deprived without a great affront to justice.¹ It is recalled that there is a plethora of environmental harm cases in which victims of environmental harm lost their rights to compensation or reinstatement. This is often predicated on legal technicalities, such as locus standi, documentary evidence, among others, which are involved in proving damages or harm suffered by the victims. Furthermore, victims often encounter the financial challenge in funding expert witnesses to prove their cases.

2. ENVIRONMENTAL HARM

Environmental harm means any impact on the environment as a result of human activity that has the effect of degrading the environment (whether temporarily or permanently).² Inflicting environmental harm might be environmental crime in some cases. According to White and Heckenberg (2014), the term “environmental harm” has been used interchangeably with “environmental crime”³. This is because, like most concepts in environmental law, environmental crime does not lend itself to any specific definition, especially, because no definition can be retrieved from international conventions.⁴ In conceptualizing environmental harm, White

¹ Cranston, M., ‘Human Right; Real and Supposed in Raphael (eds) Political Theory and the Rights of a Man’ Blooming, 1967, 52.

² Cleverline, T. B. and Nlerum, S. O., ‘Redressing Harmful Environmental Practices in the Nigerian Petroleum Industry Through the Criminal Justice Approach’, (2020) 11 (1) Journal of Sustainable Development Law and Policy; Afe Baba Lola University, <www.ajol.info/jsdp/article/view> accessed 21 September 2022.

³ White, R. and Heckenberg, D., ‘Green Criminology: An Introduction to the Study of Environmental Harm’ Routledge (2014) 348; as cited by Orlando, E. and Bergin, T., ‘Forging a Socio-Legal Approach to Environmental Harms: Global Perspective’, Routledge (2017) 3.

⁴ Mistura, A., ‘Is There Space for Environmental Crimes Under International Criminal Law? The Impact of the Office of the Prosecutor Policy Paper on Case Selection and Prioritization on the

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

(2008) proposed three approaches: the conventional criminology approach, the ecological perspectives approach, and the green criminology approach.⁵

The conventional criminology approach speaks to the conceptualization of harm from the point of view of legal instruments, such as law, rules and international conventions. Under this approach, activities are either legal or illegal.⁶ Ecological perspective approach accommodates the conceptualization of harm from the understanding of the interrelationship between species and the environment. Under this approach, the key issue is that of ecological sustainability and the categorization of social practices into benign and destructive practices.⁷ Green criminology approach conceptualizes harm from the point of view of justice for the effects of activities of human, ecological and animal rights and egalitarian concerns. This approach weighs different kinds of harm and violation of rights within the context of eco-justice framework.⁸

Environmental harm is a very broad concept that describes a physical or mental injury or moral wrongdoing to human kind and the health of other living organisms or interference with the ecological system of which form a part, including any human senses or human property.⁹ It can be caused by activities such as tree clearing, fishing, pollution and mining, damming rivers, killing native animals, soil erosion and aircraft noise.¹⁰ Environmental harm is any adverse effect on the value of the environment.¹¹ The environmental value is a quantity or physical characteristics of the environment that is conducive to ecological health or public amenity or safety.¹²

3. THE PROBLEM OF PROVING ENVIRONMENTAL HARM DURING COURT PROCEEDINGS

Many reasons have been put forward for the lack of success in proving environmental harm. This ranges from developmental interest of the government as against environmental interest, technicalities involved in the use of experts, lack of funds in securing services of experts, attitudes of the Judges who are reluctant in awarding adequate compensation, and the longevity of court proceedings or trials before cases are determined. These challenges are discussed below in three categories, namely: judicial approach

Current Legal Framework' (2018) 43 (1) Columbia Journal of Environmental Law 181, 196, <journals.library.columbia.edu> accessed 22 December 2022.

⁵ White, R., 'The Criminalization of Environmental Harm: Rob White Explores How Environmental Harm is Conceptualized and How it should be Tackled' (2008) 74 (1).

⁶ Ibid, 24.

⁷ Ibid.

⁸ Ibid.

⁹ Hughes, D., 'Environmental Law', (2003) 14 (1) Management of Environmental Quality 162, <<https://doi.org/10.1108/meq.2003.14.1.162.6>> accessed 22 December 2022.

¹⁰ Caxton Legal Centre Inc., 'Environmental Harm' (2016), as cited by Cleverline, T. B. and Nlerum, S. O., 'Redressing Harmful Environmental Practices in the Nigerian Petroleum Industry Through the Criminal Justice Approach', (2020) 11 (1) Journal of Sustainable Development Law and Policy, <www.ajol.info/jsdp>article>view> accessed 25 September 2022.

¹¹ Environmental Protection Act, 1994, s 14.

¹² Ibid, s 9.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

in deciding matters of environmental harm, developmental interest overriding sustainability and impediments such as delay, cost of litigation, etc. to environmental litigation in Nigeria.

3.1 Judicial Approach in Deciding Matters of Environmental Harm

Ecologically, apart from the aforementioned provisions meant to guard against the pollution and degradation of the Nigerian environment, the Constitution¹³ of the Federal Republic of Nigeria clearly states that the State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria. It is unfortunate that the attitude of some of the Nigerian judges towards matters relating to environmental hazards created by the multinational corporations have rendered the enforcement of environmental laws ineffective. Some members of the judiciary as noted by Ebeku¹⁴ have been reluctant to give orders compelling companies whose operations are damaging to the environment to ease the action complained of.

Perhaps, these judges consider the potential loss of income and investments of litigants at the expense of the environmental protection. Additionally, this could be the fact that Nigeria's economy depends largely on the sales of crude oil. Whichever is the case, such actions retard the implementation of environmental laws and, thereby, encourage relegating these laws to a toothless dog. According to Oluwatoyin,¹⁵ there have been several oil related cases filed in the Nigerian Courts by affected Nigerians ranging from pollution from oil exploration, loss of incomes, loss of properties, contamination of drinking water leading to water borne diseases, and so on. A few cases need to be mentioned here. In the case of *Chevron Nigeria Limited v. Nwuche and Others*¹⁶, the plaintiffs were farmers and natives of Umukene Ohaji community in Imo State of Nigeria. The plaintiffs instituted legal action against the defendant that the defendant's mineral oil exploration has caused a lot of damages to their farmlands and also deprived them of their farming benefits. The defendant contended that the trial court lacks jurisdiction to entertain the matter. Defendant further contended that the plaintiffs are not entitled to the reliefs being sought in the trial. The trial court ruled that it has jurisdiction to adjudicate on the matter. On appeal, the Court of Appeal set aside the ruling of the trial court and the plaintiffs' entire suit was struck out. Similarly, in *Amos and 4 others v. Shell B.P Nig. Ltd.*¹⁷, the plaintiffs sued the defendants jointly and severally for unlawfully blocking the Kolo Creek waterway, which passes through their farmlands in Ogbia community in Rivers State of Nigeria. The defendants contended that Kolo

¹³ Section 20 of the Constitution of the Federal Republic of Nigeria, 1999 as amended 2011.

¹⁴ Ebeku, K., 'Judicial Attitudes to Redress for Oil Related Damages in Nigeria', (2003)12 (2) RECIEL 199-208, as cited by Adamu Kyuka Usman, 'Environmental Protection Law and Practice', Ababa Press Ltd., Nigeria 2012, 228-233.

¹⁵ Osho-Adejonwo Oluwatoyin, 'The Evolution of Human Rights Approaches to Environmental Protection in Nigeria', (2005) Optiocon Documans & Task, <www.iucnael.org/index.php?> accessed 12 March 2010.

¹⁶ (2005) PH 420 (CA).

¹⁷ (1972) 4 S.C 123.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

Creek is a public waterway and that the plaintiffs have no *locus standi* to institute the legal action in a court of competent jurisdiction. The court upheld the submission of the defendants and ruled against the plaintiffs. Other similar cases discussed hereinafter are, among others, *Seismograph Services Ltd. v. Onokpasa* and *Oronto Douglas v. Shell Petroleum Development Company Ltd.*

In most of these cases and similar ones, the judicial courts are said to have refrained from making orders on how to remedy the situation of the oil spillage claims, loss of income from fishing and farming, pollution of drinking water and crops, and damage to health as a result of waterborne diseases. Instead of passing orders, which address the complaints regarding damages to the physical environment of these communities (Sagbama community, Peremabiri community in Bayelsa State and Ineh/Aku communities in Abia State of Nigeria), the courts tend to settle for compensation of the affected complainants. In this manner, the environmental laws that were meant to protect human beings and other living things are rendered ineffective. It is hoped that, the judiciary may in future begins to address cases of environmental harm not merely to award monetary compensations but to preserve a healthy environment.¹⁸

The multinational oil companies, which are normally being complained against by oil communities on gas flaring, are more likely to win an environmental litigation, especially, when it relates to technicalities of locus standi and other related issues in proving damages or environmental harm suffered. In the case of *Oronto Douglas v. Shell Petroleum Development Company Ltd. (SPDC)*, the court refused to grant the plaintiff's relief against Shell Petroleum Development Company Ltd. The court held that the Plaintiff lacked the *locus standi* to commence suit having failed to proffer evidence that he suffered any injury above that of the public.

3.2 Developmental Interest Overriding Sustainability

Many reasons have been advanced for the lack of effective environmental enforcement policies. Profit-oriented and developmental ambitions had, over the years, superseded sustainable interest. The notion here is that, in as much as the adventure is lucrative, the side-effect harm is of less priority. One of the reasons often cited is corruption of public officials charged with the duty of enforcing these laws. Corruption is a major problem in Nigeria and has pervaded almost all sectors of the economy. The enforcement agents that deal with the wealthy multinational oil companies, such as Chevron, Agip, are easily influenced to compromise against international best practices.

These factors could alone or in combination act as serious impediments to enforcing environmental regulations. It, however, offers little explanation on why the Nigerian Federal Government seems reluctant in imposing

¹⁸ Okorodudu, M.T., 'Law of Environmental Protection' (1998) Text C., as cited by Ebeku, K., 'Judicial Attitudes to Redress Oil Related Environmental Damage in Nigeria' (2003) 12 (2) RECIEL 207.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

stringent penalties on activities that caused serious environmental harm in the country, as it is in the case of gas flaring, which is highly tolerated.

The Nigerian leadership is even ready to subject the standard of living and health of its citizens over the continued flaring of gas. Though gas flaring has been declared illegal in Nigeria since 1984, and various courts of jurisdiction have ruled against its practice, it continues unabated. In the case of *Jonah Gbemre v. Shell Petroleum Development Company of Nigeria Ltd & Ors*,¹⁹ the court ruled against the activities of gas flaring and declared gas flaring as unconstitutional and a breach of fundamental rights to life and dignity of human persons. These rights are guaranteed by the African Charter on Human and People's Right and the Constitution of the Federal Republic of Nigeria.²⁰

Today, Nigeria is one of the countries with highest percentage of gas flaring, globally. Therefore, to understand why the Nigerian government seem reluctant to enforce its environmental laws to the latter, it becomes necessary to look at the nature of its economy because, as analysed herein, it shows the nature of the Nigerian economy having lopsided towards the production of a single commodity that has had the greatest impact in weakening the political will of Nigerian leaders and have effectively made it rely on rent/proceeds from oil production for its survival.

3.3. Impediments to Environmental Litigation in Nigeria

There are certain hiccups that are associated with litigation in Nigeria. This is regardless of whether such litigation is an environmental litigation or other subject matters. These impediments are not sector specific or court specific. They include factors like delays, cost of litigation and services of legal practitioners, ignorance of the law on part of citizens, remoteness of court halls from rural dwellers etc.²¹ Much litigation in courts takes time and unnecessary delays are attributable to them. It is recorded that an average length of litigation in superior courts of record lasts between five to six years and those cases that are eventually heard proceed with no real sense of urgency.²²

This is the minimum time a victim of environmental harm for instance will take to assert his right. This excludes the right of unsuccessful litigant to file appeal. Friends of the Earth International captured the exact nature of the length of environmental litigation against oil multinational companies in the following words:

“A classic example of how transitional oil companies escaped from the arm of the law using the cumbersome legal system that is time wasting to frustrate litigants. In Nigeria, delays significantly plague

¹⁹ (2005) 151 AHLR (NgHC).

²⁰ Constitution of the Federal Republic of Nigeria, 1999 as amended 2011.

²¹ Fagbemi, S.A. and Akpanke, A.R., 'Environmental Litigation in Nigeria: The Role of the Judiciary', (2019) 4 <[www.ajol.info/article>view](http://www.ajol.info/article/view)> accessed 25 September 2022.

²² Oko O. 'Seeking Justice in Transitional Societies: An Analysis of the Problems and Failures of the Judiciary in Nigeria' (2005) 9 (14) 31 Brook J Int. Law, as cited by McCaskill L., 'When Oil Attacks: Litigation Options for Nigerian Plaintiffs in U.S Federal Courts' (2013) 22 (2) Health Matrix; the Journal of Law-Medicine 560.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

the course of litigation against the poor rural communities. The delay in getting judgment in the courts discourage the prospective litigants from instituting any environmental action in court. Some cases are illustrative. According to records, a spill at Peremabiri Bayelsa State in January 1987 came to the High Court in 1992 and to the Court of Appeal in 1996; a case heard in High Court in 1985 in relation to damages suffered on a continuous basis since 1972 was held in Court of Appeal in 1994; a case held in 1987 in relation to damages suffered since 1967 was heard in the Court of Appeal in 1990 and in the Supreme Court in 1994.”²³

It is crystal clear that the victims of environmental harm are confronted with so many difficulties in trying to prove their cases with regards to harm suffered consequentially from the misconduct of another. The resultant effect of this is loss of confidence by the victims in the Nigerian courts and this has led to a number of environmental cases being taken to courts outside the shore of Nigeria.²⁴ Some victims also abandon their cases halfway due to financial constraint, delays in the judicial system and the technical doctrine of *locus standi*. Thus, the strict enforcement of the doctrine of *locus standi* has deprived numerous environmental litigants their fundamental right to access environmental justice.

The issue of *locus standi* relates to Nigerian environmental law conferring only government agencies with standing to sue. In this way, a government that fails to enact strong laws or enforces its own laws is protected by a system that bars interested members of the public from suing.²⁵ A 2015 survey of enforcement official and legal practitioners corroborates this argument.²⁶ Few courts that have exercised jurisdiction are courts of the United Kingdom,²⁷ African Commission on Human and People’s Rights²⁸ and the Economic Community of West African States (ECOWAS) Community Court of Justice that entertain matters when all other remedial local avenues to redress the injustice have been exhausted.

However, the limitation here is that such international courts do not always assume jurisdiction in every matter that is brought before it. This was demonstrated rightly in the case of *Socio-Economic Rights and Accountability Project (SERAP) v. President of the Federal Republic of Nigeria & Ors.*²⁹ In this case, the court held that while it had jurisdiction to entertain the case, its jurisdiction was only to the extent that the Federal Government of Nigeria and its agency, the Nigeria National Petroleum Company (NNPC), are

²³ Friends of the Earth, ‘Access to Environmental Justice in Nigeria: The Case for a Global Environmental Court of Justice’ (2016), <www.foei.org> accessed 23 August 2018.

²⁴ Popoola, E.O., ‘Moving the Battlefields: Foreign Jurisdictions and Environmental Justice in Nigeria’ (2017), <kujenga-amani.ssrc.org> accessed 24 September 2022.

²⁵ Ibid.

²⁶ Popoola, E. O., ‘Appraisal of the Contemporary Jurisprudence on the Right to Environment: A Case Study of Nigeria and South Africa’, Ahmadu Bello University, (2016), 390.

²⁷ *Okpabi v. Royal Dutch Shell and Others* (2018) EWCA Civ, 191.

²⁸ Article 50 of the African Charter on Human and Peoples’ Rights, 1981.

²⁹ (2010) ECW/CCJ/APP/8/09.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

parties to ECOWAS treaties but that it lacked jurisdiction over multinational corporations and proceeded to strike their names off the law suit.³⁰

In the case of *Oronto Douglas v. Shell Petroleum Development Company Ltd (SPDC)*,³¹ the plaintiff, a private citizen, brought an action against the defendant, an oil corporation, seeking a mandatory order directing the defendant to contend certain provisions of the Environmental Impact Assessment Act before continuing with a liquefied natural gas project. The court refused to grant the plaintiff's relief holding that he lacked the *locus standi* to commence suit having failed to proffer evidence that he suffered any injury above that of the public.

It is argued that the doctrine of *locus standi* is not applicable to environmental matter.³² Thus the fundamental rights rules³³ provided to the effect that the courts shall encourage and welcome public interest litigations in the human rights field and no human rights case may be struck out for want of *locus standi*.

Similarly, in *Centre for Oil Pollution Watch v. Nigerian National Petroleum Corporation (NNPC)*,³⁴ the case was initially filed at the Federal High Court by the plaintiff who brought an action against the NNPC for refusing to clean up and reinstate the Ineh/Aku streams and rivers in Abia State of Nigeria. The streams were polluted by the spilled oil from the NNPC corroded pipeline which ruptured. At the trial, the defendant (NNPC) denied liability and filed his defence action contending that the plaintiff, being a non-governmental body, has no *locus standi* to institute such legal action.

The Federal High Court upheld the submission of the defendant and struck out the action. The plaintiff filed a Notice of Appeal and challenged the decision of the Federal High Court. The Court of Appeal upheld the decision of the lower court to the effect that the plaintiff has no *locus standi* in the action. The argument of the Appellant was that the suit was instituted on the ground of public interest for the purpose of conserving the environment and that the suit reveals extreme issue that would validate an exceptional approach to the question of sufficient interest. Responding to the Appellant's argument, the respondent therein contended to the effect that the principle of *locus standi* in the administration of justice under the Nigerian judicial system has not changed and that the Appellant has not shown to the court that he personally suffered any injury or harm to its interest nor authorized by the affected community to sue on its behalf. The Court of Appeal, while delivering its judgment, therefore, acknowledged the exponential growth in the change of attitude by courts in other jurisdictions allowing pressure groups, non-governmental organisations and public-

³⁰ Ekhaton, E.O., 'Improving Access to Environmental Justice Under the African Charter on Human and Peoples' Rights: The Roles of NGOs in Nigeria' (2014) 22 (1) African Journal of International and Comparative Law 63,73.

³¹ (1988) LPELR143/97 (CA).

³² Michael Uche Ukponu, 'Environmental Law and Access to Justice in Nigeria: A Case for a Specialized Natural Environmental and Planning Tribunal (NEPT)', (2019) University of Melbourne, Melbourne Law School, Australia.

³³ Fundamental Rights (Enforcement Procedure) Rules, 2009.

³⁴ (2019) 5 NWLR (Pt. 1666) 518 (S.C.).

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

spirited taxpayers to institute an action bothering on public interest. It, nevertheless, observed that Nigerian courts are yet to adopt such approach and, therefore, dismissed the appeal. The Appellant being dissatisfied with the judgment went further on to appeal to the Supreme Court and the Supreme Court overruled the decision of the Court of Appeal. The Supreme Court held that the Court of Appeal was wrong in playing into technicalities of *locus standi* to deprive public group's right of action to redress unlawful conduct.

The Supreme Court stated that in environmental cases, as in the instant one, non- governmental organisations (NGOs) such as the Appellant in this suit, have the obligatory standing to institute legal action. Furthermore, the court noted that public interest litigation is geared towards improving access to justice for the masses, especially, the poor whose rights are infringed upon. Again, public interest litigation is for the protection of the masses and that such legal action serves as a means of liberating, transforming and protecting the interest of relegated groups. The court stated to the effect that everyone such as pressure groups, public spirited taxpayers or non-governmental organisations who *bona fide* seek a redress in the court of law in respect of the due performance of statutory functions or the implementation of statutory provisions or public laws meant or designed to safeguard human lives, public health and environment, should in appropriate definition be seen as the appropriate parties enshrined with the right standing in law to bring an action to redress unlawful conduct.

The above-mentioned cases are a clear example of cases where victims suffered untold hardship as a result of legal technicalities of *locus standi* though there is access to court. The Supreme Court is commended in this celebrated case. In *Adesanya v. President of the Federal Republic of Nigeria & Anr*,³⁵ the court stated to the effect that the words "*Locus Standi*" represent the legal capacity to institute cause of action in a court of competent jurisdiction. In this case, the court held that the claimant must give a convincing reason to justify that his interest will be affected by the action or that he is a victim of the harm done.

Sequel to the foregoing evaluations, this paper argues that delay in proceedings and strict enforcement of *locus standi* in environmental cases will deny victims of environmental harm access to environmental justice. This happens mainly in situations where the victim indirectly suffers from the harm done. The right to a serene environment belongs to everyone whose interest may be affected directly or indirectly when the environment is polluted. Wilful disobedience to laid down rules and court's orders pertaining to the use of the environment is a major challenge to sustainability. The worrisome issue is that despite the decision of the court on gas flaring as in the aforementioned case of *Jonah Gbemre v. Shell Petroleum Development Company of Nigeria Ltd. & Ors*, the multinational oil companies still flare gas in disobedience to court's order due to an overriding interest in profit making than the health of the innocent citizens.

³⁵ (1981) 5 S.C. 69.

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

It has been pointed out that the need for Nigerian courts to relax standing requirement in environmental litigation in order to engender growth of climate change litigation would help Nigeria realise its climate change mitigation and adaptation potentials more effectively.³⁶

4. THE PATHETIC SITUATION OF NIGER DELTA REGION

There is plethora of cases of environmental problems arisen from pollution, degradation and deforestation, but over 90 percent of them turned out an exercise of futility due to technicalities involved in proving cases of environmental harm in legal action for damages and compensations.³⁷ Even the few ones that succeed are given meagre compensation as the only remedy while the acts being complained of continue.

In *Shell Petroleum and Development Co. Ltd. v. Cole*,³⁸ the inhabitants of Sagbama Community in the Niger Delta sued Shell for compensation for loss of their fishing rights at the Sagbama creek, which the oil company dredged in 1971 for the purpose of oil production. The trial judge ruled in favour of the community. Shell appealed. The then Federal Supreme Court judge upheld the judgment of the lower court and held that the amount awarded as damages was far less than the loss proved by the community but could not review the award because the community did not cross appeal on the point.

The problem of getting adequate compensation can be attributed to the fact that development interest and profit-oriented ambitions are prioritized over environmental interest.³⁹ A notable case study of this is the export of toxic waste to Africa which was discovered in 1988. Containers of toxic wastes were imported by a Nigerian peasant living near the small port of koko,⁴⁰ a coastal community located in Delta State of Nigeria and lies south of the former Bendel State close to the Atlantic Ocean. In September 1987, an Italian businessman based in Nigeria, and acting on behalf of an Italian Waste Disposal Company, shipped to the port of Koko 4,000 tons of industrial and nuclear wastes for over a period of 18 months. The wastes were brought into Nigeria purportedly as industrial chemicals for Nigeria Companies.⁴¹

In reaction to the menace, the Nigerian Government enacted different environmental policies.⁴² Findings also showed that the purpose and impact

³⁶ Etemire, U., 'The Future of Climate Change Litigation in Nigeria: COPW v. NNPC in the Spotlight', (2021) CCLR (2) 159

³⁷ Awodezi Henry and Eruteya Ugiomo, 'Environmental Law Litigation and its Remedial Challenges', (2019) Human Rights Jurisprudence Journal (HRJJ); Center for African American Research Studies- CAARS; ISSN:2636-5685.

³⁸ (1992) 8 N.W.L.R. (pt. 259) 335.

³⁹ Ibid.

⁴⁰ Peter, C.M., 'Taking Environment' (1993) 3 Revenue Africaine des Droits de l, Homme, 42.

⁴¹ Eguh, E.C., 'Regulations of Trans-boundary Movements of Hazardous Wastes, Lessons from Koko' (1997) 9 RADIC 130.

⁴² Oil Pipeline Act Cap. 07 Laws of the Federation of Nigeria (L.F.N.) 2004, the Endangered Species Act Cap. E9 Laws of the Federation of Nigeria (L.F.N.) 2004, Environmental Impact Assessment Act, Cap. E12, Laws of the Federation of Nigeria (L.F.N.) 2004, Federal Environmental Protection Agency Act (F.E.P.A.), 2004 which was subsequently repealed by the

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

of some of these environmental policies are to an extent cosmetic in conception with no objective framework for implementation to achieve the desired sustainable goals. The reasons for failure are varied, complex and wide. Many regulatory frameworks fail because the government lacks necessary information and data to regulate environmental pollution. However, all nations rich or poor have no alternative but to be concerned with the environment.⁴³

On the contrary, most of these countries have not been innocent victims and, in most cases, there are contractual prearrangement between their governments and multinational corporations. These are done because of the financial gains involved and ignorance of the dangers of such actions. In *Seismograph Services Ltd. v. Onokpasa*,⁴⁴ the plaintiff/respondent found himself in a devastating situation in the sense that his school building developed cracks following the defendant/appellant's rock blasting activities near the school. The cracks became visible only after some weeks following the cessation of the appellant's seismic activities. On these facts, the court held that the respondent failed to establish a nexus between the cracks on his building and appellant's blasting activities. The court stated further that it is important to consider the duration of time between the blasting activities of the appellant and the appearance of cracks on the respondent's building.

Tied to the problem of proving environmental harm is the problem of the technical rules of prosecuting a case in the law courts and the availing defences in the rule in *Rylands v. Fletcher*.⁴⁵ In *Amos v. Shell B.P Nig. Ltd.*,⁴⁶ the plaintiffs lost their case because they sued on what was considered public nuisance without the consent of the Attorney General. In *Chinda & Ors v. Shell Petroleum Development Co. Ltd.*,⁴⁷ the plaintiffs in a representative capacity sued the defendant company for heat, noise and vibration resulting from the negligent management and control of the flare set used during gas flaring operations. This resulted in a lot of damage to the plaintiff's property. On the representative character aspect of the case, the court held that the plaintiff's action must fail because the plaintiff could not prove they had the mandate to sue in a representative capacity.

Regarding negligence, the court held that the plaintiffs could not prove negligence on the part of the defendant in the management and control of the flare set. In cases requiring such skill and technology, the inhabitants of the host rural oil communities obviously find it extremely difficult to prove negligence or that reasonable care was not taken during the defendant's operations. This problem naturally emerges because of the plaintiff's limited

National Environmental Standards and Regulations Enforcement Agency (NESREA) (Establishment) Act 2007, Harmful Waste (Special Criminal Provisions) Act 2004, among others.

⁴³ Omorogbe, Y., 'The Growth of Environmental Law in Developing Countries: Problems and Prospects' (Mimeo), 2010, 1.

⁴⁴ (1972) 73/1970 SC. as cited by Adamu Kyuka Usma, 'Environmental Protection Law and Practice' Ababa Press Ltd, Nigeria, 2012, 228-233.

⁴⁵ (1993) 7 N.W.L.R. (Pt.304) 203.

⁴⁶ (1972) 4 S.C 123.

⁴⁷ (1868) 3 L.R 330. (HL).

Prospects and Challenges to Prove Environmental Harm in Litigation: Status Quo In Nigeria

knowledge of operations in the petroleum industry. In the same vein the plaintiffs will find it difficult to prove that 'Good Oil Field Practices' were not adopted by the defendant. The defendant company on the other hand would have no difficulty in providing experts with in-depth knowledge of petroleum technology to explain such technical terms and prove that they were not negligent.

5. CONCLUSION AND RECOMMENDATIONS

Conclusively, this paper argued that legal technicalities are hindrances to assessment of environmental justice. Right to compensation or restoration in cases of environmental harm are often difficult to access due to technicalities of law during court trials.

The aforementioned cases of *Seismograph Services Ltd v. Onokpasa*, *Oronto Douglas v. Shell Petroleum Development Company Ltd. (SPDC)*, *Jonah Gbemre v. Shell Petroleum Development Company of Nigeria Ltd & Ors*, among others, are several environmental harm cases in which victims of environmental harm suffered untold hardship in the course of enforcing their rights to compensation or reinstatement not because they lack a just cause of action but due to legal technicalities. The plaintiffs in the case of *Centre for Oil Pollution Watch v. Nigerian National Petroleum Corporation (NNPC)* suffered delay impediment from the trial court to supreme court before they could not assess their right to compensation due to technicality of *locus standi*. Legal technicalities of *locus standi*, delays in trials, financial challenge, among others, are major constraints befalling victims.

A plaintiff suing for environmental harm therefore has to engage the services of a good lawyer to make success of his case and this will involve huge amount of money. Due to meagre funds in the hands of the victims, unlike the wealthy industries, the litigants continue to suffer environmental harm from the pollutant-industries. This could be traced to the fact that Nigeria's economy depends largely on the sales of crude oil. Whichever is the case, such actions retard the implementation of environmental laws and, thereby, make innocent victims to continue to suffer untold hardship from environmental harm.

Sequel to the foregoing, this paper recommends that intending or potential litigants who in one way or the other become victims of environmental harm should seek redress in court by soliciting the doctrine of *Res Ipsa Loquitur* (that is, the facts speak for itself) to establish their cases against the wealthy pollutant-industries. Under this doctrine, the court does not need the plaintiff or claimant to prove the harm done to him if the harm itself is glaring to the assessment of the ordinary man in the society.

This paper further recommends that while the innocent victims solicit the doctrine of *Res Ipsa Loquitur* in courts, the courts should in turn apply same in administering course of justice and jettison technicalities of *locus standi*, prove of harm or damage suffered by expert witness and undue delays before cases are determined. The victims of environmental harm are those whose right to clean and healthy environment are infringed upon as a

**Prospects and Challenges to Prove Environmental Harm in Litigation:
Status Quo In Nigeria**

result of damages done to their environment which consequently has adverse effect on their health or means of livelihood.

Alternatively, aggrieved parties should also seek arbitration to reconcile the dispute emerging from environmental harm. Although, this can only be made possible if all the aggrieved parties agree to resolve their dispute through arbitration. In effect, it will save cost and precious time for the aggrieved parties instead of embarking on court's proceedings which may take a longer time for the case to be determined.

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**Prospects and Challenges to Prove Environmental Harm in Litigation:
Status Quo In Nigeria**

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.

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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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