CONCEPTUALISING AND ACTIVATING KNOWLEDGE IN ENVIRONMENTAL PROTECTION LAW

BRUCE LINDSAY,* DRU MARSH† AND REBECCA NELSON‡

Knowledge is core to the key tasks of environmental protection and regulation: analysing, diagnosing, predicting and intervening to manage or prevent adverse effects of human activities on the environment and human health. Aptly, the central mechanism of the recent Environment Protection Act 2017 *(Vic) — the general environmental duty — embeds the concept of the 'state of knowledge'. This drives the new* Environment Protection Act 2017 *(Vic)'s shift to a comprehensive, flexible, risk-based approach to environmental protection. Though inspired by a similar approach under occupational health and safety law, conceptualising and implementing the state of knowledge in the environmental context will be more difficult. Importantly, environmental risks can be numerous, diverse, ambiguous, and prone to accumulation in complex ways. This article uses the scenario of stormwater management to draw out the dimensions of the state of knowledge and challenges in applying it. These challenges point to important roles for government and non-government stakeholders alike in building and disseminating knowledge about the environment and the environmental risks of relevant activities.*

CONTENTS

* Environmental Justice Australia.

† Public Service Research Group, School of Business, UNSW Canberra; Environment Protection Authority of Victoria.

‡ Melbourne Law School, The University of Melbourne.

We gratefully acknowledge the insightful comments from Dr Yung En Chee and two anonymous referees, funding from the University of Melbourne's Melbourne Sustainable Society Institute Seed Funding Scheme and the Australian Research Council (#DE180101154), and research assistance from the Melbourne Law School's Academic Research Service.

I Introduction

Humankind's approach to environmental protection is necessarily knowledge-driven. This is particularly the case when it comes to the design and implementation of a regulatory scheme to achieve environmental protection.[1] Knowledge, often in the form of scientific facts and opinions, is the technical and epistemic base informing actions, policymaking and decision-making

[1] Gerry Bates, *Environmental Law in Australia* (LexisNexis Butterworths, 9th ed, 2016) 41–2 [2.35]–[2.36].

under environmental laws.[2] It is the intellectual force underpinning regulatory action for environmental protection.

The quality and accuracy of our knowledge of the environment is subject to change. Earlier knowledge may become outdated through advances in scientific inquiry, improvements in industry practices and growing awareness of adverse impacts experienced by communities. To be effective, environmental regulation must recognise the state of that knowledge at the point in time when actions are contemplated.

Despite the central role of the state of knowledge, surprisingly little has been published on the concept, its legal characterisation, and challenges and limits to its use. This is an important gap, given that the state of knowledge is a key influence on the standards of behaviour required of duty holders under the 'general environmental duty' ('GED') which is the centrepiece of Victoria's new *Environment Protection Act 2017* (Vic) ('*EP Act*').[3]

In this paper, we describe the state of knowledge generally in the context of Victoria's new *EP Act* and its role in activating and improving the protection of the environment and engaging with the distinctive statutory and factual context of environmental protection. We then elaborate these issues using a case study. Part II introduces and traces the origins of duties-based laws from the occupational health and safety context to their translation into environmental laws, and outlines the role of the state of knowledge in discerning the behaviour required of those who undertake activities relevant to the GED. Part III analyses the dimensions of the state of knowledge and compares it to other knowledge-related concepts in environmental law. Part IV explores the complexities involved in applying the state of knowledge in implementing the GED. We use the case study of stormwater management to draw out the interpretive complexity brought about by highly diverse duty holders, a dynamic urban environment and cumulative impacts and risks of harm. We conclude by reflecting on how insights from the case study's environmental context illuminate the ongoing importance of state action and the desirability of stronger statutory duties related to knowledge generation, collection and dissemination to increase the effectiveness of the GED.

[2] Ibid.

[3] *Environment Protection Act 2017* (Vic) s 25(1) ('*EP Act*').

II From Command and Control to Duties-Based Law and the Origins of the State of Knowledge

A *Overview: Victoria's Duties-Based Approach and the Transformation of Environmental Regulation*

In 2015, the Victorian government established a Ministerial Advisory Committee ('MAC') to examine the role of the Environment Protection Authority ('EPA') as the State's lead environmental regulator.[4] The MAC recommended transformation of both the EPA and the statutory scheme it administered from a reactive to a preventive approach in addressing harm to human health and the environment.[5]

In line with the MAC's recommendation, the Victorian government adopted the *EP Act*, repealing the *Environment Protection Act 1970* (Vic) ('*EP Act 1970*'), and placing at its core a general environmental duty requiring that

> [a] person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable.[6]

The *EP Act* specified that 'minimising risks of harm' requires duty holders to eliminate risks 'so far as reasonably practicable', and if elimination is not reasonably practicable, 'to reduce' the risks so far as is reasonably practicable.[7] This construction incorporates the concept of a 'hierarchy of [risk] control[s]',[8] preferencing measures that tend to eliminate or reduce risks without relying on human interventions, like protective equipment or adherence to administrative controls.

Section 6(2) of the *EP Act* sets out the factors to be considered in determining what is, or was at the relevant time, 'reasonably practicable', with the relevant state of knowledge contained in para (c):

(a) the likelihood of those risks eventuating;

(b) the degree of harm that would result if those risks eventuated;

[4] Ministerial Advisory Committee, Victorian Government, *Independent Inquiry into the Environment Protection Authority* (Report, 31 March 2016) 4–5 [1.1]–[1.3].

[5] Ibid viii–xii.

[6] *EP Act* (n 3) s 25(1).

[7] Ibid ss 6(1)(a)–(b).

[8] Chris Maxwell, *Occupational Health and Safety Act Review* (Report, March 2004) 159–62 [707]–[713].

(c) what the person concerned knows, or ought reasonably to know, about the harm or risks of harm and any ways of eliminating or reducing those risks;

(d) the availability and suitability of ways to eliminate or reduce those risks;

(e) the cost of eliminating or reducing those risks.

The *EP Act* enacts the first GED supported by powers to take legal enforcement action, including criminal sanctions.[9] Importantly, it *replaces*, rather than complements, traditional 'command-and-control' pollution-based punishments, which have otherwise been retained in other Australian jurisdictions that have introduced a GED.[10] Therefore, the Victorian GED may better address environmental harms caused by the cumulative effect of many contributors, which may be individually minor, given that direct 'command-and-control' intervention is difficult to justify for *de minimis* activities.[11] Indeed, in recommending the GED, the MAC emphasised the need to prevent harm from pollution occurring from the 'aggregated effects of pollution and waste from [cumulative, "multiple small and medium"] sources'.[12]

B *Duties-Based Laws in Victoria and the Origins of the State of Knowledge*

Victoria's new approach to environment protection builds on decades of reform in Australia and the United Kingdom ('UK') originating in workplace or occupational health and safety ('OHS'). OHS reform was founded on the state's limited capacity to identify and control all risks of harm arising in workplaces, as the command-and-control approach confronted increasingly complex risks arising from both development in technology and the chemicals industry, highlighting that knowledge of OHS risks and controls was not the sole preserve of

[9] *EP Act* (n 3) ss 25(2)–(3). We distinguish this from formulations of a GED supported by powers to issue remedial notices and other coercive administrative powers to address noncompliance: see, eg, *Environmental Protection Act 1994* (Qld) ss 24(3), 319 ('*Qld EP Act*'); *Environment Protection Act 1993* (SA) ss 25(4), 135(1)–(4) ('*SA EP Act*').

[10] See *Qld EP Act* (n 9) ss 358–60(2); *SA EP Act* (n 9) ss 93–4, 102–3. Despite the GED being decades old in Queensland and South Australia, we are not aware of any significant jurisprudence examining the scope and role of the state of knowledge in informing these earlier duties.

[11] Joel Edwards et al, 'Implementing General Environmental Duties: Challenges and Opportunities' (2021) 80(3) *Australian Journal of Public Administration* 474, 475, quoting Ministerial Advisory Committee (n 4) 221.

[12] Ministerial Advisory Committee (n 4) 219.

the state.[13] Commencing with UK reforms,[14] common law jurisdictions have recast OHS obligations by reframing expectations and responsibility for risk from state regulation to employers, centring on a legally enforceable employer responsibility to ensure their workplaces eliminate or minimise risks to worker health and safety.[15] A well-established regulatory regime and community of practice has since developed, underpinning compliance with these statutory duties and emphasising an important role for the underlying knowledge base.

Victoria enacted duties-based OHS legislation under the *Occupational Health and Safety Act 1985* (Vic) ('*OHS Act 1985*'). The primary duty to ensure a safe and healthy workplace was broad in scope and only limited by what was 'practicable' in the duty holder's circumstances.[16] The *OHS Act 1985* defined 'practicable' to mean 'practicable' having regard to a number of factors, including 'the state of knowledge about that hazard or risk and any ways of removing or mitigating that hazard or risk',[17] thereby expressly embracing the state of knowledge concept.

The *OHS Act 1985* was reviewed in 2003–04.[18] Leading the review, Chris Maxwell concluded that the phrase 'state of knowledge about the hazard or risk' was 'ambiguous': 'It might mean the state of knowledge of the dutyholder, or it might mean the state of knowledge in the industry, or it might mean the state of knowledge in the world at large.'[19]

Maxwell explained that the phrase

> refers both to the *subjective* knowledge of the employer (including 'not merely the knowledge of its executives or officers, but also of any employee, agent or third party contractor') and to the *objectively*-determined knowledge of the industry.[20]

[13] Breen Creighton and Peter Rozen, *Health and Safety Law in Victoria* (Federation Press, 4th ed, 2017) 3 [1.09]. See also at 3 [1.12], quoting Committee on Safety and Health at Work, *Safety and Health at Work: Report of the Committee* (Cmnd 5034, 1972) 1 [13] ('*Robens Report*').

[14] *Robens Report* (n 13) 151–8 [451]–[500].

[15] Creighton and Rozen (n 13) 5–8 [1.19]–[1.32], 118 [6.02].

[16] *Occupational Health and Safety Act 1985* (Vic) s 21(1) ('*OHS Act 1985*'). Despite Victoria not adopting the so-called model OHS laws, the model OHS general duty and composition of 'reasonably practicable' closely tracks the Victorian equivalents: see *Work Health and Safety Act 2011* (Cth) ss 17–19; *Occupational Health and Safety Act 2004* (Vic) ss 20(1)–(2), 21 ('*OHS Act 2004*').

[17] *OHS Act 1985* (n 16) s 4 (definition of 'practicable' para (b)).

[18] Maxwell (n 8) 15 [1].

[19] Ibid 108 [438].

[20] Ibid 108 [439] (emphasis in original), discussing *Chugg v Pacific Dunlop Ltd [No 2]* [1999] 3 VR 934, 965 [134] (Ormiston J).

Maxwell went on to say that

> [w]hether a particular dutyholder ought reasonably to be aware of a particular hazard depends, in part, on 'the state of knowledge' generally. Where the dutyholder was not aware of a particular work-related hazard, it will be relevant to ascertain whether other participants in, or advisers to, the relevant industry were aware of it. If so, and relevant safety information was available, there is a strong case for saying that the safety duty extended to removing that hazard, regardless of the dutyholder's own ignorance of the hazard.[21]

Reform of the *OHS Act 1985* led to the insertion of the term 'reasonably practicable'[22] and the state of knowledge being articulated as 'what the person concerned knows, or ought reasonably to know, about the hazard or risk and any ways of eliminating or reducing the hazard or risk'.[23]

The phrase 'state of knowledge' remains in common use, principally as legal shorthand and for ease of expression.[24] It is the key formulation reproduced in environment protection law.

C *State Roles and Mechanisms in Developing the State of Knowledge under the* EP Act

While the GED principally requires any person engaging in an activity to be responsible for minimising the risks of harm to human health and the environment arising from their activities, the Victorian government retains a significant role through the EPA, in both framing states of knowledge relevant to such risks of harm and setting expectations for duty-compliant standards of conduct, although its likely influence over the knowledge base is broad.[25] Indeed, advancing the state of knowledge and raising awareness of how to minimise such risks become important tools for the environment regulator in fulfilling its statutory functions.[26]

[21] Maxwell (n 8) 109 [442].

[22] *OHS Act 2004* (n 16) s 20(1).

[23] Ibid s 20(2)(c).

[24] WorkSafe Victoria, *How WorkSafe Applies the Law in Relation to Reasonably Practicable: A Guideline Made under Section 12 of the* Occupational Health and Safety Act 2004 (WorkSafe Position, November 2007) 3. We use the term 'knowledge base' interchangeably with 'state of knowledge'.

[25] See below n 31.

[26] See *EP Act* (n 3) ss 357–8.

The EPA has formal and informal 'tools' for identifying, constructing and embedding the knowledge base. Formal means include directly regulating[27] or licensing activities,[28] and setting standards for specific hazards, activities or sectors through compliance codes[29] and position statements.[30] Similarly, the Environment Reference Standard ('ERS') comprises part of the evidence or knowledge base for environment protection by identifying both 'environmental values' to be protected and detailed characteristics of those values.[31] All such instruments are means by which the EPA both formalises the state of knowledge for compliance purposes and supports enforcement.

The EPA may also *informally* influence the state of knowledge, including by publishing guidance for duty holders. Although not mandatory or directly enforceable, such guidance provides a factual and informational base for assessing a duty holder's conduct. This guidance can help establish what the duty holder actually knows (for example, in circumstances where the duty holder accesses and uses the guidance) or what the duty holder *ought reasonably* to have known on the basis that the guidance is prepared and available to inform compliance. Regulator-issued guidance has long been an important element of OHS compliance and enforcement activity, and is recognised as driving the state of knowledge.[32] A challenge for the EPA may be in striking a balance between

[27] The decision of McDonald J in *Glenister v Wayne Horne Earthmoving Pty Ltd* [2018] VSC 390 explains how prescriptive regulation and general duties may work together: at [20]–[21], [45]. Various regulatory tools available under the *EP Act* (n 3) to direct or encourage relevant risk management include environmentally hazardous substance orders, obligations for managers of land and infrastructure orders, and better environment plans: pts 7.2–7.3, 8.2. These devices may direct action in relation to specific risks.

[28] Note that the *EP Act* (n 3) licensing powers require the EPA to consider 'best available techniques or technologies' ('BATT') in relation to licensed activity: ss 69(3)(d), 74(3)(d), 76(4)(d), 78(2)(d). Reference to BATT may provide a statutory basis for utilising the state of knowledge as emerging from Europe and the United States ('US') which have both legislated the BATT concept: see, eg, *Federal Water Pollution Control Act Amendments of 1972*, 33 USC § 1311(b)(2)(A) (2020); *Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on Industrial Emissions (Integrated Pollution Prevention and Control)* [2010] OJ L 344/17, ch 1 arts 3(10) (definition of 'best available techniques'), 15(2).

[29] *EP Act* (n 3) pt 5.3. Compliance codes may provide *one way* in which a duty or obligation can be met, which if adopted by a duty holder results in them deemed to comply with the relevant duty or obligation: s 103.

[30] Ibid pt 5.4. Whilst position statements do not set mandatory standards, Explanatory Memorandum, Environment Protection Amendment Bill 2018 (Vic) indicates that one purpose of a position statement is to 'add to the state of knowledge and awareness of risks of harm': at 61.

[31] Victoria, *Victoria Government Gazette*, No S 245, 26 May 2021, cls 5, 7, 10, 13 ('Environment Reference Standard').

[32] Perhaps most notable in Victoria is the role guidance has played in raising the state of knowledge on the risks and controls for workplace bullying, which has not (until recently)

producing a stable suite of reliable guidance to support duty holder compliance and recognising changes in the state of knowledge and ensuring updates accordingly. This burden is somewhat alleviated by the design of the *EP Act*, which, by rendering knowledge as a question of fact,[33] invites actors other than the EPA to contribute to building and evolving that knowledge (as discussed further below).

Finally, the *EP Act* incorporates environment protection principles to guide its implementation.[34] These include a principle of evidence-based decision-making, providing that '[a]ctions or decisions under this Act should be based on the best available evidence in the circumstances that is relevant and reliable'.[35] On its face, the principle may be interpreted as directing the relevant decision-maker to compile 'best available evidence' on relevant risks, in using the abovementioned formal tools, that may influence the state of knowledge. Such a compilation may alert users of these tools to matters of which they are unlikely to be otherwise aware. This provision has yet to receive judicial consideration.[36]

D *The Base of Knowledge Production in Environmental Contexts*

The duties-based approach to OHS necessitated a historic shift away from a state monopoly over, and indeed reliance on, relevant and probative knowledge informing the discharge of the duty.[37] This regulatory sphere came to rely on industry sectors and individual workplaces, alongside state actors, to construct

been mentioned expressly in OHS legislation. For a recent example, see WorkSafe's summary of *WorkSafe Victoria v Matthew John Sallama* (Sunshine Magistrates' Court, 17 April 2019), in which WorkSafe referred to, amongst other evidence, its own published guidance as part of what the defendant ought reasonably to know about workplace bullying risks: see WorkSafe Victoria, 'Matthew John Sallama', *Prosecution Result Summaries and Enforceable Undertakings* (Prosecution Result Summary, 23 April 2019) <https://www.worksafe.vic.gov.au/prosecution-result-summaries-enforceable-undertakings>, archived at <https://perma.cc/9PB7-DVZK>; *OHS Act 2004* (n 16) s 20(2)(c).

33 *EP Act* (n 3) s 6(2)(c). See also Leigh Howard, 'Victoria's New General Environmental Duty: A Comparison with Its OHS Forefather' (2020) 23(2) *Local Government Law Journal* 67, 77.

34 *EP Act* (n 3) pt 2.3.

35 Ibid s 19.

36 Adoption of a schema of principles into legislation has become a noteworthy feature of contemporary Victorian legislation, especially with respect to environmental legislation: see, eg, *Marine and Coastal Act 2018* (Vic) pt 2 ('*Marine and Coastal Act*'); *Climate Change Act 2017* (Vic) pt 4 div 3 ('*Climate Change Act*'). For analogous evidence-based decision-making provisions, see, eg, *Marine and Coastal Act* (n 36) s 11; *Public Health and Wellbeing Act 2008* (Vic) s 5. We discuss the related concept of 'best available science' below in Part III(D).

37 See Howard (n 33) 67–8.

the knowledge base.[38] Additional non-state actors, typically unions, also played a role outside the direct regulatory relationship of duty holder and state agency.[39] In effect, the duties-based approach dispersed governance and legal responsibility for OHS.

The set of relationships characterising the GED and its knowledge base will likely be more diverse and complex than the OHS equivalent because the GED will disperse statutory governance of (environmental) risk even more widely.[40] The actors generating knowledge about the environment, the sources of that knowledge, and the constellation of relevant interests, are wider than those engaged in employment relationships. This reflects the public interest in environmental protection issues. Relevant actors include government agencies with contingent interest in environmental management (such as councils and water authorities), industry consultants, environmental non-governmental organisations and community organisations (for example, residents' groups affected by pollution), and citizen scientists.[41] Environmental statutes commonly recognise these third-party environmental interests, usually for enforcement purposes.[42] Compared to the OHS context, this complex and crowded stage of actors poses more profound challenges to the state — represented by a statutory regulator — in its monopoly or even primacy as knowledge-holder. This broad array of governmental and non-governmental actors engaged in the public interest may both produce the knowledge base for environmental protection under the GED and mobilise it through enforcement activities.

The notion that third parties, notably non-governmental public interest actors, should be involved in producing the state of knowledge applicable to addressing environmental harm may seem exceptional, or even odd, to those familiar with the OHS equivalent.[43] However, for environmental regulation, this practice is relatively well entrenched. Non-governmental organisations produce or commission their own science,[44] citizen scientists directly collect

[38] See, eg, Creighton and Rozen (n 13) 362–3 [12.01]–[12.04].

[39] Ibid. See also *Robens Report* (n 13) 28 [87].

[40] Howard (n 33) 68, 78.

[41] See Yung En Chee, 'What Contributes to "State of Knowledge" in Practice for People Who Interact with Stormwater-Related Activities' (Unpublished Manuscript, The University of Melbourne, 5 May 2022) 3.

[42] See, eg, *EP Act* (n 3) pt 11.4.

[43] Cf *OHS Act 2004* (n 16) s 4.

[44] See, eg, '5 Gyres Published Research', *5 Gyres: Science to Solutions* (Web Page) <https://www.5gyres.org/publications>, archived at <https://perma.cc/MJ29-9CCL>.

and convey information,[45] and Indigenous communities systematise cultural knowledge to assist decision-making.[46]

In Australia, no overarching framework governs the production of, distribution of or access to information or knowledge concerning environmental matters. Exceptions to this are the statutory obligations to produce 'state of the environment' reports[47] and general 'freedom of information' laws.[48] The *EP Act* itself embraces an 'accountability' principle that

> [m]embers of the public should … have access to reliable and relevant information in appropriate forms to facilitate a good understanding of issues of harm or risks of harm to human health and the environment.[49]

However, it imposes no corresponding duty on state or non-state actors to generate and disseminate knowledge to serve that purpose.

More comprehensive legal schemes exist at the international level, and are dedicated to rules and standards about environmental and human health information. These instruments, such as the European *Aarhus Convention*[50] and the Latin American *Escazú Agreement*,[51] impose proactive duties on states parties (which do not include Australia) to generate, collect, disseminate and update a broad range of environmental information,[52] in the latter case 'in a systematic, proactive, timely, regular, accessible and comprehensible manner'.[53] States parties must establish systems for information sharing and even 'decentralization' between public authorities about environmentally relevant activities and

[45] See, eg, Yudhijit Bhattacharjee, 'Citizen Scientists Supplement Work of Cornell Researchers' (2005) 308(5727) *Science* 1402.

[46] See, eg, Lee Godden and Stuart Cowell, 'Conservation Planning and Indigenous Governance in Australia's Indigenous Protected Areas' (2016) 24(5) *Restoration Ecology* 692, 694–6.

[47] See, eg, *Commissioner for Environmental Sustainability Act 2003* (Vic) ss 17–17A, 17C.

[48] See generally *Freedom of Information Act 1982* (Cth); *Freedom of Information Act 1982* (Vic).

[49] *EP Act* (n 3) s 22.

[50] *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters*, opened for signature 25 June 1998, 2161 UNTS 447 (entered into force 30 October 2001) ('*Aarhus Convention*'). Australia is not a signatory to the *Aarhus Convention* (n 50).

[51] *Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean*, opened for signature 27 September 2018 (entered into force 22 April 2021) ('*Escazú Agreement*').

[52] Ibid art 6(1); *Aarhus Convention* (n 50) art 5(1).

[53] *Escazú Agreement* (n 51) art 6(1). See also *Aarhus Convention* (n 50) art 5(1). Regarding the breadth of information, 'state of the environment' reports are only one of 10 enumerated types of environmental information contemplated by the *Escazú Agreement* (n 51) art 6(3)(b).

environmental information more broadly.[54] We return to this observation in our concluding comments, reflecting on insights from the stormwater case study.

III Interpreting the State of Knowledge under the Victorian *EP Act*

Part II established the origins and broader context of the state of knowledge component of the GED. We now turn to a more detailed legal analysis of the state of knowledge in a general sense, and later examine its operation in the context of stormwater management.

A *The Distinguishable Domain of Risks to the Environment and Human Health*

The *EP Act* differs significantly from OHS law in the object-domain of regulation of risks to be eliminated or minimised. Regulation of risk 'so far as reasonably practicable' under OHS derives from the employment relation, although it is not confined to it,[55] and the relevant domain of risk is the 'working environment'.[56] The GED connects an 'activity' and the environment at large.[57] That nexus is mediated by harms associated with (ie 'may give rise to') 'pollution' or 'waste'.[58] OHS law and the *EP Act* can be distinguished by their differing objective and contextual spheres of operation,[59] with the contextual and purposive interpretation of statutes being particularly significant.[60]

The 'human health' aspect of the GED comes closest to its equivalent OHS duty, but the GED does not confine the space of legal protection to a

[54] *Escazú Agreement* (n 51) art 6(1); *Aarhus Convention* (n 50) art 5(1)(b).

[55] Howard (n 33) 68.

[56] Ibid 69.

[57] Ibid 69–70, 72.

[58] *EP Act* (n 3) s 25(1).

[59] As Howard (n 33) 71 tbl 1 notes, there are certain drafting and practical differences between the *OHS Act 2004* (n 16) and *EP Act* (n 3) models of the general duty.

[60] See, eg, Dennis C Pearce and Robert S Geddes, *Statutory Interpretation in Australia* (LexisNexis Butterworths, 8th ed, 2014) 39–40 [2.6]. See also *Project Blue Sky Inc v Australian Broadcasting Authority* (1998) 194 CLR 355, 381 [69] (McHugh, Gummow, Kirby and Hayne JJ) ('*Project Blue Sky*'): 'Thus, the process of construction must always begin by examining the context of the provision that is being construed'. For consideration of the question of context in environmental statutes, see, eg, *Friends of Leadbeater's Possum Inc v VicForests* (2018) 260 FCR 1, 15–18 [44]–[57] (Mortimer J); *Friends of Leadbeater's Possum Inc v VicForests [No 4]* (2020) 244 LGERA 92, 412–13 [1304] (Mortimer J).

'working' environment or any other specific 'environment'.[61] Polluting or waste-generating activities represent the limiting or confining context, but those areas of conduct are to be construed liberally if the statutory definitions of each are applied.[62] Protecting human health under the GED is comparable to the protection of 'public health', where that is connected to pollution or waste. In other words, the human health risks addressed by the GED are best understood as epidemiological in nature.[63]

While protection of human health and the environment are constructed as alternatives under the GED, there is obvious overlap and connection between them. Those linkages may arise in any particular set of circumstances, such as pollution into the atmosphere not only constituting pollution of 'the environment' but also, potentially, a risk of harm to the health of humans for whom the affected environment either is their 'surroundings' or contains elements that they consume (for example, fishing). Environmental conditions can, therefore, mediate the risks to human populations from pollution and waste. The focus on environmental harm, and the epidemiological focus on human harm, both affect the precise duties to be discharged by duty holders and extend the scope of the *EP Act*'s protective regime.

Arguably, the core object of protection under the Act remains 'the environment'. Under the Act, the 'environment' means:

(a) the physical factors of the surroundings of human beings including the land, waters, atmosphere, climate, sound, odours and tastes; and

(b) the biological factors of animals and plants; and

(c) the social factor of aesthetics.[64]

This restates the definition used by the *EP Act 1970*.[65] On its face, the direct human dimension of the environment under this definition is experience of, presumably, the natural world. The environment 'at large' under this definition is taken to be the elemental biophysical conditions of human 'surroundings'. It seems axiomatic that these 'surroundings' include the natural world, but

[61] *EP Act* (n 3) s 6(1). Cf *OHS Act 2004* (n 16) ss 20(1), 21(1).

[62] See *EP Act* (n 3) s 3(1) (definitions of 'pollution' and 'waste').

[63] See generally Michael S Bloom, 'Environmental Epidemiology' in Jerome O Nriagu (ed), *Encyclopedia of Environmental Health* (Elsevier, 2nd ed, 2019) 419. See also PB Tchounwou and WA Toscano, 'Environmental Epidemiology and Human Health: Biomarkers of Disease and Genetic Susceptibility' in Jerome O Nriagu (ed), *Encyclopedia of Environmental Health* (Elsevier, 2011) 357, 357.

[64] *EP Act* (n 3) s 3(1) (definition of 'environment').

[65] *Environment Protection Act 1970* (Vic) s 4(1) (definition of 'environment').

whether or not 'the environment' might include aspects of the (physical) built environment is not clear. This emerges as an important issue where environments have been heavily modified using built infrastructure, and is especially prominent in urban environments, such as those examined in our case study.[66]

The definition of 'environment' in s 3 of the *EP Act* has two characteristics that influence the protective task of the GED. First, as both the essential object-domain of risk identification and mitigation under the Act and the focus of the GED, the 'environment' is a matter of common pool resources, the public good or, more precisely (under this definition), an *assemblage* of public goods and a reflection of their properties as commons. Key public goods include biological diversity (including flora and fauna), waters, the atmosphere, soils, ecological processes and, at a localised level, specific public lands, fisheries, forests and so on.[67] The preponderant 'public good' focus of these environmental 'commons' is also an important point of intersection and overlap between the 'environment' and 'human health'. These 'public good', and hence public interest, qualities in risk prevention determine the scope of 'human health' under the GED.

In contrast to OHS law, which identifies and facilitates humans as both objects and agents of protection, the 'environmental' object of protection under the GED has no *inherent* human agent. Indeed, the institution of the EPA, perhaps combined with the agency of non-governmental actors pursuing civil suits, might be seen as the human agent charged with overseeing protection of the (natural) environment or, in other words, as the 'voice'[68] of the environment under risk of harm from pollution or waste. Even where risks of harm are focused on human health, the harm of many pollution and waste risks can be experienced by future generations as yet 'unborn'.[69]

Second, the definition of the 'environment' used and restated under the Act raises the question of the relationship of humans to biophysical environmental conditions. Apart from 'the biological factors of animals and plants',[70] all aspects of the 'environment' may be read as connected to humans: that is, the

66 See below Part IV.

67 See, eg, 'Environment Reference Standard' (n 31) cl 1.

68 Cf the famous dissent of Douglas J in *Sierra Club v Morton*, 405 US 727, 749–50 (1972).

69 A simple example lies in the quality of groundwater. Currently, Victorians in many areas are sustained by surface water reserves. The impact of climate change and population growth may drive greater reliance on groundwater. Current acts that pollute groundwater may thus harm future generations: Steve Barnett, Craig T Simmons and Rebecca Nelson, 'Groundwater Resources in Australia: Their Occurrence, Management and Future Challenges' in Abhijit Mukherjee et al (eds), *Global Groundwater: Source, Scarcity, Sustainability, Security, and Solutions* (Elsevier, 2021) 35, 38–9, 41, 45.

70 *EP Act* (n 3) s 3(1) (definition of 'environment' para (b)).

statutory context for the GED appears notably human-centric ('surroundings *of* human beings')[71] and the definition of 'harm' extends to cover human enjoyment of place and offences to human senses.[72] This construction could have implications for the knowledge base engaged in framing the 'reasonably practicable' treatment of risk related to the GED, and its underlying epistemic models.

The deeper proposition here is that 'the environment' is intrinsically mediated by human knowledge, and we choose how 'the environment' is to be known for the purposes of environmental protection. In practice, scientific knowledge has delimited knowledge of 'the environment' through scientific assessments, analyses and expert opinions.[73] One influential scientific model of knowledge appropriate to human-centric concepts of the environment has been the theory of 'ecosystem services'.[74] This theoretical framework is generally consistent with the set of 'public goods' identified under the s 3 definition of 'environment', associated with 'the benefits people obtain from ecosystems'.[75] Most famously expressed by the United Nation's Millennium Ecosystem Assessment, ecosystem services are broadly categorised as 'provisioning services', 'regulating services', 'supporting services' and 'cultural services'.[76] The drafting of the ERS, one of the EPA's formal tools discussed above in Part II, is consistent with this framework.[77]

Increasingly, however, scientific knowledge (in the Western, Cartesian sense) is not necessarily conclusive of the relevant state of knowledge. In particular, Aboriginal cultural knowledge and hybrid or 'pluralistic' forms of knowledge are becoming accepted and integrated into how 'the environment' is understood.[78] Insofar as the s 3 definition goes to the physical 'surroundings of human beings',[79] there is no reason to exclude Aboriginal cultural knowledge from the epistemic space of 'the environment'. Clearly, there are other important public policy reasons to integrate this knowledge base into the state

[71] Ibid s 3(1) (definition of 'environment' para (a)) (emphasis added).

[72] Ibid ss 4(1)(a)–(b).

[73] Bates (n 1) 18 [1.34]–[1.35].

[74] Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: A Framework for Assessment* (Island Press, 2003) 8.

[75] Ibid 3.

[76] Ibid.

[77] See, eg, 'Environment Reference Standard' (n 31), which defines 'environmental values' as 'the uses, attributes and functions of the environment *that Victorians value*': cl 1 (emphasis added).

[78] See, eg, Commissioner for Sustainability and the Environment, *ACT State of the Environment* (Report, 2019) 29, 33, 35, 38.

[79] *EP Act* (n 3) s 3(1) (definition of 'environment' para (a)).

of knowledge. It would appear there are moves afoot, such as in the drafting of the ERS, to do so.[80]

B *The State of Knowledge as 'Operational' Knowledge*

The relevant state of knowledge functions as the knowledge that enables duty holders to perform their statutory task of eliminating or minimising risk.[81] In this sense, the state of knowledge may be understood as 'operational' knowledge. As s 6 sets out, the state of knowledge is directed to 'the harm or risks of harm and any ways of eliminating or reducing those risks'.[82] Other information and knowledge are also relevant to the GED, such as costs,[83] but the state of knowledge is typically associated with knowledge of harm and ways to eliminate or minimise it.

The notion of knowledge as 'operational' adverts to its form and character as an independent productive force validated by technical performance[84] rather than, for example, a purely ideological, cultural or narrative condition.[85] The knowledge base in environmental protection under the GED is what can be *mobilised and used* for the purposes of knowing, framing, comprehending and anticipating risk to the environment and enabling its avoidance. Avoidance of risk can be enabled through the ordinary conduct of business, environmental assessments or other means of generating or applying knowledge. The state of knowledge is utilitarian and strategic or, in legal parlance, purposive.

[80] See 'Environment Reference Standard' (n 31) cl 1:

> All places in Victoria exist on the traditional country of Aboriginal Victorians. As recognised in the *Constitution Act 1975*, Aboriginal people have a unique status as the descendants of Australia's first peoples and a spiritual, social, cultural and economic relationship with their traditional lands and waters within Victoria.

[81] *EP Act* (n 3) s 6(2)(c).

[82] Ibid.

[83] Ibid s 6(2)(e).

[84] Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge*, tr Geoff Bennington and Brian Massumi (Manchester University Press, 1984) 46–7.

[85] As Jean-François Lyotard states:

> We may thus expect a thorough exteriorization of knowledge with respect to the 'knower' … The old principle that the acquisition of knowledge is indissociable from the training (*Bildung*) of minds … is becoming obsolete and will become ever more so. The relationship of the suppliers and users of knowledge to the knowledge they supply and use is now tending, and will increasingly tend, to assume the form already taken by the relationship of commodity producers and consumers to the commodities they produce and consume — that is, the form of value.
>
> Ibid 4.

While the knowledge base is likely to draw primarily on science and engineering, this type of knowledge is not mandated by the *EP Act*.[86] Moreover, construction of the knowledge base must, in our view, occur within the distinctive statutory and practical setting of environmental protection. The knowledge domain concerns relevant ecological 'commons' and how 'activities' interact with those 'commons'. This fact requires knowledge that is both *internally* orientated (for example, concerning production systems related to activities) and *externally* orientated (for example, concerning the characteristics and nature of affected 'commons' or 'environment'). Internal knowledge to be mobilised in complying with the GED may include plant and equipment and engineering techniques. External knowledge may relate to ecosystem sciences (such as atmospheric, hydrological or biodiversity sciences).[87] These aspects of knowledge engage the sense of 'know-how' (*savoir-faire*) and 'know-what' (*savoir-quoi*) in understanding and protecting the environment.

Limiting constructive knowledge (what a person *ought* to know) to that prevailing in an industry sector may not be sufficient or correct. Broader social and economic sectors, including scientists or third-party experts in the relevant 'environment' (including, but not limited to, citizen scientists), may bring pivotal and accessible knowledge to bear on 'activities' and the risk of harm. The environmental domain — the focus of the GED — is likely to be informed by a wider base of knowledge than that typically confined to a firm or industry sector. Constructing the appropriate knowledge base in terms of the relevant 'activity' may be the better approach.[88] This is not to say that the state of knowledge in an industry may not be the appropriate frame in the circumstances, but rather, that the knowledge base may relevantly include more than the technical know-how directly at hand in-house or in the industry.

In this context, the regulation of land use planning is a useful comparator. A range of informational tools and devices have functioned for at least two decades to both assess impacts of development proposals on biodiversity (for example, native vegetation as a form of 'public good') and inform conduct and

[86] Cf *EP Act* (n 3) s 6.

[87] See *Biomix Pty Ltd v Environment Protection Authority* [2016] VCAT 914 [32] (Senior Member Potts and Member Cook) (emphasis in original) ('*Biomix*'):

> It is … important to distinguish clearly between the processes that may *generate* specific gaseous phase pollutants such as odour, as opposed to the risk of those pollutants being *emitted* into the air environment.

[88] See, eg, *Dual Gas Pty Ltd v Environment Protection Authority* (2012) 43 VPR 231 ('*Dual Gas*'), wherein the Tribunal conceived of 'best practice' by reference to the 'activities' of coal gasification and gas turbine electricity generation, rather than by reference to the 'industry sector' of 'brown coal-fired electricity generation': at 284–6 [156]–[163] (Deputy President Dwyer and Members Potts and Sharpley).

decisions in specific instances.[89] Emergence of a parallel industry of ecological consulting, as well as elaborate digital information platforms, are products of this regulatory need and context.[90] Similar frameworks exist for other types of environmental impact assessment as well.[91]

Victoria's *Environmental Effects Act 1978* (Vic) ('*Effects Act*') represents another relevant context in which the knowledge base extends beyond a single industry, and may interact with the knowledge base relevant to the GED.[92] This legislative scheme is well entrenched and has parallels to environmental assessment laws in the United States ('US'),[93] but is limited to larger-scale proposed projects and actions.[94] Its use is discretionary.[95] That legislation could increasingly be used to inform matters to which the GED applies. It is not, however, expressly adapted to that statutory context, nor (as yet) systemically integrated into risk assessment and management under the GED.

C *A Purposive Approach to Interpreting the State of Knowledge*

We have considered the statutory and practical setting of 'the environment' under the *EP Act*. The ordinary rules of statutory construction[96] and rules set out in the statute itself[97] also influence the interpretation of the GED, including the state of knowledge it involves.

[89] Department of Environment, Land, Water and Planning (Vic), *Guidelines to the Removal, Destruction or Lopping of Native Vegetation* (Guidelines, December 2017) 7 [3.2], 11 [3.3.3]; 'Native Vegetation', *Department of Environment, Land, Water and Planning (Vic)* (Web Page, 22 September 2022) <https://www.environment.vic.gov.au/native-vegetation/native-vegetation-removal-regulations>, archived at <https://perma.cc/M4UE-DS4Y>. See also *Victoria Planning Provisions* (Vic) cl 12.01 ('*VPP*').

[90] See, eg, 'Choosing Action for Nature', *Department of Environment, Land, Water and Planning (Vic)* (Web Page, 5 September 2022) <https://www.environment.vic.gov.au/biodiversity/choosing-actions-for-nature>, archived at <https://perma.cc/DCX4-2NKR>.

[91] See generally Neil Craik, 'The Assessment of Environmental Impact' in Emma Lees and Jorge E Viñuales (eds), *The Oxford Handbook of Comparative Environmental Law* (Oxford University Press, 2019) 876.

[92] See, eg, *Environmental Effects Act 1978* (Vic) s 9 ('*Effects Act*').

[93] See, eg, *National Environmental Policy Act of 1969*, 42 USC §§ 4342–5 (2020).

[94] The ambit of the *Effects Act* (n 92) is limited to 'works [that] could reasonably be considered to have or to be capable of having a significant effect on the environment': s 3(2). Practical requirements under the *Effects Act* (n 92) to prepare an environment effects statement ('EES') and the ordinary course of undertaking public inquiries into matters set out in an EES make use of this law unlikely in the assessment of conduct, action or projects under a certain (indeterminate) threshold of scale, severity or intensity: see ss 4, 9.

[95] See generally ibid. But see ss 3(2), 8B(3)–(4).

[96] See, eg, *Project Blue Sky* (n 60) 381–2 [69]–[71] (McHugh, Gummow, Kirby and Hayne JJ).

[97] Howard (n 33) 76. See also *EP Act* (n 3) s 1.

Under the ordinary rules of construction, purposive construction of the Act requires that interpretation give effect to protection of the environment and human health in the broad sense discussed above in Part III(A).[98] Environmental legislation is interpreted liberally in order to give effect to its protective purposes.[99] 'Protection' is to be construed strictly and methods used to 'protect' must be efficacious and not amount to empty promises.[100] The operation of the GED must be considered in this light.

The *EP Act* requires that its administration have regard to the environment protection principles under pt 2.3.[101] Howard suggests that this elaborate framework of principles 'raises more questions than answers when it comes to interpreting the general environmental duty'.[102] He concludes that construction of the 'reasonable practicability' standard will not substantially depart from the legal model under OHS law, and that the GED will not create a qualitatively different duty to that operating under OHS law despite its application being open to a greater diversity and uncertainty of outcomes given the 'more equivocal objectives underpinning the *EP Act*'.[103] In any particular case, a party or actor may draw on a selection of environment protection principles in aid of its preferred construction of 'reasonable practicability'. Context will influence which principles are more influential.

The pt 2.3 principles are not, however, incoherent or ad hoc. The environment protection principles combine the 'ecologically sustainable development' ('ESD') model[104] with principles of prevention[105] and the waste management hierarchy[106] — which both emphasise avoidance of environmental harm — and with certain features of environmental democracy. If, as Bates remarks, '[a]pplication of ESD may therefore be said to pursue *optimal* protection of environmental values rather than *maximum* protection',[107] the pt 2.3 principles that are

[98] The overarching policy purposes indicated in the *EP Act* (n 3) and in its administration refer respectively to a 'legislative framework for the protection of human health and the environment from pollution and waste' and the protection of 'human health and the environment by reducing the harmful effects of pollution and waste': ss 1(f), 357(1).

[99] The courts have described such legislation as 'social legislation': see, eg, *Stratton v Van Driel Ltd* (1998) 87 IR 151, 155 (Byrne J); *DPP (Vic) v Hazelwood Pacific Pty Ltd* [2020] VSC 279, [11] (Keogh J).

[100] See *Brown v Forestry Tasmania [No 4]* (2006) 157 FCR 1, 35 [240]–[241] (Marshall J).

[101] See *EP Act* (n 3) s 11(2).

[102] Howard (n 33) 76.

[103] Ibid 77–8.

[104] See Bates (n 1) 255–7 [8.1]–[8.4]; *EP Act* (n 3) s 21(3).

[105] *EP Act* (n 3) s 15.

[106] Ibid s 18.

[107] Bates (n 1) 277 [8.38] (emphasis in original).

additional to the ESD model push environmental protection further toward the 'maximal' end of the spectrum.

Notwithstanding the abundance of environment protection principles in the *EP Act*, their overall purpose, and, it is submitted, the direct interpretation of the GED (including the question of 'reasonable practicability' and the state of knowledge), drive at both environmental protection built around an expansive concept of 'environment', and public participation enabling that outcome.[108] Principles such as accountability,[109] evidence-based decision-making,[110] and shared responsibility[111] reflect the way in which environmental protection necessarily functions in light of the defining objects and context of 'public goods' or common resources.

A distinctive context to which the environment protection principles are directed is cumulative environmental effects, to which the central concept of 'harm' also clearly relates.[112] Two environment protection principles, in particular, inform the required content of the state of knowledge in this context. First, the principle of shared responsibility[113] implies awareness of what others are doing and, at minimum, a general appreciation of the potential accumulation of environmental harms of multiple activities. Second, the principle of accountability requires a knowledge base sufficient to comprehend cumulative impacts or influences where they trigger the duty to eliminate risk of harm.[114]

The central concept of 'harm' is defined as 'an adverse effect on human health or the environment (*of whatever degree* or duration)'[115] and includes 'harm [that] may arise as a result of the cumulative effect of harm arising from an activity combined with harm arising from other activities or factors'.[116] Both the express reference to cumulative harm and the express rejection of a

[108] As Gerry Bates states:

> This new policy approach to pollution control encompasses a range of management tools … All of them are designed to reflect, ultimately, a commitment to the effective implementation of the principles of ecologically sustainable development (ESD), particularly the principle that decrees that polluters should pay for the real costs of their impacts on the environment.

Ibid 623 [15.19].

[109] *EP Act* (n 3) s 22.

[110] Ibid s 19.

[111] Ibid s 16.

[112] Ibid s 4(2).

[113] *EP Act* (n 3) s 16 provides that responsibility for environmental protection is shared between 'all levels of Government and industry, business, communities and the people of Victoria'.

[114] See above nn 37–41 and accompanying text.

[115] *EP Act* (n 3) s 4(1) (emphasis added).

[116] Ibid s 4(2).

threshold degree or duration of harm are consistent with considering cumulative effects as the aggregate effects of multiple activities, even where a single activity is individually minor.[117] This further supports interpreting the state of knowledge to include a duty holder's knowledge of the activities of others that contribute to the same types of harms as those to which the duty holder contributes. Therefore, alongside knowledge about 'the environment' itself, knowledge about other activities can be considered another aspect of 'externally' orientated knowledge[118] relevant to the GED.

While we agree with Howard that there will be much to be learnt from OHS law in the operation of the GED,[119] including the state of knowledge, there is greater nuance and coherence to the process of construction than may first appear. The constructional exercise informed by the pt 2.3 principles may include reconciling conflicting objectives and 'strik[ing] a balance'[120] between a multitude of considerations pulling in diverse directions. However, the principles governing the interpretive task are strongly, if not preponderantly, orientated towards environmental protection. They contribute a range of rules and norms aimed towards *optimising* environmental benefit and outcomes, and necessarily extend to situations of cumulative environmental harm that are less prominent in the OHS context. The constructional process may require reconciling objectives but the manner of reconciliation might be said to be shepherding the herd of principles and objects, broadly proceeding in a comparable direction and under the leading role of environmental purposes[121] to protect against scientifically complex risks of harm.

D *Comparing the State of Knowledge to Best Available Science and 'Best Practice': Temporal Aspects, Sources and Forms of Knowledge*

The relevant state of knowledge includes three components of actual and constructive knowledge: knowledge about 'environments' affected by risk of harm from 'pollution' or 'waste'; knowledge about other activities harming these environments, since this affects the risk of harm; and technical knowledge within

[117] 'Material harm' includes harm 'regardless of the period of time in which the harm occurs' — presumably allowing for incremental increases in harm to be characterised as material harm — and 'as a result of … the cumulative effect of harm arising from other activities or factors: ibid ss 5(2), (2)(c). Material harm is relevant to a finding of an aggravated breach of the GED: ss 27(1)(b)–(c).

[118] See above nn 73–7 and accompanying text.

[119] Howard (n 33) 78.

[120] Ibid 76–7.

[121] See also *Project Blue Sky* (n 60) 381–2 [70] (McHugh, Gummow, Kirby and Hayne JJ).

a firm or industry to manage such problems.[122] This knowledge base is influenced by optimising, if not maximising, environmental protection. It is also influenced by processes of public participation.[123] Legal framing of the state of knowledge, informed by the OHS equivalent, is overlaid by a distinct statutory and practical context. Both the principled framing and the content of the GED allude to a *progressive standard* or a standard of accumulating and adapting outcomes over time — an example of what regulatory theorists have called 'dynamic governance'.[124] We argue that knowledge is not static. Rather, the operation of the state of knowledge must have a temporal dimension in relation to each of its three components: that is, changes in the 'environment', in other activities that harm it, and in techniques to reduce and eliminate risk.

The language of 'minimisation' where elimination cannot be achieved, for example, implies this approach. In environmental legislation and policy, this form of progressive standard is often associated with requirements for 'best practice', 'best available techniques' or use of 'best available science'.[125] New functions of the EPA notably include providing 'information and education to the Victorian community in relation to … environmental best practice and improvements'.[126]

It is not clear that a 'best available science' or 'best available techniques' standard of knowledge informing action currently operates under the 'reasonably practicable' approach to OHS law. Few cases appear to contend with the question of the relevant or appropriate state of knowledge separate from the wider question and standard of 'reasonable practicability'. In *Warrnambool City Council v Victorian Workcover Authority*,[127] the Victorian Civil and Administrative Tribunal ('VCAT') considered the state of knowledge concerning safety features on woodchippers,[128] including whether the 'reasonably practicable' standard extended to technologies (in that instance, retrofitting a safety bar) that were not industry standard, potentially inappropriate, and, as a matter of

122 See, eg, *EP Act* (n 3) ss 4, 6, 25.

123 See ibid s 22(b).

124 David L Markell and Robert L Glicksman, 'Dynamic Governance in Theory and Application' (Pt 1) (2016) 58(3) *Arizona Law Review* 563, 571, 629.

125 See, eg, *Water Act 2007* (Cth) ss 21(4)(a)–(b); *Endangered Species Act of 1973*, 16 USC §§ 1533(b)(1)(A), (b)(2) (2020) ('*US Endangered Species Act*'); *Executive Order No 11988: Floodplain Management*, 3 CFR 118 (1978); *Executive Order No 13990 of January 20, 2021: Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis*, 3 CFR 428, 432 (2022).

126 *EP Act* (n 3) s 358(g).

127 [2012] VCAT 947.

128 Ibid [75]–[84], [143]–[144] (Deputy President Lambrick).

practice, 'in [their] infancy'.[129] At most, the respondent had to '[turn] its mind to' the innovation.[130] VCAT did not expound on how the state of knowledge ought to be constructed beyond a survey of industry knowledge but rather, in analysing the knowledge base, considered it alongside what innovations or practices were suitable and available.[131]

The question of 'availability' and 'suitability' of knowledge, techniques or innovations in constructing 'reasonable practicability' are connected, but distinct, indicia of reasonableness under both the *EP Act* and the *OHS Act*.[132] Availability and suitability are relevant considerations in risk elimination and minimisation of environmental harms.[133] The state of knowledge ought not be qualified a priori by standards of availability and suitability, just as cost is not prioritised in applying the s 6(2) criteria to the GED.[134] Other criteria under s 6(2) may influence or determine what is reasonable in particular circumstances, but the legal construction of the knowledge base is a standalone question.

Absent express legislative guidance on the temporal dimension of s 6(2)(c), one source of guidance may be s 19 of the *EP Act*, which mandates consideration of the principle of 'evidence-based decision-making' in '[a]ctions or decisions under this Act', where the evidence is 'the best available … in the circumstances that is relevant and reliable'. If applying the GED[135] is an '[a]ction … under this Act',[136] this principle has a role in the constructional exercise. Although there is no express mention of science, the reference in s 19 to evidence that is 'relevant and reliable' implies a role for scientific knowledge.[137] Relevant evidence is not exclusively scientific. However, given the nature of environmental problems, scientific knowledge maintains a prominent strategic and authoritative function in decision-making, conduct and practice.[138] Law, administrative action and society generally grant significant authority to scientific rationality and procedure, and a scientific basis may accordingly render evidence about techniques or technologies used in a particular 'activity' 'relevant and

[129] Ibid [75], [77].

[130] Ibid [79]–[80].

[131] Ibid [111]–[134].

[132] *EP Act* (n 3) s 6(2)(d); *OHS Act 2004* (n 16) s 20(2)(d).

[133] *EP Act* (n 3) s 6(2)(d).

[134] Ibid s 6(2)(e).

[135] Or, more precisely, a determination of what is reasonably practicable under *EP Act* (n 3) s 6(2).

[136] Ibid s 19.

[137] This implication is also given some weight by *EP Act* (n 3) s 374, which creates a new statutory role of 'chief environmental scientist'.

[138] Bates (n 1) 41–2 [2.35]–[2.36].

reliable'.[139] Much of the knowledge base applicable to duty holders under the *EP Act* will be informed directly or indirectly by scientific outputs and methods. Science, by definition, may include processes of experimentation, speculation or development in application.[140] Science may not be conclusive of the state of knowledge informing duty holders, but it will surely be influential. Similarly, the application of scientific approaches to practice, technology and technique will undoubtedly be influential on the standards of knowledge required of duty holders. Other sources of relevant and reliable evidence may include direct experience or observation even where it is not produced under formal scientific programs, such as knowledge derived from environmental or technical consultancies and from high-quality citizen science initiatives.[141] Similarly, Aboriginal cultural knowledge may align with this standard without requiring conformity with established, sometimes exclusionary, scientific programs and settings.

This brings us to qualifying language typically framing information and knowledge used in environmental protection, and the implications for the *forms* of knowledge that arguably need to be addressed in 'reasonably practicable' risk minimisation and elimination. As provided for in s 19 of the *EP Act*, relevant knowledge or information is commonly framed in terms of that which is 'best' and 'available'. Environmental statutes elsewhere use this qualifying formula.[142] We refer to this formulation with some caution. As we have noted, the provisions of s 6(2) do not use this form of words and refer rather to actual and constructive knowledge and 'any ways' of eliminating or reducing risk.[143] 'Best' and 'available' could be said to add a gloss to the relevant state of knowledge, but at the same time they could also function to structure decision-making and judgments as to the limits, priorities and forms of knowledge operating under s 6(2). Read in the purposive context of 'minimisation' as both a process and a progressive standard, in our view the state of knowledge must not only evidence rigour and credibility but must be open to development, innovation and

[139] *EP Act* (n 3) s 19.

[140] One of the key aspects of scientific grounding to the state of knowledge is the requirement — in order to be impressed with the authority of science — for the knowledge base to accord with accepted scientific rules and norms, including peer review, transparent and disclosed methods and datasets, verifiable results, 'known analytical techniques, and reference to an accumulated body of knowledge': Bruce Lindsay, 'The Use of "Best Available Science" in Environmental and Natural Resources Law' (2020) 156 *Precedent* 40, 42. See also at 44, quoting Bret Walker, *Murray-Darling Basin Royal Commission Report* (Report, 29 January 2019) 69 [18.3]: 'Science itself demands disclosure. Research, experimentation and decision-making are not science if they cannot be fully tested, and either validated or invalidated.'

[141] See, eg, Bhattacharjee (n 45) 1402.

[142] See, eg, *Climate Change Act* (n 36) s 23(a); *Marine and Coastal Act* (n 36) s 11.

[143] *EP Act* (n 3) s 6(2)(c).

experimentation. Any tensions between 'best' and 'available' knowledge must not be closed to the transformation of knowledge, techniques or technologies favouring environmental protection. This further supports the temporal dimension of the state of knowledge discussed earlier: old or outdated information is unlikely to be 'best' if knowledge has progressed or if the physical circumstances that are the subject of the knowledge have changed. If there is a limit to this scoping of knowledge, it is perhaps that the GED is not implemented 'haphazardly, on the basis of speculation or surmise'.[144]

In addition to the connection to 'best available science', s 19 also echoes the concept of 'best practice' used elsewhere in environmental protection law and policy.[145] That concept supports an interpretation of the state of knowledge under the GED including not only established knowledge (for example, knowledge embedded in existing practice or technique) but reliable developmental, innovative or experimental knowledge. The concept of 'best practice' informed previous environment protection instruments, such as standards for minimising the impact of atmospheric emissions through technological responses.[146] VCAT scrutinised the meaning of 'best practice' in this context in a series of cases commencing with the case of *Dual Gas Pty Ltd v Environment Protection Authority* ('*Dual Gas*').[147] In *Dual Gas*, the proponent sought works approval for a coal gasification demonstration project capable of producing energy at a commercial scale with lower emissions than coal-fired power stations.[148] The analogy in this case to the operation of the GED (and to the state of knowledge in particular) lies in the application of 'internally orientated' knowledge ('techniques, methods, processes or technology')[149] to a progressive standard of minimisation of environmental impacts. VCAT adopted a 'common sense and purposive approach' to interpreting the statutory definition of 'best practice' in this case,[150] which ought also to aid in interpreting s 6(2)(c) of the *EP Act*. It noted that 'best practice' under this approach 'invites

[144] This phrase was used by the US Supreme Court to set out the minimal standards concerning application of the 'best available science' mandate to the implementation of the *US Endangered Species Act* (n 125) § 1536(a)(2): *Bennett v Spear*, 520 US 154, 176 (Scalia J) (1997).

[145] See, eg, *Qld EP Act* (n 9) s 21.

[146] See, eg, Victoria, *Victoria Government Gazette*, No S 240, 21 December 2001, s 27(1), pt IV (definition of 'best practice') ('Air Quality Management Policy').

[147] *Dual Gas* (n 88) 283–9 [147]–[177] (Deputy President Dwyer and Members Potts and Sharpley); *Innova Soil Technology v Hobsons Bay City Council* [2013] VCAT 658, [39]–[146] (Deputy President Dwyer and Members Potts and Wilson) ('*Innova Soil Technology*'); *Biomix* (n 87) [44]–[51], [120]–[129] (Senior Member Potts and Member Cook).

[148] *Dual Gas* (n 88) 254–5 [1]–[6] (Deputy President Dwyer and Members Potts and Sharpley).

[149] 'Air Quality Management Policy' (n 146) pt IV (definition of 'best practice').

[150] *Dual Gas* (n 88) 288 [171] (Deputy President Dwyer and Members Potts and Sharpley).

comparison with other technologies, techniques, methods or processes' including
international comparisons and techniques, methods, processes or technology that are novel.[151] The cases emphasise that principles of 'best practice' in this context are directed to enabling innovation, 'continuous improvement',[152] and 'new or novel approaches',[153] and that the relevant 'techniques, methods, processes or technology' may be preliminary to those that are 'deployed and demonstrated'.[154]

VCAT's approach to 'best practice' informs the scope and available forms of operational knowledge under the GED (specifically, s 6(2)(c)) because these cases contend with the question of applied technical knowledge focused on minimisation of environmental harm ('impact'), which represents a principal focus and task of the GED. This, alongside the s 6(2)(c) requirement to include knowledge of 'any way' to eliminate or reduce environmental risks, suggests that the state of knowledge must embrace knowledge or techniques that are both established and also developmental, in trial, innovative or experimental. The state of knowledge includes knowledge with real operational potential and relevance to the task of environmental protection. The task of environmental protection, as framed through the progressive standard of minimisation of harm and risk, cannot be static but rather must look to new and leading knowledge. Accordingly, the state of knowledge must anticipate and incorporate new knowledge.

E *Structures and Agents Contributing to the State of Knowledge*

The state of knowledge is fundamentally a question of *fact*,[155] framed by law. The main limits to building a knowledge base to contribute to the state of knowledge driving the GED are practical, logistical and institutional. As discussed above, the *EP Act* itself facilitates the knowledge base to be built through formal mechanisms initiated by the state, such as the ERS, position statements, compliance codes and statutory advice.[156]

[151] *Innova Soil Technology* (n 147) [47] (Deputy President Dwyer and Members Potts and Wilson), setting out principles discernible from *Dual Gas* (n 88) 285 [157], 287 [166] (Deputy President Dwyer and Members Potts and Sharpley).

[152] *Innova Soil Technology* (n 147) [56] (Deputy President Dwyer and Members Potts and Wilson), quoting 'Air Quality Management Policy' (n 146) s 6(b).

[153] *Biomix* (n 87) [42] (Senior Member Potts and Member Cook).

[154] *Dual Gas* (n 88) 289 [175] (Deputy President Dwyer and Members Potts and Sharpley).

[155] See above n 33.

[156] See above Part II(C).

The legislative scheme also supports (indeed, depends on) other agents to contribute to knowledge-building. Duty holders themselves generate knowledge and advances when actively seeking to meet their obligations, in some cases incidentally *raising* the state of knowledge for their sector by improving the 'know-how' on risk management and setting a new standard of conduct.[157] This may even include simply learning from mistakes. Other communities of practice similarly build knowledge through research and civil institutions, industry associations, professional bodies, consultancies, and community and environment groups.[158] Relevant outputs may include peer-reviewed research findings, industry-led guidance, surveys and environmental status reports and guidance produced for 'downstream' duty holders.[159] Public consultation processes undertaken pursuant to the *EP Act*'s principle of accountability[160] may generate knowledge that may influence consequent formal knowledge-related instruments, like the ERS and position statements, or at least create an incidental knowledge base as part of the process.[161]

Enforcement activities may similarly build the state of knowledge, as may the administration of both permitting and regulatory activities within public and private sector actors dealing with environmental protection (such as councils and industry consultants). Duty holders directed by the EPA to take specific action or achieve a particular outcome[162] may need to engage appropriate expertise to acquire relevant knowledge. A court-ordered outcome against those engaging in environmentally risky activities may be sought through the new civil remedy action by individuals affected by those risks or by any other person who can satisfy the court that it is in the public interest to pursue such remedies.[163] This mechanism enables the state of knowledge to be driven by non-state actors.

[157] See, eg, 'Reporting a Notifiable Incident', *Environment Protection Authority Victoria* (Web Page, 29 September 2022) <https://www.epa.vic.gov.au/about-epa/laws/laws-and-your-business/reporting-a-notifiable-incident>, archived at <https://perma.cc/4YEB-NHNH>. See also *EP Act* (n 3) pts 3.4–3.5.

[158] See, eg, 'Chain of Ponds: Moonee Ponds Creek' (August 2020) *Chain of Ponds Collaboration Newsletter* 3–4 ('Chain of Ponds August Update').

[159] Ibid.

[160] *EP Act* (n 3) s 22: 'Members of the public should … be engaged and given opportunities to participate in decisions made under this Act, where appropriate to do so.'

[161] The review of an ERS requires public consultation, as does the making of position statements: ibid ss 97(3)–(4), 108(2)–(3).

[162] See, eg, ibid ss 25(1), 28(1), 31, 32(2), 39(1), 40(1).

[163] See ibid pt 11.4.

Problems of cumulative environmental harm, in particular, invite an interplay between state and non-state sources of knowledge. Such problems necessarily engage a wide range of duty holders and others who may contribute to knowledge about the problem.[164] At the same time, 'shifting baselines' may make harms difficult to perceive as environments are gradually degraded while still being perceived as 'normal'.[165] Accordingly, awareness of cumulative change may be challenging, if not implausible, for a 'reasonable' duty holder to perceive unaided. Both of these practical factors highlight the importance of the state's role in not only providing, but compiling, updating and disseminating knowledge from others about how activities aggregate to create environmental harm. This could contribute critically to the objective limb of the state of knowledge and combat the subjective elements of problems such as shifting baseline syndrome.

Whatever the mechanism and whoever the agent, what matters most is the probity of the facts articulated to describe the knowledge and the veracity of the 'truths' they uncover. Any contribution to the state of knowledge must also respect the jurisdictional framing of the knowledge base relevant to the GED. Principally, this means recognising that the knowledge must relate to '*pollution*' or '*waste*', and cause, or create a risk of, '*harm*' towards '*human health*' or the '*environment*' and arise in the context of an '*activity*'.[166] Questions of relevance may turn on how closely the knowledge aligns to the jurisdictional scope of the *EP Act*.

IV The State of Knowledge, Cumulative Environmental Harm, and Unresolved Problems: The Case of Stormwater

Stormwater management provides a productive context for exploring key issues that arise in considering the role and operation of the state of knowledge under the GED. Stormwater exemplifies a distinct and challenging type of environmental protection problem — namely, environmental harms from diffuse and cumulative sources. These dispersed sources may additionally be distributed across fragmented chains of responsibility, from development design and construction to waterway management. Environment protection regulation in

[164] See, eg, Christopher J Walsh et al, 'Linking Stormwater Control Performance to Stream Ecosystem Outcomes: Incorporating a Performance Metric into Effective Imperviousness' (2022) 1(2) *PLOS Water* e0000004:1–22, 7 ('Linking Stormwater Control Performance').

[165] Masashi Soga and Kevin J Gaston, 'Shifting Baseline Syndrome: Causes, Consequences, and Implications' (2018) 16(4) *Frontiers in Ecology and the Environment* 222, 222, 224. See also SK Papworth et al, 'Evidence for Shifting Baseline Syndrome in Conservation' (2009) 2(2) *Conservation Letters* 93.

[166] *EP Act* (n 3) s 25(1) (emphasis added).

Victoria and elsewhere has long recognised and responded to the issue of diffuse source pollution, and stormwater management is a well-established regulatory concern.[167] The GED was intended to address cumulative harms, and its application to the stormwater problem was specifically contemplated: in recommending a GED, the MAC expressly referred to stormwater.[168] The EPA's draft regulatory strategy similarly referred to stormwater as illustrative of cumulative and diffuse pollution impacts.[169] Indeed, an early guidance document prepared by the EPA for the purposes of interpreting and applying the GED concerns stormwater management.[170] Considering the GED in the stormwater context thus sheds light on the difficulties likely to emerge in an area of regulation that is intrinsically important, and one that epitomises the difficulties related to cumulative environmental effects in general. To ground this consideration, we use the situation of an urban catchment in north-western Melbourne: that of the Moonee Ponds Creek. Densely populated urban catchments also form an important context for considering the relationship between humans and biophysical environmental conditions.[171]

A *Background*

Simply put, urban stormwater is 'runoff from urban areas, including the major flows during and following rain as well as dry weather flows'.[172] EPA guidance explains that

[167] Preceding regulatory tools for the protection of Victorian waters expressly applied to stormwater management using the language of risk of harm from stormwater and its amelioration: Victoria, *Victoria Government Gazette*, No S 499, 23 October 2018, cl 34. See, eg, cl 34(1):

> Stormwater must be managed to minimise the risks to beneficial uses of receiving waters, so far as reasonably practicable, by reducing the impacts of flow, sediment, nutrients, pathogens, toxicants, litter and other pollutants on those receiving waters.

Certain elements of those provisions have carried over into transitional regulatory instruments: see, eg, *Environment Protection Transitional Regulations 2021* (Vic) reg 7(d).

[168] Ministerial Advisory Committee (n 4) 219.

[169] EPA Victoria, *Regulatory Strategy: 2020–2025 Draft* (Strategy No 1800.1, June 2020) 15.

[170] EPA Victoria, *Urban Stormwater Management Guidance* (Guide No 1739.1, June 2021) 4 ('*Urban Stormwater Management Guidance*').

[171] For a general discussion of this issue, see above Part III(A).

[172] Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, *National Water Quality Management Strategy: Australian Guidelines for Urban Stormwater Management* (Guide, 2000) 4 ('*Australian Stormwater Management Guidelines*').

> in urban catchments impervious surfaces like roofs and roads replace [the] natural landscape. Rain runs off these surfaces and drains rapidly transport it into rivers, lakes, estuaries and bays. This runoff is called urban stormwater and has the potential to cause harm to human health and the environment.[173]

Several statutory schema and tools deal with stormwater issues.[174] Building and planning regulations influence the development of urban stream catchments including the proliferation of impervious surfaces and land use associated with altered drainage.[175] Notably, in attempting to restore the ecological function of a semi-urban stream to that of a natural stream, one Melbourne planning scheme 'requires any building or work that creates an impervious surface of 10 m^2 or more' to include a stormwater control measure such as a rainwater tank or rain garden.[176] Water resources management treats urban rainfall and run-off as a resource for consumptive and environmental purposes — an opportunity that has greatly animated the thinking of scientists analysing the stormwater issue,[177] and policymakers responding to climate-driven water supply questions.[178]

These regulatory treatments of stormwater are relevant to the state of knowledge in 'minimising' or 'eliminating' urban stormwater as an environmental problem. Other alignments and complementarities, and no doubt tensions or misalignments, are likely to arise in the treatment of stormwater under these schema and under the GED. Regardless, the GED and the state of knowledge concerning stormwater provides a distinct regulatory

[173] *Urban Stormwater Management Guidance* (n 170) 24. Similarly, the *VPP* (n 89) adopts the definition of urban stormwater as '[t]he net increase in run-off from urban development due to water not being able to seep into the ground because of impervious surfaces, such as roofs and roads': cl 73.01 (definition of 'stormwater').

[174] See generally Rebecca Nelson, 'Sick City Streams: New Approaches to Legal Treatments' (2019) 43(2) *Melbourne University Law Review* 748 ('Sick City Streams').

[175] Ibid 777–91.

[176] Ibid 783; *Yarra Ranges Planning Scheme* (Vic) cl 42.01 sch 2 [3.0]–[5.0] ('*Yarra Ranges Planning Scheme*').

[177] See, eg, Tim D Fletcher, Geoff Vietz and Christopher J Walsh, 'Protection of Stream Ecosystems from Urban Stormwater Runoff: The Multiple Benefits of an Ecohydrological Approach' (2014) 38(5) *Progress in Physical Geography* 543, 543–5; Matthew J Burns et al, 'The Performance of Rainwater Tanks for Stormwater Retention and Water Supply at the Household Scale: An Empirical Study' (2015) 29(1) *Hydrological Processes* 152, 152–3; Christopher J Walsh et al, 'Restoring a Stream through Retention of Urban Stormwater Runoff: A Catchment-Scale Experiment in a Social–Ecological System' (2015) 34(3) *Freshwater Science* 1161, 1161–2; Peter J Coombes et al, 'Stormwater, Waterway Benefits and Water Resources Benefits of Water Conservation Measures for Australian Cities' (Conference Paper, Hydrology and Water Resources Symposium, 2016) 74.

[178] Department of Environment, Land, Water and Planning (Vic), *Central and Gippsland Region Sustainable Water Strategy* (Discussion Draft, 2021) 40, 101–3, 139–44, 146, 149–53.

device for achieving environmental outcomes, with its own terms and its own scope of operation.

B *General Scientific Knowledge about Stormwater Risks, Domains of Risk, and the Challenges of Cumulative Effects*

Hydrological, ecological, engineering, policy and social dimensions of urban stormwater and its management ('stormwater science') have developed extensively in Australia over more than two decades.[179] This science poses urban stormwater as a 'new class of environmental flow problem'[180] that alters the water balance, through extensive construction of impervious surfaces and the connection of those surfaces to 'receiving waters' ('urban streams').[181] Urban stormwater radically changes aquatic environments, and is 'a primary driver of the commonly observed, severe degradation of stream ecosystems in urban catchments'[182] known as 'urban stream syndrome'.[183] This form of environmental degradation manifests in altered stream hydrology ('flash[y]' hydrographs with little or no baseflow), poor water quality and contamination issues, depauperate stream biology, degraded stream geomorphology, and overall loss of environmental complexity, diversity and resilience.[184]

Water quality and contamination issues associated with stormwater are perhaps the best known degrading effects, and the most longstanding in regulatory responses to stormwater.[185] Important pollutants of stormwater include heavy metals, suspended solids, phosphorus and nitrogen, litter, and bacterial contamination that run off impervious surfaces.[186] Such pollutants, which

[179] Christopher J Walsh et al, 'The Urban Stream Syndrome: Current Knowledge and the Search for a Cure' (2005) 24(3) *Journal of the North American Benthological Society* 706, 707 ('The Urban Stream Syndrome'). See also Walsh et al, 'Linking Stormwater Control Performance' (n 164) 2. See generally J Ewert et al, *Review of Stormwater Science* (Report No 1919, October 2020).

[180] Christopher J Walsh, Tim D Fletcher and Matthew J Burns, 'Urban Stormwater Runoff: A New Class of Environmental Flow Problem' (2012) 7(9) *PLoS ONE* e45814:1–10, 4 ('Urban Stormwater Runoff').

[181] Ibid 2–3.

[182] Ibid 3.

[183] Walsh et al, 'The Urban Stream Syndrome' (n 179) 706.

[184] Ibid 717–18. See also *Urban Stormwater Management Guidance* (n 170) 25.

[185] See *Urban Stormwater Management Guidance* (n 170) 6–7.

[186] Ewart et al (n 179) 4, 12, 25, 28.

conventional stormwater drainage systems do not treat, harm the ecological health of streams and may make waterways unsafe for fishing and swimming.[187]

This general scientific knowledge casts the domains of risk[188] to be eliminated or minimised relevant to stormwater as both the 'environment' and 'human health'. Connections with the concept of 'ecosystem services' emerge through the potential of stormwater to enhance water supply and the need to regulate the ecosystem services provided by stormwater (for example, flood control and water purification).[189]

C *Case Study: Moonee Ponds Creek*

1 *'Exterior' Knowledge about Environmental Conditions*

Past and ongoing knowledge-gathering initiatives paint a detailed picture of stormwater impacts on the environmental conditions of the Moonee Ponds Creek catchment. As a preliminary observation, we note that knowledge about past and present environmental conditions of the Moonee Ponds Creek, and connected social values, have been collected under a wide range of formal scientific studies, concept plans, and strategies over the last half-century.[190] These knowledge-gathering initiatives have often involved extensive community consultation.[191] Citizen science initiatives have also emerged.[192] State agencies have often facilitated larger collaborations of agencies and non-governmental organisations ('NGOs').[193] We see, through this scenario, the kind of dispersed roles

187 EPA Victoria, *Stormwater and Protecting Our Waterways* (Fact Sheet No 1304.1, March 2015) 1 ('*Stormwater and Protecting Our Waterways*').

188 See above Part III(A).

189 Liana Prudencio and Sarah E Null, 'Stormwater Management and Ecosystem Services: A Review' (2018) 13(3) *Environmental Research Letters* 033002:1–13, 2–4.

190 For a description of early plans, see Melbourne Water, Moreland City Council and City of Moonee Valley, *Chain of Ponds: Moonee Ponds Creek Plan* (Report, 2018) 45–8, 320–3 ('*Chain of Ponds*'); Victorian Planning Authority, *Arden Vision* (Report, 2018) 5, 8, 14, 20, 25–6, 37–40 (in relation to the Moonee Ponds Creek).

191 *Chain of Ponds* (n 190) 326–43.

192 See, eg, Bridie Byrne, 'Melbourne Water Invites Community To Help Discover Animals Living in Moonee Ponds Creek', *Herald Sun* (online, 7 November 2017) <https://www.heraldsun.com.au/leader/north-west/melbourne-water-invites-community-to-help-discover-animals-living-in-moonee-ponds-creek/news-story/e413ba9c55d51f3aca9427c05c35f342>, archived at <https://perma.cc/U6XG-YJ2R>.

193 'Chain of Ponds Collaboration', *Melbourne Water* (Web Page, 4 October 2022) <https://www.melbournewater.com.au/building-and-works/projects/chain-ponds-collaboration>, archived at <https://perma.cc/VYQ6-62ZR>. This is a collaboration involving 15 different government and community entities.

in constructing knowledge about environmental risk discussed earlier[194] as a key difference from the OHS context.

Analysing this information reveals knowledge about both current environmental conditions (related to land, waters, animals, plants, and aesthetics[195] for the purposes of the GED) and human health risks, as well as environmental conditions that are either *likely* if current risks are not addressed or *intended* based on restoration initiatives in progress. This environmental dynamism raises the question of the relevance to the GED of past, present and likely or intended future environmental conditions, and the 'exterior' state of knowledge available about each.

The current Moonee Ponds Creek environment now has 'little remaining pre-settlement form',[196] having morphed from a chain of ponds where Wurundjeri people met and gathered food,[197] to a colonial agricultural landscape, and then to a concrete-lined drain intended to reduce flooding with maximum efficiency.[198] The Creek's overall environmental condition is poor, with highly 'variable and unpredictable' flows[199] and numerous sources of pollution[200] exacerbated by banks that are naturally prone to erosion in some reaches.[201] Without intervention, stormwater-related effects and climate change are expected to lead to future decline of bird species, frogs, macroinvertebrates and vegetation in the Creek.[202] Risks to human health arise from apparently small-scale fishing[203] in polluted Creek waters,[204] and flood flows that overtop the Creek's banks may pose a risk to users of the adjacent walking and cycle

194 See above Parts II(C)–(D), III(E).

195 *EP Act* (n 3) s 3(1) (definition of 'environment').

196 *Chain of Ponds* (n 190) 133.

197 Ibid 21, 23–5.

198 David Sornig, *Blue Lake: Finding Dudley Flats and the West Melbourne Swamp* (Scribe, 2018) 341; ibid 21, 27–36.

199 *Chain of Ponds* (n 190) 61.

200 Ibid 63, 65.

201 Ibid 53.

202 Melbourne Water, *Co-Designed Catchment Program for the Maribyrnong Catchment Region (including Moonee Ponds Creek)* (Strategy, October 2018) 63–4 ('*Healthy Waterways Maribyrnong*'). See ibid 105–7.

203 Personal observation by Rebecca Nelson on various occasions between 2011–21. See *Healthy Waterways Maribyrnong* (n 202) 27.

204 *Chain of Ponds* (n 190) 81–2.

path.[205] Nonetheless, amenity[206] is considered high, particularly for cyclists and pedestrians.[207] The multi-million dollar *Chain of Ponds: Moonee Ponds Creek Plan* ('*Chain of Ponds*') restoration initiative, currently in progress, aims to significantly improve environmental conditions[208] and recently received an award from Victoria's peak stormwater body.[209]

Knowledge about future planned restoration (and perhaps restoration in progress), and potentially the effects of climate change do not clearly fall within the *EP Act* definition of 'environment'. Yet the strength and long history of current initiatives, and the many community and government actors involved, suggest they should not be ignored. Indeed, ignoring them would seem misaligned with the GED as a progressive standard reflective of dynamic governance,[210] and with other *EP Act* tools that embrace restoration objectives.[211] The ERS[212] that forms part of the state of knowledge as to environmental conditions for GED purposes[213] includes environmental values 'to be achieved' as well as those to be 'maintained'.[214] However, in the case of the Moonee Ponds Creek, the current ERS[215] may not assist restoration objectives. It does not apply to waters in 'stormwater drains'[216] (which may arguably include fully concreted reaches of

[205] Ibid 79.

[206] Amenity arises as a component of the 'environment' insofar as it reflects the 'social factor of aesthetics': *EP Act* (n 3) s 3(1) (definition of 'environment' para (c)). Amenity is also relevant to a finding of 'harm' to the environment or human health: s 4(1)(a).

[207] *Healthy Waterways Maribyrnong* (n 202) 62–3; *Chain of Ponds* (n 190) 117.

[208] *Chain of Ponds* (n 190) 149, 155–72.

[209] 'Melbourne Water Projects Recognised at Stormwater Victoria Awards', *Melbourne Water* (Web Page, 9 December 2019) <https://www.melbournewater.com.au/about/what-we-do/news/melbourne-water-projects-recognised-stormwater-victoria-awards>, archived at <https://perma.cc/AAU8-CTNL>.

[210] See above n 113 and accompanying text.

[211] The *EP Act* (n 3) specifically provides for restoration obligations in relation to 'pollution incidents' which are separate from the GED: ss 29, 31.

[212] Ibid s 93.

[213] The ERS identifies 'areas that have significant environmental values or that are particularly sensitive to harm', which may require 'stricter measures to comply with the GED': EPA Victoria, *Guide to the Environment Reference Standard* (Guide No 1992, June 2021) 15. The EPA will likely consider the ERS in understanding the significance of impacts caused by activities on human health or the environment: at 14.

[214] *EP Act* (n 3) s 93(2).

[215] 'Environment Reference Standard' (n 31).

[216] Ibid cl 13(2)(a)(i).

the Moonee Ponds Creek) and the water quality and biological indicators and objectives that apply to the Creek are among the lowest in Victoria.[217]

Rather than acting as knowledge of 'the environment', it may be that documented plans for restoration are most relevant to the state of knowledge about the degree of harm of further stormwater risks eventuating: they recognise, and arguably popularise, through the scientific metric of 'directly connected imperviousness' or 'effective imperviousness',[218] knowledge that stormwater is so ecologically damaging as to justify major restorative action.[219] It flows naturally that constructing further connected impervious surfaces should objectively be known to have a higher degree of associated harm.[220] In this context, we note recent Federal Court jurisprudence in a different context of ecological restoration, which emphasised the need to 'arrest and reverse [the Greater Glider's and Leadbeater's Possum's] rate of population decline'.[221]

Applying these general observations to the multi-contributor, cumulative nature of stormwater risks reveals significant differences with the OHS context. A natural 'receiving environment' for risk is comparatively less controlled, less well known and less clearly defined than a single workplace, while arguably being affected by more numerous and diverse risks. These differences raise issues about actual and constructive exterior and interior knowledge discussed below. Expecting an employer to understand risks to worker safety in a well-defined workplace is quite different to expecting a duty holder to understand the risks of harm of their activity to a potentially distant biophysical environment as it interacts in scientifically complex ways with other activities to create cumulative harm.

The stormwater context highlights the potential gap between actual and constructive knowledge if the latter comprises multiple agencies and sectors,[222]

[217] Ibid cl 19 tbls 5.8–5.9. Note that the Moonee Ponds Creek is a tributary of the Yarra River for these purposes.

[218] Wonmin Sohn, Jun-Hyun Kim and Ming-Han Li, 'Low Impact Development for Impervious Surface Connectivity Mitigation: Assessment of Directly Connected Impervious Areas ("DCIAs")' (2017) 60(10) *Journal of Environmental Planning and Management* 1871, 1872; Christopher J Walsh, 'Protection of In-Stream Biota from Urban Impacts: Minimise Catchment Imperviousness or Improve Drainage Design?' (2004) 55(3) *Marine and Freshwater Research* 317, 325; Christopher J Walsh, Tim D Fletcher and Anthony R Ladson, 'Stream Restoration in Urban Catchments through Redesigning Stormwater Systems: Looking to the Catchment To Save the Stream' (2005) 24(3) *Journal of the North American Benthological Society* 690, 691; Walsh et al, 'Linking Stormwater Control Performance' (n 164) 2.

[219] Nillumbik Shire Council, *Integrated Water Management Strategy 2013* (Strategy, 2013) 13.

[220] See also *EP Act* (n 3) ss 6(2)(b)–(c).

[221] *VicForests v Friends of Leadbeater's Possum Inc* (2021) 285 FCR 70, 115–16 [185]–[191] (Jagot, Griffiths and SC Derrington JJ).

[222] See above Part III(B).

including the most informed industry. Constructive knowledge of stream conditions in an industry that is closely involved in water issues, regularly monitors waterways, and has its own scientific resources (for example, a water authority responsible for sewerage systems) would be considerably different to that of an industry that has no direct interface with water issues (say, a builder with a construction site in the upper parts of the catchment), or of a household. Larger-scale developers whose activities (such as expansion of connected impervious surfaces) substantially contribute to stormwater are arguably in the middle of this notional spectrum. The activities that pollute the Creek occur in different parts of the catchment that drain it,[223] so individual duty holders who undertake a relevant activity may be relatively distant from the receiving environment that is adversely affected: they may not *actually* be aware of the whole suite of adverse effects, and may not be able to identify the kind of environment likely to be impacted by their activities (streams), let alone the specific waterway, particularly in relation to cumulative-type harms. Any judicial reluctance to attribute high levels of knowledge in respect of individually minor 'everyday' activities that only become significant in the aggregate may act as a fundamental barrier to successfully applying the GED to cumulative harm. This problem may be less pronounced where activities require interaction with local councils, for example, where such interaction produces greater actual knowledge of stream conditions and adverse effects.

In the Moonee Ponds Creek context, a universally higher standard for the general state of knowledge about environmental conditions and risks seems plausible in the light of longstanding concerns about the ecological and water quality conditions of the Creek,[224] and the many related government initiatives and associated documents, including the *Chain of Ponds* restoration plan.[225] These suggest that the degraded state of the Creek, the contribution of stormwater to this degradation, and the activities that produce it, are (or ought reasonably to be) well known and form part of the general state of knowledge for both individuals and sophisticated industry sectors operating in the Creek's catchment.

2 *Activities and 'Factors' Affecting the Risks of Activities*

Activities relevant to the GED involve '*risks of harm to human health or the environment* from *pollution* or *waste*',[226] noting that the ordinary meaning of

[223] See, eg, *Chain of Ponds* (n 190) 11, 63, 83, 85.

[224] Ibid 8, 83–6.

[225] See above n 190.

[226] *EP Act* (n 3) s 25(1) (emphasis added).

'activity' is widened under the *EP Act* to include 'the storage or possession of waste or any other substance or thing'.[227] The term 'pollution' is defined widely to include 'any emission, discharge, deposit, disturbance or escape of … a solid, liquid or gas'.[228] This encompasses activities that give rise to risks of stormwater flows, being the 'emission' or 'escape' of a liquid.[229] The term 'waste' includes, in relevant part, 'solid, liquid, [or] gaseous' matter that is 'deposited, discharged, emitted or disposed of into the environment in a manner that alters the environment'.[230] This encompasses stormwater and its contaminants. The lack of a requirement that pollution 'alter the environment' de-emphasises the need for a precise causal link between an emission of stormwater and environmental alteration. This is advantageous where there are scientific difficulties quantifying the precise nature of an individual contribution to cumulative harm. Even where scientific knowledge gaps remain — such as about precisely how water pollution affects the ecological health of the Moonee Ponds Creek[231] — the GED's focus on 'risks' of harm, rather than actual harm, minimises the regulatory challenge posed by these gaps.

The relevant activities that may give rise to a risk of harm to the Creek are highly diverse and stretch across multiple business sectors, government entities, and the everyday activities of the general public.[232] They need to be understood from a catchment scale (for example, macro changes to the catchment such as urban development)[233] down to the point source scale[234] (for example, specific discharge points such as failing infrastructure). In the Moonee Ponds Creek catchment, intensified land uses, such as high density infill development and large impervious surfaces such as airports,[235] have changed the frequency and magnitude of stormwater disturbances and degraded water quality.[236] Notable pollutants include litter from commercial areas, sediment-laden run-off from construction sites, microplastics, cigarette butts, waste from inadequately managed gross pollutant traps (which remove non-biodegradable pollutants from the waterway), animal faeces, excess fertiliser run-off from parks and gardens, and toxic stormwater run-off from roadways that lack stormwater treatment

[227] Ibid s 3(1) (definition of 'activity' para (a)).

[228] Ibid s 3(1) (definition of 'pollution' para (a)).

[229] Ibid.

[230] Ibid s 3(1) (definition of 'waste' para (a)).

[231] *Chain of Ponds* (n 190) 281–2.

[232] See, eg, ibid 83.

[233] See, eg, ibid 155.

[234] See, eg, *Australian Stormwater Management Guidelines* (n 172) 30.

[235] Nelson, 'Sick City Streams' (n 174) 776.

[236] *Healthy Waterways Maribyrnong* (n 202) 63–4; *Chain of Ponds* (n 190) 63–6.

systems.[237] Sewers that leak and overflow to stormwater in high rainfall events pose an important risk that is addressed in some (but not all) parts of the catchment using artificial wetlands.[238] Some of these, notably microplastics,[239] engage with novel and still emerging scientific knowledge that may lead to contestation about whether knowledge about the risk is sufficient (or sufficiently well known) to lead to a requirement for changed behaviour under the GED.

Many of the activities canvassed above fit comfortably within the *EP Act* definition,[240] such as the activities on construction sites, littering, spills, and microplastic contamination where the entity engaging in the corresponding activity is (relatively) certain, if not challenging to detect in some instances. Some harms may be attributed to activities relying on the extended definition — for example, leaking sewerage may be considered an activity as 'possession of waste'[241] conducted by those possessing that infrastructure.

Others are problematic, such as road run-off and litter that reaches the Creek by the facilitation of road infrastructure. Here, there is a disconnect with the activity that generates the source of harm (for example, litter on road verges, shred tyre particles from the freeway, and run-off in general) and the factors designed into the roadway that facilitate transmission to the Creek without any contemporaneous participation by the road manager. It may be arguable that the relevant activity arose during the design and construction of the roadway in the first place without due consideration to the risks of harm that would be generated. On this view, for established roads, the duty would not apply due to the presumption against the retrospectivity of criminal laws.[242] Many of the prevailing harms impacting urban waterways fit this legacy category where a failure to consider the catchment-scale impacts of urban design in the past has embedded enduring risks of harm to human health and the environment.[243] An alternative view would focus on a lack of modern maintenance approaches (such as forms of street cleaning that reduce nutrients in run-off — for example,

237 'Chain of Ponds August Update' (n 158) 3; *Chain of Ponds* (n 190) 83, 95.

238 R Pfleiderer, 'Royal Park Stormwater Wetland and Reuse Scheme' in *Towards Water Sensitive Cities and Citizens: The 6th International Water Sensitive Urban Design Conference and Hydropolis #3* (2009) 870, 871–2, 875.

239 Bingxu Nan et al, 'Identification of Microplastics in Surface Water and Australian Freshwater Shrimp *Paratya Australiensis* in Victoria, Australia' (2020) 259 *Environmental Pollution* 113865:1–9, 1–2, 5.

240 See *EP Act* (n 3) s 25(1).

241 Ibid s 3(1) (definition of 'activity' para (a)).

242 *DPP (Cth) v Keating* (2013) 248 CLR 459, 479 [48] (French CJ, Hayne, Crennan, Kiefel, Bell and Keane JJ).

243 See, eg, *Chain of Ponds* (n 190) 14.

those from vegetative litter)[244] or the omission of installed feasible stormwater control methods not prevented by the original road design. On this view, current emissions of water from roads should fall within the definition of an 'activity' for the purposes of the GED.

3 *The Challenges of Cumulative Effects and Implications for the State of Knowledge about Activities*

Individually minor but abundant activities may lead to cumulatively significant urban stormwater harms. This relates to knowledge 'about the harm or risks of harm'[245] under s 6(2)(c) in several ways. First, these other activities might be considered a 'factor' relating to how 'harm' arises.[246] Second, the fact of other contributing activities arguably increases the 'degree of harm',[247] knowledge about which is knowledge 'about the harm'.[248] However conceived, where an individual activity is minor, actual or constructive knowledge about other activities is relevant to whether it is *reasonable* to expect an individual duty holder to perceive that their activity involves risk to the environment or human health, and to modify their conduct pursuant to the GED. The fact itself of cumulative risks and impacts may be part of the state of knowledge and, additionally in this context, it is questionable whether there is any *de minimis* principle applying to persons generating those risks of harm.[249]

The existence of numerous contributors involves practical challenges to obtaining scientific knowledge about risks of harm. Understanding the relative contributions of different activities relies on knowledge derived from environmental monitoring data acquired over long periods.[250] In the Moonee Ponds Creek scenario, scientific surveys have sought to reduce uncertainty about precise sources of pollution.[251]

244 Ewart et al (n 179) 24.

245 *EP Act* (n 3) s 6(2)(c).

246 Ibid s 4(2).

247 Ibid s 6(2)(b).

248 Ibid s 6(2)(c).

249 We note here one exception: *EP Act* (n 3) sets a *de minimis* threshold on harm that relates to amenity and the 'enjoyment of … place or premises', which implies that a *reasonable* level of interference with amenity is to be tolerated: s 4(1)(a).

250 Rebecca Nelson, 'Water Data and the Legitimacy Deficit: A Regulatory Review and Nationwide Survey of Challenges Considering Cumulative Environmental Effects of Coal and Coal Seam Gas Developments' (2019) 23(1) *Australasian Journal of Water Resources* 24, 25. See generally Gary M Lovett et al, 'Who Needs Environmental Monitoring?' (2007) 5(5) *Frontiers in Ecology and the Environment* 253.

251 'Chain of Ponds August Update' (n 158) 3–4.

Understanding cause and effect as between many contributors to harm also creates uncertainty that derives from complex interaction effects and nonlinear ecological responses to stressors.[252] Assessments of cumulative environmental impacts often rely heavily on scientific modelling techniques,[253] which can be descriptive or predictive in nature, and can be available at scale or applicable to individual localised actions or conduct. Investing in scientific models will help regulated entities understand the effect of their activities in the cumulative context, as will efforts to compile and popularise data about environmental conditions and existing activities.

Viewed through the lens of cumulative harm,[254] other environmental 'factors' increase the risks of harm posed by activities subject to the GED relative to harms posed in other catchments that lack these factors. Perhaps the most important such 'factor' affecting the risks of activities is the drainage systems that, with great hydraulic efficiency, convey stormwater and its contaminants from impervious surfaces all over the catchment to the Creek itself.[255] This gives rise to the scientific measure and proxy for harm of 'directly-connected imperviousness' as an indicator of urban catchment condition.[256] The Creek's embankments are also highly erodible, which contributes to sedimentation, to which sediment-laden run-off from construction sites adds.[257] Climate change is also predicted to increase peak flows that are exacerbated by the impervious surfaces of developed areas.[258] Knowledge of these 'factors' is also relevant to appreciating the risks of activities in the catchment.

252 Emma E Hodgson, Benjamin S Halpern and Timothy E Essington, 'Moving Beyond Silos in Cumulative Effects Assessment' (2019) 7 *Frontiers in Ecology and Evolution* 211:1–8, 4, citing Daniel E Schindler and Ray Hilborn, 'Prediction, Precaution, and Policy under Global Change' (2015) 347(6225) *Science* 953, 953. See also Emma E Hodgson and Benjamin S Halpern, 'Investigating Cumulative Effects across Ecological Scales' (2019) 33(1) *Conservation Biology* 22, 27, in relation to mapping methods in ecology, generally assuming cause and effect relationships are 'linear and additive'.

253 See Ewart et al (n 179) 28.

254 *EP Act* (n 3) s 4(2), which provides that 'harm may arise as a result of the cumulative effect of harm arising from an activity combined with harm arising from other activities or factors'.

255 Walsh et al, 'Urban Stormwater Runoff' (n 180) 2–3.

256 M Urrutiaguer et al, 'Using Directly Connected Imperviousness Mapping To Inform Stormwater Management Strategies' (Conference Paper, International Conference on Water Sensitive Urban Design, 21 February 2012) 314, citing Christopher J Walsh and Joshphar Kunapo, 'The Importance of Upland Flow Paths in Determining Urban Effects on Stream Ecosystems' (2009) 28(4) *Journal of the North American Benthological Society* 977, 978, WD Shuster et al, 'Impacts of Impervious Surface on Watershed Hydrology: A Review' (2005) 2(4) *Urban Water Journal* 263, 265. See also above n 218.

257 See *Chain of Ponds* (n 198) 53, 79.

258 Ibid 66.

State-sponsored investment in generating and compiling the state of knowledge will be critical to enabling the GED to address cumulative environmental harm in an effective way. Cumulative impacts tend to require knowledge to be acquired, analysed, produced and distributed at a massed scale ('socialised') in order to inform broad-based rules or policies of acceptability, which can then be applied to individual activities.[259] Indeed, in the climate change context,

> many courts have recognised … that climate change is caused by cumulative emissions from a myriad of individual sources, each proportionally small relative to the global total of [greenhouse gas] emissions, and will be solved by abatement of the [greenhouse gas] emissions from these myriad of individual sources.[260]

4 *'Interior' State of Knowledge about Eliminating and Minimising Stormwater Harms Related to Flows and Pollution*

Simple onsite measures may be used to eliminate or minimise risks of these harms. Measures to address flow- and pollution-related harms are described in numerous state and industry publications on sector-specific stormwater impacts and mitigation measures and academic publications, popularised through EPA guidance.[261] As well as simply reducing impervious areas, the guidance covers engineering solutions available at the catchment, street and lot scale to reduce directly connected impervious areas, and thereby also reduce the contribution of stormwater pollutants to streams.[262] These measures include artificial wetlands, rainwater tanks and rain gardens, which include water quality treatment controls that filter or otherwise remove contaminants.[263] Such guidance also recommends using bunds to manage chemical liquids, securing loose and fine material,[264] construction sites minimising soil erosion and minimising

[259] See, eg, *Gloucester Resources Ltd v Minister for Planning* (2019) 234 LGERA 257.

[260] Ibid 371 [516] (Preston CJ).

[261] See, eg, above n 169; Christopher J Walsh et al, 'Principles for Urban Stormwater Management To Protect Stream Ecosystems' (2016) 35(1) *Freshwater Science* 398; 'Stormwater Management during Construction', *Melbourne Water* (Web Page, 27 September 2017) <https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/standards-and-specifications/stormwater>, archived at <https://perma.cc/3EKQ-44JL>; *Urban Stormwater Management Guidance* (n 170) 10–11, 13–22; Victorian Stormwater Committee, *Urban Stormwater: Best Practice Environmental Management Guidelines* (CSIRO Publishing, 1999) ch 7.

[262] See also *Chain of Ponds* (n 190) 155–62.

[263] *Urban Stormwater Management Guidance* (n 170) 11, 13–22. See also discussion in the context of a specific case study scenario above in Part IV(C).

[264] *Stormwater and Protecting Our Waterways* (n 187) 2.

vegetation clearing,[265] and individuals picking up after their pets and not using excessive pesticides and fertiliser.[266] Much EPA guidance builds sector-specific states of knowledge analogous to the OHS context, where the state of knowledge pertains to knowledge about context-specific processes for 'ways of eliminating or reducing' risks.[267] Land use planning regulation contains extensive provision for stormwater treatments, applicable both to urban zones generally[268] and in specific municipal planning schemes attaching to specific waterways in more innovative ways.[269] All planning rules and policy must be considered an inexhaustive part of the state of knowledge. They contain content relevant to 'interior' (ie technical) and 'exterior' (ie environmental) facets of knowledge of risks of harm. Academic science has long pointed to the availability of additional and more experimental approaches to minimising risks of stormwater harm, such as green roofs and geothermal paving systems.[270] Innovative technical responses to stormwater risks frequently originate with practical applications of academic stormwater science, including by way of collaborations with water authorities, local government and/or industry.[271] These innovations occur in concert with key policy and regulatory tools conceptualising environmental risk from stormwater, such as 'directly connected imperviousness' or 'effective imperviousness'.[272]

In the Moonee Ponds Creek context, this 'interior' knowledge has been translated by the *Chain of Ponds* restoration initiative in identifying appropriate measures for specific reaches of the Creek and parcels of land in the catchment, supporting a conclusion that these measures are 'reasonably practicable' in that specific context.[273] It identifies numerous options for reducing environmental harm, including stormwater measures at the catchment scale (for example,

265 EPA Victoria, *Civil Construction, Building and Demolition Guide* (Guide No 1834, November 2020) 34.

266 EPA Victoria, *Reducing Stormwater Pollution at Home* (Publication No 977, 2005) 1.

267 *EP Act* (n 3) s 6(2)(c).

268 See, eg, *VPP* (n 89) cl 53.18.

269 The leading example is the *Yarra Ranges Planning Scheme* (n 176) cl 42.01 sch 2.

270 See, eg, Mariana da Silva et al, 'Assessing the Retention Capacity of an Experimental Green Roof Prototype' (2020) 12(1) *Water* 90, 91, citing Abigail Graceson et al, 'The Water Retention Capabilities of Growing Media for Green Roofs' (2013) 61 *Ecological Engineering* 328, 328; Kiran Tota-Maharaj and Parneet Paul, 'Sustainable Approaches for Stormwater Quality Improvements with Experimental Geothermal Paving Systems' (2015) 7(2) *Sustainability* 1388, 1389–90. See generally Jeremie Bonneau et al, 'Stormwater Infiltration and the "Urban Karst": A Review' (2017) 552 (September) *Journal of Hydrology* 141.

271 See, eg, Walsh et al, 'Linking Stormwater Control Performance' (n 164) 7.

272 On the emerging translation of experimental to applied stormwater science, see ibid; Ewert et al (n 179) 22.

273 *Chain of Ponds* (n 190) 155–70.

stormwater harvesting from drains, various wetland systems, infiltration trenches, urban forestry to slow run-off, planning controls to protect floodplains, and freeway run-off management), street scale (for example, rain gardens, street greening, permeable road pavements, removing redundant impervious surfaces, and installing gross pollutant traps), and lot scale (for example, rainwater tanks, green roofs and onsite detention ponds), as well as measures on the Creek itself (for example, installing rock riffles, vegetating or widening the channel, and installing terraces).[274]

Interestingly, however, there is a mismatch between duty holders and some measures that are aimed at mitigating cumulative harms, rather than risks posed by individual activities. To the extent that the focus of harm reduction relates to catchment- and street-level measures (rather than measures at the lot scale, at which most individual activities occur), these would generally be implemented by government bodies rather than directly by duty holders who undertake relevant 'activities'.[275] A key exception to this is roads authorities, which have powers over larger areas of land and could feasibly undertake larger-scale measures.[276] This highlights a final observation about the difficulties of applying the state of knowledge in the context of a complex natural environment and cumulative effects: understanding the degree of benefit of measures to eliminate or reduce stormwater risks of harm is difficult since the cumulative effect of multiple duty holders using multiple stormwater control measures greatly exceeds the individual benefits of single options.[277] While a pragmatic approach may be to observe that any control measure known to reduce the risk of harm will be relevant 'interior' knowledge, this may simply postpone the difficulties to a later analysis about the proportionality between costs and benefits of risk control measures.

V Conclusion

The introduction of the GED marks a significantly reconceived approach to environmental protection in Victoria, which emphasises prevention, moves away from a state monopoly on knowledge related to environmental protection, and transforms the *EP Act*'s ability to deal with cumulative environmental impacts. The context of stormwater management in an urban ecological setting tests the boundaries of the statutory provisions related to the state

[274] Ibid.

[275] Ibid 155–60.

[276] See, eg, *Road Management Act 2004* (Vic) ss 3(1) (definitions of 'road' and 'road authority'), 34(1), 40–41(1).

[277] *Chain of Ponds* (n 190) 177.

of knowledge. It engages some of the most difficult aspects of dealing with cumulative impacts: numerous actors contributing diverse aggregating threats subject to some knowledge gaps, diverse mitigation options, environmental conditions that have changed significantly through time for which restoration is planned, and background factors like erosive soil and climate change.

These aspects can produce practical challenges discerning the state of knowledge. At minimum, the constructive state of knowledge may vary between sectors that produce relevant harms, such that it will be challenging to apportion and control aggregate harm caused by actors from many sectors. The facts of cumulative harm and risks of harm themselves, however, are likely to be part of the relevant state of knowledge. The complexity of cumulative harms and benefits, and the knowledge required to understand them, means that a workable answer likely relies on government influence to build the state of knowledge among all duty holders by collecting and disseminating knowledge generated by diverse state and non-state actors. Beyond the EPA, local planning and drainage authorities responsible for authorising 'activities' of duty holders that may cause stormwater harms, and technical specialists involved in decision-making, such as consultants, could play powerful roles in embedding and raising the state of knowledge in their spheres of influence. This is especially important since the government entities that are likely to have substantial subjective knowledge of measures to eliminate or reduce stormwater harms may not necessarily be duty holders, at least to the extent that they authorise the activities of others.

Ultimately, even where cumulative risks of harm arise there is a collective, if proportionate, responsibility on all actors as embodied in the GED and relevant to the state of knowledge. Our case study suggests the ongoing importance of state action to build and embed the state of knowledge for duty holders, and to clarify its application in complex urban settings involving many actors. Important differences between the OHS and environmental contexts make it unlikely that the GED alone, without such state action, will effectively restrain cumulative environmental harm. The role of the state in this domain, however, is neither exclusive nor exhaustive. Also of prominence is the need to drive innovation and the translation of academic science to practical initiatives as a logical extension of the state of knowledge principle. Strategically, there is a need to better identify who the lead actors are, including the key polluters, in both achieving the behaviour change sought by the new *EP Act* and establishing new norms of environmental protection. The interpretive and practical complexity associated with the state of knowledge also suggests the need for a stronger statutory emphasis both on information collection and sharing duties, and on resources to deliver them. International agreements, such as the recent

Escazú Agreement, underscore that progressive, preventive environmental protection needs accessible knowledge. In no case is this more evident than in Victoria's transformative adoption of the GED.