Shale Gas and Hydraulic Fracturing in South Africa:

Towards a Petroleum Legal Framework that Provides for Innovative Technologies that Support Energy Security of Supply and Mitigation of Climate Change

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By

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ACKNOWLEDGMENTS

I dedicate this thesis to my children, Noah (11) and Amavi (2), who had to do with what little time I had left between my work and this PhD study. I commit to spending so much more time with you my boy, and baby girl, to play with you, travel with you, teach you, and guide you in your own journeys through school and life. Thanks to my wife, Yolanda, for being there for my kids, carrying Amavi during the critical 9 months, and almost single-handedly looking after her in the first year following her birth.

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ABSTRACT

It is estimated that South Africa contains vast amounts of shale gas. Meanwhile, the country relies on coal as a primary energy source, as a result, it ranks amongst the highest carbon dioxide emitting countries globally, therefore is a significant contributor to climate change. Climate change is a cause for global concern, if not mitigated it will cause more severe devastation to society. The exploitation of shale gas requires the use of hydraulic fracturing, a technology that has generated controversy globally.

This thesis investigates whether South Africa's petroleum legal framework provides adequately for the protection of the environment against the risks posed by the use of hydraulic fracturing in shale gas development. It posits that with a petroleum legal framework premised on avoiding, mitigating and remediating environmental damage, shale gas could be developed in an environmentally sensible manner in South Africa, to enhance energy security of supply while reducing the country's carbon dioxide emissions to the atmosphere. The assessment employs the comparative legal research methodology and uses the prevention principle (avoidance), precautionary principle (mitigation), and polluter-pays principle (remediation) as comparative themes. The comparative jurisdictions are South Africa, the United Kingdom, and Canada. The United Kingdom and Canada are more mature petroleum provinces/jurisdictions, therefore, have relatively advanced legal frameworks for petroleum extraction.

The study finds that the petroleum legal framework of South Africa is inadequate to regulate shale gas development, to begin with, it does not provide for hydraulic fracturing. The study further finds that the environmental principles of avoidance, mitigation and remediation are already embedded in the South African environmental legal framework. Therefore, the appropriate petroleum legal framework for shale gas development in South Africa would be one that provides for the rigorous application of these principles, in an integrated and complementary manner, with close monitoring and enforcement. The capacity of the relevant regulatory agencies will have to be enhanced to ensure effective compliance monitoring and enforcement.

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API	American Petroleum Institute
CEAA	Canadian Environmental Assessment Act, 2012
CH_4	Methane
CO_2	Carbon Dioxide
COP	Conference of Parties
DECC	Department of Energy and Climate Change (UK)
DMRE	Department of Mineral Resources and Energy (SA)
EIA	Environmental Impact Assessment
EU	European Union
GTL	Gas-to-Liquids
IEA	International Energy Administration
IPCC	Intergovernmental Panel on Climate Change
LDAR	Leak Detection and Repair
MPRDA	Mineral and Petroleum Resources Development Act, No. 28 of 2002 (SA).
NDP	National Development Plan
NEMA	National Environmental Management Act, No. 107 of 1998 (SA).
NWA	National Water Act, No. 36 of 1998 (SA).
SA	South Africa
TCF	Trillion Cubic Feet
TKAG	Treasure the Karoo Action Group
UK	United Kingdom
UKCS	United Kingdom Continental Shelf

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UKOOG	UK Onshore Operators Group
UNEP	United Nations Environmental Programme
US	United States of America
US.EIA	United States Energy Information Administration
WMO	World Meteorological Organization

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CHAPTER 1: INTRODUCTION

1.1 Introduction

The main question this thesis seeks to answer is 'how can shale gas be developed in an environmentally sustainable manner in South Africa?' The thesis has the following sub-questions:

(i) Does the petroleum legal framework of South Africa provide adequately for shale gas exploration and production?

(ii) How does (and should) the petroleum legal framework provide for the protection of the environment against the risks posed by hydraulic fracturing, the main technology used to exploit shale gas?

South Africa potentially contains vast amounts of shale gas.[1] It is estimated to hold 390 trillion cubic feet (tcf) of technically recoverable shale gas resources, thus ranking eighth in the world in terms of the resource size.[2] This is a significant gas resource, which if produced, could enhance the country's energy security of supply.[3] This amount of gas could also aid the country's efforts to reduce its contribution to climate change, and transition towards more cleaner energy sources, such as wind and solar.[4] It is however not known with sufficient scientific certainty whether shale gas exists in commercial quantities in South Africa,[5] because there has been no recent exploration

[1] U.S. Energy Information Administration 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States' (2013) available at *https://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf* at 10, accessed on 14 May 2022; Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi & Doug Cole et al 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, 113 *S Afr J Sci* 9/10.

[2] U.S. Energy Information Administration 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States' (2013) at 10, available at *https://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf,* accessed on 14 May 2022; R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review* 18(2).

[3] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8); R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review* 18(2).

[4] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden (eds) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) at 227 (Oxford University Press, London); Sally M. Benson & S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) in *The Bridge-Linking Engineering and Society* at 42 (National Academy of Engineering, Washington) 44(1).

[5] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, 107 *S Afr J Sci* (7/8).

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done to quantify the resource.[6] No wells have recently been drilled and hydraulically fractured in the Karoo to assess the ability of the gas to flow when produced, which is key in the determination of whether shale gas in the Karoo could be exploited at a commercial scale.[7]

A recent study by South African geoscientists indicates that the shale gas resource potential of the Karoo could be as low as 13 – 49 tcf, due to heating by dolerite sills and metamorphism, which resulted in the thermal maturity of organic matter and the destruction of hydrocarbon potential.[8] The authors of that study however acknowledge that the two wells upon which their study is based fall outside of the area deemed to be prospective in shale gas in the karoo, the so called 'sweet-spot area'.[9] The 13 – 49 tcf of gas still represents a significant resource that could help sustain the South African petroleum industry.[10] This is considering that the Mossgas (now PetroSA) gas-to-liquids refinery in Mossel Bay, was developed based on one trillion cubic feet of natural gas found off the south coast of South Africa.[11] That amount of gas sustained the GTL refinery operations in Mossel Bay for 28 years from 1992 to 2020.[12]

This amount of gas is also significant in the broader context of national energy security of supply. Almost half of the country's current installed electricity generation capacity of 51.7 Gigawatt (GW)[13] could be generated with 13 – 49 tcf of gas over a 20-year

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[6] Academy of Science of South Africa (ASSAf) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 58 (ASSAf, Pretoria); M Burns, D Atkinson, O Barker & C Davis et al 'Scenarios and Activities' in Robert Scholes, Paul Lochner, Greg Schreiner & Luanita Snyman-Van der Walt (eds) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 1-12 (CSIR, Pretoria).

[7] Academy of Science of South Africa (ASSAf) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 58 (ASSAf, Pretoria).

[8] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi & Doug Cole et al 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 11, *S Afr J Sci*; 113 (9/10).

[9] Ibid,1.

[10] Ibid.

[11] C. Geel, M. de Wet, AT Booth & H-M. Schulz et al 'Palaeo-Environment, Diagenesis and Characteristics of Permian Black Shales in the Lower Karoo Supergroup Flanking the Cape Fold Belt Near Jansenville, Eastern Cape, South Africa: Implications for the Shale Gas Potential of the Karoo Basin' (2015) at 250, *Geological Society of South Africa.*

[12] PetroSA 'Annual Report 2020 available from *http://www.petrosa.co.za/discover_petroSA/Documents/PetroSA%20AR%202020%20Final.pdf at 61*, accessed on 25 June 2022.

[13] Department of Mineral Resources and Energy 'Integrated Resource Plan' (2019) available from *http://www.energy.gov.za/IRP/2019/IRP-2019.pdf* at 10, accessed on 27 June 2022.

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period.[14] The Karoo shale gas also has the potential to reduce the country's high carbon dioxide emissions, thus its climate change impact.[15] Climate change is of a global concern because it is causing unprecedented changes to human and natural systems, such as rising sea levels, more frequent floods and droughts, loss of biodiversity and other types of extreme weather conditions.[16] These changes are causing increasing risks to vulnerable countries, including to food and water scarcity, human migration and political instability in some regions.[17]

South Africa heavily relies on coal as a primary energy source.[18] Coal accounts for about 75% of the country's currently installed electricity generation,[19] and a third of liquid fuels (petrol, diesel, paraffin) production.[20] Coal is a major contributor to climate change, as a result, South Africa is ranked amongst the highest carbon dioxide emitting countries globally.[21] It is the 12th largest emitter of carbon dioxide, contributing about 1.6 per cent of global emissions, and almost half of Africa's emissions.[22] The exploitation of shale gas could provide new solutions to reduce the country's carbon dioxide emissions and mitigate climate change.[23] Natural gas is a cleaner energy

[14] According to the National Development Plan, 24 tcf of gas could generate 20 GW of electricity over a 20-year period. National Development Plan 2030: Our future - make it work (2011) at 169, available at *https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-work.pdf*, accessed on 15 May 2022.

[15] R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review* 18(4).

[16] IPCC 'Global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty' (2018) at 53, *In Press*.

[17] International Energy Agency 'Africa Energy Outlook (2022) World Energy Outlook Special Report' available at *www.iea.org.weo* at 46, accessed on 18 July 2022.

[18] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 1, *S Afr J Sci*; 110(3/4); Department of Mineral Resources and Energy 'Integrated Resource Plan' (2019) available at *http://www.energy.gov.za/IRP/2019/IRP-2019.pdf* at 10, accessed on 27 June 2022.

[19] Department of Mineral Resources and Energy 'Integrated Resource Plan 2019' (2019) available at *http://www.energy.gov.za/IRP/2019/IRP-2019.pdf* at 10, accessed on 27 June 2022.

[20] Theresa Moyo 'Low Carbon and Climate Resilient Investments – Is South Africa Doing Enough?' (2016) at 129, *Africa Insight* 45(4).

[21] Ibid.

[22] Ibid.

[23] Mark D. Zoback & Douglas J. Arent 'Shale Gas Development: Opportunities and Challenges' (2014) at 18 in *The Bridge-Linking Engineering and Society* (Washington, National Academy of Engineering) 44(1).

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source than coal, it produces 50 per cent less carbon dioxide than coal, and 30 per cent less than oil.[24]

However, the exploitation of shale gas is contentious because hydraulic fracturing poses serious risks to human health and the environment.[25] Environmental concerns associated with hydraulic fracturing include its use of vast amounts of water and chemicals that could contaminate surface and groundwater sources.[26] Hydraulic fracturing produces a considerable amount of wastewater that requires treatment for safe disposal, the handling and disposal of which are a threat to surface waters.[27] The potential of shale gas development to emit methane gas, a potent greenhouse gas,[28] and induce seismic events are also of significant environmental concern.[29] Several contamination incidents, induced tremors and non-compliance with regulations in the earlier days of shale gas development in the United States spurred public concerns.[30] Public concern was worsened by the refusal of several industry players to disclose the chemicals used in the hydraulic fracturing process publicly,[31] and led to more intense opposition, public protests, and lawsuits.[32]

[24] Joseph Tawonezvi 'The Legal and Regulatory Framework for the EU's Shale Gas Exploration and Production Regulating Public Health and Environmental Impacts' (2017) at 4, 2(1) *Energy.Ecol.Environ*; Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8).

[25] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22.

[26] Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) *Science of the Total Environment;* U.S. EPA 'Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)' (2016), Washington, DC, EPA/600/R-16/236F, available at www.epa.gov./hfstudy at 37, accessed on 28 May 2022.

[27] Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24.

[28] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

[29] Matthew Cotton 'Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and plannin' (2017) at 186, 22(2) *Local Environment,* 185-202.

[30] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 32, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 3 October 2020.

[31] Ibid.

[32] Ibid.

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This thesis investigates whether South Africa's petroleum legal framework provides adequately for the protection of the environment against the risks posed by shale gas development. These risks emanate from the use of the hydraulic fracturing technology to extract the resource. It posits that with a petroleum legal framework premised on the effective application of the principles of avoidance, mitigation, and remediation, shale gas could be developed in an environmentally responsible manner in South Africa, to enhance energy security of supply, and reduce the country's carbon dioxide emissions to the atmosphere.

The study acknowledges that renewable energy sources are more environmentally friendly, therefore more effective at mitigating climate change than shale gas.[33] However, renewable energy sources such as wind and solar cannot yet ensure an uninterrupted supply of energy, hence energy security of supply.[34] When the wind is not blowing, and the sun is not shining, no wind or solar energy is generated.[35] Moreover, the technologies required to store the electricity generated from these energy sources, which could aid security of supply during these non-generative periods are not yet fully developed.[36] A more robust energy security of supply, and climate change mitigation strategy for South Africa, thus, would be one that is more diversified, and includes renewable energy sources and shale gas.[37]

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[33] Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' in *The Bridge-Linking Engineering and Society* (2014) at 42 (Washington, National Academy of Engineering) 44(1); Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden (eds) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) at 227 (Oxford University Press, London).

[34] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) at 224 (London, Oxford University Press); Steffen Nolte, Clair Geel, Alexandra Amann-Hildenbrand, Bernhard M.Krooss, Ralf Littke 'Petrophysical and geochemical characterization of potential unconventional gas shale reservoirs in the southern Karoo Basin, South Africa' (2019) at 1, *International Journal of Coal Geology* 212.

[35] Marloes Dignum, Aad Correlje, Eefje Cuppen, Udo Pesch and Behnam Taebi 'Contested Technolgoeis and Design for Values: The Case of Shale Gas' (2015) at 1174, *Sci Eng Ethics* 22.

[36] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 749, *The Georgetown Envtl. Law Review* 29.

[37] National Development Plan 2030: Our future - make it work (2011) at 169, available at https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf at, accessed on 28 May 2022.

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The South African Constitution,[38] 'affords everyone the right to an environment that is not harmful to their health or well-being,[39] and to have the environment protected for the benefit of present and future generations'.[40] 'The environment must be protected through reasonable legislative and other measures that prevent pollution and ecological degradation,[41] promote conservation,[42] and secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development'.[43] The Mineral and Petroleum Resources Development Act,[44] seeks to give effect to this mandate of the South African Constitution.[45] Attaining the delicate balance required for shale gas development, while mitigating the risks associated with shale gas extraction requires unconventional wisdom.

The interests to be balanced, and stakeholders involved are also manifold. Environmental interest groups are concerned about the impact of shale gas development on the natural environment, in particular on surface and groundwater resources.[46] Landowners are concerned about the impact on their farming and agricultural activities.[47] The interest of local communities is in the socio-economic benefits that shale gas might bring.[48] The South African government on the other hand has a keen interest in shale gas, since the exploitation thereof could aid national energy security of supply and mitigating climate change.[49]

[38] Constitution of the Republic of South Africa, 1996.
[39] S 24(a) of the Constitution.
[40] S 24(b) of the Constitution.
[41] S 24(b)(i) of the Constitution.
[42] S 24(b)(ii) of the Constitution.
[43] S 24(b)(iii) of the Constitution.
[44] Minerals and Petroleum Resources Development Act, No. 28 of 2002.
[45] Section 3(3) of the Minerals and Petroleum Resources Development Act, No. 28 of 2002.
[46] P Hobbs, E Day, P Roserwarne & S Esterhuyse et al, 'Water Resources' in Robert Scholes, Paul Lochner, Greg Schreiner & Luanita Snyman-Van der Walt et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 5-9 (CSIR, Pretoria).
[47] N Oettle, L Lindeque, J du Toit & I Samuels et al 'Impacts on Agriculture' in Robert Scholes, Paul Lochner, Greg Schreiner & Luanita Snyman-Van der Walt et al*, Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 8-7 (CSIR, Pretoria).
[48] Van Zyl H, Fakir S, Leiman T & Standish B 'Impact on the Economy' in Scholes R, Lochner P, Schreiner G & Snyman-Van der Walt L et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 10-6 (CSIR, Pretoria).
[49] National Development Plan 2030: Our future - make it work (2011) at 169.

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South Africa started paying attention to its potential shale gas resource around 2010 following applications for exploration rights by Bundu Gas and Oil Exploration (Pty) Ltd (Bundu), Falcon Oil and Gas Limited (Falcon) and Shell Exploration Company B.V (Shell).[50] These applications triggered opposition from environmental interest groups such as the Treasure the Karoo Action Group (TKAG), the Centre for Environmental Rights (CER), and the Sustainable Alternatives to Fracking and Exploration Alliance (SAFE).[51] These environmental interests groups contend that shale gas development would cause irreparable damage to the Karoo's biodiversity.[52]

As a result, the Minister of Mineral Resources and Energy imposed a moratorium on shale gas exploration and established a Ministerial Task Team in December 2011, to advise government on the potential impact of using hydraulic fracturing to extract shale gas in the Karoo.[53] The Task Team produced a report recommending that normal exploration for shale gas (excluding hydraulic fracturing) be allowed under the current regulatory framework.[54] The Task Team also recommended that the current regulatory framework be augmented, and once in place, for hydraulic fracturing operations to be allowed under strict supervision from a Monitoring Committee, which the Task Team also recommended should be constituted by the government.[55] Cabinet approved these recommendations in September 2012 and constituted the Monitoring Committee.[56]

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[50] *John Douglas Stern and others vs Minister of Mineral Resources, para 3&4,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

[51] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 35, *Stellenbosch Law Review*.

[52] Ibid.

[53] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 11 (790/2018) [2019] ZASCA 99 (4 July 2019); Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 26.

[54] Department of Mineral Resources 'Report on Investigation of Hydraulic Fracturing in the Karoo of South Africa' (2012) available at http://www.info.gov.za/view/DownloadFileAction?id=174015, at 68, accessed on 5 July 2022.

[55] Ibid.

[56] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 14 (790/2018) [2019] ZASCA 99 (4 July 2019).

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In 2014 the Petroleum Agency SA notified Bundu Gas, Falcon Oil and Shell that their applications for exploration rights would be processed, however they should revise their environmental management programmes to exclude hydraulic fracturing, and embark on a further public participation process in terms of s 79(4)(a) of the MPRDA.[57] Despite this, no exploration right for shale gas has yet been awarded in South Africa,[58] due to the lack of an appropriate petroleum legal framework to regulate shale gas exploration and production.[59] In essence, the Supreme Court of Appeals reviewed and set aside the regulations that would govern the use of hydraulic fracturing in shale gas development until such time that they were lawfully promulgated.[60]

1.2 Research Objectives and Questions

1.2.1 Research Objective

The objective of this study is to identify critical shortcomings in the petroleum legal framework of South Africa in relation to shale gas exploration and exploitation and recommend measures to close the gaps in the petroleum legal framework.

1.2.2 Research Questions

This study seeks to answer the following question: How can shale gas be developed in an environmentally sustainable manner in South Africa? Engaging with this question entails considering at least the following two sub-questions:

(iii) Does the petroleum legal framework of South Africa provide adequately for shale gas exploration and production?

(iv) How does (and should) the petroleum legal framework provide for the protection of the environment against the risks posed by hydraulic fracturing, the main technology used to exploit shale gas?

[57] Ibid, para 15.
[58] Ibid, para 16.
[59] Ibid, para 56.
[60] Ibid, para 56.

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1.2.3 Delimitations

This study is limited to the assessment of the adequacy of South Africa's petroleum legal framework for shale gas exploration and exploitation. While of interest to the broader shale gas discourse,[61] this study does not examine the potential economic impact of shale gas development in South Africa. The study recognizes shale gas development as an important economic activity that needs to be appropriately regulated to ensure that it does not affect the environment adversely. Anyway, there has been no exploration done in search of shale gas in South Africa, except for the onshore exploration wells that were drilled in the Karoo in the 1960s.[62] While the onshore exploration programme of the 1960s coincidentally discovered shale gas,[63] it is not known with sufficient scientific certainty whether shale gas exists in commercial quantities in the country.[64] This makes the assessment of the potential economic impact of shale gas in the country highly speculative.

The economic potential of South Africa's shale gas will therefore only be known once a significant number of wells have been drilled and commercial flow rates established.[65] Furthermore, the exploitation of shale gas can be quite costly, due to the technical complexities associated with horizontal drilling and hydraulic fracturing.[66] As a result, the economics of shale gas are dependent on the geology, accessibility, and proximity of the shale gas from transportation and processing infrastructure, such as gas pipelines, power plants and chemical plants among others.[67] Isolated shale gas

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[61] Lanre Aledeitan & Chisom Nwosu 'Shale Gas Development: Their Gain, Our Pain and the Cost' (2013) at 216, *Journal of Politics and Law* 3(6).

[62] Academy of Science of South Africa (ASSAf) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 58 (ASSAf, Pretoria); M Burns, D Atkinson, O Barker, C Davis & E Day et al 'Scenarios and Activities' in Robert Scholes, Paul Lochner, Greg Schreiner & Luanita Snyman-Van der Walt et al (eds) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 1-12 (CSIR, Pretoria); Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, & Doug Cole et al 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, *S Afr J Sci*; 113 (9/10).

[63] Ibid.

[64] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8).

[65] Bob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager (eds) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 10, Pretoria: CSIR; Jan Glazewski 'Sustainable development and proposed shale extraction in South Africa: prospects and challenges' (2016) at 226 UK, Edward Elgar Publishing Limited.

[66] Lanre Aledeitan & Chisom Nwosu 'Shale Gas Development: Their Gain, Our Pain and the Cost' (2013) at 219, *Journal of Politics and Law* 3(6).

[67] Lanre Aledeitan & Chisom Nwosu 'Shale Gas Development: Their Gain, Our Pain and the Cost' (2013) at 219, *Journal of Politics and Law* 3(6); R. Wait & R. Rossouw 'A Comparative Assessment of

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basins, such as the Karoo, can therefore be expected to have higher development and production costs, due to lack of infrastructure and scarcity of water.[68]

1.3 Methodology

This study relies on doctrinal analysis because there has been limited scholarly engagement with the petroleum legal framework of South Africa, within the context of shale gas exploration and exploitation. The study compares the petroleum legal frameworks of South Africa with those of the United Kingdom (UK) and Canada, which are more mature petroleum jurisdictions, therefore have relatively advanced legal frameworks for petroleum extraction. It uses the environmental legal principles of avoidance (prevention principle), mitigation (precautionary principle) and remediation (polluter-pays principle) as comparative themes.

Comparative law is concerned with a comparison of various legal systems to ascertain similarities and differences in the problems faced and solutions employed.[69] It enables the objective and systematic analysis of solutions that various legal systems offer to similar legal problems.[70] Using comparative law to study another country's legal style "*the system's history, mode of thought in legal matters, sources of law, and legal ideology*" makes it possible to understand, appreciate and evaluate the country of study's legal regime in a systematic way.[71]

There are inherent challenges with a comparison of legal systems between different jurisdictions.[72] However, while a comparison of the legal rules of closely related legal systems may be intellectually meaningful, the minor differences potentially limit the

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the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 3, *Southern African Business Review*; 18(2).

[68] Lanre Aledeitan & Chisom Nwosu 'Shale Gas Development: Their Gain, Our Pain and the Cost' (2013) at 219, *Journal of Politics and Law* 3(6).

[69] Peter de Cruz 'Comparative law in a changing world' (1999) 2nd ed at 7 (Cavendish Publishing Ltd: London); Imre Zajtay 'Aims and methods of comparative law' (1974) at 322, *Comparative and International Law Journal of Southern Africa* 07.

[70] Ibid.

[71] Peter de Cruz 'Comparative law in a changing world' (1999) 2nd ed, at 7 (Cavendish Publishing Ltd: London); LG Baxter 'Pure comparative law and legal science in a mixed legal system' (1983) at 85, *Comparative and International Law Journal of Southern Africa* 16.

[72] Frank Bates 'Comparative common law: a justification (1981) at 259, *Comparative and International Law Journal of Southern Africa* 14(3).

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significance of the comparative assessment.[73] Nonetheless, there are features of petroleum law that are international in character, which help mitigate the difficulties associated with comparative international law.[74] Examples of the international character of petroleum law include: first, the affirmation of the sovereignty of states over their natural resources.[75] Secondly, the ownership of petroleum in situ.[76] Thirdly, the licensing of petroleum rights,[77] and fourthly, access to surface land for the purpose of exploration and production of petroleum resources.[78]

1.4 Motivation for Choice of Comparative Jurisdictions

South Africa and Canada are former British colonies, therefore their legal systems have their historical roots in the common law of England.[79] The common law systems of South Africa, the UK and Canada historically adhered to the Roman-law maxim "*cuius est solum eius et usque ad coelum et ad inferos",*[80] which affirms mineral rights as belonging to the landowner.[81] This changed in South Africa with the promulgation of the MPRDA.[82] Nonetheless, all three legal systems recognize minerals in situ as public property.[83] Unsevered mineral and petroleum resources in South Africa are the common heritage of the people of South Africa, thus ownership thereof vests in the nation, with the State as custodian thereof.[84] The State therefore grants petroleum rights to private players on application for such rights.[85]

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[73] Ibid.
[74] Tina Hunter, Legal Regulatory Framework for the Sustainable Extraction of Australian Offshore Petroleum Resources – A Critical Functional Analysis (2010) at 33, PhD Thesis, University of Bergen.
[75] UN, General Assembly resolution 1803 (XVII) 'Permanent Sovereignty over Natural Resources' (1962); United Nations 'The Rio Declaration on Environment and Development' (1992) Principle 2.
[76] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 3(1); Petroleum Act, 1998, s 2(1); Canada Petroleum Resources Act, 1985.
[77] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 3(1); Petroleum Act, 1998, s 2(1); Canada Petroleum Resources Act, 1985.
[78] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 3(1); Petroleum Act, 1998, s 2(1); Canada Petroleum Resources Act, 1985.
[79] PJ Badenhorst 'Ownership of Minerals In situ in South Africa: Australian Darning to the Rescue' (2010) at 646, *SALJ* 127(4).
[80] Ibid.
[81] Elmarie van der Schyff 'South African mineral law: A historical overview of the State's regulatory power regarding the exploitation of minerals, 2012, at 133, *New Contree* 64
[82] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 3(1)
[83] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 3(1); Petroleum Act, 1998, s 2(1); Canada Petroleum Resources Act, 1985.
[84] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 3(2)(a).
[85] Ibid.

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The ownership of petroleum in the sub-surface in the UK and Canada on the other hand vest with the Crown.[86] Similar to South Africa, the ownership of land in the UK and Canada does not confer the rights to the petroleum below the surface, rather the Crown has the exclusive right to the petroleum and can issue rights for the exploration and production thereof.[87] South Africa, the UK, and Canada's environmental legal frameworks recognize the need for sustainable development.[88] These legal frameworks furthermore embed the prevention principle,[89] the precautionary principle,[90] and the polluter pays principle,[91] which are used as comparative themes in this thesis. In terms of jurisprudence, environmental legal principles are important in limiting the application of arbitrary power, thus ensuring that the administration of environmental decision making is more rational.[92]

Moreover, Canada followed the United States in producing shale gas on a commercial scale,[93] and remains the second largest producer of shale gas globally.[94] Unconventional gas production (shale gas and tight gas) constitutes more than 50% of total natural gas production in Canada.[95] Shale gas and tight gas (unconventional resources which utilize horizontal drilling and hydraulic fracturing to exploit) production in Canada occurs mainly in British Columbia, Alberta, New Brunswick, Nova Scotia

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[86] Jill Morgan *Sustainability and stakeholder participation: shale gas extraction in the United Kingdom* in James R. May & John C. Dernbach *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 144 (eds) (Edward Elgar Publishing Limited, UK); Petroleum Act, 1998, s 2(1); Canada Petroleum Resources Act, 1985

[87] Ibid, Minerals and Petroleum Resources Development Act, No. 28, 2002, s 3(2)(a).

[88] National Environmental Management Act, No.107 of 1998; Environmental Protection Act 1990; Canadian Environmental Protection Act, 1999.

[89] J. Verschuuren 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) at 1, *Potchefstroom Electronic Law Journal* (1)*;* Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 194, *Stellenbosch Law Review* 26(1).

[90] United Nations 'The Rio Declaration on Environment and Development' (1992) Principle 15.

[91] United Nations 'The Rio Declaration on Environment and Development' (1992) Principle 16.

[92] Paul G.W Henderson 'Some thoughts on distinctive principles of South African Environmental Law' (2001) at 141, *South African Journal of Environmental Law and Policy* 8(2).

[93] Jiehui Yuan, Dongkun Luo & Lianyong Feng 'A review of technical and economic evaluation techniques for shale gas development' (2015) at 50, *Applied Energy*; Jan Glazewski & Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) at 22 (Claremont, Juta and Company (Pty) Ltd); Leonie Reins 'The Shale Gas Extraction Process and Its Impacts on Water Resources' (2011) at 300, *Review of European Community & International Environmental Law* 20 (3).

[94] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 748, *The Georgetown Envtl. Law Review* 29.

[95] Government of Canada, Natural Resources Canada: Exploration and Production of Shale and Tight Resources, 2016, available at *https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/clean-fossil-fuels/natural-gas/shale-tight-resources-canada/exploration-and-production-shale-and-tight-resources/17677*, accessed on 9 February 2022.

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and Quebec.[96] Systematically developed with the increasing exploitation of shale, Canada has a progressive shale gas regulatory framework that seeks to address the environmental concerns associated with shale gas exploitation.[97] Valuable lessons can thus be learned from Canada's shale gas regulatory framework.

Similarly, the UK is an appropriate jurisdiction from which South Africa can draw lessons. Although the exploration for shale gas in the UK is still at infancy,[98] the UK's experience of hydraulic fracturing and directional drilling for non-shale applications spans several decades.[99] Over 2000 wells have been drilled onshore the UK since the 1970s, and at least 200 of those wells have been hydraulically fractured to enhance oil and gas recovery.[100] Advances in directional drilling enabled the development of the Wytch Farm, Europe's largest onshore field in 1979.[101] Most onshore oil production in the UK came from this giant oil field, which had over 200 wells drilled, producing over 500 million barrels of cumulative oil reserves.[102]

The UK has at least 60 years of regulating onshore and offshore oil and gas exploration and production activities.[103] It has periodically reviewed its petroleum regulatory framework, thus has a stringent regulatory framework, which is being augmented to

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[96] Ibid.

[97] Jan Glazewski & Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) at 22 (Claremont, Juta and Company (Pty) Ltd).

[98] John Paterson & Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom).

[99] Eike Albrecht and Dorte Schneemann 'Fracking in the United Kingdom: Regulatory Challenges between Resource Mobilisation and Environmental Protection' (2014) at 239, *Carbon & Climate Law Review* 8(4); John Paterson & Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom.

[100] John Paterson & Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom); Eike Albrecht & Dorte Schneemann 'Fracking in the United Kingdom: Regulatory Challenges between Resource Mobilisation and Environmental Protection' (2014) at 239, *Carbon & Climate Law Review* 8(4); The Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing (2012) available from https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf at 17, accessed on 3 August 2022.

[101] Ibid.

[102] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) available at https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf at 17, accessed on 3 August 2022.

[103] Ibid.

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provide for shale gas exploration and production.[104] In fact, the UK government proposed fiscal and legislative measures to facilitate shale gas exploration.[105] However, public concerns regarding the negative environmental impacts of shale gas such as on water resources and climate change have ledd to minimal exploration activity.[106]

1.5 Significance of this Study

South Africa has significant security of energy supply challenges.[107] The country has a shortage of power supply, demonstrated by electricity supply cuts (rolling blackouts) over the last few years.[108] Furthermore, the country is overly reliant on coal in terms of its energy supply.[109] Coal is the greatest emitter of carbon dioxide, which is a major contributor to global climate change.[110] Technological advancements, particularly the use of horizontal drilling combined with hydraulic fracturing,[111] improved the United States of America's energy security, and reduced its carbon dioxide emissions to the atmosphere.[112] Between 2000 and 2014, the United States reduced its carbon dioxide emissions by 18 per cent from the 1990 climate change baseline.[113] The adaptation of the hydraulic fracturing technology to mitigate its environmental risks is poised to

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[104] Jan Glazewski & Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) at 23 (Claremont, Juta and Company (Pty) Ltd).

[105] Jill Morgan 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' at 145 in James R. May and John C. Dernbach *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) Edward Elgar Publishing Limited, UK.

[106] Ibid; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom).

[107] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 4, *S Afr J Sci*; 110(3/4).

[108] Hugo Meyer van den Berg & Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) at 258 (London, Oxford University Press).

[109] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 4, *S Afr J Sci*; 110(3/4).

[110] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8).

[111] Lanre Aledeitan & Chisom Nwosu 'Shale Gas Development: Their Gain, Our Pain and the Cost' (2013) at 217, *Journal of Politics and Law* 3(6)

[112] Paolo D. Farah & Riccardo Tremolada 'A Comparison between Shale Gas in China and Unconventional Fuel Development in the United States: Water, Environmental Protection, and Sustainable Development' (2016) at 581, 41 *Brook. J. Int'l L* 579.

[113] Administration of Donald J. Trump, Remarks Announcing United States Withdrawal From the United Nations Framework Convention on Climate Change Paris Agreement (2017) at 6, Authenticated U.S. Government Information (GPO) - Daily Compilation of Presidential Documents.

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catalyse the development of shale gas globally.[114] Therefore, the adoption of a petroleum legal framework that integrates the environmental legal principles of prevention, mitigation and remediation could enable the sustainable development of shale gas in South Africa.

1.6 Thesis Structure

This thesis has 9 Chapters. Chapter 1 covers the aims, objectives, and methodology of the research. Chapter 2 provides an overview of the technical aspects of shale gas extraction. It focuses on the technologies used to produce shale gas, such as horizontal drilling and hydraulic fracturing, and the associated environmental risks. Chapter 3 examines the public participation provisions within the relevant legal framework in South Africa and whether the effective implementation thereof could aid the societal acceptance of shale gas development. Chapter 4 reviews the international climate change regime, under the United Nations Framework Convention on Climate Change (UNFCCC).[115] An understanding of the international climate change regime, and South Africa's commitment thereto are important to properly contextualise the role shale gas could play in climate change mitigation.

Chapter 5 reviews the Regulations for Petroleum Exploration and Production (Hydraulic Fracturing Regulations), which were gazetted in 2015 to regulate the use of hydraulic fracturing in South Africa. These are examined, as part of the broader assessment of the adequacy of the South African petroleum legal framework to regulate shale gas extraction. Chapter 6 focuses on Sustainable Development, a cornerstone of international environmental law. The chapter furthermore conducts a comparative assessment of the South African petroleum and environmental legal frameworks with those of the United Kingdom and Canada, using avoidance as the comparative theme. The Principle of Prevention is core to avoidance therefore is a key focus in Chapter 6.

[114] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8).
[115] United Nations 'United Nations Framework Convention on Climate Change' (1992) available at https://unfccc.int/resource/docs/convkp/conveng.pdf, accessed on 11 June 2022.

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Chapter 7 is a comparative assessment of the petroleum and environmental legal frameworks of the comparative jurisdictions using mitigation as a comparative theme. Central to mitigation is the Precautionary Principle, which advocates for uncertainty to be factored into environmental decision-making. Chapter 8 is a comparative assessment of the application of the Polluter-Pays Principle in the comparative jurisdictions, to ascertain whether the principle could be used as a mechanism to deter or remediate environmental harm that may arise from shale gas development in South Africa.

Chapter 9 is the concluding chapter of this thesis. It brings together the key findings of this research. This study finds the petroleum legal framework of South Africa to be inadequate to regulate shale gas exploration and exploitation, since the MPRDA does not provide explicitly for the mitigation of the risks associated with hydraulic fracturing.[116] Furthermore the Regulations for Petroleum Exploration and Production which were gazetted in 2015 to regulate the use of hydraulic fracturing were set aside by the Eastern Cape High Court in Grahamstown in 2015,[117] and further invalidated by the Supreme Court of Appeals in 2019.[118]

This research further finds that the environmental legal principles of prevention, mitigation and remediation, upon which this comparative assessment is based, are already embedded in the South African environmental legal framework. Therefore, the appropriate petroleum legal framework to guide shale gas development in South Africa would be one that provides for the rigorous application of these principles, in an integrated and complementary manner, with close monitoring and enforcement. Furthermore, the capacity of the relevant regulatory agencies will have to be enhanced to ensure effective compliance monitoring and enforcement.

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[116] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1441, *Potchefstroom Electronic Law Journal* 18(5).

[117] *John Douglas Stern and others v Minister of Mineral Resources,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

[118] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 2019).

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CHAPTER 2: THE TECHNICAL ASPECTS OF SHALE GAS

2.1 Introduction

This chapter focuses on the technical aspects of shale gas development and the associated environmental risks. It outlines the geological evolution of shale gas, and the techniques associated with its extraction, namely, horizontal drilling and hydraulic fracturing. It attempts to explain the difficulty of choices to be made in South Africa, related to whether and how to engage with hydraulic fracturing for shale gas development, considering the concerns being raised in the South African context. Before delving into the intricacies of shale gas, this chapter defines petroleum and the exploration and production thereof in general.

In South Africa, petroleum is defined as 'any liquid or solid hydrocarbon or combustible gas that is existing in a natural condition in the earth's crust'.[119] Accordingly, 'petroleum does not include coal, bituminous shale or other stratified deposits from which oil can be obtained by destructive distillation or gas arising from a marsh or other surface deposit'.[120] The exploitation of petroleum found beneath the earth's surface generally occurs in three main stages, these are, exploration; production (which includes appraisal and development); and decommissioning (which includes rehabilitation).[121] Exploration involves the acquisition or reprocessing of seismic data to identify geological structures that may be suitable for exploratory drilling, named prospects, to determine the presence of oil and gas resources.[122] During appraisal, exploration prospects are firmed up using extended well tests and additional drilling, to determine if the development of the reservoirs will be economically feasible.[123]

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[119] Mineral and Petroleum Resources Development Act, No.28 of 2002, s 1; PJ Badenhorst & RW Shone "Minerals, "Petroleum" and "Operations" in the Mineral and Petroleum Resources Development Act of 2002: A Geologist as Devil's Advocate for a Change? (2008) at 33,*OBITER*.

[120] Ibid.

[121] Academy of Science of South Africa (ASSAF) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 30 (ASSAf, Pretoria).

[122] Mineral and Petroleum Resources Development Act, No.28 of 2002, s 1.

[123] Bob Scholes, Paul Lochner, Greg Schreiner & Luanita Snyman-Van der Walt et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 1-52 (CSIR, Pretoria).

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During field development and production, infrastructure is developed to enable the production of oil and gas from the reservoirs until the economical reserves are depleted.[124] Lastly, the decommissioning and rehabilitation stage entails the abandonment of wells and related pipelines, the removal of surface production facilities, and the restoration of the area disturbed by the oil and gas production activities to an environmentally sensible state.[125]

2.2 What is Shale Gas

Shales are a common type of sedimentary rocks formed from deposits of mud, silt, clay and organic matter in low-energy environments, such as lakes, lagoons, tidal flats and deep-water basins, where the fine-grained clay particles fall out of suspension in quiet waters.[126] Algae, plant, and animal-derived organic debris are mixed with these fine-grained sediments when they are deposited.[127] When the mud turns into shales over geologic times, millions of years, bacteria metabolize the organic matter and release biogenic gas (methane – CH_4).[128] Natural gas is also formed when deeply buried organic matter is cracked by high pressure and heat, converting it into thermogenic methane gas.[129] The very fine sheet-like clay mineral grains and laminated layers of sediment result in a rock with permeability that is limited horizontally and extremely limited vertically.[130] This low permeability means that gas trapped in shale cannot move easily within the rock,[131] therefore require technologies such as hydraulic fracturing to create fractures within the rock thereby enabling the gas to flow.[132]

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[124] Ibid.
[125] Ibid.
[126] J. Daniel Arthur, Brian Bohm and David Cornue 'Environmental Considerations of Modern Shale Gas Development' (2009) p2, SPE Paper No. 122931, Presented at SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October 2009; Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8) Art No. 791.
[127] Ibid.
[128] Ibid.
[129] Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 23 (ASSaf, Pretoria).
[130] Ibid, at 24.
[131] J.C. Shaw, M.M. Reynolds, L.H. Burke 'Shale Gas Production Potential and Technical Challenges in Western Canada' (2006) at 2, Paper 2006-193, presented to the Petroleum Society's 7th Canadian International Petroleum Conference, Calgary, Alberta, Canada, 13-15 June.
[132] Ibid.

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Shale gas is regarded as an unconventional resource because natural gas was originally regarded as originating from shales as source rocks, then migrate into porous and permeable formations, reservoirs, which are then drilled into to produce the gas.[133] Shale gas on the other hand involves drilling directly into the source rock (the shale) to produce the gas.[134] In fact, shales constitute about 80% of all drilled sections of oil and gas wells, because they overlie (serve as cap rocks or seal) or underlie (serve as source rocks) most hydrocarbon bearing reservoirs.[135] In terms of its chemical composition, as is the case with conventional natural gas, shale gas comprises approximately 90% methane and small amounts of slightly heavier gases such as ethane, propane, and butane.[136] When burnt, natural gas releases significant amounts of energy, while emitting less carbon dioxide into the atmosphere than oil and coal.[137]

2.3 Shale Gas in the Karoo

As stated in Chapter 1 of this thesis, the South African Karoo (figure 1) potentially holds 390 tcf of technically recoverable shale gas resources, and is ranked eighth in the world in terms of the resource size.[138] To the contrary, and based on wells falling outside of the area deemed prospective in shale gas in the Karoo, a more recent study by South African geoscientists indicates that the shale gas resource potential of the Karoo could be as low as 13 tcf.[139] This is due to heating by dolerite sills and metamorphism, which resulted in the thermal maturity of organic matter and the destruction of hydrocarbon potential.[140] Even 13 tcf of shale gas is significant potential

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[133] Michael Esposito, *Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction* (2013) at 170, 22, *Tulane Journal of International & Comparative Law*.

[134] Ibid.

[135] Audrey Ougier-Simonin, Francois Renard, Claudine Boehm and Sandrine Vidal-Gilbert 'Microfracturing and microporosity in shales' (2016) at 4, *Earth Science Reviews.*

[136] A.M. Dayal 'Shale' at 7, in Anurodh Mohah Dayal and Devleena Mani *Shale Gas: Exploration and Environmental and Economic Impacts* (2017) Elsevier, Oxford, United Kingdom.

[137] J. Daniel Arthur, Brian Bohm and David Cornue 'Environmental Considerations of Modern Shale Gas Development' (2009) p2, SPE Paper No. 122931, Presented at SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October 2009.

[138] U.S. Energy Information Administration 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States' (2013) available at *https://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf,* accessed on 14/05/2022; R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review*; 18(2).

[139] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, Doug Cole, Annette E. Götz, Claire Geel & Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 11, *S Afr J Sci*; 113 (9/10), Art No. 2016-0331.

[140] Ibid.

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that the South African government is interested to know whether indeed exists, and could be exploited commercially to enhance the country's energy security of supply in the transition towards more renewable energy sources.[141]

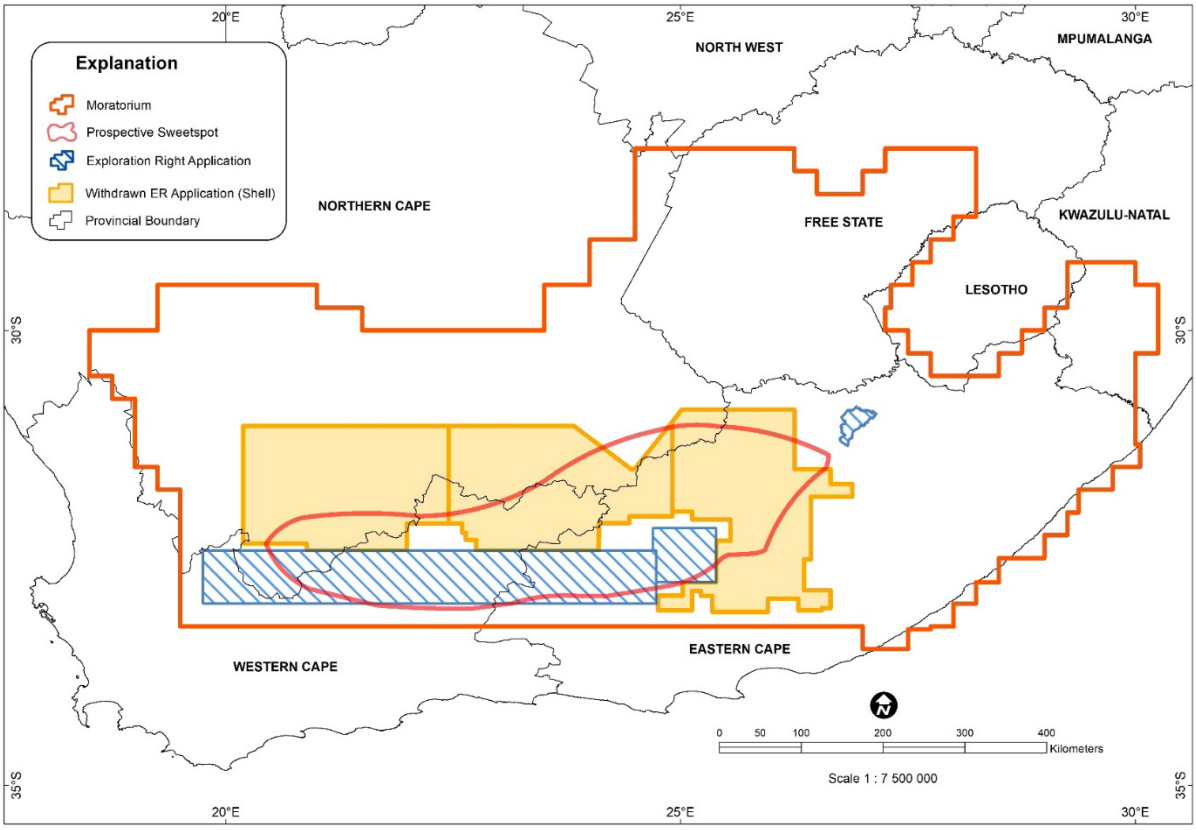

Figure 1: Map of the South African Karoo and Areas Earmarked for Sha*le Gas* Development[142]

The main Karoo is made up of sedimentary formations of the Karoo Supergroup, and covers an area of approximately 700,000 km^2, which represents more than half of South Africa's land surface.[143] Shale gas in the Karoo was formed some 275 million years ago, when deeply buried mud and organic matter, was transformed into natural

[141] National Development Plan 2030: Our future - make it work (2011) at 169, available from https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf, accessed on 15/05/2022.

[142] Petroleum Agency SA 'Recent Advances in South Africa's Upstream Petroleum Sector – Unlocking the Onshore & Offshore Oil & Gas Potential' (2022) Presented to the Southern Africa Oil and Gas Conference, Cape Town, 15 September.

[143] Bob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager, *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 1-29, Pretoria, CSIR.

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gas and oil.[144] The free gas and oil escaped out of the Karoo rock formations, however, some gas may have remained preserved in the shale rock layers, named Prince Albert and White Hill Formations.[145]

The Whitehill Formation is considered the most promising rock formation, due to its total organic carbon content, maturity, mineralogy, thickness and burial depth.[146] It has a total organic carbon content averaging 4.5 per cent,[147] maturity of 1 – 4.3 percent,[148] mineralogy with an average quartz of 50 percent; and is likely to be sufficiently thick, with average burial depth of 2 – 4.5 km.[149] The total organic content, thermal maturity and presence of natural fractures particularly determine whether a shale formation constitute a reservoir that has the potential to produce commercially.[150] Albeit characterised by lower total organic content, the underlying Prince Albert Formation is another encouraging rock formation that could extend the shale gas prospective area in the Karoo.[151]

The Karoo however has a high degree of geological risk and uncertainty, since the Cape Fold Belt thermal tectonism and deep burial along the southern margin of the Karoo Basin may have resulted in the over-cooking and destruction of porosity (the ability of the rock formation to store the gas) thus reducing the volume of gas originally in place.[152] Further north, the intrusion of the Karoo dolerites during the Jurassic

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[144] Academy of Science of South Africa (ASSAF) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 25 (ASSAF, Pretoria).

[145] Ibid.

[146] Ibid, at 60.

[147] C. Geel, M. de Wet, AT Booth, H-M. Schulz and B. Horsfield 'Palaeo-Environment, Diagenesis and Characteristics of Permian Black Shales in the Lower Karoo Supergroup Flanking the Cape Fold Belt Near Jansenville, Eastern Cape, South Africa: Implications for the Shale Gas Potential of the Karoo Basin' (2015) at 259, *Geological Society of South Africa.*

[148] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, Doug Cole, Annette E. Götz, Claire Geel & Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 8, *S Afr J Sci*; 113 (9/10), Art No. 2016-0331.

[149] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 3, *S Afr J Sci*; 107(7/8).

[150] M.Y. Soliman, Johan Daal and Loyd East 'Impact of Fracturing and Fracturing Techniques on Productivity of Unconventional Formations' (2012) at 2, SPE Paper No. 150949, Presented at the SPE/EAGE European Unconventional Resources Conference and Exhibition, Vienna, Austria, 20-22 March.

[151] D.E Black, AT W.K. Booth and M.J de Wet 'Petrographic, geochemical and petro-physical analysis of the Collingham Formation near Jansenville, Eastern Cape, South Africa – potential cap rocks to shale gas in the Karoo' (2016) at 172, *South African Journal of Geology* 119.1 (171-186).

[152] Bob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager*, Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 1-32, Pretoria, CSIR.

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geological time (millions of years ago) may have had a similar effect, and may also have resulted in the explosive degassing of the shale and the compartmentalization of shale reservoirs.[153] To gain a better understanding of the Karoo's geology and the risks associated with the extraction of shale gas requires exploration that includes the drilling of wells. Such exploration will require the use of special techniques such as horizontal drilling and hydraulic fracturing, these are discussed below.

2.4 Horizontal Drilling

As illustrated in figure 2 below, horizontal drilling entails the drilling of a vertical section of a well from surface to a certain depth, where the wellbore is curved away from the vertical plane until it reaches the targeted shale formation.[154] The wellbore is then extended laterally within the shale formation to a specific location in the subsurface.[155] This allows the wellbore to contact greater amounts of the reservoir formation and existing fractures and thereby drain a much larger section of the shale reservoir relative to a vertical well.[156] Shale gas extraction through horizontal wells is also beneficial from an environmental perspective, because horizontal wells can be used to avoid sensitive areas such as wetlands and watercourses if gas beneath is targeted for extraction.[157] Furthermore, the environmental footprint associated with the extraction of shale gas is minimized through horizontal wells.[158] This is because horizontal well pads (clustering of horizontal wells together) are less densely spaced than vertical well pads.[159] This minimizes potential habitat fragmentation and disruption of wildlife movement patterns, the visual landscape, and conflicts with other land uses such as forestry and agriculture.[160]

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[153] Ibid.
[154] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 37, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 31 August 2022.
[155] Ibid.
[156] Ibid.
[157] Matthew D Alexander, Lining Qian, Tim A Ryan and John Herron 'Considerations for Responsible Gas Development of the Frederick Brook Shale in New Brunswick' (2011) at 8, Fundy Engineering and Atlantica Centre for Energy.
[158] Ibid.
[159] Ibid.
[160] Ibid.

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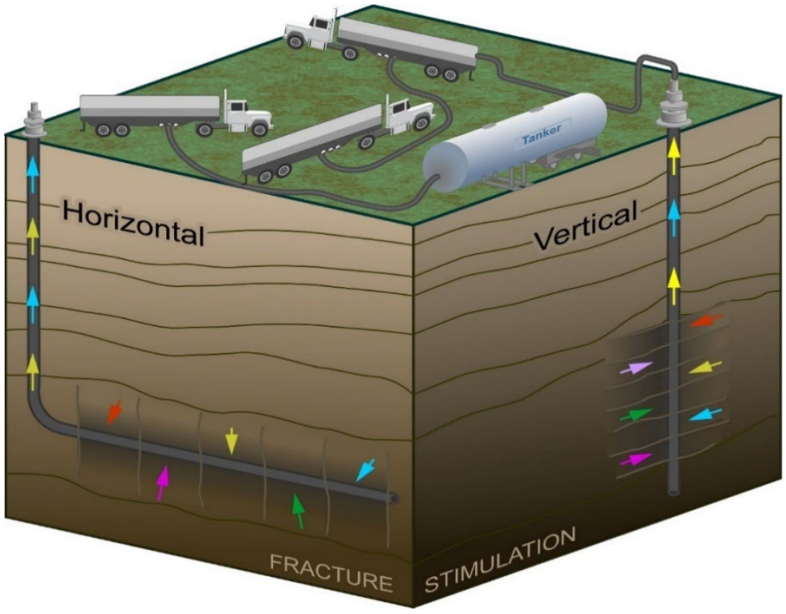

Figure 2: Horizontal and Vertically Fractured Wells [161]

Horizontal drilling is a crucial complementary technology to the hydraulic fracturing of shale formations, particularly since shales, are much thinner reservoirs compared to conventional reservoirs (sandstones and limestones).[162] The long-lateral section of the horizontal well enables a much larger section of the shale formation to be accessed, therefore more gas to be produced from the shale.[163] The hydraulic fracturing technology is dealt with in section 2.5 below.

2.5 Hydraulic Fracturing

The exploitation of shale gas without the use of hydraulic fracturing is currently not possible.[164] This is because the shales which hold the gas do not have sufficient permeability, that is, the flow-path through which the gas can flow.[165] Cracking the shale rock formation through hydraulic fracturing creates the flow-paths required to produce the gas to the surface.[166] However, hydraulic fracturing poses serious risks to

[161] Figure 2 was adapted from a schematic obtained from Steven Finley, Eugene Wexler & Robin Watts 'Shale Gas Workshop' (2014) available at www.lindeoilandgas.com, accessed on 31 August 2022.
[162] M Burns, D Atkinson, O Barker, C Davis, L Day, A Dunlop, S Esterhuyse, Hobbs P, I McLachlan, H Neethling, N Rossou, S Todd, L Snyman-Van der Walt, E Van Huyssteen, S Adams, M de Jager, Z Mowzer and B Scholes 'Scenarios and Activities' (2016) at 1-9, in Bob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager, *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (Pretoria, CSIR).
[163] Ibid, at 1-10.
[164] Academy of Science of South Africa (ASSAf) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 24 (ASSAF, Pretoria).
[165] Ibid.
[166] Ibid.

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human health and the environment, if not mitigated.[167] The hydraulic fracturing process and evolution are outlined below.

2.6 Hydraulic Fracturing: Process and Evolution

Hydraulic fracturing (figure 3) commences once a well has been drilled and completed.[168] It involves the firing of explosive charges by an electric current to perforate holes at selected rock intervals where shale gas is to be produced.[169] Pumps are used to inject fracturing fluids, mainly water, proppant (sand), and small amounts of chemicals (e.g. hydrochloric acid, methanol, ethylene glycol, sodium hydroxide and others)[170] under high pressure into the well.[171] The injection of the hydraulic fracturing fluids under pressure create the fractures in the shale formation.[172] The newly formed fractures extend a few hundred meters into the rock formation and are kept open by the injected sand/proppant.[173] Additional fluids are pumped into the well to maintain pressure so that fracture development can continue and the sand can be carried deeper into the formation.[174]

[167] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22.
[168] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 8, available from https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf accessed on 03/08/2022; Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 37, available at https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf, accessed on 03/08/2022.
[169] Ibid.
[170] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 56, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31/08/2022.
[171] Jasmin Cooper, Laurence Stamford, and Adisa Azapagic 'Environmental Impacts of Shale Gas in the UK: Current Situation and Future Scenarios' (2014) at 1013, *Energy Technology* 2.
[172] Ibid.
[173] Ibid.
[174] Ibid.

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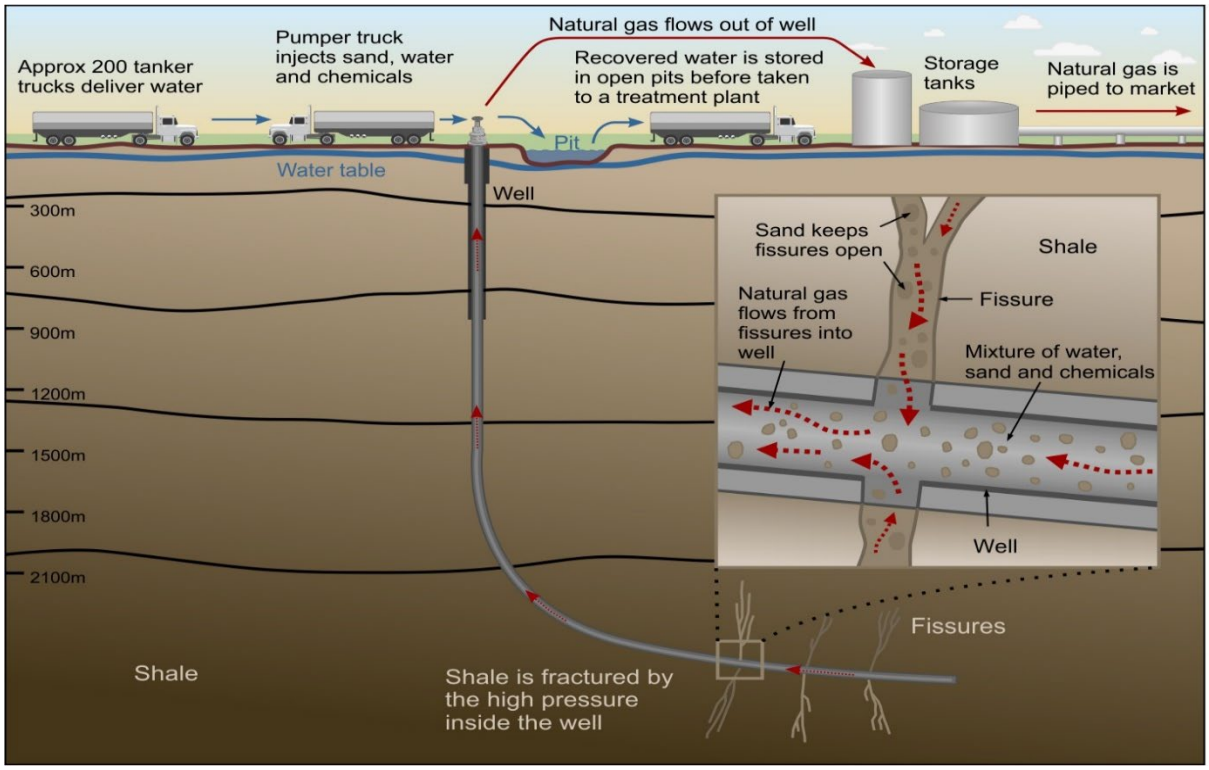

Figure 3: The Hydraulic Fracturing Process [175]

Before a well is hydraulically fractured, a series of tests are conducted to ensure that the well, wellhead and fracturing equipment are in good working condition and will safely withstand the fracture treatment pressures and pump rates to protect the environment.[176] Well construction and fracture design standards are regulated to ensure that the operations are safe and the environment is protected.[177] South Africa does not yet have regulations for shale gas wells and hydraulic fracturing operations,[178] there is therefore a risk that these tests could fail in the absence of guidelines to ensure the integrity of the wells and fracturing equipment. This thesis

[175] Figure 3 was adapted from a schematic obtained from Michael Quentin Morton 'Unlocking the Earth – A Short History of Hydraulic Fracturing' (2013) 10(6) GEOExPro, available at *http://www.geoexpro.com/articles/2014/02/unlocking-the-earth-a-short-history-of-hydraulic-fracturing*, accessed on 31 August 2022.

[176] J. Daniel Arthur, Brian Bohm & Davd Cornue 'Environmental Considerations of Modern Shale Gas Development' (2009) at 3, SPE Paper No. 122931, Presented to the SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October; The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 25, available from *https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf* accessed on 3 August 2022.

[177] Daniel Arthur, Brian Bohm & Davd Cornue 'Environmental Considerations of Modern Shale Gas Development' (2009) at 3, SPE Paper No. 122931, Presented to the SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October.

[178] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 20219).

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therefore recommends the adoption of the precautionary approach, where hydraulic fracturing on a commercial scale will only be allowed once the appropriate regulations have been promulgated.

Hydraulic fracturing is not an entirely new technology,[179] the first shale gas well was drilled and hydraulically fractured in Fredonia, New York, USA in 1821, although in a less sophisticated form.[180] This predates the drilling of the first oil well by Edwin Drake in Titusville, US, by almost 40 years.[181] From the 1860s to the 1920s, natural gas was produced in the Appalachian and Illinois basins from shallow and low-pressured fractured shales.[182] In the 1930s, shale gas was produced in the Northern Michigan Basin through the use of hydraulic fracturing.[183] In its more sophisticated modern-day form, the use of hydraulic fracturing to stimulate conventional oil and gas wells dates back to 1947.[184]

Another significant technological development necessary to enable further shale gas production was the development of downhole motors (when lowered into the well/borehole these motors help steer the drilling, since they turn the drill bit from the vertical to a horizontal direction) in the early 1970s.[185] This technology made directional drilling, thus the drilling of horizontal wells possible.[186] Recent innovations that combine hydraulic fracturing with horizontal drilling and related technologies

[179] Paul C. Stern, Thomas Webler & Mitchell J. Small 'Special Issue: Understanding the Risks of Unconventional Shale Gas Development' (2014), at 1, *Environmental Science & Technology.*

[180] Carla Tagliaferri, Roland Clift, Paola Lettieri & Chris Chapman 'Shale gas: a life-cycle perspective for UK production' (2016) at 2, *Int J Life Cycle Assess.*

[181] J.C. Shaw, M.M. Reynolds, L.H. Burke 'Shale Gas Production Potential and Technical Challenges in Western Canada' (2006) at 2, Paper 2006-193, presented to the Petroleum Society's 7th Canadian International Petroleum Conference, Calgary, Alberta, Canada, 13-15 June.

[182] Ibid.

[183] O. Hausberger, L.A Högn & K Soliman 'Management Decision Matrix for Shale Gas Projects in Europe (2012) at 1, SPE Paper No. 162921, Presented to the SPE Hydrocarbon, Economics, and Evaluation Symposium, Alberta, Calgary, 24 - 25 October.

[184] Peter Jones, David Hillier and Daphne Comfort 'Fracking and public relations: rehearsing the arguments and making the case' (2013) at 385, *J. of Public Affairs* 13, 384-390.

[185] O. Hausberger, L.A Högn & K Soliman 'Management Decision Matrix for Shale Gas Projects in Europe (2012) at 1, SPE Paper No. 162921, Presented to the SPE Hydrocarbon, Economics, and Evaluation Symposium, Alberta, Calgary, 24 - 25 October.

[186] Ibid.

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(micro-seismic and other three-dimensional mapping techniques that were established in the 1980s),[187] made shale gas development more commercially viable in the US.[188]

The combination of these technologies to drill the first shale gas well in the Barnett shale by Michell Energy kick-started the shale gas revolution.[189] As a result more than one million shale gas wells have been hydraulically fractured to date, with about 20,000 new wells being hydraulically fractured in the United States annually.[190] It is fairly recently that the evolution of hydraulic fracturing and its more widespread use in areas that were not familiar to oil and gas activities has led to concerns.[191] These concerns have influenced the response of countries newly identified for shale gas exploitation, such as South Africa (section 2.7 below outlines these risks and concerns).

2.7 Hydraulic Fracturing: Risks and Concerns

The following sections provide a discussion of the main concerns associated with hydraulic fracturing, particularly the risks it poses to human health and the environment.[192] Environmental concerns associated with hydraulic fracturing include its use of vast amounts of water and chemicals that could contaminate surface and groundwater sources.[193] Secondly, it produces a considerable amount of wastewater that requires treatment for safe disposal, otherwise pose a risk to surface waters.[194]

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[187] Ibid.

[188] Michael Esposito, *Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction* (2013) at 172, 22, *Tulane Journal of International & Comparative Law*.

[189] O. Hausberger, L.A Högn & K Soliman 'Management Decision Matrix for Shale Gas Projects in Europe (2012) at 1, SPE Paper No. 162921, Presented to the SPE Hydrocarbon, Economics, and Evaluation Symposium, Alberta, Calgary, 24 - 25 October. Symposium, Alberta, Calgary, 24 - 25 October.

[190] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at ES-6, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31/08/2022.

[191] Paul C. Stern, Thomas Webler & Mitchell J. Small 'Understanding the Risks of Unconventional Shale Gas Development' (2014) at 1, *Environmental Science & Technology*.

[192] Michael Esposito '*Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction'* (2013) at 172, *Tulane Journal of International & Comparative Law* 22.

[193] Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) at 37, *Science of the Total Environment;* U.S. EPA 'Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)' (2016), Washington, DC, EPA/600/R-16/236F, available at www.epa.gov./hfstudy, accessed on 28/05/ 2022.

[194] Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24.4.

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Thirdly, the emission of methane, a potent greenhouse gas.[195] Fourthly, shale gas development could induce seismic events.[196]

2.7.1 Volume of Water Required

Shale gas development competes with the normal uses of water by plants, animals, and humans who rely on groundwater or surface water to survive.[197] Hydraulic fracturing requires large amounts of water over short periods of time, typically 10 and 30 million litres of water per well.[198] While significant, the amount of water needed to fracture a well is on par with other industrial uses.[199] To contextualize, the amount of water needed to fracture and operate a shale gas well for 10 years is equivalent to that required to water a golf course for a month, or to operate a 1,000 MW coal-fired power plant for 12 hours.[200] The water could be sourced from local groundwater aquifers, surface water sources, such as dams and rivers, treated wastewater from hydraulic fracturing operations, or transported from elsewhere (Figure 4).[201] The problem is that,

[195] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

[196] Matthew Cotton 'Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning' (2017) at 186, *Local Environment* 22(2).

[197] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 2-2, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31 August 2022.

[198] Academy of Science of South Africa, *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 77, DOI: http://dx.doi.org/10.17159/assaf.2016/0003; M Burns, D Atkinson, D, O Barker, C Davis, L Day, A Dunlop, S Esterhuyse, P Hobbs, I McLachlan, H Neethling, N Rossouw, S Todd, L Snyman-Van der Walt, E Van Huyssteen, S Adams, M de Jager, M, Z Mowzer and B Scholes 'Scenarios and Activities' (2016) at 1-62, in R Scholes, P Lochner, G Schreiner, L Snyman-Van der Walt G, and M de Jager (eds.) 'Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks' (2016), Pretoria: CSIR.

[199] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 20, available from https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf accessed on 3 August 2022.

[200] United Kingdom Department of Energy and Climate Change, *Fracking UK shale: water* (2014) at 6, available at http://www.programmeofficers.co.uk/Cuadrilla/CoreDocuments/CD41/CD41.53.pdf, accessed on 10 June 2022.

[201] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 4-5, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31 August 2022.

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given the size of the estimated resource, shale gas development in South Africa will require thousands of wells, therefore vast quantities of water.[202]

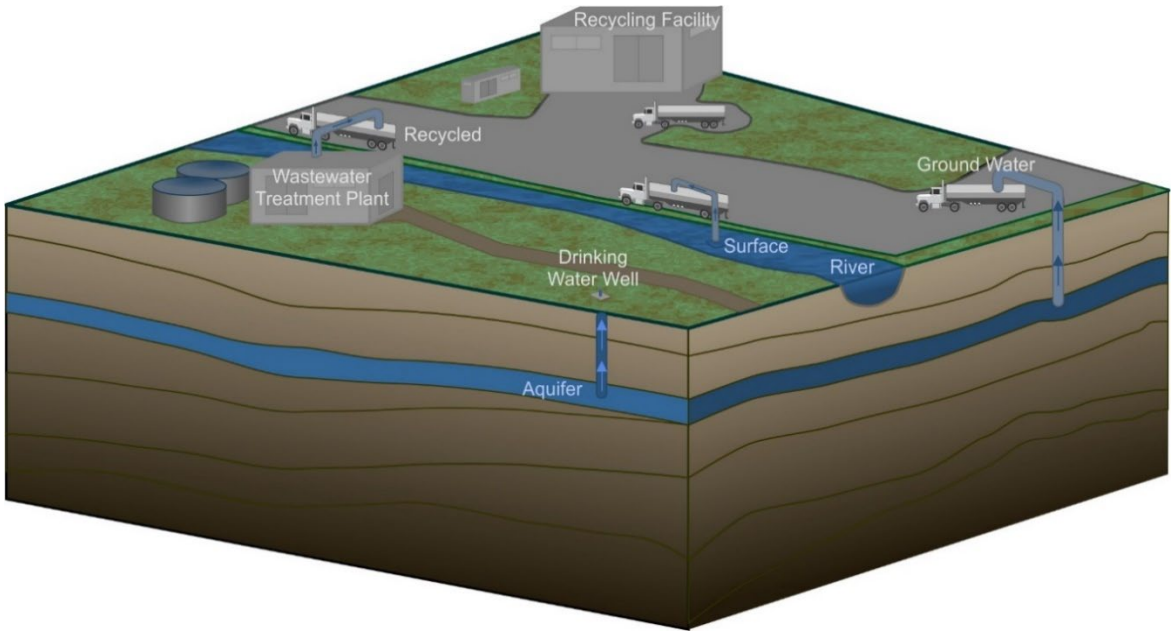

Figure 4: Potential Water Sources for Shale Gas Development [203]

South Africa is however water stressed and could become a water scarce country by 2025.[204] The Karoo is located inland of the coastal mountain ranges in the relatively dry interior of South Africa.[205] Due to a lack of dams and rivers, and sporadic rainfall, most Karoo towns heavily rely on groundwater resources for water supply.[206] There is therefore very limited surface water to enable significant industrial activities in the Karoo.[207]

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[202] P Hobbs, E Day, P Rosewarne & S Esterhuyse et al *Water Resources* (2016) at 5-9, in R Scholes, P Lochner, G Schreiner & L Snyman-Van der Walt et al (eds.) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) Pretoria: CSIR.

[203] This schematic has been simplified based on a schematic obtained from: United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at ES-10, Office of Research and Development, Washington DC, available at *www.epa.gov./hfstudy* accessed on 31 August 2022.

[204] Academy of Science of South Africa, *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 80.

[205] Ibid.

[206] Ibid.

[207] South African National Energy Development Institute, *A Study of Surface Issues and Geography of Potentially Suitable Gas Exploitation* (2015) at v, unpublished report.

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In relation to the decision as to whether and how to introduce hydraulic fracturing for shale gas in South Africa, the availability of ground water in the Karoo is not deeply understood.[208] This is due to a lack of information and data on groundwater systems at depths below 1000 meters, and their interaction with shallow water or ground water aquifers at depths of approximately 300 meters.[209] The quantity of water required for shale gas development, and the potential impact of hydraulic fracturing on water quality (discussed below) requires a holistic approach to the use and protection of water resources in the Karoo.[210] Such an approach must be preceded by the assessment of the availability and quality of surface and groundwater, and verification of existing uses.[211]

2.7.2 Contamination of Water Resources

The contamination of ground and surface water resources by chemicals used during the hydraulic fracturing process is a major concern globally and in the Karoo.[212] Contamination could be due to the upward migration of the hydraulic fracturing fluids into drinking water sources, groundwater and surface water.[213] The composition of hydraulic fracturing fluids differs from one reservoir to another, and between fracturing fluid contractors, but typically contains approximately 90 - 95 per cent water, 4 - 5 per cent proppant normally sand and 0.1 - 0.5 per cent chemicals (figure 5).[214]

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[208] Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 73.

[209] Ibid.

[210] Ibid.

[211] P Hobbs, E Day, P Rosewarne & S Esterhuyse et al *Water Resources* (2016) at 5-7, in R Scholes, P Lochner, G Schreiner & L Snyman-Van der Walt et al (eds.) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) CSIR, Pretoria.

[212] Terence J. Centner and Ludivine Petetin 'Permitting program with best management practices for shale gas wells to safeguard public health' (2015) 163 *Journal of Environmental Management 174-183;* P Hobbs, E Day, P Rosewarne, S Esterhuyse, R Schulze, J Day, J Ewart-Smith, M Kemp, N Rivers-Moore, H Coetzee, D Hohne, A Maherry, A Mosetsho and M de Jager (eds) 'Water Resources" (2016) at 5-9, in R Scholes, P Lochner, G Schreiner, L Snyman-Van der Walt G, and M de Jager (eds.) 'Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks' (2016) CSIR, Pretoria..

[213] Michael Esposito, *Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction* (2013) at 172, *Tulane Journal of International & Comparative Law* 22.

[214] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 26, available from *https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf* accessed on 3 August 2022.

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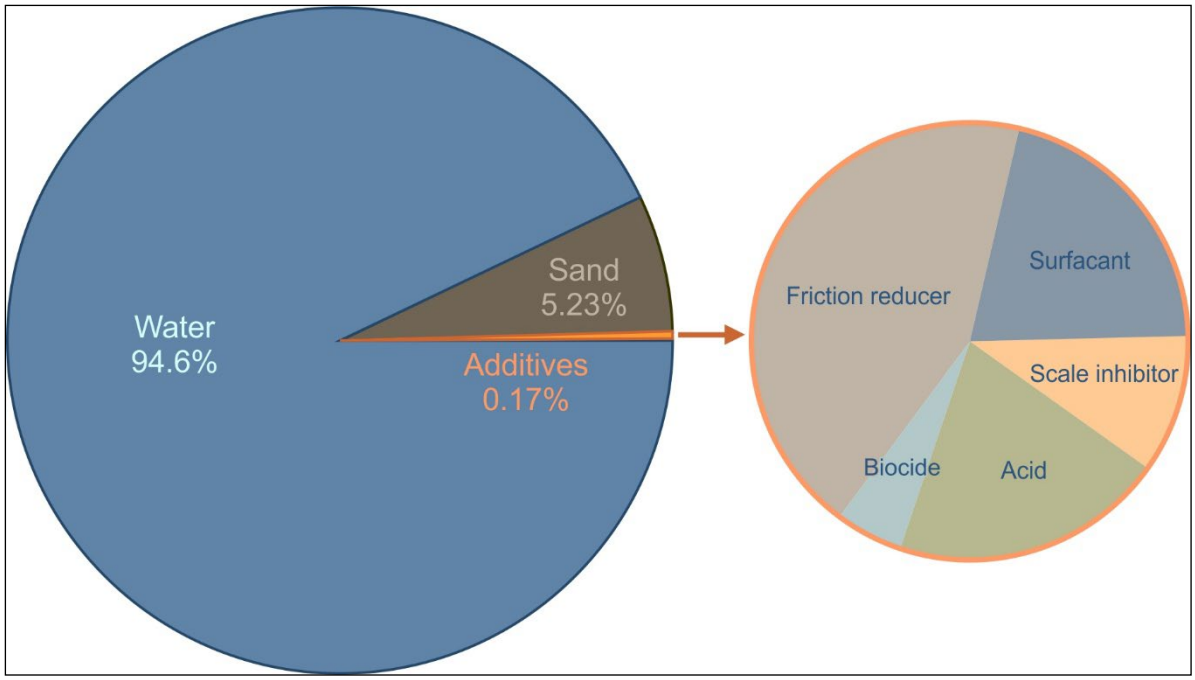

Figure 5: The Typical Composition of Hydraulic Fracturing Fluids [215]

Hydraulic fracturing fluids are engineered to create and extend fractures in the targeted rock formation, carry proppant through the gas wells into the newly created fractures, and keep the fractures open to enable the continuous flow of shale gas.[216] The chemicals used in hydraulic fracturing serve specific purposes, such as the dissolution of minerals and initiation of fractures in the rock; the elimination of bacteria that produce corrosive by-products in the water; the prevention of formation clays from swelling; and the prevention of corrosion of the pipes.[217]

The detailed composition of the chemical additives has been controversial because the companies that manufacture fracturing fluid components initially refused to

[215] Figure 4 was adapted from a schematic obtained from: The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 26, *available from https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf accessed on 3 August 2022*.

[216] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 5-8, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31 August 2022.

[217] Terence J. Centner and Ludivine Petetin 'Permitting program with best management practices for shale gas wells to safeguard public health' (2015) 163 *Journal of Environmental Management 174-183;* United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 5-8, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31 August 2022.

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disclose their exact composition on the basis that it was proprietary.[218] In 2010, growing concerns about the use of potentially harmful chemicals in the hydraulic fracturing process resulted in the United States House of Representative Committee on Energy and Commerce launching an investigation.[219] The investigation focussed on the chemicals used in hydraulic fracturing by fourteen oil and gas service companies in the period from 2005 until 2009.[220] That investigation found that some of the chemicals used were common and generally harmless such as salt and citric acid, while some were extremely toxic, such as benzene and lead.[221]

Subsequently, the United States Environmental Protection Agency (EPA) conducted a more comprehensive investigation of chemicals used in hydraulic fracturing operations in the US over the period 2005 to 2013, about 1084 chemicals.[222] The EPA found that some of the chemicals used for hydraulic chemicals are potentially harmful to human health, particularly if they enter drinking water sources.[223] Potential human health effects associated with oral exposure to some of the chemicals include cancer, immune system effects, changes in body weight, changes in blood chemistry, cardiotoxicity, neurotoxicity, liver and kidney toxicity, and reproductive and developmental toxicity.[224]

Given the concerns related to the use of potentially hazardous chemicals in the hydraulic fracturing process in South Africa, a transparent approach that compels full

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[218] US House of Representatives Committee on Energy and Commerce 'Chemicals used in hydraulic Fracturing' *(*2011) at 1, available at *http://ecolo.org/documents/documents_in_english/gas-_Hydraulic-Fract-chemicals-2011-report.pdf accessed on 31 May 2022;* Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 76, available at https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf, accessed on 3 August 2022.

[219] US House of Representatives Committee on Energy and Commerce 'Chemicals used in hydraulic Fracturing' *(*2011) at 1, available at *http://ecolo.org/documents/documents_in_english/gas-_Hydraulic-Fract-chemicals-2011-report.pdf* accessed on 31 May 2022.

[220] Ibid.

[221] Ibid.

[222] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at ES-20, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 31August 2022.

[223] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016) at 9-80, Office of Research and Development, Washington DC, available at *www.epa.gov./hfstudy* accessed on 31 August 2022.

[224] Ibid.

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disclosure of the chemicals used in hydraulic fracturing, while prohibiting those chemicals that pose a serious health hazard is recommended. Nonetheless, as standard practice, after the drilling of a shale gas well, and before the commencement of the hydraulic fracturing process, the well is sealed/cased with cement (figure 6) to prevent hydraulic fracturing chemicals from permeating into groundwater aquifers.[225] Nonetheless, almost all the incidents where groundwater contamination is reported to have occurred in the US mainly relate to bad cement casing jobs.[226] Regulating and monitoring the quality of cementing and well casing will therefore be crucial in South Africa, to ensure well integrity, thus the protection of water resources.

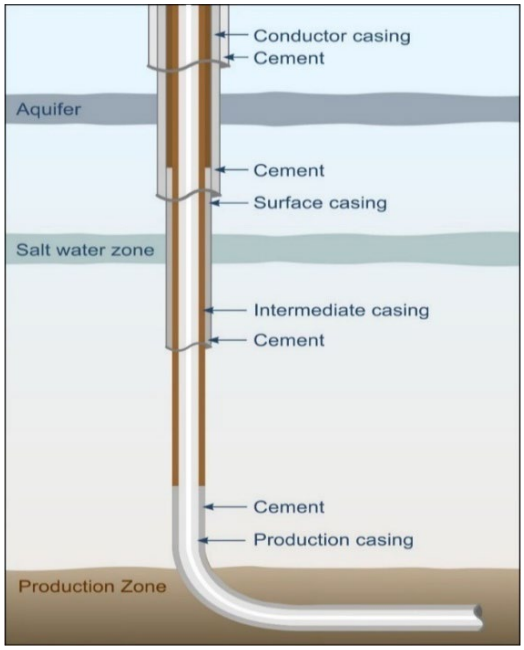

Figure 6: An Example of a Shale Gas Well Design [227]

2.7.3 Disposal of Wastewater

After the hydraulic fracturing of a shale gas well has been completed, the well is depressurised, and some of the injected fluid flow back to the surface for treatment,

[225] Michael Esposito, *Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction* (2013), at 172 *Tulane Journal of International & Comparative Law* 22.
[226] Ibid.
[227] This schematic was adapted from a schematic obtained from: The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 24, *available from https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf* accessed on 3 August 2022.

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recycling or disposal.[228] This fluid is mixed with gas, saline water containing minerals from the shale formation,[229] and chemicals used during the hydraulic fracturing process, some of which are toxic.[230] The volume of flow-back water depends on the properties of the shale, the fracturing design, and the type of fracturing fluid used.[231] The production of oil and gas from reservoirs typically comes with reservoir water production.[232] The hydraulic fracturing fluids consist of water, sand, and chemicals that are pumped into the reservoir during the fracturing process only.[233] Reservoir water continues to be produced to the surface throughout the life of the shale gas well.[234]

The management of the combined flow back and produced water streams (wastewater) has been of concern in the US and globally, particularly the uncontrolled releases or spillages that could contaminate surface water sources.[235] The treatment, recycling, and discharge of the wastewater stream also generated controversy in the US.[236] The standard wastewater disposal method in the US has been to inject the wastewater in underground reservoirs through a disposal well.[237] US legislators and environmental lobby groups have spoken out against this practice, concerned that the toxic substances in the wastewater could seep into drinking water sources, and the wastewater could result in earthquakes.[238] A more prudent practice is to recycle the wastewater for re-use in other hydraulic fracturing operations, as well as to treat the wastewater to drinkable level quality.[239]

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[228] Charles G. Groat & Thomas W. Grimshaw 'A Fact-Based Regulation for Environmental Protection in Shale Gas Development' (2012) at 24, Energy Institute - The University of Texas at Austin.
[229] Ibid.
[230] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 173, *Tulane Journal of International & Comparative Law* 22.
[231] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 20, available from *https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf* accessed on 3 August 2022.
[232] Charles G. Groat & Thomas W. Grimshaw 'A Fact-Based Regulation for Environmental Protection in Shale Gas Development' (2012) at 24, Energy Institute - The University of Texas at Austin.
[233] The Royal Society and Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing (2012) at 20, available from *https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf* accessed on 3 August 2022.
[234] Ibid.
[235] Charles G. Groat & Thomas W. Grimshaw 'A Fact-Based Regulation for Environmental Protection in Shale Gas Development' (2012) at 24, Energy Institute - The University of Texas at Austin.
[236] Ibid.
[237] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 173, *Tulane Journal of International & Comparative Law* 22.
[238] Ibid.
[239] Ibid.

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Moreover, waste such as mud used during drilling and produced water, can be managed by routine on-site containment.[240] The amount of waste and other possible impacts can be further minimized by reducing the number of wells drilled and locating some wells on the same well pad/containment area.[241] Such co-locating of multiple wells on the same pad enables the use of closed mud systems to maintain mud quality from well to well and cut down on waste by re-using mud.[242] The method of steel tanks for mud management allows operators to segregate speciality muds that may only be used over short intervals, while the tank can be moved to other wells.[243]

In South Africa, the National Environmental Management: Waste Act regulates waste and wastewater management.[244] The Act provides norms and standards for regulating the management of waste, licensing and control of waste management activities, remediation of contaminated land, and compliance and enforcement measures.[245] The Act does not specifically provide for waste from shale gas operations, therefore should be revisited to take such waste into consideration.

2.7.5 Induced Earth Tremors

Induced seismicity (earth tremors or minor earthquakes) is one of the key concerns associated with shale gas development.[246] Shale gas development can induce earth tremors in two ways, firstly, the hydraulic fracturing process can under certain circumstances give rise to minor earth tremors.[247] Secondly, the injection of wastewater (from the hydraulic fracturing process into shale formations as a means of

[240] Daniel Arthur, Brian Bohm and David Cornue, *Environmental Considerations of Modern Shale Gas Development* (2009) SPE Paper No. 122931, at 5, Presented at SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October 2009.
[241] Ibid.
[242] Ibid.
[243] Ibid.
[244] National Environmental Management: Waste Act, No. 59, 2008.
[245] National Environmental Management: Waste Act, No. 59, 2008.
[246] Huimin Tan, Gabrielle Wong-Parodi, Shumin Zhang and Jianhua Xu 'Public risk perceptions of shale gas development: A comprehensive review' (2022) at 6, vol.89, *Energy Research & Social Science*; Laurence Williams and Benjamin K. Sovacool 'The discursive politics of 'fracking': Frames, storylines, and the anticipatory contestation of shale gas development in the United Kingdom' at 2, (2019) vol 58, *Global Environmental Change 101935.*
[247] Academy of Science of South Africa, *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 109, DOI: http://dx.doi.org/10.17159/assaf.2016/0003.

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disposal) reaching natural geological faults could give rise to more underground movements, which can potentially be felt at ground level.[248]

In 2011, small tremors were experienced at Preese Hall near Blackpool in the United UK, where hydraulic fracturing operations were taking place.[249] As a result, the UK Department of Energy and Climate Change suspended all operations at the site and instituted an investigation into the cause.[250] The tremors measured magnitudes 1.5 and 2.3 on the Richter scale.[251] Earthquakes of this size are not normally felt at the surface.[252] The detailed technical investigations and independent review found that the tremors may have been caused when hydraulic fracturing fluids flowed into a geological fault.[253]

US shale gas operations have been associated with larger earthquakes, for example, minor earthquakes associated with hydraulic fracturing that recorded 4.6 on the Richter scale occurred in Texas and were felt all the way to San Antonio.[254] These were associated with large quantities of wastewater being re-injected into the rock formations.[255] A lesson to be learned is that before any commercial shale gas production takes in South Africa, the geology of the Karoo needs to be thoroughly studied, including geological faults that may exist in the shale gas sweet spot area. Such a deeper understanding of the Karoo's geology which can only be gained through exploration drilling would ensure that the placement of shale gas wells is done in a manner that avoids the faults, thus hydraulic fracturing operations inducing seismic events when the pressurized fluids flow into natural geological faults.

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[248] Ibid.
[249] Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing' (2012) at 41.
[250] Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing' (2012) at 41.
[251] Ibid.
[252] Ibid.
[253] Ibid.
[254] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 174, *Tulane Journal of International & Comparative Law* 22.
[255] Ibid.

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2.7.4 Methane Emissions

There is general recognition that natural gas emits less carbon dioxide per unit energy produced relative to coal or oil.[256] This is however negated by the fact that the greenhouse gas effect of methane (the main component of natural gas, averaging 90 percent in concentration) is much higher than that of carbon dioxide.[257] Greenhouse gases are the gaseous constituents of the atmosphere that absorb and re-emit infrared radiation.[258] These gases, which include carbon dioxide and methane, intensify a natural phenomenon called the *greenhouse effect*, by forming an insulating layer in the atmosphere. [259]. This insulating layer reduces the amount of the sun's heat that radiates back into space, therefore having the effect of making the earth warmer.[260]

Methane may be more effective at trapping heat in the atmosphere than carbon dioxide, which makes methane a more potent greenhouse gas.[261] The impact of methane emissions from shale gas extraction to climate change may therefore be more severe.[262] Climate change refers to the ongoing change in weather patterns as a result of a general rise in atmospheric temperature.[263] The rise in the average global temperature is mainly due to the increasing concentration of greenhouse gases (GHGs) in the atmosphere as a result of human activities.[264] Methane gas can be emitted to the atmosphere during shale gas exploitation through flaring, venting or leakage.[265]

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[256] Joseph Tawonezvi 'The Legal and Regulatory Framework for the EU's Shale Gas Exploration and Production Regulating Public Health and Environmental Impacts' (2017) at 4, 2(1) *Energy.Ecol.Environ*.

[257] Robert W. Howarth 'A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

[258] Ibid.

[259] JT Houghton, GJ Jenkins & JJ Ephraums, *Climate Change: The IPCC Scientific Assessment* (1990) IPCC Working Group Report 1, University Press, Cambridge, Great Britain; Department of Environmental Affairs 'National Climate Change Response White Paper' (2011), at 8.

[260] Ibid.

[261] Ibid.

[262] Ibid.

[263] United Nations Framework Convention on Climate Change (1992) article 1.

[264] Ibid.

[265] Laurence Stamford & Adisa Azapagic *A Fractured truth* (2014), at 27, The Chemical Engineer; Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4).

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During flaring, methane (the main component in natural gas) is converted to carbon dioxide through the combustion process.[266] During venting on the other hand, methane does not undergo any combustion or burning, therefore is emitted to the atmosphere as is.[267] It is the emission of this vented methane that is more detrimental to the atmosphere, in terms of its greenhouse gas effect, than carbon dioxide from the burning of coal or oil.[268] Furthermore, the methane emissions from shale gas may be significantly larger than from conventional gas, considering the full shale gas lifecycle, which includes drilling, processing, transportation and use of the gas.[269] Therefore, methane emissions from shale gas and conventional gas could contribute more to greenhouse gas emissions than other fossil fuels, such as oil and coal, particularly over a 20-year time horizon following emission.[270] The 20-year time horizon is concerning because shale gas is regarded as a transitional fuel towards renewable energy sources over the next two to three decades.[271]

It should thus not be taken for granted that the exploitation of shale gas in South Africa will lead to a reduction in the country's greenhouse gas emissions, hence net-zero carbon emissions by 2050, consistent with global efforts under the Paris Agreement.[272] This is because methane emissions could be released into the atmosphere during shale gas extraction,[273] thereby negating the benefit of using gas to reduce the country's carbon dioxide emissions, since methane will have more impact to climate change over this period. The Intergovernmental Panel on Climate Change (IPCC) confirm that methane is a more potent greenhouse gas than carbon dioxide, however it has a much shorter residence time in the atmosphere, so its effect on global warming

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[266] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4).
[267] Laurence Stamford & Adisa Azapagic, *A Fractured truth* (2014) at 27, The Chemical Engineer.
[268] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural gas (2014) at 2, *Energy Science and Engineering*.
[269] Robert W. Howarth, Renee Santoro & Anthony Ingraffea 'Methane and the greenhouse gas footprint of natural gas from shale formations' (2011) at 685, *Climate Change Letter*.
[270] Ibid.
[271] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 2, *Energy Science and Engineering.*
[272] Steven Hadden, Jonathan D. Moyer and Jessica Rettig, *Fracking for shale gas in South Africa: blessing or curse?* (2013) at 4-5, Institute for Security Studies.
[273] Steven Hadden, Jonathan D. Moyer and Jessica Rettig 'Fracking for shale gas in South Africa: blessing or curse?' (2013) at 4-5, *Institute for Security Studies*.

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dissipates quickly.[274] Howarth concurs that methane has an atmospheric lifetime of about 12 years, while carbon dioxide has an effective influence on atmospheric chemistry of a century or longer.[275] This implies that methane has a short-term effect on the atmosphere compared to carbon dioxide.[276] In thinking about a legal framework that addresses hydraulic fracturing specifically, South Africa could learn from the US experience, and ensure that the petroleum legal framework provides for mitigations against methane emissions during shale gas exploitation.

2.8 Conclusions

The use of hydraulic fracturing to enhance the production of oil and gas is a well-established practice in the international petroleum industry, and dates back at least seven decades.[277] Refinements of the hydraulic fracturing technology, especially the combination of hydraulic fracturing with horizontal drilling,[278] and the emergence of technology to better image the sub-surface was an innovative breakthrough that ultimately led to the US shale gas revolution.[279] As a result, the US has made great strides towards its energy security.[280] The US furthermore significantly reduced its greenhouse gas emissions, therefore its contribution to climate change.[281] Approached correctly, and learning from the US experience, the exploitation of shale gas could potentially enhance South Africa's energy security of supply, and significantly reduce its carbon dioxide emissions. Chapter 3 below explores the global climate change regime, South Africa's role in it, and how the exploitation of shale gas could contribute to the country's efforts to transition to net-zero carbon emissions by 2050.

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[274] IPCC 'Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2015). IPCC, Geneva, Switzerland.

[275] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 6, *Energy Science and Engineering.*

[276] R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 4, *Southern African Business Review*; 18(2).

[277] O. Hausberger, L.A Högn & K Soliman, Management Decision Matrix for Shale Gas Projects in Europe (2012) at 1, SPE Paper No. 162921, Presented to the SPE Hydrocarbon, Economics, and Evaluation Symposium, Alberta, Calgary, 24 - 25 October 2012.

[278] Ibid.

[279] Ibid.

[280] Minh-Thong Le 'An assessment of the potential for the development of the shale gas industry in countries outside of North America' (2018) at 2, *Helyon* 4.

[281] Ibid, at 3.

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CHAPTER 3: CLIMATE CHANGE AND SHALE GAS

3.1 Introduction

As outlined in Chapter 1 of this thesis, shale gas could reduce South Africa's carbon dioxide emissions, therefore the country's contribution to climate change.[282] This is an important consideration because South Africa is reliant on coal as a primary energy source.[283] As a result, it is a significant contributor to global climate change, comparable to industrialised countries,[284] and more populous and fast-growing developing countries, such as India and China.[285] Climate change, which manifests as increasing temperatures, flooding, erratic changes in rainy seasons, and winds, have a detrimental impact on water and food security, people's health, infrastructure, the ecosystem, and biodiversity.[286] The consequence is the retardation of social and economic development, particularly in developing countries, where economic development is critically needed.[287]

Recognising the increasing risks posed by global climate change, the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to help assess the available scientific data and recommend strategies

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[282] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* at 227 (Oxford University Press, London); Mark D. Zoback & Douglas J. Arent 'Shale Gas Development: Opportunities and Challenges' (2014) in The Bridge *Linking Engineering and Society* at 44(1) (National Academy of Engineering, Washington); R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review*; 18(4); Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 42 in *The Bridge – Linking Engineering and Society* 44(1) (National Academy of Engineering, Washington).

[283] Theresa Moyo 'Low Carbon and Climate Resilient Investments – Is South Africa Doing Enough?' (2016) at 130, *Africa Insight* 45(4).

[284] Ibid.

[285] Miguel Arias Canete 'Paris is Much More Than the Deal' (2015) at 40, *New Scientist* (234) 3129.

[286] IPCC 'Climate Change 2014: Synthesis Report – Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2014) at 6 (IPCC, Geneva, Switzerland); Gina Ziervogel et al 'Climate change in South Africa – how are we tackling this?' (2015) at 6, *Quest* 11; International Energy Agency 'Africa Energy Outlook: World Energy Outlook Special Report' (2022) at 46, available at https://iea.blob.core.windows.net/assets/6fa5a6c0-ca73-4a7f-a243-fb5e83ecfb94/AfricaEnergyOutlook2022.pdf, accessed on 18 July 2022.

[287] Gina Ziervogel et al 'Climate change in South Africa – how are we tackling this?' (2015) at 6, *Quest* 11.

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to manage climate change.[288] As a result, scientists from across the globe worked together to deepen the scientific understanding of climate change.[289] In 1990, this work culminated in the First Assessment of the IPCC.[290] Since then, the IPCC's reports have become authoritative on the growing scientific understanding of climate change and its impact.[291] The appreciation that global climate change was a reality that was brought about by the IPCC scientific assessment led to the global climate change treaty dubbed the *United Nations Framework Convention on Climate Change* (UNFCCC).[292] The UNFCCC is discussed below, together with the evolving climate change regime, which seeks to galvanise global action to mitigate climate change.

3.2 The United Nations Framework Convention on Climate Change

The UNFCCC emanated from concern that human activities were increasing the atmospheric concentrations of greenhouse gases, thereby leading to a warming of the earth.[293] Greenhouse gases include Carbon Dioxide (CO_2); Methane (CH_4); Nitrous Oxide (N_2O); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).[294] Greenhouse gases absorb and re-emit infrared radiation, rather than allowing it to escape to space, thus causing a warming of the earth.[295] The

[288] JT Houghton, GJ Jenkins & JJ Ephraums 'Climate Change: The IPCC Scientific Assessment' (1990) at iii (Cambridge University Press, Cambridge); Milan M. Radovanovic, Vladan Ducic & Saumitra Mukherjee 'Climate Changes Instead of Global Warming' (2014) at 1056, *Thermal Science* (18)3.

[289] JT Houghton, GJ Jenkins & JJ Ephraums 'Climate Change: The IPCC Scientific Assessment' (1990) at iii (Cambridge University Press, Cambridge); Pamela Chasek 'The Paris Negotiations: Background and Context' (2021) at 21 in Hendrik Jepsen, Magnus Lundgren, Kai Monheim & Hayley Walker (Eds) *Negotiating the Paris Agreement: The Insider Stories* (Cambridge University Press United Kingdom).

[290] Ibid.

[291] Robin Kundis Craig 'Mitigation and Adaptation' (2021) at 50 in Elise Johansen, Signe Veierud Busch & Ingvild Ulrikke Jakobsen *The Law of the Sea and Climate Change: solutions and constraints* (2021) (University Printing House, Cambridge).

[292] United Nations 'United Nations Framework Convention on Climate Change' (1992) FCCC/INFORMAL/84GE.05-62220 (E) 200705; Pamela Chasek 'The Paris Negotiations: Background and Context' (2021) at 21 in Hendrik Jepsen, Magnus Lundgren, Kai Monheim & Hayley Walker (Eds) *Negotiating the Paris Agreement: The Insider Stories* (Cambridge University Press, United Kingdom).

[293] United Nations 'United Nations Framework Convention on Climate Change' (1992) FCCC/INFORMAL/84GE.05-62220 (E) 200705.

[294] United Nations 'Kyoto Protocol to the United Nations Framework Convention on Climate Change' (1997) Annex A, available at https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf, accessed on 11 June 2022; JT Houghton, GJ Jenkins & JJ Ephraums 'Climate Change: The IPCC Scientific Assessment 1' (1990) at 5 (Cambridge University Press, Cambridge); Mesarovic M.M 'Scientific Uncertainties Feed Scepticism on Climate Change' (2015) at 259, *Thermal Science* (19)2.,

[295] Article 1(5) of the UNFCCC.

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UNFCCC was adopted at the UN Earth Conference on Environment and Development in Rio de Janeiro in June 1992 and came into force in March 1994.[296]

The ultimate objective of the UNFCCC and related legal instruments that the Conference of the Parties (COP) adopted was to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human interference with the climate system.[297] Such a level had to be achieved within a time horizon that would enable ecosystems to adapt naturally to climate change, to ensure security of food supply and sustainable economic development.[298] The UNFCCC is the cornerstone of global climate change governance, and its rules, norms, institutions, and procedures are facilitating cooperative action, affecting behaviour, and are galvanising funding support for climate action.[299] To give effect to the UNFCCC, the Kyoto Protocol,[300] was adopted on 11 December 1997 in Kyoto, Japan,[301] see discussion below.

3.3 The Kyoto Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change,[302] was adopted at the third Conference of the Parties on 11 December

[296] Jana von Stein 'The International Law and Politics of Climate Change: Ratification of the United Nations Framework Convention and the Kyoto Protocol' (2008) at 245, *The Journal of Conflict Resolution* 52(2); James Ford, Michelle Maillet, Vincent Pouliot, Thomas Meredith & Alicia Cavanaugh 'Adaptation and Indigenous Peoples in the United Nations Framework Convention on Climate Change' (2016) at 430, *Climate Change* 139.

[297] Article 2 of the UNFCCC; Donald Zillman, Martha Roggenkamp, LeRoy Paddock, & Lee Godden 'Introduction: How Technological and Legal Innovation Are Transforming Energy Law' (2018) at 4 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, London).

[298] Article 2 of the UNFCCC; Yun Gao, Xiang Gao and Xiaohua Zhang 'The 2 °C Global Temperature Target and the Evolution of the Long-Term Goal of Addressing Climate Change - From the United Nations Framework Convention on Climate Change to the Paris Agreement' (2017) at 272, *Engineering 3*.

[299]James Ford, Michelle Maillet, Vincent Pouliot, Thomas Meredith and Alicia Cavanaugh 'Adaptation and Indigenous Peoples in the United Nations Framework Convention on Climate Change' (2016) at 430, *Climate Change* 139.

[300] United Nations 'Kyoto Protocol to the United Nations Framework Convention on Climate Change' (1997) available at *https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf*, accessed on 11 June 2022.

[301] Jana von Stein 'The International Law and Politics of Climate Change: Ratification of the United Nations Framework Convention and the Kyoto Protocol' (2008) at 245, *The Journal of Conflict Resolution* 52(2).

[302] United Nations 'Kyoto Protocol to the United Nations Framework Convention on Climate Change' (1997) available at *https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf*, accessed on 11 June 2022.

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1997.[303] Due to a complex ratification process, the Protocol only entered into force on 16 February 2005 following ratification by 55 parties to the UNFCCC, including parties accounting for at least 55 percent of the total carbon dioxide emissions in 1990.[304] When it came into effect,141 countries had ratified the Protocol, and 192 countries are currently parties to it.[305]

Premised on the UNFCCC principle of *common but differentiated responsibility based on respective capabilities*, a foundational principle to share the burden of addressing climate change,[306] the Protocol only bound developed countries in the first commitment period.[307] This is because it recognized that they were primarily responsible for the high levels of greenhouse gas emissions in the atmosphere.[308] The Protocol set a target for industrialized countries to reduce their combined greenhouse gas emissions by at least five per cent below 1990 levels in the first commitment period (2008 to 2012).[309] The Kyoto Protocol further sought to encourage governments to enhance energy efficiencies, promote research, development, and the use of new and renewable forms of energy, together with innovative and environmentally sound technologies.[310]

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[303] Jana von Stein 'The International Law and Politics of Climate Change: Ratification of the United Nations Framework Convention and the Kyoto Protocol' (2008) at 245, *The Journal of Conflict Resolution* 52(2).

[304] United Nations 'What is the Kyoto Protocol?' available at *https://unfccc.int/kyoto_protocol*, accessed on 11 June 2022.

[305] Ibid.

[306] Article 3 of the Kyoto Protocol; Mizan R. Khan & Sirazoom Munira 'Climate change adaptation as a global public good: implications for financing' (2021) at 2, *Climate Change* 167(50); Robyn Eckersley 'The common but differentiated responsibilities of states to assist and receive climate refugees' (2015) 486, *European Journal of Political Theory* 14(4) 481 – 500; Yoshiro Matsui 'Some Aspects of the Principle of Common but Differentiated Responsibilities' (2012) at 155, *International Environmental Agreements: Politics, Law and Economics* 2: 151-171.

[307] Article 3 of the Kyoto Protocol; Sandrine Maljean-Dubois 'The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in Climate Regime?' at 151, (2016) *Review of European Community & International Environmental Law* 25(2); Mizan R. Khan & Sirazoom Munira 'Climate change adaptation as a global public good: implications for financing' (2021) at 2, *Climate Change* 167(50).

[308] Mizan R. Khan & Sirazoom Munira 'Climate change adaptation as a global public good: implications for financing' (2021) at 2, *Climate Change* 167(50); Sandrine Maljean-Dubois 'The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in Climate Regime?' at 151, (2016) *Review of European Community & International Environmental Law* 25(2).

[309] Article 3 of the Kyoto Protocol.

[310] Article 2 of the Kyoto Protocol; Sandrine Maljean-Dubois 'The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in Climate Regime?' at 151, (2016) *Review of European Community & International Environmental Law* 25(2)

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The United States did not ratify the Kyoto Protocol because they were not happy that the Protocol only set a target for developed countries to reduce their greenhouse gas emissions when developing countries such as China and India were significant contributors to greenhouse gas emissions.[311]

3.4 The Copenhagen Accord

The 15th Conference of the Parties (COP15) to the UNFCCC was held in Copenhagen, Denmark in December 2009, and was widely expected to result in commitments on quantified emissions reduction targets being made for the post-2012 climate change regime.[312] Despite several countries, including South Africa,[313] committing to quantifiable emissions reduction targets in Copenhagen, COP15 did not meet expectations.[314] The Copenhagen Accord which emerged from COP15 is merely a political agreement and does not represent a legal Protocol pertaining to the post-2012 period.[315] Despite that, the Accord contained several key elements of convergence.[316] Chief among these was the long-term goal of limiting the global average temperature increase to 2 degrees Celsius above pre-industrial levels.[317]

Secondly, the consideration to limit the temperature increase below 1.5 degrees Celsius.[318] Thirdly, developed countries committed to fund efforts by developing

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[311] Sandrine Maljean-Dubois 'The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in Climate Regime?' at 151, (2016) *Review of European Community & International Environmental Law* 25(2); Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 50, *China Perspectives*, Issue 1.

[312] Werner Scholtz 'The promotion of regional environmental security and Africa's common position on climate change' (2010) at 22, *African Human Rights Law Journal* 10(1).

[313] Daniel Bodansky 'The Copenhagen Climate Change Conference: A Postmortem' (2010) at 233, *American Journal of International Law* 230.

[314] Miguel Arias Canete 'Paris is Much More Than the Deal' (2015) at 40, *New Scientist* 234(3129).

[315] Werner Scholtz 'The promotion of regional environmental security and Africa's common position on climate change' (2010) at 22, *African Human Rights Law Journal* 10(1); Daniel Bodansky 'The Copenhagen Climate Change Conference: A Postmortem' (2010) at 235, *American Journal of International Law* 230.

[316] Miguel Arias Canete 'Paris is Much More Than the Deal' (2015) at 40, *New Scientist* 234(3129); Daniel Bodansky 'The Copenhagen Climate Change Conference: A Postmortem' (2010) at 230, *American Journal of International Law* 230.

[317] United Nations '*United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session'* at 5, held in Copenhagen from 7 to 19 December 2009; Miguel Arias Canete 'Paris is Much More Than the Deal' (2015) at 40, *New Scientist* 234(3129); Daniel Bodansky 'The Copenhagen Climate Change Conference: A Postmortem' (2010) at 230, *American Journal of International Law* 230.

[318] United Nations 'United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session, at 5 - 7, held in Copenhagen from 7 to 19

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countries to reduce their greenhouse gas emissions and adapt to the effects of climate change.[319] Fourthly, developed countries committed to provide US$30 billion towards climate change mitigation in developing countries for the period 2010 to 2012 and mobilize long-term finance of a further US$100 billion a year by 2020.[320] An agreement on the measurement, reporting and verification of developing country emissions and actions to mitigate climate change also emerged from Copenhagen.[321] The failure to have a legally binding Protocol in Copenhagen subsequently led to a more robust review of the progress made to emissions reductions as espoused in the Kyoto Protocol.[322] The resultant comprehensive review culminated into the Doha Amendments to the Kyoto Protocol,[323] discussed in section 3.5 below.

3.5 The Doha Amendment to the Kyoto Protocol

At the end of the first commitment period on 8 December 2012, the Kyoto Protocol was amended in Doha, Qatar.[324] The amendments included binding greenhouse gas reduction commitments for all countries that have ratified the amendment to the Kyoto Protocol.[325] This is unlike the first commitment period of the Protocol which only had binding commitments for developed countries.[326] The amendment marked the second commitment period covering 1 January 2013 to 31 December 2020.[327] Nonetheless, the United States' continued non-ratification of the Kyoto Protocol served to discourage other countries to implement their greenhouse gas reduction targets, therefore

December 2009; The Copenhagen Climate Change Conference: A Postmortem' (2010) at 230, *American Journal of International Law* 230.

[319] United Nations 'United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session, at 5 - 7, held in Copenhagen from 7 to 19 December 2009; The Copenhagen Climate Change Conference: A Postmortem' (2010) at 237, *American Journal of International Law* 230.

[320] United Nations 'United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session, at 5 - 7, held in Copenhagen from 7 to 19 December 2009; The Copenhagen Climate Change Conference: A Postmortem' (2010) at 237, *American Journal of International Law* 230.

[321] United Nations 'United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session, at 5 - 7, held in Copenhagen from 7 to 19 December 2009.

[322] Miguel Arias Canete 'Paris is Much More Than the Deal' (2015), at 40, *New Scientist*, Vol.234, Issue 3129.

[323] United Nations 'Doha amendment to the Kyoto Protocol' (2012).

[324] Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) 293, *The American Journal of International Law* 110 (269).

[325] Article 1 of the Doha amendment to the Kyoto Protocol.

[326] Annexure B of the Kyoto Protocol (1998).

[327] Article 1 of the Doha amendment to the Kyoto Protocol.

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rendering the Protocol ineffective.[328] This was recognized in 2011 at COP17 in Durban, South Africa.[329]

The Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) was therefore established to develop a new global agreement to limit greenhouse gas emissions to the atmosphere.[330] Such an agreement had to have legal force and be applicable to all parties under the UNFCCC.[331] The ADP had to complete its work no later than 2015, so that the emergent agreement (Paris Agreement, discussed in section 3.6 below) could be adopted at the 21st Conference of the Parties at the end of 2015.[332] The Fifth Assessment Report (AR5) of the IPCC underscored the gravity of the situation.[333] It observed that recent climate changes had a devastating impact on human and natural systems on all continents and across oceans.[334]

3.6 The Paris Agreement

The Paris Agreement was adopted at the 21st Conference of the Parties by 195 countries and the EU.[335] By then it had become clear that limiting future climate change required substantial and sustained reduction of greenhouse gas emissions.[336] Prior to the 21st Conference of the Parties, participating countries were urged to make pledges known as 'Intended Nationally Determined Contributions' to reduce their carbon emissions, according to their respective capabilities.[337] This consensus-driven

[328] Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 49, *China Perspectives* 1.
[329] United Nations 'Report of the Conference of the Parties on its seventeenth session' (2012) at 2, held in Durban from 28 November to 11 December 2011.
[330] Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) 293, *The American Journal of International Law* 110(269).
[331] United Nations 'Report of the Conference of the Parties on its seventeenth session' (2012) at 2, held in Durban from 28 November to 11 December 2011.
[332] Ibid.
[333] IPCC, *Climate Change 2014: Synthesis Report – Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014) at 6, IPCC, Geneva, Switzerland.
[334] Ibid.
[335] United Nations 'Paris Agreement' (2015) available at *https://unfccc.int/sites/default/files/english_paris_agreement.pdf* accessed on 11 June 2022; Ralph Bodle, Lena Donat and Matthias Duwe 'The Paris Agreement: Analysis, Assessment and Outlook' (2016) at 5, *CCLR* 1.
[336] Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 49, *China Perspectives* 1.
[337] UCT 'South Africa's "fare share": mitigation targets in the updated first NDC in an international context' (2021) at 8, Energy Systems Research Group, University of Cape Town, Cape Town; Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate

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approach amassed considerable buy-in as demonstrated by the overwhelming support of the Paris Agreement.[338]

The legally binding accord set the long-term goal of limiting global warming to well below two degrees Celsius, with the ultimate goal to reduce global warming to 1.5 degrees Celsius above pre-industrial levels by the end of the 21st Century.[339] Other non-binding concessions were made in Paris, such as participating countries agreeing to review their respective Nationally Determined Contributions every five years, as a mechanism to monitor the effectiveness of greenhouse gas emissions reduction globally.[340]

Furthermore, developed countries undertook to discuss a roadmap to boost climate finance to US$100 billion per year by 2020, to help developing countries in mitigating and adapting to the impact of climate change.[341] The Paris Agreement came into effect in 2021, following the expiration of the Kyoto Protocol in December 2020.[342] Soon after its coming into effect, the 26th Conference of the Parties that was held in Glasgow, Scotland in 2021 resulted in the Parties to the UNFCCC taking far reaching decisions, such as the pledge to reduce global carbon emissions to net-zero by 2050.[343] The Outcome of the 26th Conference of the Parties and implications is discussed in section 3.9 of this chapter.

Change' (2016) at 49, *China Perspectives* 1; Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) at 293.

[338] Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) at 289, *The American Journal of International Law* 110(269); Brian Deese 'Paris Isn't Burning' (2017) at 83, *Foreign Affairs* 96(4).

[339] Article 2(a) of the Paris Agreement (2015), Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) 290, *The American Journal of International Law* 110 (269); Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 51, *China Perspectives* 1.

[340] Article 4(9) of the Paris Agreement (2015).

[341] Article 9 of the Paris Agreement (2015).

[342] Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 51, (1) *China Perspectives*.

[343] United Nations 'United Nations Framework Convention on Climate Change' Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021.

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The Paris Agreement overcame significant political challenges that prevented the effective implementation of the Kyoto Protocol.[344] The critical stance of the United States on the leniency of the Kyoto Protocol towards developing countries some of whom are major contributors to climate change, and China's attitude towards climate change was a major hindrance to the implementation of the Kyoto Protocol.[345] Under the Obama administration, concerted bilateral efforts by the United States and China led to a more solution oriented approach to climate change by these two major world economies.[346] The prior constructive engagements between the United States and China are to a large extent credited for the emergence of the Paris Agreement.[347]

The election of Mr Donald Trump as the American President in 2016 threatened global efforts to mitigate climate change.[348] Six months after he was sworn in, President Trump announced the withdrawal of the US from the Paris Agreement on 1 June 2017.[349] This was because 'the Paris Accord placed a huge financial and economic burden on the United States, thus disadvantaging the United States to the benefit of other countries'.[350] Consequently, together with the onerous energy restrictions that it places on the United States, the Paris Accord could cost the United States as much as 2.7 million jobs by 2025.[351] President Trump further asserted that the Paris Agreement was punishing the United States, a leader in environmental protection,

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[344] Daniel C. Esty and Dena AT Adler 'Changing International Law for a Changing Climate' (2018) 284 *American Journal of International Law* 112.

[345] Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) 293, *The American Journal of International Law* 110(269); Brian Deese 'Paris Isn't Burning' (2017) at 83, *Foreign Affairs* 96(4); Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 50, *China Perspectives* 1.

[346] Daniel Bodansky 'The Paris Climate Change Agreement: A New Hope' (2016) 293, *The American Journal of International Law* 110(269); Anthony H.F Li 'Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change' (2016) at 50, *China Perspectives* 1.

[347] Ibid.

[348] Brian Deese 'Paris Isn't Burning' (2017) at 83, 96(4) *Foreign Affairs*, Jul/Aug.

[349] Daniel C. Esty and Dena AT Adler 'Changing International Law for a Changing Climate' (2018) 280 *American Journal of International Law* 112; UCT 'South Africa's "fare share": mitigation targets in the updated first NDC in an international context' (2021) at 39, Energy Systems Research Group, University of Cape Town, Cape Town; Administration of Donald J. Trump 'Remarks Announcing United States Withdrawal From the United Nations Framework Convention on Climate Change Paris Agreement' (2017), Authenticated U.S. Government Information (GPO) - Daily Compilation of Presidential Documents, 1 June.

[350] Administration of Donald J. Trump 'Remarks Announcing United States Withdrawal From the United Nations Framework Convention on Climate Change Paris Agreement' (2017) Authenticated U.S. Government Information (GPO) - Daily Compilation of Presidential Documents, 1 June.

[351] Ibid.

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while imposing no meaningful obligations on the world's leading polluters such as China and India.[352]

President Trump's decision to withdraw the United States from the Paris Agreement led to international condemnation.[353] The European Union strongly condemned the United States withdrawal from the Paris Agreement because such action could potentially reverse the 'first-ever truly global climate deal, a major multi-lateral deal of the twenty-first century'.[354] While carbon emissions from developed countries were declining, accounting for less than 35 per cent of global emissions, the European Union remained resolute that a global climate change pact that would galvanize the world towards decisive action had to emerge in Paris.[355] Accordingly, any meaningful deal had to have the buy-in and commitment of the major greenhouse gas emitters in the developing world, China, India, Brazil, South Africa, and Indonesia otherwise it was doomed to fail.[356]

The Trump Administration's thrust towards climate change led to a far-reaching-decision by the US Supreme Court in June 2022.[357] In *West Virginia et al. v. Environmental Protection Agency et al.*, the US Supreme Court ruled that the Clean Air Act,[358] does not give the US Environmental Protection Agency (EPA) the authority to set greenhouse gas emissions limits for existing coal power plants.[359] The process called generation shifting stems from the Obama administration's Clean Power Plan, a commitment to reduce US greenhouse gas emissions consistent with the Paris Agreement.[360]

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[352] Ibid.
[353] Brian Rowe 'Paris climate deal exit 'deeply troubling' to Catholic leaders' (2017), at 18, *National Catholic Reporter*, 16 June.
[354] Miguel Arias Canete 'Paris is Much More Than the Deal' (2015), at 40, *New Scientist* 234 (3129)
[355] Ibid.
[356] Ibid.
[357] *West Virginia et al. v. Environmental Protection Agency et al*. Supreme Court of the United States Certiorari to the United States Court of Appeals for the District of Columbia Circuit, No.20-1530, June 30, 2022.
[358] United States Clean Air Act, 1970.
[359] *West Virginia et al. v. Environmental Protection Agency et al*, at 6, Supreme Court of the United States Certiorari to the United States Court of Appeals for the District of Columbia Circuit, No.20-1530, June 30, 2022.
[360] Environmental Protection Agency 'Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units: Finale Rule' (2015) at 64663, *Federal Register* 80(205).

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Recognizing that power plants contribute the most to greenhouse gas emissions in the US, the Clean Power Plan recommends that limits be set for greenhouse gas emissions, and for measures to encourage a transition from coal to gas, and ultimately renewable energy sources for power generation be put in place.[361] In arriving at its decision, the US Supreme Court relied on the 'major questions doctrine'.[362] In terms of this doctrine, any issue with major economic or political consequences requires explicit congressional authorization in law.[363] The Supreme Court decision has the potential to curtail the EPA's efforts to regulate greenhouse gas emissions from existing power plants.[364]

The Supreme Court did not however altogether remove the EPA's authority to regulate carbon dioxide or other air pollutants from power plant pollutants.[365] While standards based on generation shifting are no longer allowed, the Clean Air Act,[366] still requires the EPA to regulate greenhouse gas pollution from power plants.[367] The EPA can still set standards for existing power plants,[368] to the extent that such emissions reduction standards do not require generation shifting to clean energy.[369] Furthermore, the *West Virginia v. EPA* ruling left many of the Clean Air Act's provisions intact, for example, the EPA can still regulate greenhouse gas emissions from new power plants.[370] The

[361] Ibid.
[362] *West Virginia et al. v. Environmental Protection Agency et al*, at 4, Supreme Court of the United States Certiorari to the United States Court of Appeals for the District of Columbia Circuit, No.20-1530, June 30, 2022.
[363] *West Virginia et al. v. Environmental Protection Agency et al*, at 6, Supreme Court of the United States Certiorari to the United States Court of Appeals for the District of Columbia Circuit, No.20-1530, June 30, 2022.
[364] Earthjustice & Evergreen Action "What Does West Virginia v. EPA Mean for Climate Action?" (2022) July 6, 2022, available at *https://earthjustice.org/blog/2022-july/what-does-west-virginia-v-epa-mean-for-climate-action* accessed on 09/07/2022.
[365] Earthjustice & Evergreen Action "What Does West Virginia v. EPA Mean for Climate Action?" (2022) July 6, 2022, available at *https://earthjustice.org/blog/2022-july/what-does-west-virginia-v-epa-mean-for-climate-action* accessed on 9 July 2022.
[366] United States Clean Air Act, 1970.
[367] Earthjustice & Evergreen Action "What Does West Virginia v. EPA Mean for Climate Action?" (2022) available at *https://earthjustice.org/blog/2022-july/what-does-west-virginia-v-epa-mean-for-climate-action* accessed on 9 July 2022.

[368] In terms of section 111(d) of the Clean Air Act, 1970.
[369] Earthjustice & Evergreen Action "What Does West Virginia v. EPA Mean for Climate Action?" (2022) July 6, 2022, available at *https://earthjustice.org/blog/2022-july/what-does-west-virginia-v-epa-mean-for-climate-action* accessed on 9 July 2022.
[370] Section 111(b) of the Clean Air Act, 1970.

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EPA can also still regulate carbon dioxide emissions from cars and methane emissions from oil and gas wells.[371]

Resolute to forge ahead with decisive action to tackle climate change in the US, President Joe Biden issued a very strong statement against the decision of the Supreme Court.[372] He lambasted the Supreme Court's ruling as 'another devastating decision that aimed to take the US backward and put the nation's ability to keep the air clean and combat climate change at risk'.[373]

As stated earlier in this chapter, the ultimate objective of the UNFCCC is to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system.[374] However, the related legal instruments that the Conference of the Parties historically adopted primarily focused on the impact of carbon dioxide emissions to climate change.[375] This was partly because from a legal and policy perspective, anthropogenic carbon dioxide is generally regarded as the most critical greenhouse gas since it is linked directly to the use of fossil fuels, particularly coal.[376] Furthermore, carbon dioxide remains in the atmosphere for a century or more, such that the earth remains warmer for a considerable amount of time into the future.[377]

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[371] Ibid.

[372] White House – Statements and Releases 'Statement by President Joe Biden on Supreme Court Ruling on West Virginia v. EPA' (2022) June 30 available *at https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/30/statement-by-president-joe-biden-on-supreme-court-ruling-on-west-virginia-v-epa/* accessed on 9 July 2022.

[373] Ibid.

[374] United Nations 'United Nations Framework Convention on Climate Change' (1992) Article 2.

[375] Robin Kundis Craig 'Mitigation and Adaptation' in Elise Johansen, Signe Veierud Busch, Ingvild Ulrikke Jakobsen 'The Law of the Sea and Climate Change: solutions and constraints' (2021) at 54 (University Printing House, Cambridge, United Kingdom).

[376] Robin Kundis Craig 'Mitigation and Adaptation' in Elise Johansen, Signe Veierud Busch, Ingvild Ulrikke Jakobsen 'The Law of the Sea and Climate Change: solutions and constraints' (2021) at 54 (University Printing House, Cambridge, United Kingdom); IPCC 'Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2014) at 44. IPCC, Geneva, Switzerland.

[377] Robin Kundis Craig 'Mitigation and Adaptation' in Elise Johansen, Signe Veierud Busch, Ingvild Ulrikke Jakobsen 'The Law of the Sea and Climate Change: solutions and constraints' (2021) at 54 (University Printing House, Cambridge, United Kingdom); IPCC 'Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2014) at 45. IPCC, Geneva, Switzerland.

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A growing concern within the global climate change discourse relates to the warming potential of methane emissions relative to carbon dioxide emissions,[378] and that the mitigation measures that have so far primarily focussed on carbon dioxide emissions may be grossly inadequate.[379] Methane is the major component in natural gas and constitutes at least 90 percent of natural gas or shale gas.[380] For natural gas to serve as a transitional fuel towards cleaner energy sources in South Africa, the legal framework for shale gas should compel oil and gas companies to implement measures to prevent methane emissions to the atmosphere. Examples of some of these measures are outlined in section 3.8 below.

3.8 Methane Emissions - Another Area of Concern

There is general recognition that gas burns cleaner than oil or coal, that is, less carbon dioxide is emitted per unit energy of gas relative to coal or oil.[381] This is however negated by the fact that the greenhouse gas effect of methane is much higher than that of carbon dioxide.[382] Methane is deemed more effective at trapping heat in the atmosphere than carbon dioxide, which makes methane a more potent greenhouse gas.[383] The impact of methane emissions from shale gas extraction to global warming may therefore be more severe.[384] Methane gas can be emitted to the atmosphere

[378] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, Energy Science and Engineering.

[379] Robin Kundis Craig 'Mitigation and Adaptation' in Elise Johansen, Signe Veierud Busch, Ingvild Ulrikke Jakobsen 'The Law of the Sea and Climate Change: solutions and constraints' (2021) at 54 (University Printing House, Cambridge, United Kingdom); IPCC 'Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2014) at 44. IPCC, Geneva, Switzerland.

[380] A.M. Dayal 'Shale' at 7, in Anurodh Mohah Dayal and Devleena Mani, at 7 (1.6) 'Shale Gas: Exploration and Environmental and Economic Impacts' (2017) Elsrivier, Oxford, United Kingdom.

[381] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8); Theresa Moyo 'Low Carbon and Climate Resilient Investments – Is South Africa Doing Enough?' (2016) at 129, *Africa Insight*; 45(4).

[382] Zhan Zhang, Evan D. Sherwin, Daniel J. Varon and Adam R. Brandt 'Detecting and quantifying methane emissions from oil and gas production: algorithm development with ground-truth calibration based on Sentinel-2 satellite imagery' (2022) at 7155, *Atmospheric Measurements Techniques* 15.

[383] Shanru Tian, Kathleen M. Smits, Younki Cho, Stuart N. Riddick, Daniel J. Zimmerle and Aidan Duggan 'Estimating methane emissions from underground natural gas pipelines using an atmospheric dispersion-based method' (2022) at 1 *Elementa: Science of the Anthropocene* 10(1).

[384] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

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during shale gas drilling or production through flaring, venting or leakage (also referred to as fugitive emissions).[385]

During flaring, methane is converted to carbon dioxide through the combustion process.[386] During venting or leakage, methane does not undergo any combustion or burning, the resultant methane content therefore resembles the original methane content of the natural gas.[387] It is the emission of this vented methane that is more detrimental as a greenhouse gas than carbon dioxide from the burning of coal or oil.[388] In their 2011 publication, which fuelled the global debate on the methane emissions of shale gas, Howarth and colleagues, concluded that methane emissions from shale gas are significantly larger than from conventional natural gas, considering the full shale gas lifecycle.[389] Therefore, methane emissions from shale gas and conventional gas could contribute more to greenhouse gas emissions than other fossil fuels, such as oil and coal, particularly over a 20-year time horizon following emission.[390]

The 20-year time horizon is relevant because natural gas is touted as a transitional fuel towards a lower carbon future over the next two to three decades.[391] It should therefore not be taken for granted that the production of shale gas will necessarily lead to a reduction in the country's greenhouse gas emissions.[392] This is because methane emissions could be released into the atmosphere during shale gas extraction, thereby negating the impact of the reduction of the use of coal in favour of natural gas.[393] In its fifth assessment, the IPCC confirm that methane is a more potent greenhouse gas

[385] Laurence Stamford & Adisa Azapagic 'A Fractured truth' (2014), at 27, *The Chemical Engineer*; Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4)..

[386] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4), Art No. 2013-0194.

[387] Laurence Stamford & Adisa Azapagic 'A Fractured truth' (2014) at 27, *The Chemical Engineer*.

[388] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural gas (2014) at 2, *Energy Science and Engineering*.

[389] Robert W. Howarth, Renee Santoro & Anthony Ingraffea 'Methane and the greenhouse gas footprint of natural gas from shale formations' (2011) at 685, *Climate Change Letter* 106.

[390] Ibid.

[391] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 2, *Energy Science and Engineering.*

[392] Steven Hadden, Jonathan D. Moyer and Jessica Rettig, *Fracking for shale gas in South Africa: blessing or curse?* (2013) at 4-5, Institute for Security Studies.

[393] Ibid.

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than carbon dioxide, however, methane has a much shorter residence time in the atmosphere so its effect on global warming dissipates quickly.[394]

Howarth concurs that methane has a shorter atmospheric lifetime than carbon dioxide which has an effective influence on atmospheric chemistry of a century or longer.[395] This implies that methane has a short-term impact to the atmosphere compared to carbon dioxide.[396] Underscoring the growing importance of methane emissions in the global climate change debate, the 26th Conference of the Parties that took place in Glasgow took a decision on what the parties to the UNFCCC are expected to do to mitigate methane emissions.[397]

Consequently, a Global Methane Pledge was signed by more than 100 countries, including major emitters of greenhouse gases.[398] This is in recognition that to meet the Paris Agreement goal of keeping global warming well below 2 degrees Celsius, while pursuing efforts to limit warming to 1.5 degrees Celsius, significant methane emission reductions must be achieved globally by 2030.[399] More specifically, the Global Methane Pledge aims to limit methane emissions by 30 per cent by 2030 compared to 2020 levels.[400] Methane emissions from shale gas operations can be reduced through

[394] IPCC '*Climate Change 2014: Synthesis Report. Contribution of Working Groups I,II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change'* (2015) IPCC, Geneva, Switzerland.

[395] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 6, *Energy Science and Engineering.*

[396] European Commission, United States of America 'Global Methane Pledge' 2021, available at *https://www.ccacoalition.org/en/resources/global-methane-pledge* accessed on 30 September 2022.

[397] United Nations Framework Convention on Climate Change 'Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021' (2022) "Glasgow Climate Pact" available at *https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf* accessed on 2 July 2022.

[398] European Commission, United States of America 'Global Methane Pledge' 2021, available at *https://www.ccacoalition.org/en/resources/global-methane-pledge* accessed on 30 July 2022.

[399] Ibid.

[400] Ibid.

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existing technologies,[401] and the stricter enforcement of regulations against non-emergency flaring.[402]

There are a number of emerging technologies that are already being used to reduce methane emissions from oil and gas operations and shale gas development in particular.[403] These include Leak Detection and Repair (LDAR),[404] and Carbon Capture and Storage (CCS).[405] Furthermore, the development of regulations or stricter enforcement of existing standards, reducing routine flaring, and only allowing emergency flaring of gas could go a long way in reducing the methane emissions of shale gas development.[406] These are discussed below.

3.8.1 Leak Detection and Repair

As indicated in the preceding paragraphs, fugitive emissions from gas production, processing and pipeline networks are a significant source of methane emissions to the atmosphere.[407] About 30 per cent of onshore gas system leaks emanate from pipeline fittings such as seals, valve connectors etcetera.[408] The Leak Detection and Repair (LDAR) technology is used to reduce methane emissions, through locating the leaks

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401 Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 227 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (London, Oxford University Press).

402 International Energy Agency 'Africa Energy Outlook (2022) at 146, World Energy Outlook Special Report, available at *www.iea.org.weo accessed* on 18/07/2022.

403 Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 226 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden 'Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions' (London, Oxford University Press).

404 Ibid.227.

405 Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 42 in *The Bridge - Linking Engineering to Society* 44(1) (Washington, National Academy of Engineering).

406 International Energy Agency 'Africa Energy Outlook (2022) at 146, World Energy Outlook Special Report, available at www.iea.org.weo accessed on 18 July 2022.

407 Shanru Tian, Kathleen M. Smits, Younki Cho, Stuart N. Riddick, Daniel J. Zimmerle and Aidan Duggan 'Estimating methane emissions from underground natural gas pipelines using an atmospheric dispersion-based method' (2022) at 1, *Elementa Science of the Anthropocene* 10(1); Zhan Zhang, Evan D. Sherwin, Daniel J. Varon and Adam R. Brandt 'Detecting and quantifying methane emissions from oil and gas production: algorithm development with ground-truth calibration based on Sentinel-2 satellite imagery' (2022) at 7155, *Atmospheric Measurements Techniques* 15.

408 Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 227 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (London, Oxford University Press).

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to repair them promptly, and recover the leaking gas for onward sale to gas users.[409] There is ongoing research to improve the cost effectiveness of the LDAR technologies, to encourage oil and gas producing companies to install these systems thereby aiding climate change mitigation.[410]

Notable initiatives include the Stanford University's Natural Gas Initiative, where researchers have focused on the effectiveness of the LDAR technology.[411] That work led to the development of the Fugitive Emissions Abatement Simulation Toolkit (FEAST) with the purpose to accurately simulate the evolution of methane leakage from gas operations over time.[412] NASA's Jet Propulsion Laboratory and the California Institute of Technology assessed the practicality of using airborne instruments to identify and measure methane emissions on a regional basis.[413] Based on an area covering Arizona, Colorado, New Mexico, and Utah in the United States, where natural gas is produced from at least 20,000 oil and gas wells, two airborne spectrometers were used and successfully identified and measured methane emissions from different sources.[414] That program found the sources to be well pads, gas processing facilities, pipelines, and storage tanks.[415]

3.8.2 Carbon Capture and Storage

Carbon Capture and Storage (CCS) could contribute significantly to global efforts to mitigate climate.[416] CCS refers to the capture of carbon dioxide (CO_2) from large

[409] C Kemp, A Ravikumar and A Brandt 'Comparing Natural Gas Leakage Detection Technologies Using an Open-source "Virtual Gas Field" Simulator' (2016) at 1, *Environmental Science and Technology.*
[410] Ibid, at 2.
[411] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 228 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden 'Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions' (London, Oxford University Press).
[412] Ibid.
[413] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 229 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden 'Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions' (London, Oxford University Press).
[414] Ibid.
[415] Ibid.
[416] Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 42 in *The Bridge – Linking Engineering to Society* (Washington, National Academy of Engineering) 44(1); IPCCC 'Sixth Assessment Report Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change' (2022), at 141 (IPCC, Geneva, Switzerland).

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stationary sources such as coal power plants and crude oil refineries, the purification thereof to a concentration of about 95%, and the transportation and subsequent injection thereof into deep geological formations, where it should remain safely stored.[417] The deep geological formations include depleted oil and gas reservoirs, saline formations and coal beds among others.[418]

In fact, large amounts of CO_2 could potentially be stored in depleted oil and gas reservoirs.[419] The storage of CO_2 in oil and gas reservoirs is feasible because of the presence of proven geological traps and seals, which prevent the movement and leakage of the injected CO_2.[420] While geological formations have stored oil and gas for millions of years, their efficiency to store CO_2 is still being studied.[421] Therefore, CO_2 sequestration projects in oil and gas fields have to consider a complete evaluation of their long-term efficiency, and that CO_2 will remain stored in the reservoirs for decades to consider the storage process efficient with respect to climate change.[422]

A critical aspect of CCS is the required capability to model and monitor the injected CO_2 efficiently.[423] Environmental considerations necessitate the prediction and verification of CO_2 movement over time to ensure that additional environmental problems, such as the contamination of aquifers are not created.[424] Reservoir and geological knowledge are important, to optimize the CCS process and predict the

[417] Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 43 in *The Bridge – Linking Engineering to Society* (Washington, National Academy of Engineering).
[418] Ibid, at 44.
[419] J.M. Ketzer, B. Carpentier, Y. Le Gallo, and AT Le Thiez'Geological Sequestration of CO_2 in Mature Hydrocarbon Fields: Basin and Reservoir Numerical Modelling of the Forties Field, North Sea' (2005) at 260, *Oil & Gas Science and Technology* 60(2), 259-273.
[420] Ibid.
[421] Ibid.
[422] Ibid.
[423] D.N Nguyen 'Geological Sequestration: Technical and Economic Review' (2003) SPE paper 81199, proceedings of 2003 SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, U.S.A., 10-12 March 2003.
[424] Brinks, J. and Fanchi, J 'Geologic Sequestration: Modeling and Monitoring Injected *CO_2*' (2011) SPE paper 66749, proceedings of 2001 SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, 26-28 February 2001.

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movement of the injected CO_2, while monitoring the injected CO_2 after CCS will help ascertain whether the injected CO_2 is retained in the reservoirs.[425]

There are numerous CCS projects related to oil and gas operations globally.[426] Most of these projects focus on capturing and injecting CO_2 into producing oil and gas reservoirs to enhance the recovery of the oil and gas, thus aid the commercial viability of such operations.[427] CCS projects related to oil and gas started in 1996 with the Statoil project at the Sleipner gas field offshore Norway.[428] That project was partly motivated by a tax of US$50/t CO_2 produced which would have heavily weighed on the commercial viability of the project.[429] Subsequently, projects led by ExxonMobil, BP, PanCanadian, Shell, and Sonatrach initiated CCS projects associated with natural gas cleanup facilities, synfuels, or hydrogen production units in the US, Canada, Algeria etcetera.[430]

These projects are being monitored by academics, governments, and the petroleum industry to ensure that the CO_2 stays underground and to evaluate how closely the migration of CO_2 conform to simulation models.[431] Seismic imaging and pressure monitoring of the movement of the injected CO_2 have proven very useful in tracking the location of the stored CO_2 and detecting potential leakage.[432] All in all, the results from these CCS projects confirm that CO_2 can be safely stored in underground structures as a means of mitigating CO_2 emissions to the atmosphere and enhancing oil and gas recovery.[433] There is also no evidence of groundwater contamination from

[425] Nguyen, D.N 'Geological Sequestration: Technical and Economic Review' (2003) SPE paper 81199, proceedings of 2003 SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, U.S.A., 10-12 March 2003.
[426] Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 45 in 'The Bridge' (Washington, National Academy of Engineering) Vol.44, No.1.
[427] Ibid.
[428] Ibid.
[429] Ibid.
[430] Ibid.
[431] Ibid.
[432] Ibid, at 47.
[433] Ibid.

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CCS projects to date.[434] The Glasgow Climate Pact below outlines other key outcomes from the 26th Conference of the Parties.

3.9 The Glasgow Climate Pact

The 26th Conference of the Parties to the United Nations Framework Convention on Climate Change that was held in Glasgow, Scotland,[435] reaffirmed the Paris Agreement goal of limiting the increase in global average temperatures to well below 2°C above pre-industrial levels.[436] It further resolved to pursue efforts to limit the average temperature increase to 1.5°C.[437] Moreover, recognising that parties to the UNFCCC had committed to reduce CO_2 emissions by 45 per cent in order to reach net-zero carbon emissions by 2050,[438] but that with current NDCs this target would not be met, the Glasgow Climate Pact calls on all countries to revise their national action plans in 2022 as opposed to the original timeline of 2025.[439] Countries also called on the UNFCCC to conduct an annual NDC assessment to ascertain whether the nationally determined contributions are sufficient to move the world towards net-zero emissions by 2050.[440]

The most contested decision to come out of Glasgow is the call to move away from fossil fuels, particularly the agreement to phase-down coal power and phase-out the subsidisation of fossil fuels.[441] COP26 noted 'with deep regret' that the US$100 billion per annum by 2020 funding commitment that developed countries made to developing countries as part of the Paris Agreement was not met.[442] Consequently, COP26 urged developed countries to make good and fully deliver on the commitment urgently, and through to 2025.[443] Furthermore, COP26 called for the doubling of finance to support developing countries in adapting to the effects of climate change and building

[434] Ibid.
[435] United Nations 'United Nations Framework Convention on Climate Change' Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021.
[436] United Nations 'United Nations Framework Convention on Climate Change' para 20, Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021.
[437] Ibid, para 21.
[438] Ibid, para 22.
[439] Ibid, para 29.
[440] Ibid, para 30.
[441] Ibid, para 36.
[442] Ibid, para 44.
[443] Ibid, para 46.

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resilience.[444] A work programme to define a global goal on adaptation, which will identify collective needs and solutions to the climate crisis that was already affecting many countries was also established at COP26.[445]

3.10 South Africa's Climate Change Policy Framework

South Africa is a party to the global climate change regime.[446] It has ratified the United Nations Framework Convention on Climate Change,[447] the Kyoto Protocol,[448] the Paris Agreement,[449] and the Glasgow Climate Change Pact.[450] The country has a moral and legal obligation to contribute towards global efforts to mitigate climate change.[451] Unlike the rest of Africa, South Africa is a significant emitter of greenhouse gas emissions,[452] with its emissions on par with those of industrialized countries.[453] Nonetheless, South Africa's climate change response derives from the common African position that is enunciated in the Bali Action Plan.[454] The four main pillars of the Bali Action Plan are adaptation, mitigation, financing and technology transfer.[455] The Bali Action Plan embodies the shared African vision with regard to climate change.[456] It advocates for an 'inclusive, fair and effective' climate change regime that

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[444] Ibid, para 19.
[445] Ibid, para 27.
[446] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 35, (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP); Kjersti Fløttum & Øyvind Gjerstad 'The Role of Social Justice and Poverty in South Africa's National Climate Change Response White Paper' (2014) at 85, *South African Journal of Human Rights* 29.
[447] United Nations 'United Nations Framework Convention on Climate Change' (1992) FCCC/INFORMAL/84GE.05-62220 (E) 200705.
[448] United Nations 'Kyoto Protocol to the United Nations Framework Convention on Climate Change' (1997) available at https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf, accessed on 11 June 2022.
[449] United Nations 'Paris Agreement' (2015) available at https://unfccc.int/sites/default/files/english_paris_agreement.pdf accessed on 11 June 2022.
[450] United Nations 'Framework Convention on Climate Change : Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021' (2022) available at *https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf* accessed on 2 July 2022.
[451] Department of Environmental Affairs 'National Climate Change Response White Paper' (2011) at 25, available at https://www.gov.za/sites/default/files/gcis_document/201409/nationalclimatechangeresponsewhitepaper0.pdf accessed on 2 July 2022.
[452] Kjersti Fløttum & Øyvind Gjerstad '*The Role of Social Justice and Poverty in South Africa's National Climate Change Response White Paper* (2014) at 61, *South African Journal of Human Rights* 29.
[453] Gina Ziervogel et al 'Climate change in South Africa – how are we tackling this?'(2015) at 6, *Quest* 11.
[454] Werner Scholtz 'The promotion of regional environmental security and Africa's common position on climate change' (2010) at 13, *African Human Rights Law Journal*.
[455] Ibid.
[456] Ibid.

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recognizes the need for developing countries to respond in a manner that does not hinder their development.[457]

South Africa's climate change response policy recognizes that all countries in the Southern Africa Development Community (SADC) are beset by poverty, limited access to water resources, food insecurity, and other development challenges.[458] It furthermore, recognizes that SADC countries are confronted with similar climate change risks, therefore may have similar adaptation needs.[459] South Africa's climate change response policy thus commits the country to collaborate with other SADC countries to develop climate change adaptation strategies that seek to reduce risk and vulnerability, and share resources, technology and learning.[460] Accordingly, a regional approach underpinned by climate change resilience could have significant socio-economic benefits.[461]

South Africa's climate change policy is anchored in mitigation (reducing greenhouse gas emissions to the atmosphere) and adaptation (responding to the adverse effects of climate change).[462] Its main objectives are:[463] firstly, to manage the effect of climate change in a manner that builds and sustains the country's social, economic and environmental resilience and emergency response capacity. Secondly, to contribute to global efforts fairly, to stabilize greenhouse gas concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system.[464] This should be done with due regard to enabling socio-economic growth and sustainable development.[465]

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[457] Ibid.
[458] Department of Environmental Affairs 'National Climate Change Response White Paper' (2011) at 16, available at *https://www.gov.za/sites/default/files/gcis_document/201409/nationalclimatechangeresponsewhitepaper0.pdf* accessed on 2 July 2022.
[459] Ibid.
[460] Ibid.
[461] Ibid.
[462] Ibid, at 13.
[463] Department of Environmental Affairs 'National Climate Change Response White Paper' (2011) at 11, available at *https://www.gov.za/sites/default/files/gcis_document/201409/nationalclimatechangeresponsewhitepaper0.pdf* accessed on 2 July 2022.
[464] Ibid.
[465] Ibid.

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The policy is furthermore cognizant of the need to manage the unintended consequences of its climate change measures on other countries, and likewise responds to the unintended consequences of the climate change measures of other countries.[466] Ultimately South Africa's Climate Change Response Policy aspires for economic, social, and environmental interventions that integrate mitigation and adaptation within a developmental context.[467] The climate change policy sought to give effect to the commitment South Africa made at COP15 in Copenhagen, to reduce its greenhouse gas emissions by 34 percent by 2020 and 42 percent by 2025, based on a 2009 baseline.[468] Consistent with article 4.7 of the UNFCCC this commitment was conditional on the provision of the necessary finance, technology, and capacity-building support from the international community.[469]

In December 2015 at COP21, South Africa signed the Paris Agreement and committed to reducing its greenhouse gas emissions to between 398 and 614 Mega tons carbon dioxide equivalent ($MtCO_2e$) over the period 2025 to 2030.[470] This is consistent with South Africa's greenhouse gas emissions reduction commitment in Copenhagen in 2009,[471] however, is inadequate and not in line with the 'fair approach' the Paris Agreement calls for.[472] In terms of the 'fair approach' countries should strive to reduce their GHG emissions in a manner that would collectively limit global warming to less than two degree Celsius above pre-industrial levels by the turn of the 21st century.[473]

Leading up to COP26 in Glasgow, South Africa revised its Nationally Determined Contribution pursuant to its obligation in terms of the Paris Agreement.[474] In terms of

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[466] Ibid,13.
[467] Ibid.
[468] Ibid,25.
[469] United Nations 'United Nations Framework Convention on Climate Change' (1992) Article 4.7.
[470] Hugo Meyer van den Berg & Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 246 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (London, Oxford University Press).
[471] Ibid
[472] Ibid.
[473] Ibid.
[474] UCT 'South Africa's "fare share": mitigation targets in the updated first NDC in an international context' (2021) at 8, Energy Systems Research Group, University of Cape Town, Cape Town; Department of Environment, Forestry and Fisheries 'South Africa First Nationally Determined Contribution under the Paris Agreement: Updated September 2021' (2021) at 2, available at *https://unfccc.int/sites/default/files/NDC/2022-*

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the revised NDC, greenhouse gas emissions in South Africa are expected to peak in the period 2020 to 2025, plateau between 2025 and 2035 and decline thereafter.[475] The ultimate objective is to achieve an absolute decline in GHGs by 2040.[476] Even with the new NDC commitments made by all the Parties to the UNFCCC the target to reduce net-zero carbon emissions by 2050 will not be met.[477] The Glasgow Climate Pact, to which South Africa is a party, therefore calls on all countries to revise their national action plans in 2022 as opposed to the original timeline of 2025.[478]

Emerging case law is demonstrating the posture of South Africa's judiciary towards climate change. In *Earthlife Africa ("Earthlife") Johannesburg v Minister of Environmental Affairs and others*, Earthlife sought a review of the decision by the Chief Director of Environmental Affairs to grant an environmental authorisation to Thabametsi Power Company ("Thabametsi") in February 2015, and the Minister of Environmental Affairs's upholding of that decision in March 2016, following an appeal by EarthLife.[479] The environmental authorization was for the building of a 1200-megawatt (MW) coal-fired powered station, near Lephalele in the Limpopo Province that was expected to operate until 2061.[480]

Earthlife is a non-profit organisation that was established to galvanise civil society around protecting the environment and was in this case an interested and affected party ("IAP").[481] Earthlife therefore is entitled to participate in public consultation forums on the potential environmental impacts of planned industrial activities such as

06/South%20Africa%20updated%20first%20NDC%20September%202021.pdf accessed on 31 October 2022.

[475] Department of Environment, Forestry and Fisheries 'South Africa First Nationally Determined Contribution under the Paris Agreement: Updated September 2021' (2021) at 2, available at *https://unfccc.int/sites/default/files/NDC/2022-06/South%20Africa%20updated%20first%20NDC%20September%202021.pdf* accessed on 31 October 2022.

[476] Ibid.

[477] Para 29 of the Glasgow Climate Pact.

[478] Ibid.

[479] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 2, (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP).

[480] Ibid, para 1.

[481] as contemplated in s 24(4)(v)(a) of the National Environmental Management Act, No.7 of 1998; para 3; National Environmental Management Act, No. 107 of 1998.

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the Thabametsi coal-fired power station.[482] Earthlife is also entitled to bring a review application in the interest of protecting the environment.[483]

In this case, Earthlife contended that the Chief Director failed to honour the obligation to consider the climate change impact of the proposed power station before granting the environmental authorisation.[484] The NEMA provides that activities which are listed or specified by the Minister of Environmental Affairs, such as the Thabametsi proposed power station, must obtain an environmental authorization prior to commencement.[485] Upon appeal of the Chief Director's decision by Earthlife, the Minister of Environmental Affairs acknowledged that the climate change impacts of the proposed power station were not thoroughly assessed before the environmental authorization was granted.[486] However, the Minister did not withdraw the environmental authorization granted to Thabametsi, instead the Minister amended the authorisation to compel Thabametsi to undertake a climate change impact assessment before commencement of the power station project, to be reviewed by the Department of Environmental Affairs.[487]

Earthlife took this decision of the Minister on review, on the basis that the Minister undermined the purpose of the climate change impact assessment, and the environmental authorisation process.[488] Consequently, if the anticipated climate change impact assessment indicated that environmental authorisation should not have been granted, the Minister would have no power to withdraw the environmental authorization.[489] Earthlife contended that the Minister's decision to uphold a decision to grant an environmental authorisation without due consideration of the climate change impact of the proposed power station was unlawful, irrational and

[482] Ibid, para 3
[483] in terms of s 32(1) of the National Environmental Management, No.7 of 1998; Ibid, para 3.
[484] as contemplated in s 24 of the National Environmental Management, No.7 of 1998; Ibid, para 4.
[485] S 24 of the National Environmental Management Act, No. 107 of 1998; *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 5, (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP).
[486] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 5, (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP).
[487] Ibid, para 7.
[488] Ibid, para 9.
[489] Ibid.

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unreasonable.[490] This is because the NEMA requires that the Chief Director considers all relevant factors, climate change in this case, in granting or rejecting an application for environmental authorization.[491]

Handing down judgment Judge Murphy J ruled that the granting of the environmental authorization without consideration of the climate change impact of the proposed Thabametsi power station was prejudicial.[492] The proposed project would emit greenhouse gas emissions for a significant period of time, at least 40 years.[493] Thus, a thorough assessment of its climate change impact ought to be given appropriate consideration.[494] The court directed the Minister to reconsider the environmental authorization of the proposed project, based on new evidence that would arise from a thorough climate change impact assessment report.[495] The court suspended the environmental authorization that was granted to Thabametsi, subject to a climate change impact assessment being done and submitted to the Department of Environmental Affairs for review.[496]

The Thabametsi judgment confirms that climate change poses significant risks to sustainable development, hence recommend the comprehensive consideration of the impact of climate change as a prerequisite to protect future generations.[497] The judgment has set precedence as to how South African courts should handle climate change-related cases.[498] In fact, a climate change impact assessment, can be

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[490] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 10; Margo-Ann Palani and Justine Sweet 'SA's first climate change court case' (2017) at 37-38, *Without Prejudice* 17 (4).

[491] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 11; Margo-Ann Palani and Justine Sweet 'SA's first climate change court case' (2017) at 37-38, *Without Prejudice* 17 (4).

[492] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 119; Margo-Ann Palani and Justine Sweet 'SA's first climate change court case' (2017) at 37-38, *Without Prejudice* 17 (4).

[493] Ibid.

[494] Ibid.

[495] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 126.1.

[496] *Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others*, para 126.2; The suspension was based on s 43 of the National Environmental Management Act, No. 107 of 1998.

[497] Tracy-Lynn Humby 'A landmark case on climate change in SA' (2017) available at *https://www.wits.ac.za/gci/media/a-landmark-case-on-climate-change-in-sa/* accessed on 21 March 2018.

[498] Ibid.

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expected prior to the environmental authorization of shale gas exploration and production in the Karoo.

The emerging South African climate change law, the 'Climate Change Bill'[499] which was introduced in Parliament in February 2022, provides for the Minister of Forestry, Fishing and the Environment to make regulations to give effect to South Africa's international climate change commitments and obligations.[500] Such regulations may include the need to assess the potential impact to climate change of industrial activities such as shale gas development prior to their environmental authorization. Noneless, the Bill seeks to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate resilient economy and society in South Africa, within the context of sustainable development.[501]

3.12 Conclusions

The exploitation of shale gas could contribute to climate change mitigation.[502] Shale gas production is credited for the reduction of the US's carbon dioxide emissions from a peak of 6,023 megatons of CO_2 in 2007 to 5,290 megatons of CO_2 in 2012.[503] A growing concern within the global climate change discourse relates to the effect of methane emissions to global warming.[504] While the hydraulic fracturing technology pose significant emissions risks, if implemented with adequate safeguards and monitoring, the greenhouse gas emissions from shale gas operations could be prevented through improvements in technology, industry standards and best practice.[505]

[499] Republic of South Africa 'Climate Change Bill' in Government Gazette No.45299 of 11 October 2021.
[500] Republic of South Africa 'Climate Change Bill' in Government Gazette No.45299 of 11 October 2021, s 27.
[501] Republic of South Africa 'Climate Change Bill' in Government Gazette No.45299 of 11 October 2021.
[502] Paul C. Stern, Thomas Webler & Mitchell J. Small 'Special Issue: Understanding the Risks of Unconventional Shale Gas Development' (2014) at 1, *Environmental Science & Technology*.
[503] Laurence Stamford & Adisa Azapagic '*A Fractured Truth* (2014) at 27, *The Chemical Engineer*.
[504] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.
[505] Paul C. Stern, Thomas Webler & Mitchell J. Small 'Special Issue: Understanding the Risks of Unconventional Shale Gas Development' (2014) at 1, *Environmental Science & Technology*.

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For shale gas to contribute to the transition towards net-zero greenhouse gas emissions in South Africa, the regulatory framework for shale gas will have to impose measures to mitigate greenhouse gas emissions to the atmosphere. Examples of some of these measures as mentioned earlier in this chapter include, Leak Detection and Repair,[506] and Carbon Capture and Storage.[507] Furthermore, the development of regulations or stricter enforcement of existing standards, reducing routine flaring, and only allowing emergency flaring of gas could go a long way in reducing the methane emissions of shale gas development.[508]

[506] Ibid.227.

[507] Sally M. Benson and S. Julio Friedmann 'Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change' (2014) at 42 in *The Bridge 44(1)* (Washington, National Academy of Engineering).

[508] International Energy Agency 'Africa Energy Outlook (2022) at 146, World Energy Outlook Special Report, available at *www.iea.org.weo* accessed on 18 July 2022.

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CHAPTER 4: PUBLIC PARTICIPATION

4.1 Introduction

As discussed in Chapter 2 of this thesis, shale gas development has been contentious because hydraulic fracturing, the process used to extract shale gas, poses serious risks to human health and the environment.[509] Consequently, environmental interest groups successfully halted the exploration for shale gas in South Africa based on concerns related to the hydraulic fracturing process.[510] Ineffective public participation contributed to the controversy surrounding shale gas development in the Karoo.[511] This chapter examines how the legal framework that is relevant to shale gas exploration and production in South Africa provides for public participation or stakeholder engagement.

4.2 What is Public Participation

Public participation or stakeholder engagement is premised on the principle that the satisfaction of one stakeholder group does not have to be at the expense of another stakeholder group.[512] Effective public participation improves communication among key stakeholders, including local communities, who are often the most marginalised and vulnerable to the negative effects of industrial processes.[513] Public participation, a critical element of environmental governance, could lead to more informed decisions in respect of shale gas development in the Karoo.[514]

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[509] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22.

[510] *John Douglas Stern and others vs Minister of Mineral Resources*, para 42, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 2019).

[511] *John Douglas Stern and others vs Minister of Mineral Resources*, para 42, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 2019).

[512] Thomas Donaldson and Lee E. Preston 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications' (1995) at 80, *Academy of Management Review* 20(1).

[513] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 134, *Edward Elgar Publishing Limited* (Cheltenham, UK).

[514] Ibid.

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For public participation to be effective, the relevant provisions of the law must go beyond procedural and compliance requirements, and call for the substantive engagement of interested and affected parties.[515] When interested and affected parties or local communities feel that their input or expectations are not being considered in project planning or development, they might withdraw from constructive engagement, which could lead to conflict or litigation,[516] as has happened with shale gas development in the Karoo.[517] Environmental and social justice issues, such as concerns related to the potential impact of Karoo shale gas on human health and the natural environment,[518] could be better handled through a legal framework that balances procedural and administrative requirements with substantive commitments to public participation.[519]

Furthermore, effective stakeholder engagement appeal to the consideration of a broader array of people, groups, or organizations as stakeholders, including the nominally powerless.[520] This view is consistent with democratic principles and social justice, where the interests of the relatively powerless must be considered.[521] One of the challenges of effective stakeholder engagement lies in the difficulty of considering '*mute*' stakeholders, such as the natural environment, and '*absent*' stakeholders, such as future generations, or potential victims.[522] There is difficulty in considering the natural environment as a stakeholder because most definitions of stakeholders, usually treat them as groups or individuals, thereby exclude the environment, because it is not a human group or community.[523]

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[515] Ibid, at 135.
[516] Ibid.
[517] *John Douglas Stern and others vs Minister of Mineral Resources*, para 42, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).
[518] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22.
[519] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 135, *Edward Elgar Publishing Limited (Cheltenham, UK).*
[520] John M Bryson 'What To Do When Stakeholders Matter: Stakeholder Identification and Analysis Technique' (2004) at 22, *Public Management Review* 6 (1).
[521] Ibid.
[522] Branco M.C & Rodrigues L.L 'Positioning Stakeholder Theory within the Debate on Corporate Social Responsibility' (2007) at 7, *Electronic Journal of Business Ethics and Organization Studies* 12 (1).
[523] Ibid.

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One way to view the environment as a stakeholder is through the interests of future generations.[524] It is however impossible to ask the opinion of the natural environment or future generations since they cannot participate in consultative processes.[525] Nonetheless, if among the interests of legitimate stakeholders is a concern for the natural environment, it has to be taken into account.[526] Moreover, stakeholders require different degrees and types of attention, depending on their attributed possession of power, legitimacy and urgency.[527] The levels of these attributes (salience) can vary from issue to issue and from time to time.[528] This is challenging because there needs to be an understanding of how different stakeholder groups might be characterized by differing levels of salience over time.[529] It is also important to recognize that different stakeholder groups may mobilize support through engaging one another in coalitions, to impose their will.[530]

In the context of this thesis, stakeholders are those groups or individuals that can enable or deter shale gas exploration and production in the Karoo. These are the South African government, local communities, landowners, and environmental interest groups. The concerns and views of these stakeholders therefore need to be considered in the planning and subsequent exploration and exploitation of shale gas in South Africa. The rationale for the identification of these stakeholders as vital to shale gas development in the Karoo is provided below.

4.3 Government as a Stakeholder

The Government is a key stakeholder as it has to regulate the exploration and production of shale gas, and ensure that the risks associated with shale gas development are mitigated.[531] Relying on natural gas as a source of energy could

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[524] Ibid.
[525] Ibid.
[526] Ibid.
[527] Sonpar K, Pazzaglia F & Kornijenko J 'The Paradox and Constraints of Legitimacy' (2010) at 4, *Journal of Business Ethics* 95.
[528] Ibid.
[529] Ibid.
[530] Ibid.
[531] *John Douglas Stern and others vs Minister of Mineral Resources*, para 13, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 16 (790/2018) [2019] ZASCA 99 (4 July 20219).

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ensure that South Africa makes inroads towards its international obligation to reduce its climate change impact, by reducing its dependence on coal.[532] Furthermore the Government has an interest in the possibility that natural gas from shales could contribute to national energy security,[533] and local socio-economic development.[534]

4.4 Local Communities

Local communities are key stakeholders since shale gas development could utilize land and water resources that would otherwise be preserved for their use.[535] Also of concern to local communities is that shale gas extraction could have an adverse impact on the local landscape,[536] noise levels,[537] and could lead to seismic events, such as earth tremors or minor earthquakes.[538] Local communities are however also interested in the potential socio-economic benefits that shale gas could bring.[539]

4.5 Karoo Landowners

Landowners are a key stakeholder because of the potential negative impact of shale gas development on their land and agricultural activities.[540] Landowners are obliged to allow access to their land by shale gas exploration right holders.[541] This is provided that the right holders notify and consult with them before commencing exploration or

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[532] Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 4, *South African Journal of Science*.

[533] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, *S Afr J Sci*; 107(7/8) Art No. 791; R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 2, *Southern African Business Review*; 18(2).

[534] J. Butler-Adam 'Resolving fractured debates about fracking? the shale gas industry in South Africa' (2016) at 1, *South African Journal of Science.*

[535] Ibid.

[536] Department of Mineral Resources 'Report on Investigation of Hydraulic Fracturing in the Karoo Basin of South Africa' (2012) at 47.

[537] Ibid.

[538] Ibid.

[539] H. Van Zyl, S. Fakier, T.Leiman and B. Standish 'Impacts on the Economy' in Robert Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 825 (10-4), Pretoria, CSIR; R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 29, *Southern African Business Review*; 18(2).

[540] N. Oettle, L. Lindeque, J. du Toit, I. Samuels, A. Osler S. Vetter, and E.A van Garderen 'Impacts on Agriculture' in Rob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 716 (8-7), Pretoria, CSIR; Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 44, *Stellenbosch Law Review*.

[541] S 5(3)(a) of the Minerals and Petroleum Resources Development Act, No. 28, 2002.

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production activities.[542] Meanwhile petroleum right holders have no obligation to pay compensation to landowners for the petroleum resources beneath their land, except in circumstances where it has been determined that the landowner or lawful occupier of the land has suffered or is likely to suffer loss or damage as a result of shale gas development.[543] Rather the State is paid tax, royalties and other fees by right holders.[544] This implies that landowners, through whose land shale gas in the sub-surface will have to be accessed, will gain nothing from the extraction of shale gas resources beneath their land.[545] It may be prudent for agriculture and conservation organizations to work together to influence the development of legislation that would ensure that landowners are compensated by oil and gas companies for access to their land.[546]

4.6 Environmental Interest Groups

Environmental interest groups are key stakeholders due to their concern about the impact of shale gas development on the natural environment, particularly its use of vast amounts of water and potential contamination of water resources.[547] It comprises among others the Treasure the Karoo Action Group; the Centre for Environmental Rights; the Sustainable Alternatives to Fracking and Exploration Alliance; and the Southern Cape Land Committee and Landowners.[548]

Stakeholder engagement or public participation related to shale gas development in South Africa is provided for in the Minerals and Petroleum Resources Development

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[542] S 5(4)(c) of the Minerals and Petroleum Resources Development Act, No. 28, 2002.

[543] S 54(3) of the Minerals and Petroleum Resources Development Act, No. 28, 200; Devan Allen McGranahan and Kevin Peter Kirkman 'Be proactive on energy sprawl: South Africa must anticipate surface impacts of fracking in rural areas' (2021) at 3, *Resources Policy* 72.

[544] R. Wait & R. Rossouw 'A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa' (2014) at 4, *Southern African Business Review* 18(2).

[545] Steven Hedden, Jonathan D. Moyer and Jessica Rettig, *Fracking for shale gas in South Africa: blessing or curse?* (2013) at 6, *Institute for Security Studies*.

[546] Devan Allen McGranahan and Kevin Peter Kirkman 'Be proactive on energy sprawl: South Africa must anticipate surface impacts of fracking in rural areas' (2021) at 3, *Resources Policy* 72.

[547] AT Hobbs, E. Day, AT Roserwarne, S.Esterhuyse, R.Schulze, J. Day, J. Ewart-Smit, M. Kemp, N. Rivers-Moore, H. Coetzee, D. Hohne, A. Maherry and Mosetsho and M. de Jager 'Water Resources' in Bob Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 382 (5-9), Pretoria, CSIR; Jeannie van Wyk 'Fracking in the Karoo: Approvals Requred?' (2014) at 34, *Stellenbosch Law Review.*

[548] Jeannie van Wyk 'Fracking in the Karoo: Approvals Requred?' (2014) at 34, *Stellenbosch Law Review.*

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Act,[549] the National Environmental Management Act,[550] the National Water Act,[551] and the National Environmental Management: Waste Act.[552] The relevant provisions of this legal framework are discussed in sections 4-7 below.

4.7 Public Participation under the MPRDA

The Minerals and Petroleum Resources Development Act (MPRDA),[553] affirms the ownership of the country's mineral and petroleum resources as belonging to the nation,[554] with the State being the custodian thereof.[555] The MPRDA further obligates the State to protect the natural environment, ensure the ecologically sustainable development of mineral and petroleum resources, and promote economic and social development.[556] The State therefore has the overall responsibility to grant, issue, control, administer and manage all mineral and petroleum rights.[557] To conduct oil and gas exploration and production in South Africa, companies are granted petroleum rights by the Minister responsible for mineral resources, upon recommendation by the designated agency, currently the Petroleum Agency South Africa (Petroleum Agency).[558]

Petroleum rights are initiated through the granting of a Technical Cooperation Permit (TCP).[559] This is followed by the granting of an Exploration Right (ER),[560] and subsequently a Production Right (PR).[561] The TCP has a one-year duration,[562] the ER, a nine-year duration,[563] and the PR a duration of up to 30 years.[564] Petroleum Rights are limited real rights in relation to the petroleum and land to which they relate,[565] and

[549] Mineral and Petroleum Resources Development Act, No.28 of 2002.
[550] National Environmental Management Act, No.107 of 1998.
[551] National Water Act, No.36 of 1998.
[552] National Environmental Management: Waste Act, No. 59 of 2008.
[553] Minerals and Petroleum Resources Development Act, No. 28, 2002.
[554] S 3(1) of the MPRDA.
[555] S 3(1) of the MPRDA.
[556] S 3(3) of the MPRDA.
[557] Elmarie van der Schyff 'South African mineral law: A historical overview of the State's regulatory power regarding the exploitation of minerals' (2012) at 132 *New Contree* 64.
[558] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 69.
[559] S 76(1) of the MPRDA.
[560] S 79(1) of the MPRDA.
[561] S 83(1) of the MPRDA.
[562] S 77(4)(b) of the MPRDA.
[563] S 80(5) of the MPRDA
[564] S 84(4) of the MPRDA.
[565] S 5(1) of the MPRDA.

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are registered at the Mineral and Petroleum Titles Registration Office in terms of the Mining Titles Registration Act.[566] The MPRDA compels the Petroleum Agency to publish applications for petroleum exploration rights within fourteen days of receiving an application.[567]

The Petroleum Agency is also required to call upon interested and affected persons to submit comments regarding the application within 30 days from the date of the notice.[568] Should there be an objection to the granting of an exploration right, the objection must be considered and the Minister of Mineral Resources and Energy advised thereto.[569] The MPRDA furthermore provides that once an exploration right application is accepted by the Petroleum Agency, and the applicant notified,[570] the applicant should notify and consult the landowner or lawful occupier of the land before commencing with exploration or production activities.[571] Moreover, the applicant is required to submit the relevant environmental reports required in terms of Chapter 5 of the NEMA,[572]within 120 days from the notice.[573]

The MPRDA recognises the landowner or lawful occupier of the land as a key stakeholder because petroleum exploration and production have a direct impact on their land.[574] The exploration and production right holder can enter the land to which the right relates, bring onto it machinery, lay surface or sub-surface infrastructure that may be required for the exploration and production of petroleum.[575] The petroleum right holder can also conduct petroleum exploration and production activities,[576] and commercialise the produced petroleum for his or her benefit.[577] Subject to the National

[566] S 2(4) of the Mining Titles Registration Act, No.16 of 1967.
[567] S 10(1)(a) of the MPRDA.
[568] S 10(1)(b) of the MPRDA.
[569] S 10(2) of the MPRDA.
[570] S 79(4) of the MPRDA.
[571] S 79(4)(a) of the MPRDA.
[572] National Environmental Management Act, No.107 of 1998.
[573] S 79(4)(b) of the MPRDA.
[574] S 5(4)(c) of the MPRDA; N. Oettle, L. Lindeque, J. du Toit, I. Samuels, A. Osler S. Vetter, & E.A van Garderen 'Impacts on Agriculture' in Robert Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) at 716 (8-7), Pretoria, CSIR; Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 44, *Stellenbosch Law Review*.
[575] S 5(3)(a) of the Minerals and Petroleum Resources Development Act, No. 28, 2002.
[576] S 5(3)(a) of the MPRDA.
[577] S 5(3)(c) of the MPRDA.

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Water Act,[578] the petroleum right holder can furthermore use water from any river or stream situated or flowing through such land or drill a well or borehole required for the petroleum operations.[579]

The environmental impact assessment is an important matter for stakeholder consultation in terms of the EIA regulations[580] More specifically, the EIA must establish baseline data on the affected environment, to determine protection, remediation and environmental management objectives.[581] The EIA must assess, investigate and evaluate the potential impact to the environment,[582] and socio-economic conditions of any person who might be directly affected by the proposed petroleum exploration and production.[583] The environmental management programme must include an environmental awareness plan, describing the risks involved and how the applicant intends to mitigate such risks to avoid degradation of the environment.[584]

As stated in section one of this chapter, another key stakeholder that has affected shale gas exploration in the Karoo are environmental interest groups.[585] Environmental interest groups objected to the granting of exploration licenses for shale gas in the Karoo.[586] Their objection led to the Minister of Mineral Resources putting a moratorium on shale gas exploration in the country in March 2010.[587] This resulted in the Petroleum Agency not issuing shale gas exploration licenses that various oil and gas

[578] National Water Act, No.36 of 1998.
[579] S 5(3)(d) of the MPRDA.
[580] Environmental Impact Assessment Regulations, 2014, in Government Notice R982, Government Gazette No. 38282 of 4 December 2014 Chapter 6.[581] S 24(4)(a)(iii) of the NEMA.
[581] S 24(4)(a)(iii) of the NEMA.
[582] S 24(4)(b)(i) of the NEMA.
[583] S 23(2)(b) of the NEMA.
[584] S 24N(3)(c) of the NEMA.
[585] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 35, *Stellenbosch Law Review; John Douglas Stern and others vs Minister of Mineral Resources*, para 42, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 2019).
[586] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 35, *Stellenbosch Law Review; John Douglas Stern and others vs Minister of Mineral Resources*, para 42, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 2019).
[587] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 35, *Stellenbosch Law Review*.

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companies had applied for.[588] The moratorium on shale gas exploration was subsequently lifted in September 2012, following recommendations of a Ministerial Task Team that was established to advise the Minister on shale gas exploration in the country.[589]

Despite the lifting of the moratorium, no licenses for shale gas exploration have yet been issued in South Africa,[590] largely because there has not been an effective engagement of the relevant stakeholders. Rather than calling for the substantive engagement of key stakeholders, the MPRDA merely provides for interested and affected parties to be consulted,[591] a critical shortcoming in the MPRDA. To enable the societal acceptance of shale gas development in the Karoo, the meaningful and substantive engagement of key stakeholders will be crucial, as provided for in the NEMA.[592] section 5 below.

4.8 Public Participation under the NEMA

The National Environmental Management Act (NEMA),[593] prescribes the environmental management principles to be applied when making decisions that may have a significant impact on the environment.[594] A key principle of the NEMA is that environmental management must have people and their needs at its core.[595] Environmental decisions must consider the interests, needs and values of all affected and interested parties (key stakeholders).[596] Development should be socially, environmentally and economically sustainable.[597] Sustainable development requires

[588] Ibid.
[589] Ibid.
[590] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 15 (790/2018) [2019] ZASCA 99 (4 July 2019).
[591] S 10(1)) of the MPRDA.
[592] S 2(4) of the NEMA.
[593] National Environmental Management Act, No.107 of 1998.
[594] National Environmental Management Act, No.107 of 1998.
[595] S 2 (2) of the NEMA.
[596] S 2 (4)(g) of the NEMA.
[597] S 2 (3) of the NEMA.

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that environmental degradation be avoided, and where it cannot be entirely avoided, be minimized and remedied.[598]

The NEMA provides that the participation of key stakeholders in environmental governance be promoted.[599] It calls for all stakeholders to be given an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation.[600] It calls for the participation of vulnerable and disadvantaged groups to be ensured.[601] Accordingly, community wellbeing and empowerment must be promoted through environmental education, awareness and the sharing of knowledge and experience and other appropriate means.[602] The social, economic and environmental impacts of activities, including disadvantages and benefits must be considered, assessed and evaluated, with appropriate decisions taken in the context of such consideration and assessment.[603]

The NEMA Environmental Impact Assessment Regulations,[604] list oil and gas exploration and production as part of environmentally invasive activities.[605] These activities require scoping and environmental impact assessments to be done prior to embarking on them.[606] Furthermore, the NEMA Environmental Impact Assessment Regulations,[607] affirm the MPRDA requirement that exploration right holders should notify and consult the landowner or lawful occupier of the land to which the right applies before commencing with petroleum exploration or production activities.[608]

The NEMA Environmental Impact Assessment Regulations, provide a stronger formulation, which requires that written consent to undertake invasive environmental

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[598] S 2 (4) of the NEMA.
[599] S 2 (4)(f) of the NEMA.
[600] Ibid.
[601] Ibid.
[602] S 2 (4)(h) of the NEMA.
[603] S 2 (4)(i) of the NEMA.
[604] Environmental Impact Assessment Regulations (2014) in Government Notice R982, Government Gazette 38282.
[605] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 46, *Stellenbosch Law Review*.
[606] Ibid.
[607] Environmental Impact Assessment Regulations, Government Gazette No. 38282, 2014.
[608] Environmental Impact Assessment Regulations, Government Gazette No. 38282, 2014; Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 46, *Stellenbosch Law Review*; S 79(4)(a) of the MPRDA.

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activities be obtained from the landowner or person in control of the land.[609] The provision, however, excludes petroleum exploration and production from this requirement.[610] One of the main shortcomings of the NEMA and EIA Regulations' public participation framework is its limitation to the application process for a prospecting or exploration right.[611] Once a prospecting or petroleum exploration right is approved, the public or stakeholders have no influence on prospecting or exploration activities.[612] The public cannot monitor project activities or be involved in project design and other related decisions.[613] The petroleum and environmental laws of South Africa should therefore be strengthened, to provide for the involvement of key stakeholders for the duration of the exploration and production rights. This would allow key stakeholders to monitor and influence decisions pertaining to shale gas development.

4.9 Public Participation under the NWA

Shale gas development is contentious largely because the hydraulic fracturing process uses vast amounts of water, and chemicals that could contaminate surface and groundwater resources.[614] Furthermore hydraulic fracturing produces a considerable amount of wastewater that requires treatment for safe disposal.[615] The handling and disposal of this wastewater is a threat to surface waters.[616]

The National Water Act (NWA) regulates the protection and appropriate management of water resources in South Africa.[617] This is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled, taking into account the basic human needs of present and future generations.[618] The NWA

[609] S 39(1) of the Environmental Impact Assessment Regulations (2014) in GN R982 GG 38282
[610] S 39(2)(b) of the Environmental Impact Assessment Regulations.
[611] P Kind and C Reddell 'Public Participation and Water Use Rights' (2015) at 11 *PER/PELJ 4(18)*.
[612] Ibid.
[613] Ibid.
[614] Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) at 37, *Science of the Total Environment;* U.S. EPA 'Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)' (2016), Washington, DC, EPA/600/R-16/236F, available at www.epa.gov./hfstudy, accessed on 28 May 2022.
[615] Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24: 14579 – 14594.
[616] Ibid.
[617] National Water Act, No.36 of 1998.
[618] S 1(2)(a) of the NWA.

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furthermore facilitates equitable access to water, social and economic development.[619] It also promotes the efficient, sustainable and beneficial use of water in the public interest, taking into account the growing demand for water, ecosystems and biological diversity and international obligations. [620]

Hydraulic fracturing is a controlled activity under the relevant provisions of the National Water Act.[621] This implies that companies applying for shale gas exploration rights will also have to apply for an integrated water use license at the Department of Water and Sanitation.[622] Before the issuing of the water use license, the reserve for the specific catchment has to be determined.[623] The reserve defines the quantity and quality of water from a source that is required to supply the basic human needs, and to protect aquatic ecosystems, to ensure ecologically sustainable development and use of water resources.[624]

Consequently, companies applying for shale gas exploration licenses will be required to identify the sources of water supply within their exploration area of interest, or nearby, and to develop a water resource management plan, which must include mitigation of potential impacts on the water resources.[625] The long-term monitoring of water use, together with liability obligations are to be a condition of the water use license.[626] Moreover, water management strategies such as the use of alternative

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[619] S (1)(2)(a) of the NWA.
[620] S (1)(2)(a) of the NWA.
[621] Academy of Science of South Africa (ASSAf) *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 83 (ASSAf, Pretoria); Department of Water and Sanitation 'Declaration of the Exploration for and Production of Onshore Unconventional Oil or Gas Resources or any Activities Related Thereto Including but not Limited to Hydraulic Fracturing as a Controlled Activity, Government Gazette, No. 39299 of 16 October 2015.
[622] Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 83 (ASSAf, Pretoria); Department of Water and Sanitation 'Declaration of the Exploration for and Production of Onshore Unconventional Oil or Gas Resources or any Activities Related Thereto Including but not Limited to Hydraulic Fracturing as a Controlled Activity, Government Gazette, No. 39299 of 16 October 2015.
[623] S 3(15) of the NWA.
[624] S 3(15) of the NWA.
[625] Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 83 (ASSAf, Pretoria).
[626] Ibid.

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water sources or water withdrawal restrictions can reduce the frequency or severity of impacts on drinking water sources from shale gas development.[627]

The NWA provides for consultation with the broader society on strategies aimed at managing water resources.[628] It provides that a responsible authority, which is required to consider applications for water use licences, may provide comments from any State organ or interested persons.[629] It may require applicants to give notice describing the licence applied for,[630] and stating that written objections may be lodged against the application before a specified date, no less than 60 days after the publication of notice.[631] The responsible authority may also require applicants to take such steps as it may direct to bring the application to the attention of the relevant organs of state, interested persons and the general public,[632] and to satisfy the responsible authority that the interests of any other person having an interest in the land will not be adversely affected.[633]

The NWA further provides that the competent authority must afford applicants an opportunity to make representations on any aspect of the licence application.[634] The word 'must' strengthen this requirement of the NWA, compared to the discretionary formulations in sections 42(2)(c) and 41(4) of the NWA, providing for public participation in relation to applications for water use licences.[635] The NWA does not however provide an inclusive mechanism for public participation that ensures the ventilation of all matters of concern in relation to water use.[636] It also provides no detail as to the nature and extent of the public participation procedure to be undertaken.[637]

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[627] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016), at 15, Office of Research and Development, Washington DC, available at www.epa.gov./hfstudy, accessed on 25 July 2022.
[628] S 5(5)(iii) of the NWA
[629] S 41(2)(c) of the NWA
[630] S 41(4)(a)(i) of the NWA
[631] S 41(4)(a)(ii) of the NWA
[632] S 41(4)(b) of the NWA
[633] S 41(4)(c) of the NWA
[634] S 41(2)(d) of the NWA
[635] P Kind and C Reddell 'Public Participation and Water Use Rights' (2015) at 11 *PER/PELJ* 4(18).
[636] Ibid.
[637] Ibid.

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Such an inclusive mechanism, enabling robust public participation in water use licensing processes,[638] could aid the societal acceptance of shale gas in the Karoo.

4.10 Public Participation under the NEM: WASTE ACT

As discussed in chapter 2, hydraulic fracturing produces a considerable amount of wastewater that requires treatment for safe disposal,[639] and the handling and disposal of this wastewater is a threat to surface waters.[640] The National Environmental Management: Waste Act (NEM: Waste Act)[641] provides for national norms and standards for regulating the management of waste.[642] It provides for the licensing and control of waste management activities and for the remediation of contaminated land.[643] It furthermore provides for a national waste information system, and for the compliance and enforcement of waste management.[644] In terms of the Act, the Minister or MEC responsible for the environment must invite members of the public to submit written representations or objections related to a proposed waste generating activity.[645] The Minister or MEC must take such representations or objections into account when taking a decision to authorise such an activity or not.[646]

The invitation must be through a notice in the Government Gazette,[647] and in at least one newspaper that is distributed nationally or locally.[648] Such a notice must allow the public at least 30 days to make the written representations or objectives to the proposed activity.[649] The notice must contain sufficient information to enable the members of the public to submit the representations or objections.[650] The Minister or

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[638] Ibid.
[639] Hans-Holger Rogner & Ruud Weijermars 'The Uncertainty of Future Commercial Shale Gas Availability' (2014) SPE Paper No. 167710, at 6, presented to the SPE/EAGE European Unconventional Conference and Exhibition, Vienna, Austria, 25 – 27 February 2014; Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24.
[640] Ibid.
[641] National Environmental Management: Waste Act, No. 59 of 2008.
[642] Ibid.
[643] Ibid.
[644] Ibid.
[645] S 73(2)(a) of the NEM: Waste Act.
[646] S 73(4)(a) of the NEM: Waste Act.
[647] S 73(1)(a) of the NEM: Waste Act.
[648] S 73(1)(b) of the NEM: Waste Act.
[649] S 73(2)(a) of the NEM: Waste Act.
[650] S 73(2)(b) of the NEM: Waste Act.

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MEC, may, in appropriate circumstances, allow any interested person or community to make oral representations or objections to the Minister or MEC, or to a person designated by the Minister or MEC on the proposed activity.[651] Effective public participation leveraging the aforementioned provisions, could ensure that the risk of contaminating ground and surface waters or the environment by toxic waste arising from shale gas development is mitigated.

4.11 A New Era for Public Participation in the Oil and Gas Sector

Three recent court cases are quite instructive on the approach of the courts with regards to public participation related to the exploration of oil and gas in South Africa.[652] Two of these cases were heard in the Eastern Cape High Court in Grahamstown in November and December 2021 respectively.[653] The third case, was heard in the Western Cape High Court in Cape Town in February 2022.[654] In all three cases, the applicants sought an order interdicting various oil and gas companies from conducting seismic surveys off the coasts of South Africa.[655] These cases are outlined in sections 4.11.1 to 4.11.3 below.

[651] S 73(3) of the NEM: Waste Act.

[652] *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021); *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

[653] *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021).

[654] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

[655] *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021); *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

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4.11.1 Border Deep Sea Angling v Minister of Mineral Resources and Energy

4.11.1.1 Introduction

In *Border Deep Sea Angling v Minister of Mineral Resources and Energy*, the applicants sought to interdict BG International Limited, Shell Exploration and Production South Africa BV, and Impact Africa Limited (collectively referred to in the case as 'Shell') from conducting a 3 dimensional (3D) seismic survey off the East Coast of South Africa (also known as the wild coast) under Exploration Right 12/3/252 from 1 December 2021 onwards.[656] The interdict was to come into effect pending the final determination of an application for review and setting aside of the grant of the Exploration Right by the Minister responsible for Mineral Resources, and its various renewals on 20 December 2017 and in May 2020 respectively.[657] The application for review had not yet been lodged when the case was heard on 30 November 2021, and set down on 3 December 2021, therefore the notice of motion provided that, should the review not be instituted by 10 January 2022 the interdict would lapse.[658] The application was lodged on an urgent basis because the seismic survey was planned to begin on 1 December 2021, or shortly thereafter, and that its commencement would cause substantial and irreversible harm.[659]

4.11.1.2 Public Participation as it Relates to this Case

Impact Africa applied for the Exploration Right in terms of section 79 of the MPRDA,[660] to explore for oil and gas in the Transkei and Algoa exploration areas in 2013.[661] Upon acceptance of the application, the applicants were requested to develop an Environmental Management Programme (EMPr) required in terms of section 39 of the MPRDA.[662] To that effect, a public participation process was undertaken in 2013, when the draft EMPr was published for the consideration of interested and affected

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[656] *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, para 2, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021).
[657] Ibid, para 2.
[658] Ibid, para 2.
[659] Ibid, para 4.
[660] Ibid, para 16.
[661] Ibid.
[662] Ibid.

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parties.[663] The Exploration Right was then granted to Impact Africa in April 2014, following the approval of the EMPr.[664]

The Exploration Right entered into its first renewal period in December 2017, and into the second renewal period in August 2021.[665] The granting of the Exploration Right occurred before the regulation of the environmental aspects of oil and gas activities fell under the NEMA, pursuant to the One Environmental System.[666] Therefore the EMPr that was approved in terms of the MPRDA could, according to the respondents, be regarded as an Environmental Management Plan (EMP) approved under the NEMA.[667] The applicants however alleged that Shell was required to obtain environmental authorisation in terms of the NEMA before embarking on exploration activities such as the seismic survey, which Shell did not have.[668]

4.11.1.3 Ruling

Judge Govindjee AJ, dealt with the requisites for an interim relief. First, a clear right, if not clear, a *prima facie* right had to be established; secondly, if the right is only *prima facie* established, there should be a well-grounded apprehension of irreparable harm if the interim relief is not granted and the ultimate relief is eventually granted; thirdly, the balance of convenience should favour the granting of an interim interdict; fourthly, the applicants should have no other satisfactory remedy.[669]

Accordingly, the applicants demonstrated that, if interim protection was given, they had a *prima facie* right to only part of the relief sought in the review, and that there was no alternative remedy available.[670] The applicants however could not convince Judge Govindjee that there was a well-grounded apprehension of irreparable harm if the interim relief was not granted, and the ultimate relief was eventually granted, or that the balance of convenience favoured the applicants.[671] The judge therefore rejected

[663] Ibid.
[664] Ibid.
[665] Ibid.
[666] Ibid, para 18.
[667] Ibid
[668] Ibid.
[669] Ibid, para 11.
[670] Ibid, para 40.
[671] Ibid.

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the application for an interim order interdicting Shell's 3D seismic acquisition off the wild coast.[672]

4.11.2 Sustaining the Wild Coast v Minister of Mineral Resources and Energy

4.11.2.1 Introduction

In *Sustaining the Wild Coast v Minister of Mineral Resources and Energy*,[673] the applicants sought an order interdicting Shell Exploration and Production South Africa BV; Impact Africa Limited; and BG International Limited (herein referred to as Shell) from continuing their three-dimensional (3D) seismic survey pending the outcome of the relief sought in Part B of the case.[674] In Part B, the applicants sought an interdict prohibiting the same respondents from proceeding with the seismic survey on the basis that the respondents did not have an environmental authorization to conduct the seismic survey granted under the National Environmental Management Act.[675]

The applicants are non-profit organisations, natural persons, and a communal property association.[676] Their interests range from promoting sustainable livelihoods that construct, rehabilitate and protect the natural environment on the Wild Coast; traditional healing; small-scale fishing; and the mitigation of climate change.[677] Collectively, the applicants act in the public interest and in the interest of protecting the environment.[678] The respondents are the Minister of Minerals Resources and Energy; Minister of Environment, Forestry and Fisheries; and Shell.[679]

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[672] Ibid.
[673] *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021).
[674] *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, para 1, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021).
[675] Ibid.
[676] Ibid, para 2.
[677] Ibid.
[678] Ibid.
[679] Ibid, para 3.

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4.11.2.2 Public Participation as it Relates to this Case

In 2013 Impact Africa applied for an Exploration Right,[680] at the Petroleum Agency SA (Petroleum Agency) to explore for oil and gas in the Transkei and Algoa exploration areas.[681] The application was accepted by the Petroleum Agency on 1 March 2013.[682] A draft environmental management programme (EMPr) was made available to interested and affected parties, to enable them to raise concerns on the proposed exploration activities.[683] Comments on the draft EMPr were required from 22 March to 12 April 2013.[684] Advertisements were placed in several newspapers, including, The Times, Die Burger (Eastern Cape), The Herald, and The Daily Dispatch, notifying the public of the proposed project.[685] The advertisements provided details of the consultation process, and shared information on how members of the public could provide input to the EMPr process.[686]

A final EMPr was produced during June 2013, and was approved by PASA on 9 September 2013, subject to certain conditions.[687] The Deputy Director-General of the department responsible for mineral resources approved the EMPr, and on 29 April 2014 the Exploration Right was granted.[688] Shell therefore conducted a seismic survey off the Eastern Coast of South Africa covering an area of 6 011 square kilometres at the beginning of December 2021.[689] The seismic survey, which would last for 110 – 120 days depending on the weather, sea currents, and conditions, would provide imaging of the subsurface, which are used to identify geological structures that might contain oil and gas resources.[690]

[680] In terms of section 79 of the MPRDA.
[681] *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, para 3.
[682] Ibid, para 5.
[683] Ibid.
[684] Ibid.
[685] Ibid.
[686] Ibid.
[687] Ibid.
[688] Ibid.
[689] Ibid, para 6.
[690] Ibid.

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4.11.2.3 Ruling

In deciding the case, Judge Bloem J, dealt with the requisites for an interim interdict. First, the applicants had to satisfy the court that they had established a *prima facie* right even if open to some doubt.[691]Secondly, that there was a reasonable apprehension of irreparable and imminent harm to the right if the interim interdict was not granted.[692] Thirdly, the balance of convenience favoured the granting of the interim interdict.[693] Fourthly, the applicants have no other satisfactory remedy.[694] Shell contended that the application should be dismissed because the applicants could not establish any of these.[695]

In his ruling, Judge Bloem affirmed that despite having the duty to meaningfully consult with the communities and individuals who would be impacted by the seismic survey, Shell failed to meaningfully consult, as demonstrated by evidence showing that the consultation process was inadequate and substantially flawed.[696] He therefore, accepted that the applicant's right to meaningful consultation constituted *prima facie* rights that deserved to be protected by way of an interim interdict.[697] He furthermore accepted that the Exploration Right, which was awarded based on a substantially flawed consultation process was unlawful and invalid.[698] Moreover, on whether Shell had to have an environmental authorization obtained under the NEMA, the Minister confirmed that the environmental management program that was used to support the renewal application by Impact Africa constituted an environmental authorization, as envisaged by the NEMA, which may not be the case, this would be dealt with under Part B of the notice of motion.[699]

On whether there was a reasonable apprehension of irreparable and imminent harm if the interim interdict was not granted, the court accepted the expert evidence that

[691] Ibid, para 7.
[692] Ibid.
[693] Ibid.
[694] Ibid.
[695] Ibid.
[696] Ibid, para 33.
[697] Ibid, para 34.
[698] Ibid.
[699] Ibid.

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without its intervention, there was a real threat of irreparable harm to marine life,[700] and that Shell's mitigation measures were inadequate to mitigate against the possible harm from the seismic survey.[701] Furthermore, the seismic survey would negatively impact the livelihoods of the fishers, and cause cultural and spiritual harm.[702] On the balance of convenience, the Judge weighed the harm that the applicants would suffer if the interim interdict was not granted, against the harm that Shell would suffer if the interim interdict was granted,[703] and ruled that the balance of convenience favoured the granting of the interim interdict.[704] In terms of an alternative remedy being available to the applicants, the Judge also ruled that the only available remedy was to grant the interim interdict.[705]

4.11.3 Adams v Minister of Mineral Resources and Energy

4.11.3.1 Introduction

In *Adams v Minister of Mineral Resources and Energy*,[706] the applicants sought an interim interdict or urgent order interdicting Searcher Geodata UK Limited, Searcher Seismic Australia, and BGP "Pioneer" (collectively Searcher) from commencing or continuing a seismic survey along the West and South Coasts of South Africa.[707] The seismic survey was conducted based on a Reconnaissance Permit granted in terms of section 74 of the MPRDA.[708] The two-part application was sought by small-scale fishers, indigenous communities, an environmental organization ('Green Connection'), and an organization established to enhance good governance ('We are South Africans').[709] The interim interdict was sought pending the outcome of the applicant's internal appeal

[700] Ibid, para 64.
[701] Ibid, para 65.
[702] Ibid, para 66.
[703] Ibid.
[704] Ibid, para 73.
[705] Ibid, para 77.
[706] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).
[707] Ibid, para 1.
[708] Ibid.
[709] Ibid, para 2.

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against the granting of the Reconnaissance Permit to Searcher in terms of section 96 of the MPRDA, and the decision on Part B,[710] of the applicant's application.[711]

4.11.3.2 Public Participation as it Relates to this Case

Searcher applied for a Reconnaissance Permit at the Petroleum Agency SA on 30 April 2021, for approval by the Minister of Mineral Resources and Energy in terms of s 74 of the MPRDA.[712] The application was accepted on 18 May 2021 on condition that Searcher develops an Environmental Management Programme (EMPr).[713] Searcher developed the EMPr and submitted it to the Petroleum Agency on 11 September 2021. Meanwhile, on 11 June 2021, the Department of the Environment, Forestry and Fisheries (DFFE) issued amendments to the Environmental Impact Assessment Regulations (EIA Regulations) Listing Notice 1, 2 and 3.[714]

In terms of the new EIA Regulations, applicants for a Reconnaissance Permit submitted on or after 11 June 2021 were required to obtain an Environmental Authorization (EA), issued in terms of section 24 of the NEMA and the EIA Regulations of 2014.[715] Prior to the amendments to the EIA Regulations on 11 June 2021, applications for Reconnaissance Permits did not require Environmental Authorization.[716] Searcher's application for a Reconnaissance Permit, having been made before 11 June 2021 did not require an Environmental Authorization, therefore had to be finalized in terms of the law prevailing when the application was made.[717]

In terms of Part A of this case, the issue was whether an urgent order interdicting Searcher from commencing, or continuing a seismic survey along the West and South

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[710] Part B is based on whether Searcher had the right to commence the seismic survey without an environmental authorisation issued by the Minister of Minerals and Energy in terms of s 24F(1)(a) of the NEMA and s 5A of the MPRDA.
[711] Ibid, para 1.
[712] Ibid, para 22.
[713] Ibid.
[714] Environmental Impact Assessment Regulations, 2014 in GN R517 Government Gazette 44701; *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, para 22, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).
[715] Ibid.
[716] Environmental Impact Assessment Regulations, 2014 in GN R517 Government Gazette 44701.
[717] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, para 22, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

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Coasts of South Africa, ought to be granted pending the decision on Part B.[718] Specific questions for consideration by the Court were: first, whether the Reconnaissance Permit issued to Searcher was illegal, on the basis that it did not have Environmental Authorisation in terms of the NEMA and related Environmental Impact Assessment Regulations,[719] therefore the commencement of the seismic survey on 24 January 2022 was illegal.[720] Secondly, whether the survey would cause irreparable harm; thirdly, public interest and, fourthly, the balance of convenience.[721]

In clarifying what an Interim Order is, Judge Thulare J outlined it as being 'a court order preserving or restoring the *status quo* pending the final determination of the rights of the parties'.[722] 'An interim order therefore does not involve a final determination of the rights of the parties and does not affect their determination'.[723] He outlined the requisites for an interim interdict as being firstly, a *prima facie* right; secondly, a well-grounded apprehension of irreparable harm if the interim relief is not granted and the ultimate relief is eventually granted; thirdly, the balance of convenience favours the granting of an interim interdict; fourthly, the application has no other satisfactory remedy.[724] Accordingly, based on the discretionary nature of an interim interdict, these requisites could not be assessed in isolation, but rather had to be looked at holistically in recognition of their interdependence.[725]

4.11.3.3 Ruling

Judge Thulare recalled that the MPRDA provides that if an application for a reconnaissance permit is accepted, the Petroleum Agency must within 14 days of the receipt of such an application notify the applicant to consult with the landowner, lawful occupier of the land in question, and interested and affected parties in the prescribed

[718] Ibid, para 3.
[719] s 24F(1)(a) of the NEMA; Environmental Impact Assessment Regulations, 2014 in GN R517 Government Gazette 44701.
[720] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, para 4, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).
[721] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, para 4, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).
[722] Ibid, para 5.
[723] Ibid.
[724] Ibid.
[725] Ibid.

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manner.[726] The results of such consultation must be included in the relevant environmental reports in terms of Chapter 5 of the NEMA.[727] The applicants in this case, therefore, constituted the interested and affected parties referred to in the MPRDA,[728] therefore ought to have been consulted, since they were concerned, had an interest, and wanted to be involved in the decisions related to the seismic survey, because it could have an effect in their lives.[729] The small scale fishers and their communities were not consulted.[730] The justification given for not considering them in the consultation process was that they were not directly affected by the seismic acquisition.[731]

Even the publication of the consultation process in the newspapers, e-mail notifications, publication on the website and hard copies that were placed at libraries clearly did not target small scale fishers and their communities.[732] This is because had this grouping of stakeholders been a consideration, the publications would not have been limited to only the English and Afrikaans languages when IsiXhosa was one of the main languages spoken in these communities.[733] They would also not have been limited to people who were literate and had access to technological devices such as computers, cellphones, and data to access the internet.[734] The court noted that, according to the applicants, meaningful consultation could have been better achieved if Searcher had publicized the consultation process on the community radio stations, and called community meetings.[735] Furthermore, Searcher is deemed to have outsourced its obligation to consult to an NGO, to fulfil the requirements of formal compliance with no regard to the substance of the duty to consult.[736]

In essence, the applicant's case was that in the absence of consultation the survey posed an immediate risk to marine and bird life and to the communities who relied on

[726] Ibid, para 6.
[727] Ibid.
[728] S 74(4)(a) of the MPRDA.
[729] *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, para 7, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).
[730] Ibid, para 7.
[731] Ibid, para 7.
[732] Ibid, para 8.
[733] Ibid.
[734] Ibid.
[735] Ibid, para 14.
[736] Ibid.

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the sea for their livelihoods and food sources.[737] Therefore the failure to consult rendered Searcher's seismic survey unlawful hence required an immediate interdictory relief to avoid the anticipated harm.[738] Searcher's non-consultation of small scale fishers, indigenous communities, Non-Governmental Organisations and other interest groups and individuals in the fishing sector in the West Coast meant that there was no adequate and appropriate opportunity for public participation in decisions that affected the public and that could affect the environment.[739]

Taking into account that the reconnaissance permit granted to Searcher might not be legal, rendering the commencement of the seismic survey illegal,[740] that there was a reasonable apprehension the survey could cause irreparable harm,[741] public interest,[742] and that the balance of convenience favoured the applicants,[743] the court granted the interdict, ordering Searcher from continuing seismic survey off the West Coast of South Africa based.[744] The interdict is pending the outcome of the applicant's internal appeal against the granting of the reconnaissance permit to Searcher and the decision on Part B.[745] This ruling underscores the criticality of substantive public participation in the upstream oil and gas sector in South Africa, which will have to be the guiding principle if shale gas development is to have any chance at societal acceptance.

4.12 Insights and Learnings from Case Law

As stated earlier in this chapter, lessons can be learned from these three court cases with regards to public participation related to the exploration of oil and gas in South Africa.[746] Common among these cases is that oil and gas exploration activities were

[737] Ibid, para 16.
[738] Ibid.
[739] Ibid, para 46.
[740] Ibid, para 22.
[741] Ibid, para 34.
[742] Ibid, para 36.
[743] Ibid, para 41.
[744] Ibid, para 50.
[745] Ibid.
[746] *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021); *Christian John Adams and Others v Minister of Mineral Resources and Energy*

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interdicted while already underway. The cases clarified the requisites for interim interdicts as they pertain to public participation related to permits and rights for the exploration of oil and gas. Accordingly, a clear right, or a *prima facie,* right even if open to some doubt, had to be established. Secondly, there should be a reasonable apprehension of irreparable and imminent harm to the right if the interim interdict was not granted. Thirdly, the balance of convenience should favour the granting of the interim interdict. Fourthly, there should be no other satisfactory remedy.

While in the first case,[747] which was very rushed, with the interdict lodged a few days before the actual commencement of the seismic acquisition and heard a day before the commencement of activities, the Judge ruled against the applicants.[748] The basis for the rejection was that the Judge was not convinced that there was a well-grounded apprehension of irreparable harm if the interim relief was not granted, and the ultimate relief was eventually granted, or that the balance of convenience favoured the applicants.[749] The Judge did not deal with public participation as a critical consideration in this case.

This omission was dealt with in the subsequent cases,[750] where it was affirmed that despite having the duty to meaningfully consult with the communities and individuals who would be impacted by the planned activities, the companies concerned failed to meaningfully consult, and that the consultation process was inadequate and substantially flawed. Accordingly interested and affected parties' rights to meaningful consultation constituted *prima facie* rights that deserved to be protected. Consequently, the Exploration Right, which was awarded based on a substantially flawed consultation process in the Shell case was revoked as unlawful and invalid.

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and others, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

747 *Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others*, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021).

748 Ibid, para 40.

749 Ibid.

750 *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others*, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021); *Christian John Adams and Others v Minister of Mineral Resources and Energy and others*, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

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The consultation was flawed because key stakeholders/interested and affected parties were not consulted. For example, in the Searcher case, small-scale fishers and their communities were not consulted. Even the publication of the consultation process in the newspapers, e-mail notifications, publication on the website and hard copies that were placed at libraries did not target small scale fishers and their communities. According to the ruling, that grouping of stakeholders been a consideration, the publications would not have been limited to only the English and Afrikaans languages when IsiXhosa was one of the main languages spoken in these communities. They would also not have been limited to people who were literate and had access to technological devices such as computers, cellphones, and data to access the internet. The court even noted that, according to the applicants, meaningful consultation could have been better achieved if Searcher for example had publicized the consultation process on the community radio stations and called community meetings.

The courts further affirmed that there was reasonable apprehension of irreparable and imminent harm associated with oil and gas exploration activities, which require the meaningful engagement of stakeholders which should not be taken for granted, and that the use of an accessible language was central to meaningful public participation. As stated earlier in this section, this case law underscores the criticality of meaningful public participation in the upstream oil and gas sector in South Africa, which will have to be the guiding principle if shale gas development is to gain societal acceptance.

4.13 Conclusions

The review of the legal framework, including the relevant legislation and case law on public participation related to the exploration and production of oil and gas in South Africa, reveals that the societal acceptance of shale gas development will need to be earned through meaningful public participation. This implies substantive engagement of local communities and other relevant stakeholders at every stage of shale gas development.[751] This will require the applicants and holders of permits and rights for shale gas exploration and exploitation to share pertinent project information with the

[751] International Energy Agency 'Energy Policies of IEA Countries: Canada 2015 Review' (2016) at 115, available at https://iea.blob.core.windows.net/assets/e9e4c6be-dc28-44a8-8bcc-7e0af3a8f19e/EnergyPoliciesofIEACountriesCanada2015Review.pdf accessed on 25 July 2022.

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relevant stakeholders or interested and affected parties.[752] That implies, provide full details on the technical aspects of shale gas exploration and exploitation, the associated risks, and mitigation measures to be put in place to protect the environment at the planning stage of shale gas development and in an accessible language.

Meaningful public participation could also mean giving the public access to independent experts to help them with in-depth analysis of the hydraulic fracturing process.[753] Furthermore, there should be openness to adopt processes or project implementation plans in alignment with public concerns, perspectives, and expectations.[754] This should be premised on the recognition that stakeholders have legitimate interests in procedural or substantive aspects of industrial activity,[755] and that these interests have intrinsic value.[756]

Accordingly, the petroleum right holders should provide sufficient opportunity for comment on plans, operations, and performance, listen to concerns, and respond appropriately and promptly.[757] Right holders should be encouraged to devise strategies and plans of engagement in accordance with statutory requirements. Moreover, the industry should work towards maximizing the economic benefits to local communities from their operations, for example by considering local employment and utilizing contractors or service providers, where possible. Participatory approaches to addressing environmental challenges have the potential to facilitate knowledge sharing, lessen contradictions, and build trust among key stakeholders, leading to support for industrial activities such as shale gas extraction.[758]

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[752] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 135, *Edward Elgar Publishing Limited* (Cheltenham, UK).

[753] Thomas Donaldson and Lee E. Preston 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications' (1995) at 67, 20(1) *Academy of Management Review.*

[754] Ibid.

[755] Ibid.

[756] Ibid.

[757] International Energy Agency 'Energy Policies of IEA Countries: Canada 2015 Review' (2016) at 115, available at https://iea.blob.core.windows.net/assets/e9e4c6be-dc28-44a8-8bcc-7e0af3a8f19e/EnergyPoliciesofIEACountriesCanada2015Review.pdf accessed on 25 July 2022.

[758] Mark S. Reed, Steven Vella, Edward Challies, Joris de Vente, Lynne Frewer, Daniela Hohenwallner-Ries, Tobias Huber, Rosmarie K. Neumann, Elizabeth A. Oughton, Julian Sidoli del Ceno & Hedwig van Delden 'A theory of participation: what makes stakeholder and public engagement in environmental management work?' (2018) at s7, *Restoration Ecology* 26.

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The requirement for substantive public consultation, and the obligation to obtain the full and informed consent of customary communities was emphasized in *Baleni v Minister of Mineral Resources.*[759] Therefore, the soft formulation of the MPRDA, calling for consultation instead of substantive and comprehensive engagement of stakeholders therefore needs to be addressed to aid the societal acceptance of shale gas. A requirement for consent by landowners or persons in control of the land over which a petroleum right has been awarded would also go a long way to appease landowners in the Karoo. In essence, public participation in relation to shale gas exploration and production in the Karoo should be about ensuring that the interests of diverse stakeholders are coordinated in a way that could lead to amicable outcomes.[760] The legal mechanisms as outlined in this chapter, could also assure stakeholders that their concerns and interests are considered in decision making.[761]

[759] *Baleni v Minister of Mineral Resources*, 2019 2 SA 453 (High Court of South Africa, Gauteng Division, Pretoria) (2016) para 84(2). The Baleni case relates to a dispute between the local community or villagers of Umgungundlovu who hold informal land rights on the wild coast in the Eastern Cape, South Africa who did not want Australian Mining Company – Transworld Energy and Mineral Resources (SA) Pty Ltd (TEM) to mine the titanium-rich sands on their ancestral land, under the Xolobeni Mineral Sands Project, on the basis that such mining would interfere with their way of life.

[760] Thomas Donaldson and Lee E. Preston 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications' (1995) at 80, 20(1) *Academy of Management Review.*

[761] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 134, *Edward Elgar Publishing Limited* (Cheltenham, UK).

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CHAPTER 5: SOUTH AFRICA'S LEGAL FRAMEWORK FOR SHALE GAS

5.1 Introduction

The exploitation of shale gas in South Africa will require hydraulic fracturing because shale gas does not naturally flow into a well, therefore the shale rock needs to be fractured/cracked to allow the production of the gas at commercial scale.[762] However, the country's petroleum legal framework does not provide adequately for hydraulic fracturing.[763] This resulted in the Petroleum Agency not awarding exploration rights for shale gas, despite several oil and gas companies having applied for such rights as far back as 2010.[764] At the centre of the impasse is whether South Africa's Regulations for Petroleum Exploration and Production (the 'Hydraulic Fracturing Regulations') which were gazetted to regulate the use of hydraulic fracturing specifically,[765] are adequate to protect the environment from the risks associated with shale gas extraction.[766] The regulations were successfully challenged at the High Court in

[762] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, Doug Cole, Annette E. Götz, Claire Geel & Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 2, *S Afr J Sci*; 113 (9/10); J.C. Shaw, M.M. Reynolds, L.H. Burke 'Shale Gas Production Potential and Technical Challenges in Western Canada' (2006) at 2, Paper 2006-193, presented to the Petroleum Society's 7th Canadian International Petroleum Conference, Calgary, Alberta, Canada, 13-15 June.

[763] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 260, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

[764] *John Douglas Stern and others vs Minister of Mineral Resources*, para 13, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others*, para 16 (790/2018) [2019] ZASCA 99 (4 July 2019).

[765] Regulations for Petroleum Exploration and Production, Government Notice R.466 in Government Gazette No.38855 of 3 June 2015.

[766] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1466, *Potchefstroom Electronic Law Journal* 18(5). Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 85, in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) Claremont, Juta and Company (Pty) Ltd; Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 260, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

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Grahamstown,[767] and their set aside was confirmed by the Supreme Court of Appeal.[768]

Despite being invalidated by the High Court, the regulations will invariably form the point of departure for regulating hydraulic fracturing in South Africa. This is because the regulations were developed with the oversight of the Monitoring Committee that is charged with ensuring the comprehensive and coordinated augmentation of the regulatory framework for shale gas.[769] The monitoring Committee comprises of representatives from the Departments of Mineral Resources and Energy, Forestry, Fisheries and Environment, Water and Sanitation and Science and Technology.[770] The Monitoring Committee continues to exist and is overseeing the refinement of the hydraulic fracturing regulations to be promulgated by the Minister of Forestry, Fisheries and the Environment. This chapter examines the 2015 regulations which were set aside, as part of the broader assessment of the adequacy of the South African petroleum legal framework to regulate shale gas development.

5.2 Selected Tenets of the Transitioning Petroleum Legislative Framework

An independent petroleum legal framework is emerging in South Africa, pending the separation of oil and gas regulation from mineral regulation.[771] This might help address the impracticality of introducing the appropriate framework for hydraulic fracturing under the current combined legislation.[772] This section discusses the existing legal

[767] *John Douglas Stern and others vs Minister of Mineral Resources, para 58,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).
[768] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others*, para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 20219).
[769] Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Minera Resources and others, para 13 (790/2018) [2019] ZASCA 99 (4 July 2021).
[770] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Minera Resources and others*, para 14 (790/2018) [2019] ZASCA 99 (4 July 2021).
[771] Draft Upstream Petroleum Resources Development Bill, Government Notice R.1706 in Government Gazette No.42931 of 24 December 2019; Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 85, in Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) Claremont, Juta and Company (Pty) Ltd
[772] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at

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framework as it relates to three important tenets that will affect the ability to use hydraulic fracturing in exploring for shale gas, these are ownership issues, licencing and authorisation challenges, and environmental requirements. It also addresses expected changes to the existing law in the wake of the new, but still deficient, regulation of upstream petroleum resources.

5.2.1 Separating Petroleum from Hard-Rock Minerals in the Law

The separation of petroleum from minerals is crucial to enable the appropriate regulation of shale gas exploration and production.[773] This is because petroleum is fluid, unlike hard rock minerals, which are naturally found in a solid phase, the usual rules of land boundaries are hence not applicable.[774] Furthermore, international standards and practices governing oil and gas exploration and production are quite distinct from hard rock mining practices.[775] To this effect, the Minister of Mineral Resources and Energy gazetted the draft Upstream Petroleum Resources Development Bill (UPRD Bill) on 24 December 2019 and invited interested and affected parties to submit written comments on the Bill by 21 February 2020.[776] Following the public comment process, the UPRD Bill was tagged as a section 76 Bill, that is, an ordinary bill affecting the provinces, and introduced to the National Assembly in July 2021.[777] It was subsequently referred to the National House of Traditional and Khoi-San Leaders in August 2021 to solicit their comments over a two-month period.[778]

The UPRD Bill, 2021 iteration was issued for public comment in July 2022.[779] Modelled closely on the MPRDA, the Bill suffers from the same weakness in relation to shale gas. In particular, it does not provide for shale gas exploitation using hydraulic

252, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* Oxford, Oxford University Press.

[773] Ibid, at 254.

[774] Ibid.

[775] Ibid.

[776] Draft Upstream Petroleum Resources Development Bill, Government Notice R.1706 in Government Gazette No.42931 of 24 December 2019.

[777] Upstream Petroleum Resources Development Bill (B13-2021), Government Gazette No. 44694 of 11 June 2021.

[778] SABINET Law 'Comment Sought on Upstream Petroleum Resources Development Bill' (13 July 2022) available from https://legal.sabinet.co.za/articles/comment-sought-on-upstream-petroleum-resources-development-bill/ accessed on 6 August 2022.

[779] Ibid.

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fracturing specifically.[780] It however recognizes shale gas as one of the resources whose exploration and production must be administered by the Petroleum Agency.[781] Furthermore, the Bill provides for shale gas to be designated as a frontier area by notice in the Gazette, because there is no or limited knowledge of its geology.[782] It thus does not help in closing the gap in existing legislation, instead, it affirms key elements of the MPRDA, such as providing for the orderly and sustainable development of the nation's petroleum resources, and equitable access thereto.[783] It affirms the custodianship of the nation's petroleum resources,[784] the legal nature of the petroleum rights,[785] and the rights of holders thereto.[786] Unlike the MPRDA, which provides for exploration and production rights separately, the UPRDB provides for a petroleum right that integrates the right to explore and produce the petroleum resources.[787]

Other new provisions in the Bill include, providing for the designation of the Petroleum Agency as the regulatory authority for the upstream petroleum sector,[788] and for matters connected thereto.[789] It provides for a controlled application system through licensing rounds, as it seeks to create an enabling environment for the acceleration of exploration and production of petroleum resources.[790] The Bill affirms the requirement for the participation of black persons in the development of the nation's petroleum resources,[791] the reservation of blocks for black persons,[792] and for the holder of a petroleum right to retain its empowerment status after the exit of black persons under

[780] Upstream Petroleum Resources Development Bill (B13-2021), Government Gazette No. 44694 of 11 June 2021.
[781] S 8(1) of the MPRDB, 2021.
[782] S 8(2) of the MPRDB, 2021.
[783] S 3(1) of the UPRDB, 2021.
[784] S 3(1) of the UPRDB, 2021.
[785] S 5(1) of the UPRDB, 2021.
[786] S 5(2-3) of the UPRDB, 2021.
[787] S 5(3)(a-e)
[788] S 9 of the UPRDB, 2021.
[789] S 10 of the UPRDB, 2021.
[790] S 13-20 of the MPRDB, 2021.
[791] S 31 of the UPRDB, 2021.
[792] S 32 of the UPRDB, 2021.

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circumscribed circumstances.[793] It furthermore provides for the designation of a State-owned Company to manage the State's carried interest in petroleum rights.[794]

It provides for the advancement of national developmental imperatives,[795] and for a petroleum right holder to sell a percentage of petroleum to the State for strategic stocks requirements.[796] It provides for third party access to upstream petroleum infrastructure,[797] and for local content, as a development strategy for skills development, local recruitment and national participation, through the supply of goods and services.[798] Given the public participation and parliamentary process that the UPRD Bill is still undergoing, such as soliciting public comments by the parliamentary portfolio committee on mineral resources and energy in July 2022,[799] there is still an opportunity to influence the review of the Bill to provide for the use of hydraulic fracturing to produce shale gas. Nonetheless, until such time that the UPRD Bill is enacted into law, oil and gas exploration and production in South Africa continues to be governed by the Mineral and Petroleum Resources Development Act,[800] as outlined in the following section.

5.2.2 The Ownership of Petroleum in the Sub-Surface

Until the promulgation of the MPRDA in 2002, South Africa's mineral law was premised on the common law principle that the owners of land also owned the minerals beneath their land.[801] The Roman-Dutch law maxim *cuius est solum eius et usque ad coelum et ad inferos*, which means 'to whom the soil belongs, to that person it belongs all the way to the sky and the depths'[802] then affirmed mineral rights as belonging to the

[793] S 33 of the UPRDB, 2021.
[794] S 34(1) of the UPRDB, 2021.
[795] S 35 of the UPRDB, 2021.
[796] S 36 of the UPRDB, 2021.
[797] S 68 of the UPRDB, 2021.
[798] S 107(1)(a) of the UPRDB, 2021.
[799] SABINET Law 'Comment Sought on Upstream Petroleum Resources Development Bill' (13 July 2022) available from https://legal.sabinet.co.za/articles/comment-sought-on-upstream-petroleum-resources-development-bill/ accessed on 6 August 2022.
[800] Mineral and Petroleum Resources Development Act, No.28 of 2002.
[801] F.T. Cawood and R.C.A. Minnitt 'A historical perspective on the economics of the ownership of mineral rights ownership' (1998) at 370, *The Journal of The South African Institute of Mining and Metallurgy;* Elmarie van der Schyff 'South African mineral law: A historical overview of the State's regulatory power regarding the exploitation of minerals' (2012) at 133, *New Contree 64.*
[802] Barry Barton 'The Common Law of Subsurface Activity' (2014), at 22, in Donald N. Zillman, Aileen McHarg, Lila Barrera-Hernandez and Adrian Bradbrook 'The Law of Energy Underground:

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landowner.[803] A consequence of the common law principle is that surface landowners could claim ownership of the subsurface, thus interference with the surface landowner's right to what is contained in the subsurface could be deemed as trespass, similar to the trespassing of surface land.[804]

The Mining Titles Registration Act,[805] formally separated the ownership of minerals and petroleum resources from landownership.[806] Subsequently, the MPRDA changed the nature of rights to minerals fundamentally, from common-law rights to statutory rights.[807] Having come into effect in 2004, the MPRDA now affirms South Africa's mineral and petroleum resources as the common heritage of its people, thus vests ownership of these resources in the nation.[808] The MPRDA furthermore designates the state as custodian of the country's mineral and petroleum resources for the benefit of all South Africans.[809]

Notwithstanding, the owner of the land where petroleum is located remains the owner of the unsevered petroleum resources.[810] However exploitation of these resources requires exploration and production rights, which are granted by the state.[811]

Understanding New Developments in Subsurface Production, Transmission and Storage' (2014), Oxford University Press, Oxford.

[803] Elmarie van der Schyff 'South African mineral law: A historical overview of the State's regulatory power regarding the exploitation of minerals' (2012) at 133, *New Contree* 64.

[804] Barry Barton 'The Common Law of Subsurface Activity' (2014), at 23, in Donald N. Zillman, Aileen McHarg, Lila Barrera-Hernandez and Adrian Bradbrook 'The Law of Energy Underground: Understanding New Developments in Subsurface Production, Transmission and Storage' (2014), Oxford, Oxford University Press.

[805] Mining Titles Registration Act, No. 16 of 1967.

[806] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 65, in Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) Claremont, Juta and Company (Pty) Ltd.

[807] PJ Badenhorst and NJJ Olivier 'Host Communities and Completing Applications in Terms of the Mineral and Petroleum Resources Development Act 28 of 2002' (2011) at 127, *De Jure.*

[808] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 3(1); PJ Badenhorst 'Ownership of Minerals In situ in South Africa: Australian Darning to the Rescue' (2010) at 647, *SALJ*, 127(4).

[809] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 3(1); H Mostert 'Land as a "National Asset" Under the Constitution: The System Change Envisaged by the 2011 Green Paper on Land Policy and What This Means for Property Law Under the Constitution' (2014) at 768, *PELJ*, (17)(2).

[810] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 65, in Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) Claremont, Juta and Company (Pty) Ltd.

[811] S 3(2) of the MPRDA.

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Consequently, while the ownership of mineral or petroleum resources are vested in the landowner in common law, ownership only exists until the minerals or petroleum has been extracted from the land.[812] Once the minerals or petroleum have been separated, it becomes movable property with ownership then vesting in the mineral or petroleum rights holder.[813] As the custodian, the State must ensure the sustainable development of the country's mineral and petroleum resources, within a framework of national environmental policy, norms and standards, while promoting economic and social development.[814] The State, therefore, acting through the Minister responsible for Mineral Resources has the responsibility to grant, issue, control, administer and manage all petroleum rights in South Africa.[815] The Minister responsible for mineral resources also has the responsibility in consultation with the Minister of Finance, to determine and levy fees or considerations payable in relation to petroleum rights.[816]

Petroleum rights granted under the MPRDA are limited real rights with respect to the land to which the rights relate.[817] A holder of a petroleum right is entitled to enter the land to which the right relates, explore or produce from it for their benefit,[818] and subject to the National Water Act,[819] to use water from any natural water resource on such land.[820] A landowner cannot prevent access to their land by the holder of a right.[821] However, the holder of the right is obliged to notify and consult with the landowner before commencing with exploration or production activities.[822] Furthermore,

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[812] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 65, in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (Claremont, Juta and Company (Pty) Ltd); *Agri South Africa v Minister of Minerals and Energy*, para 8, 2013, CCT 51/12 (ZACC9).

[813] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 65, in Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) Claremont, Juta and Company (Pty) Ltd; *Agri South Africa v Minister of Minerals and Energy*, para 8, 2013, CCT 51/12 (ZACC9).

[814] S 3(3) of the MPRDA.

[815] S 3(2)(a) of the MPRDA; AT J. Badenhorst, 'The nature of new order prospecting rights and mining rights: a can of worms? (2017) at 361, *SALJ* 134 (2).

[816] S 3(2)(b) of the MPRDA.

[817] S 5(1) of the MPRDA; Elmarie van der Schyff 'Who "owns" the country's mineral resources? The possible incorporation of the public trust doctrine through the Mineral and Petroleum Resources Development Act' (2008) at 759, *TSAR* 4.

[818] S 5(3)(b) of the MPRDA.

[819] National Water Act, No.36, 1998.

[820] S 5(3) (d) of the MPRDA.

[821] S 5(4)(c) of the MPRDA.

[822] S 5(4)(c) of the MPRDA.

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petroleum right holders have no obligation to pay compensation to landowners for the petroleum resources beneath their land.[823] The MPRDA does however provide for the compensation of landowners by petroleum right holders for loss or damage resulting from prospecting or mining operations.[824]

The implication is that landowners, through whose land shale gas in the sub-surface will have to be accessed, will gain nothing from the extraction of shale gas resources beneath their land.[825] Consequently, landowners are objecting to the granting of shale gas exploration rights, even challenging the making of related regulations.[826] The strengthening of the requirement to notify and consult landowners to a requirement to obtain consent could provide some leverage that could lead to mutually beneficial outcomes to the right holders and the landowners, while enabling the development of shale gas in an environmentally responsible manner.

The *Agri South Africa v Minister of Minerals and Energy* Constitutional Court case,[827] and the *Anglo Operations vs Sandhurst* Supreme Court of Appeals case,[828] are instructive in terms of the approach of the South African courts in relation to the conflicting rights of surface landowners and mineral right holders. In the *Agri South Africa (Agri SA) v Minister of Mineral Resources and Energy (Minister)* Agri SA appealed a judgment in favour of the Minister by the Supreme Court of Appeal (SCA).[829] The Minister's appeal was on an earlier judgment in favour of Agri SA by the North Gauteng High Court.[830]

The case centred on whether the MPRDA expropriated mineral rights that existed prior to its coming into effect.[831] Agri SA argued that the MPRDA expropriated the coal rights

[823] S 54(3) of the MPRDA.
[824] S 54 of the MPRDA.
[825] Steven Hedden, Jonathan D. Moyer and Jessica Rettig, *Fracking for shale gas in South Africa: blessing or curse?* (2013) at 6, Institute for Security Studies.
[826] *John Douglas Stern and others v Minister of Mineral Resources, para 58,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).
[827] *Agri South Africa v Minister of Minerals and Energy*, 2013, CCT 51/12 (ZACC9).
[828] *Anglo Operations Ltd v Sandhurst Estates (Pty) Ltd*, 2006, 634/05 (ZASCA 146).
[829] *Agri South Africa v Minister of Minerals and Energy*, para 18.
[830] Ibid.
[831] Ibid.

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of Sebenza (Pty) Ltd (Sebenza) and vested them in the Minister.[832] This rendered the MPRDA unconstitutional with the provisions of section 25(2)(b) of the Constitution, which requires that expropriation be subject to compensation.[833] Agri SA on the other hand had acquired the right to take the matter to court from Sebenza for R250 000.

In counter argument, the Minister contended that the decision for Sebenza to lose the coal rights, following its inability to convert the old-order rights to new order rights under the MPRDA did not imply expropriation by the state, since the state did not acquire such rights as a result of the deprivation.[834] The Constitutional Court upheld the Supreme Court of Appeal judgment in favour of the Minister.[835] It asserted that although the MPRDA deprived Sebenza of its coal rights, the deprivation did not constitute expropriation.[836] This is because expropriation requires acquisition of the right by the expropriator, which is not what the MPRDA had achieved.[837] According to the judgment, the MPRDA is unequivocal on facilitating equitable access to the country's mineral and petroleum resources, promote the sustainable development thereof and eradicate all forms of discriminatory practices in the mining sector.[838]

In the *Anglo Operations v Sandhurst*, Anglo Operations Ltd (Anglo Operations) appealed a judgment of the Pretoria High Court that was in favour of Sandhurst Estates Ltd (Sandhurst Estates).[839] Sandhurst Estates owned a farm near Bethal in Mpumalanga, thus held the surface rights to the farm.[840] Anglo Operations on the other hand held the sub-surface rights to coal on the farm.[841] What was in dispute was Anglo Operations' attempt to engage in open cast mining of coal on the farm, and to access water on the farm in support of its mining operations.[842] The case centred on whether the award of the mining right to Anglo Operations explicitly or tacitly permitted Anglo to conduct open cast mining on the farm owned by Sandhurst Estates.[843] In essence,

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[832] *Agri South Africa v Minister of Minerals and Energy*, para 56.
[833] Ibid.
[834] Ibid, para 57.
[835] Ibid, para 72.
[836] Ibid, para 68.
[837] Ibid, para 69.
[838] Ibid, para 64.
[839] *Anglo Operations Ltd v Sandhurst Estates (Pty) Ltd*, 2006, para 1, 634/05 (ZASCA 146).
[840] Ibid.
[841] Ibid.
[842] Ibid.
[843] Ibid.

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the SCA was required to consider whether the rights of a mineral right holder included the right to open-cast mining at the expense of the surface rights owner.[844]

Based on the application of English law, the Pretoria High Court had ruled that unless open-cast mining was specifically authorised by the grant, the mineral rights holder was limited to underground mining operations.[845] Applying the Roman-Dutch law, the SCA overturned the decision of the High Court on the basis that the South African common law holds that unless specifically prohibited in the grant, the mineral rights holder is entitled to conduct open-cast mining, if reasonably necessary to remove the minerals beneath the surface of the land.[846] It was particularly so if the open-cast mining operations would be done in a manner that was not necessarily damaging to the interests of the owner of the surface land.[847] The SCA therefore decided that Anglo Operations had satisfied both requirements, therefore the High Court should not have ruled against it in the matter.[848]

A key learning from the two cases above is that a requirement for consent by landowners, or persons in control of the land over which a petroleum right has been awarded would go a long way in support of activities such as the exploration and production of shale gas in the Karoo. The soft formulation of the MPRDA, calling for the consultation instead of substantive engagement/consent of stakeholders, including landowners, needs to be revisited as part of the review of the existing petroleum legal framework. Section 5.2.3 below outlines the licensing of petroleum rights under the MPRDA.

5.2.3 Licensing of Petroleum Rights

To conduct oil and gas exploration and production in South Africa companies are granted petroleum rights by the Minister of Mineral Resources, upon recommendation by the Petroleum Agency South Africa.[849] A petroleum right is initiated by granting a

[844] Ibid.
[845] *Anglo Operations Ltd v Sandhurst Estates (Pty) Ltd*, para 40.
[846] Ibid.
[847] Ibid.
[848] Ibid.
[849] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 69.

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technical cooperation permit (TCP),[850] followed by the award of an exploration right (ER).[851] A production right (PR) is granted following successful exploration.[852] The TCP has a one-year duration,[853] the ER, a nine-year duration,[854] and the PR, up to 30 years.[855] As indicated in the preceding section, petroleum rights are limited real rights, in relation to the petroleum and land to which they relate.[856] They must therefore registered at the Mineral and Petroleum Titles Registration Office in terms of the Mining Titles Registration Act.[857]

The MPRDA compels the Petroleum Agency to publicise applications for petroleum exploration rights, within fourteen days of receiving an application.[858] The Petroleum Agency is also required to call upon interested and affected persons to submit comments regarding the application within 30 days from the date of notice.[859] Should there be an objection to the granting of an exploration right, the objection must be considered and the Minister of Mineral Resources and Energy advised by the Petroleum Agency.[860]

The MPRDA furthermore provides that once an exploration right application is accepted by the Petroleum Agency, and the applicant notified,[861] the applicant should notify and consult the landowner or lawful occupier of the land before commencing with exploration or production activities.[862] The environmental provisions pertaining to oil and gas exploration and production are outlined in the following section.

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[850] S 76(1) of the MPRDA
[851] S 79(1) of the MPRDA.
[852] S 83(1) of the MPRDA
[853] S 77(4)(b) of the MPRDA.
[854] S 80(5) of the MPRDA
[855] S 84(4) of the MPRDA.
[856] S 5(1) of the MPRDA; Elmarie van der Schyff 'Who "owns" the country's mineral resources? The possible incorporation of the public trust doctrine through the Mineral and Petroleum Resources Development Act' (2008) at 759, *TSAR* 4.
[857] S 2(4) of the Mining Titles Registration Act.
[858] S 10(1)(a) of the MPRDA.
[859] S 10(1)(b) of the MPRDA.
[860] S 10(2) of the MPRDA.
[861] S 79(4) of the MPRDA.
[862] S 79(4)(a) of the MPRDA.

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5.2.4 Environmental Requirements

As indicated in chapter one of this thesis, the South African Constitution, calls for the protection of the environment for the benefit of present and future generations.[863] Such protection must be done through reasonable legislative and other measures that,[864] prevent pollution and ecological degradation;[865] promote conservation;[866] and secure ecologically sustainable development and use of natural resources.[867] The National Environmental Management Act (NEMA) is the principal statute giving effect to environmental protection in South Africa,[868] including pertaining to petroleum exploration and production.[869] The NEMA prescribes the environmental management principles to be applied when making decisions that may have a significant impact on the environment.[870]

To give effect to the duty created in the Constitution, to have the environment protected through reasonable legislative measures,[871] the NEMA incorporates other key international environmental principles, such as the *prevention principle*, the *precautionary principle, and the polluter pays* principle.[872] These principles are core to this thesis, therefore are dealt with in greater detail in chapters six to eight. The NEMA advocates a risk-averse approach to environmental protection, an approach which could allow the time required to develop the appropriate legal framework before shale gas extraction takes place in the country.[873]

The National Water Act (NWA) regulates the protection and appropriate management of water resources.[874] While the National Environmental Management: Waste Act

[863] Constitution of the Republic of South Africa, 1996, s 24(b)
[864] S 24(b) of the Constitution.
[865] S 24(b)(i) of the Constitution.
[866] S 24(b)(ii) of the Constitution.
[867] S 24(b)(iii) of the Constitution.
[868] National Environmental Management Act, No. 107 of 1998.
[869] Section 50A(2)(a) National Environmental Management Act, No. 107 of 1998.
[870] National Environmental Management Act, No. 107 of 1998.
[871] Constitution of the Republic of South Africa, 1996, s 24(b).
[872] S 28(1) of the NEMA; Loretta Feris 'Constitutional Environmental Rights: An Under-Utilized Resource' (2008) at 36, S*AJHR* 24.
[873] Academy of Science of South Africa (2016) RSA Technical Readiness for Shale Gas Extraction, at 33 (ASSAf, Pretoria).
[874] National Water Act, No.36 of 1998.

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(NEM: Waste Act)[875] regulates waste and wastewater.[876] This legislation complements the NEMA and will be critical in regulating the use and management of water resources and wastewater related to shale development. The relevance of this legislation to shale gas exploitation is also dealt with in greater detail in chapter six to eight of this thesis. For now, it suffices to point out that MPRDA's prescribed application procedure for exploration rights is what initiates the compliance requirements with environmental provisions.

It is also worth noting that the National Environmental Management Laws Amendment Act served to repeal the environmental provisions in the MPRDA.[877] More specifically, the Mineral and Petroleum Resources Development Act,[878] the National Environmental Management Act,[879] and the National Water Act,[880] were amended to create the One Environmental System.[881] This was done to regulate all environmental aspects associated with mining and petroleum operations through the One Environmental System.[882] All environmental provisions in the MPRDA were therefore repealed.[883] Section 50A was subsequently inserted in the NEMA by section 17 of the National Environmental Management Laws Amendment Act,[884] effective from 2 September 2014.[885] By the same token, section 163A was inserted in the National Water Act,[886] by section 5 of the National Water Amendment Act.[887]

Consequently the Minister of Forestry, Fisheries and the Environment is responsible for the development of the regulatory framework, norms and standards pertaining to

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875 National Environmental Management: Waste Act, No. 59, 2008.
876 Ibid.
877 National Environmental Laws Amendment Act, No. 25 of 2014.
878 Mineral and Petroleum Resources Development Act, No.28 of 2002 s 39.
879 National Environmental Management Act, No. 107 of 1998, s 50A.
880 National Water Act, No.36 of 1998, s 163A.
881 W du Plessis, Regulation of Hydraulic Fracturing in South Africa: A Project Life-Cycle Approach? (2015) at 1444, *PER/PELJ* 18(5).
882 Ibid.
883 *John Douglas Stern and others v Minister of Mineral Resources*, para 21 (a), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).
884 National Environmental Management Laws Act, No.25 of 2014, s 17.
885 *John Douglas Stern and others v Minister of Mineral Resources*, para 21 (a), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).
886 National Water Act, No.36 of 1998, s 163A.
887 National Water Amendment Act, No.27 of 2014, s 5; *John Douglas Stern and others vs Minister of Mineral Resources*, para 21 (a), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); National Environmental Management Laws Act No.25 of 2014.

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the environmental aspects of mining and oil and gas exploration and production.[888] The Minister of Mineral Resources and Energy on the other hand is responsible for the implementation of the environmental provisions of the NEMA, as they relate to mineral prospecting and mining or the exploration and production of oil and gas.[889] An oversight in the integration of environmental considerations under the NEMA is the fact that the Minister of Mineral Resources and Energy remains the authority and key decision maker for granting environmental authorizations for petroleum exploration and production.[890] This does not best serve environmental protection relating to shale gas development, particularly given the environmental risks associated with hydraulic fracturing.[891]

The criticality of vesting jurisdiction on the protection of the environment from hydraulic fracturing operations to the Minister of Forestry, Fisheries and the Environment has been clarified by the Eastern Cape High court in *John Douglas Stern and others vs Minister of Mineral Resources*.[892] Passing judgment, Judge Bloem GH ruled that the Minister of Mineral Resources and Energy did not have the authority to promulgate the Regulations for Petroleum Exploration and Production,[893] since they are meant to regulate environmental aspects of hydraulic fracturing which is the domain of the Minister of Forestry, Fisheries and the Environment.[894]

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[888] *John Douglas Stern and others v Minister of Mineral Resources*, para 21 (b), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

[889] *John Douglas Stern and others v Minister of Mineral Resources*, para 21 (b), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

[890] Hugo Meyer van den Berg & Hanri Mostert (2018) 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' at 256, in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden (2018) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

[891] W du Plessis, Regulation of Hydraulic Fracturing in South Africa: A Project Life-Cycle Approach? (2015) at 1466, *PER/PELJ* 18(5)*;* Hugo Meyer van den Berg & Hanri Mostert (2018) 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' at 257, in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden (2018) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

[892] *John Douglas Stern and others vs Minister of Mineral Resources*, para 29, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1441, *Potchefstroom Electronic Law Journal* 18(5); Jan Glazewski *Sustainable development and proposed shale extraction in South Africa: prospects and challenges* (2016) at 211 (UK, Edward Elgar Publishing Limited).

[893] Ibid.

[894] *John Douglas Stern and others v Minister of Mineral Resources*, para 38.

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5.3 South Africa's Shale Gas Regulations compared with the UK and Canada

As stated in the introduction of this chapter, South Africa's then Minister of Mineral Resources gazetted the Regulations for Petroleum Exploration and Production on 3 June 2015.[895] This was to augment the existing petroleum legal framework to provide for the use of hydraulic fracturing to extract shale gas.[896] The regulations were however set aside by the Grahamstown High Court.[897] Judge Bloem J found that the Minister of Mineral Resources did not have the authority to promulgate the Regulations for Petroleum Exploration and Production,[898] since they are meant to regulate environmental aspects of hydraulic fracturing, which is the domain of the Minister of Environmental Affairs.[899]

The Court also found that the development of the regulations was procedurally unfair.[900] This was because the Proposed Technical Regulations for Petroleum Exploration and Exploitation,[901] which were issued for public comment in October 2013, and ultimately became the Regulations for Petroleum Exploration and Production, did not include the hazardous substances listed in Schedule 1 of the Regulations for Petroleum Exploration and Production.[902] The substances are prohibited for use in the hydraulic fracturing process.[903] Nonetheless, the Court did not examine the substance of the regulations because the material aspects thereof were not challenged specifically.[904] The Court therefore left the question of whether the regulations are adequate to regulate shale gas exploration and production in South Africa unanswered, a question that this thesis attempts to answer.

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[895] Regulations for Petroleum Exploration and Production, Government Notice R.466 in Government Gazette No.38855 of 3 June 2015.
[896] Reg 85(1), GN R.466.
[897] *John Douglas Stern and others v Minister of Mineral Resources*, para 59; S. Esterhuyse, D. Vermeulen and J. Glazewski 'Developing and enforcing fracking regulations to protect groundwater resources' (2022) at 6, *NPJ Clean Water* 5(3).
[898] Ibid, para 29.
[899] Ibid, para 38.
[900] Ibid, para 42.
[901] Proposed Technical Regulations for the Petroleum Exploration and Exploitation, Government Notice R1032 in Government Gazette, No.36938 of 2013.
[902] *John Douglas Stern and others v Minister of Mineral Resources*, para 39.
[903] Ibid, para 39.
[904] Ibid, para 43.

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As is the case in South Africa, the United Kingdom does not have regulations for shale gas and hydraulic fracturing specifically,[905] rather it has regulations for conventional oil and gas exploration and production,[906] complemented by the UK Onshore Shale Gas Well Guidelines.[907] Similar to South Africa, the UK regulatory framework for hydraulic fracturing leverages established and existing laws on health and safety, the environment, land and property rights, combined with new requirements.[908] The framework comprises command-and-control approaches such as regulatory standards and permits, planning permissions, self-regulatory arrangements and common law principles.[909]

The UK Onshore Shale Gas Well Guidelines were developed for the drilling of shale gas wells and use of hydraulic fracturing to stimulate production specifically.[910] The guidelines are limited to the exploration and appraisal phases of shale gas development only and are based on good industry practice.[911] The exploration and appraisal phases are treated as a pilot to gain experience, and ensure that high safety

[905] Jill Morgan 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' (2016) in James R. May and John C. Dernbach *Shale Gas and the Future of Energy: Law and Policy for Sustainability* at 144 (Edward Elgar Publishing Limited, UK); Eike Albrecht and Dorte Schneemann 'Fracking in the United Kingdom: Regulatory Challenges between Resource Mobilisation and Environmental Protection' (2014) at 240, *Carbon & Climate Law Review* 8(4).

[906] The Borehole Sites and Operations Regulations, No. 2038 of 1995; The Offshore Installation and Wells (Design and Construction etc) Regulations, No.913 of 1996; The Dangerous Substances and Explosive Atmospheres Regulations, No.2776 of 2002; The Hazardous Waste (England and Wales) Regulations, No.894 of 2005.

[907] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 292, *Journal of World Energy Law and Business* 11; The United Kingdom Onshore Operators' Group 'UK Onshore Shale Gas Well Guidelines' (2016) at 17, available at https://www.ukoog.org.uk/images/ukoog/pdfs/Shale_Gas_Well_Guidelines_Issue_4.pdf accessed on 3 October 2022.

[908] John Pearson and Gary Lynch-Wood 'Concern and counter-concern: The challenge of fragmented fears for the regulation of hydraulic fracturing' (2017) at 673, *The Extractive Industries and Society* 4; Mark K Brewer 'Corporate Social Responsibility in the Age of Hydraulic Fracturing in the United States and the United Kingdom' (2018) at 582, *Creighton Law Review* 51.

[909] John Pearson and Gary Lynch-Wood 'Concern and counter-concern: The challenge of fragmented fears for the regulation of hydraulic fracturing' (2017) at 673, *The Extractive Industries and Society* 4.

[910] United Kingdom Onshore Operators' Group 'UK Onshore Shale Gas Well Guidelines' (2016) at 5; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 292, *Journal of World Energy Law and Business* 11.

[911] Ibid.

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and environmental management standards are achieved prior to the production phase.[912]

Canada on the other hand is already a significant producer of shale gas, the second largest producer in the world and have regulations and guidelines in place for shale gas exploration and production.[913] Assessing Canada's shale gas regulatory framework helps remedy the shortcoming of assessing draft regulations and guidelines in the case of South Africa and the UK. Technological advancements and increased gas prices enabled the production of shale gas on a commercial scale in the early 2000's in the United States, and a few years later in Canada.[914] Shale gas in Canada occurs in the western provinces, mainly British Columbia, Alberta, and Saskatchewan,[915] and its extraction and related activities are regulated primarily by the provinces.[916] Notwithstanding, the drilling, completion, maintenance and abandonment of oil and gas wells in federal lands in Canada are regulated through the Canada Oil and Gas Drilling and Production Regulations.[917]

The following sections review the regulations and guidelines pertaining to shale gas development in South Africa, the United Kingdom and Canada. The assessment covers the exploration phase, which includes planning; disclosure and transparency; risk identification and assessment; the design and construction of shale gas wells, as well as hydraulic fracturing.[918] It furthermore covers the production phase,[919] and finally, the decommissioning and abandonment phase.[920]

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[912] Ibid.
[913] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 749, The Georgetown Envtl. Law Review 29.
[914] Ibid.
[915] Ibid.
[916] Ibid, at 753.
[917] Canada Oil and Gas Drilling and Production Regulations, 2009.
[918] Department of Mineral Resources 'Regulations for Petroleum Exploration and Production' (2015) Government Gazette, No.38855; UK Onshore Operators Group 'UK Onshore Shale Gas Well Guidelines' (2016); Council of Canadian Academies/The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) Ottawa (ON).
[919] Ibid.
[920] Ibid.

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5.3.1 Disclosure and Transparency

South Africa's Regulations for Petroleum Exploration and Production do not provide explicitly for public participation.[921] Rather the NEMA regulates all environmental aspects associated with the exploration and production of oil and gas, including public participation.[922] The NEMA provides that the participation of all key stakeholders in environmental governance be promoted,[923] while, the NWA, provides for public participation in relation to applications for water use licences.[924] Hydraulic fracturing is a controlled activity in terms of the NWA.[925] This implies that companies applying for shale gas exploration rights will also have to apply for an integrated water use licence at the Department of Water and Sanitation, a process that requires public participation.[926]

In terms of the NEMA and EIA Regulations, however, public participation is considered only as part of the application process for a petroleum exploration right.[927] Once a petroleum exploration right is approved, the public or stakeholders have no influence on exploration activities.[928] The public cannot monitor project activities or be involved in project design and other related decisions.[929] The National Water Act,[930] another complementary legislation as regards shale gas exploitation, also falls short of providing for public participation that ensures the ventilation of all matters of concern

[921] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1466 *Potchefstroom Electronic Law Journal* 18(5).
[922] National Environmental Management Act, No. 107 of 1998, s 50A(2)(a); *John Douglas Stern and others v Minister of Mineral Resources*, para 21 (a), 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1466 *Potchefstroom Electronic Law Journal* 18(5).
[923] S 2(4)(f) of the NEMA.
[924] S 41(4) of the NWA
[925] Department of Water and Sanitation 'Declaration for the Exploration for and Production of Onshore Unconventional Oil or Gas Resources or any Activities Related Thereto Including but not Limited to Hydraulic Fracturing as a Controlled Activity, Government Gazette, No. 39299 of 16 October 2015.
[926] Academy of Science of South Africa 'South Africa's Technical Readiness to Support Shale Gas Development' (2016) at 83 (ASSAf, Pretoria).
[927] P Kind and C Reddell 'Public Participation and Water Use Rights' (2015) at 11 *PER/PELJ* 4(18).
[928] Ibid.
[929] Ibid.
[930] National Water Act, No.36 of 1998.

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in relation to water use.[931] It provides little detail as to the nature and extent of the public participation procedure to be undertaken.[932]

To gain societal acceptance for shale gas development in the Karoo, the substantive engagement of key stakeholders will be crucial. A stronger requirement of the petroleum and environmental legal frameworks that calls for substantive public participation across the shale gas development lifecycle could assure interested and affected parties that their concerns and interests are factored into decisions on shale gas development. Furthermore, while South Africa's Regulations for Petroleum Exploration and Production provide for the disclosure of the chemicals used in the hydraulic fracturing process,[933] . such disclosure only has to be to the designated agency, the Petroleum Agency SA, the Department of Water and Sanitation, and to the Competent Authority as part of the application for Environmental Authorisation.[934] Given the possible contamination of scare water resources in the Karoo as a result of leakage into groundwater aquifers, the disclosure of the chemicals used in the hydraulic fracturing process should be mandatory.[935]

In the United Kingdom, shale gas operators are encouraged to engage host communities at each stage of shale gas development, beginning in advance of any operations, and where possible, in advance of any application for planning permission.[936] Shale gas operators are expected to provide sufficient opportunity for host communities to comment on plans, operations and performance, listen to concerns and respond appropriately and promptly.[937] The emphasis is on recognizing relations with the host community as a key management priority, thus need to develop

[931] P Kind and C Reddell 'Public Participation and Water Use Rights' (2015) at 11 *PER/PELJ* 4(18).
[932] Ibid.
[933] Regs 110(2)(b)(v); 113(2) GN R.466.
[934] Regs 110(2)(b); 113(2); W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1466 *Potchefstroom Electronic Law Journal* 18(5).
[935] Geoffrey Chapman, Requier Wait & Ewert Kleynhans 'The governance of shale gas production in South Africa' (2015) at 70, *South African Journal of International Affairs* 23(1).
[936] The United Kingdom Onshore Operators' Group (2016) Guidelines for UK Well Operations on Onshore Shale Gas Wells, at 7.
[937] Ibid.

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a stakeholder engagement strategy or plan that complies with and complements statutory processes early on.[938]

While the UK planning system provide for open consultation, shale gas operators are further encouraged to engage more broadly with stakeholders.[939] Operators are expected to explain openly and honestly their drilling, fracturing design and operational practices, including environmental, safety, and health risks and how they will be addressed.[940] This is to enable the public to gain a clear understanding of the challenges, risks and benefits associated with the development.[941]

In relation to hydraulic fracturing, operators are expected to measure and disclose operational information such as the amount of water to be used, the volumes and characteristics of wastewater, and the methods to be used to dispose of wastewater.[942] Fracturing fluid additives (constituents, concentrations and volumes) also need to be disclosed,[943] together with the emissions related to shale gas extraction.[944] Furthermore, fracturing design, and containment and any expected induced seismicity are to be disclosed.[945]

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[938] Ibid.

[939] Jill Morgan 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in James R. May and John C. Dernbach *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 144 (Edward Elgar Publishing Limited, UK); Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 313, *Journal of World Energy Law and Business* 11.

[940] The United Kingdom Onshore Operators' Group (2016) Guidelines for UK Well Operations on Onshore Shale Gas Wells, at 8; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 313, *Journal of World Energy Law and Business* 11.

[941] Jill Morgan 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in James R. May and John C. Dernbach *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 144 (Edward Elgar Publishing Limited, UK).

[942] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 300 *Energy & Law 18* (Intersentia Ltd, Cambridge: United Kingdom).

[943] John Pearson and Gary Lynch-Wood 'Concern and counter-concern: The challenge of fragmented fears for the regulation of hydraulic fracturing' (2017) at 678, *The Extractive Industries and Society* 4.

[944] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 298 *Energy & Law 18* (Intersentia Ltd, Cambridge: United Kingdom)

[945] The United Kingdom Onshore Operators' Group (2016) Guidelines for UK Well Operations on Onshore Shale Gas Wells, at 8.

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Good data measurement and transparency are deemed vital to public confidence in the UK, such as the tracking and documentation of wastewater to demonstrate to stakeholders that good practices are being adopted, and the proper treatment and disposal of wastewater is being recorded.[946] Furthermore, public disclosure of the chemicals used in the hydraulic fracturing process, and the volumes, constituents and concentrations involved is deemed necessary to assist the public in understanding the process involved.[947] Operators are required to demonstrate how they intend to minimize disruption to the community during operations, such as vehicle movement and noise reduction measures.[948] Operators are also urged to work towards maximizing the economic benefits to local communities from their operations, such as through considering local employment and utilizing local contractors where possible.[949]

As stated above, the exploration and production of oil and gas, including shale gas, in Canada are primarily regulated by the provinces.[950] New laws therefore emerged at the provincial level in response to the advent of shale gas.[951] To that effect, Alberta revised its *Well Drilling and Completion Data Filing Requirements,*[952] to include requirements for reporting sources of water and groundwater quality for hydraulic fracturing operations.[953] British Columbia introduced a requirement for companies conducting hydraulic fracturing operations to disclose the hydraulic fracturing fluids used.[954] New Brunswick also introduced the mandatory disclosure of the hydraulic fracturing fluids in 2013.[955] Furthermore, New Brunswick requires companies conducting hydraulic fracturing operations to submit a risk assessment of the potential

[946] Ibid.
[947] Ibid.
[948] Ibid; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 313, *Journal of World Energy Law and Business* 11.
[949] Ibid.
[950] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 753, The Georgetown Envtl. Law Review 29.
[951] Ibid.
[952] Alberta, Directive 59: Well Drilling and Completion Data Filing Requirements (2012).
[953] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 753, *The Georgetown Envtl. Law Review* 29.
[954] British Columbia, Drilling and Production Regulation (2012).
[955] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 753, *The Georgetown Envtl. Law Review* 29.

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health and environmental risks of each of the chemical additives, with mitigation measures.[956]

Industry codes of good practice complement the general oil and gas legislation and regulations in respect of shale gas development.[957] The Canadian Association of Petroleum Producers developed the guiding principles and operating practices for hydraulic fracturing activities for its members.[958] The Petroleum Services Association of Canada also developed its own code of conduct to guide hydraulic fracturing operations.[959] The Horn River Basin Producers Group, which comprises of shale gas operators in Northern British Columbia also produced a voluntary code in respect of shale gas development projects.[960]

Furthermore, the Canadian Constitution,[961] recognizes and affirms the treaty rights of First Nations, that is, the Aboriginal people, the Indian, Inuit and Métis,[962] including treaty rights acquired by way of land claim agreements.[963] Shale gas development must therefore take the First Nations treaty rights, interests and concerns into account.[964] Several judgments of the Supreme Court of Canada affirmed the Constitutional right of First Nations to be consulted in good faith, with the intention of

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[956] Ibid.

[957] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 202, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf,* accessed on 3 October 2020.

[958] Canada's Oil and Natural Gas Producers 'Hydraulic Fracturing Guiding Principles and Operating Practices' (2019) available at *https://www.capat ca/wp-content/uploads/2019/11/CAPP_Hydraulic_Fracturing_Guiding_Principles_and_Operating_Practices_Packag-339104.pdf* accessed on 3 October 2020.

[959] Petroleum Services Commission of Canada 'Code of Conduct for Hydraulic Fracturing Operations' (2019) available at *https://www.psac.ca/wp-content/uploads/2019/08/WEC-Code.pdf*, accessed on 15 November 2020.

[960] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 202, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 3 October 2020.

[961] Constitution Act, 1982, s 35(1).

[962] Canada Constitution Act, 1982, s 35(2)

[963] Canada Constitution Act, 1982, s 35(3)

[964] Merryn Thomas, Nick Pidgeon, Michael Bradshaw 'Shale development in the US and Canada: A review of engagement practice' (2018) at 557, *The Extractive Industries and Society* 5.

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addressing substantially the concerns of Aboriginal people whose lands are at issue.[965]

In *Haida vs. British Columbia*,[966] the Court established that the Crown had an obligation to consult meaningfully with First Nations, where a proposed project subject to government authorization may have an adverse effect on treaty rights and traditional ways of life.[967] Since the provinces own the oil and gas resources, it is their responsibility to ensure compliance with this requirement such that they can request operators to amend their development plans, to avoid impacts on Aboriginal and treaty rights.[968]

In sum, public engagement is crucial for shale gas development to gain public support and acceptance.[969] The acceptance of shale gas development will depend on how the affected local communities perceive the legitimacy of the decision-making processes related to it.[970] If local communities do not trust the oil and gas companies involved, or the government to protect their interests, they are not easily going to support shale gas development irrespective of its merits.[971] Public acceptance can also be situational, for example, shale gas development in the United States occurred fairly rapidly in the States of Pennsylvania, Texas, West Virginia, Wyoming and Colorado.[972] The States of New York, Maryland and Vermont on the other hand banned hydraulic fracturing due to local concerns and lack of support.[973]

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[965] *Haida Nation v British Columbia* (Minister of Forests), 2004, File No.: 29419, para 40; *Taku River Tlingit First Nation v. British Columbia (Project Assessment)*; *Mikisew Cree First Nation v Canada (Minister of Canadian Heritage)*.

[966] *Haida Nation v. British Columbia (Minister of Forests)*, 2004, File No.29419.

[967] *Haida Nation v. British Columbia (Minister of Forests)*, 2004, para 41, File No.29419.

[968] Allan Ingelson 'Shale Gas Law and Regulation in North America' in Tina Hunter 'Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions' (2016) at 312, *Energy & Law 18* (Intersentia Ltd, Cambridge: United Kingdom).

[969] Merryn Thomas, Nick Pidgeon, Michael Bradshaw 'Shale development in the US and Canada: A review of engagement practice' (2018) at 557, *The Extractive Industries and Society* 5.

[970] Ibid.

[971] Ibid, at 558.

[972] Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) at 17, Claremont, Juta and Company (Pty) Ltd.

[973] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 761-762, *The Georgetown Envtl. Law Review* 29; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 287, *Journal of World Energy Law and Business* 11.

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A public engagement strategy in respect of shale gas development thus need to take these differences into account and be oriented to the local context, capacity and concerns.[974] Gaining and maintaining social acceptance requires continuous effort, since information sharing, transparency and improvements in technology and risk mitigation practices could lead to confidence and legitimize shale gas development.[975] Public engagement must involve dialogues between the companies that hold rights to exploit shale gas and the local communities.[976] Such dialogues must recognize that local communities have a legitimate stake in the management of the land in their locality, and on which shale gas development will occur if supported.[977]

To obtain community support, public engagement needs to start early in the shale gas development planning, and continue through production and until decommissioning.[978] Developing good relations between shale gas operators and the local community is best served through transparency.[979] Transparency could lead to public trust, if shale gas companies provide access to relevant information timely to local communities and decision-makers.[980] The information must be detailed, including on plans, operations, the amount of water and chemical additives in the hydraulic fracturing fluids, together with wastewater and air emissions.[981]

5.3.2 Risk Identification and Assessment

In South Africa, before any exploration and production activities related to petroleum are undertaken, environmental authorization is required in accordance with the Environmental Impact Assessment Regulations.[982] The Regulations for Petroleum Exploration and Production require that the Petroleum Agency SA (PASA), Council of Geosciences (CGS), and the Council for Scientific and Industrial Research (CSIR) be

[974] Merryn Thomas, Nick Pidgeon, Michael Bradshaw 'Shale development in the US and Canada: A review of engagement practice' (2018) at 559-560, *The Extractive Industries and Society* 5.
[975] Ibid.
[976] Ibid.
[977] Ibid
[978] Ibid.
[979] Ibid.
[980] Ibid.
[981] Ibid.
[982] Department of Environmental Affairs 'Environmental Impact Assessment Regulations' Government Notice No. R982, Government Gazette, No.38282 of 4 December 2014.

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identified as interested and affected parties for the purpose of public participation.[983] The EIA must be complemented by the assessment of the geology and geohydrology of the affected area before the design of wells, with a geological overview report submitted to PASA for approval.[984]

Prior to the design of shale gas wells, the exploration right holder has to conduct a well risk assessment.[985] This includes the identification of the risks associated with the drilling of the well, and related hydraulic fracturing operations, and how such risks will be mitigated.[986] The risk assessment must ensure that there is adequate isolation of permeable zones,[987] through cement casing.[988] It must ensure that groundwater is protected, while also preventing the migration of high salinity groundwater into the well.[989] It must ensure that the decommissioning of the wells at the end of the shale gas production life is considered in the well design.[990] Casing deformation and cement degradation must be considered,[991] together with fracturing containment.[992]

The risk assessment must consider the possibility of hydraulic fracturing inducing seismicity.[993] The potential deformation of aquifers and geological strata as a result of injecting hydraulic fracturing fluids or due to the extraction of fluids must also be taken into account,[994] together with the possible subsidence of the surface as a result of the deformation of aquifers and geological strata.[995] Furthermore, the petroleum right holder has to prepare the area over which the right has been granted in compliance to the Environmental Authorization and Environmental Management Programme.[996]

[983] Reg 86(4) GN R.466.
[984] Reg 87(1).
[985] Reg 94.
[986] Reg 94(1).
[987] Reg 94(2)(a).
[988] Reg 94(2)(b).
[989] Reg 94(2)(c).
[990] Reg 94(2)(c).
[991] Reg 94(2)(d).
[992] Reg 94(2)(e).
[993] Reg 94(2)(f).
[994] Reg 94(2)(g).
[995] Reg 94(2)(h).
[996] Reg 90.

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The drilling site must be prepared in a manner that will prevent the contamination of the environment through providing an impermeable site underlay and drainage system.[997] Control measures must be put in place based on the risk assessment,[998] and be documented as part of the well's basis of design and operations programmes.[999] The well design risk assessment together with the control measures must be submitted to the competent authority as part of the environmental authorization process.[1000]

In the UK, while the regulators set out goals in relation to health and safety risks, operators bear the primary responsibility for identifying, assessing and mitigating environmental hazards.[1001] Operators are required to assess the risks associated with their activities and specify the mitigation measures that they will implement to reduce those risks as low as reasonably practicable (ALARP).[1002] The risk assessment must as a minimum cover personal and process safety, environmental impacts and well integrity.[1003]

In terms of the UK Offshore Operators Group, operators are expected to adhere to the following guidelines, when conducting hydraulic fracturing operations: First, to safeguard the quality of surface and groundwater resources, through sound wellbore construction practices, and minimization of the use of freshwater through finding alternative sources of water, and recycling water for re-use.[1004] Secondly, to measure and disclose water usage in an effort to minimize environmental impacts.[1005] Thirdly, to support the development of fracturing fluids and additives that have the least environmental risks.[1006] Fourthly, to advance technologies and best practices that

[997] Reg 91.
[998] Reg 94(3)(a).
[999] Reg 94(3)(b).
[1000] Reg 94(4).
[1001] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter 'Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions' (2016) at 286, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom); Michael Burns, Charlie Reid & Justyna Bremen 'UK Shale Gas – A Policy Tug War' (2016) at 249, *Journal of Energy & Nat Resources Law* 34(2).
[1002] Ibid.
[1003] Ibid.
[1004] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) 7(7.1)(1).
[1005] Ibid, 7(7.1)(2).
[1006] Ibid, 7(7.1)(3).

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minimize the potential environmental risks of hydraulic fracturing.[1007] Fifth, to minimize or eliminate fugitive emissions where possible,[1008] and sixth, to disclose the chemicals used in hydraulic fracturing publicly.[1009]

Canada, on the other hand, follows a management-based regulatory approach to the assessment, safe and appropriate management of risks associated with shale gas development and hydraulic fracturing in particular.[1010] In terms of the assessment of risks associated with water resources, operators are required to prepare and submit a documented hydraulic fracturing programme that include the determination of fracture planning zones, a risk assessment of offset and energizing wells etcetera.[1011] Furthermore in recognition that hydraulic fracturing fluids may contaminate drinking water sources, certain provinces within Canada, such as Alberta, require operators to prepare a risk assessment when hydraulic fracturing operations are to be conducted above, or within a 100 metres below an area designated by the regulator as the base of groundwater protection.[1012]

In fact, five separate risk management plans are required to support applications for onshore drilling operations that involve hydraulic fracturing in Canada.[1013] These are a Safety Plan; Risk Assessment Plan; Environmental Protection Plan; Waste Management Plan and a Spill Contingency Plan.[1014] The Safety Plan has to provide sufficient detail to demonstrate the procedures, practices, resources, sequence of key safety-related activities, and monitoring measures necessary to ensure the safety of the proposed activity by the operators.[1015]

[1007] Ibid, 7(7.1)(4).
[1008] Ibid, 7(7.1)(5).
[1009] Ibid, 7(7.1)(6).
[1010] Allan Ingelson 'Shale Gas Law and Regulation in North America' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 313, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom).
[1011] Ibid, at 314.
[1012] Ibid, at 320.
[1013] National Energy Board 'Filling Requirements for Onshore Drilling Operations Involving Hydraulic Fracturing' (2013) at 12 (Calgary, Alberta, Canada).
[1014] Ibid.
[1015] Ibid.

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The Risk Assessment Plan must describe the risk assessment and management processes with enough detail to demonstrate that operators have effective processes in place to identify hazards and threats to safety and the environment and have effective measures in place to evaluate and manage the associated risks.[1016] Secondly, the Plan must demonstrate that the operators have taken or will take all the reasonable precautions to ensure that the safety and environmental risks are mitigated.[1017]

The Environmental Protection Plan has to provide sufficient detail to demonstrate an understanding of how the activity will interact with the environment.[1018] The plan also has to have the procedures, practices, resources, and monitoring necessary to manage hazards and protect the environment from the impacts of the proposed activity, including potential impacts to groundwater.[1019] Furthermore, the plan has to demonstrate that the identified environmental hazards and risks, including the preventive and mitigation measures in the environmental assessment are incorporated.[1020]

In terms of the Waste Management Plan, operators are required to take all reasonable measures to minimize the volumes of waste materials generated by their operations, and the quantity of environmentally hazardous substances in the waste materials.[1021] Accordingly, no substance can be discharged to the environment unless the National Energy Board has determined that the discharge will not have a detrimental impact on the environment.[1022] The Spill Contingency Plan calls for emergency response procedures to mitigate safety and environmental impacts from unplanned or accidental discharges to the environment.[1023] The contingency plans for spill response has to provide enough detail to demonstrate that effective systems, processes, procedure,

[1016] Ibid.
[1017] Ibid.
[1018] Ibid, at 13.
[1019] Ibid.
[1020] National Energy Board 'Filling Requirements for Onshore Drilling Operations Involving Hydraulic Fracturing' (2013) at 13 (Calgary, Alberta, Canada).
[1021] Ibid, at 14.
[1022] Ibid.
[1023] Ibid.

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and capabilities are in place to minimize impacts to the natural environment from unauthorized or accidental discharges, and to protect workers and the public.[1024]

5.3.2.1 Assessment of water resources

In South Africa, an assessment of water resources is also required, therefore an exploration right holder is obliged to appoint an independent specialist to conduct a hydro-census of the affected area.[1025] The hydro-census must identify and indicate priority water resources and domestic groundwater supplies on geo-hydrological maps.[1026] A proposed water resource monitoring plan must be prepared and form part of the application for a water use license for approval by the department responsible for water affairs.[1027] The water resource monitoring plan must identify the water sampling methodology, monitoring points, parameters, frequency, and reporting frequency.[1028]

The monitoring plan must furthermore be submitted to the competent authority as part of the application for Environmental Authorization.[1029] The water samples collected as part of the monitoring plan must be analysed by an accredited laboratory, and the results submitted to the Petroleum Agency and the department responsible for water affairs within seven days upon receipt of the results.[1030] A comprehensive water monitoring report must be included in the EMPr required in terms of the EIA Regulations.[1031]

After conducting the baseline water quality assessment, the exploration right holder must continue water monitoring in line with the approved plan.[1032] The exploration right holder must subject the water resources to sampling, analysis and interpretation of

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[1024] Ibid.
[1025] Reg 88(1) GN R.466.
[1026] Reg 88(1).
[1027] Reg 88 (2).
[1028] Reg 88(2)(a-e).
[1029] Reg 88 (3).
[1030] Reg 88(4).
[1031] Reg 88(6); Department of Environmental Affairs 'Environmental Impact Assessment Regulations' Government Notice No. R982, Governmet Gazette, No.38282 of 4 December 2014, Reg 23(a).
[1032] Regulations for Petroleum Exploration and Production, Government Notice R.466 in Government Gazette No.38855 of 3 June 2015, Reg 88(7) GN R.466.

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water quality and changes in water levels by an independent specialist that is approved by PASA.[1033] The results of the water sampling analysis must be submitted to PASA and the department responsible for water affairs within seven days of receipt thereof, together with the monitoring reports.[1034]

Furthermore, PASA, CGS and CSIR, designated local authorities, or the department responsible for water affairs, must be allowed access to collect samples of fluids encountered in the exploration and production area (water or hydrocarbons at depth or at the surface) for their own analysis and interpretation if they deem it prudent to do so.[1035] The data collected must be published, provided it does not enable an assessment of the presence of hydrocarbons and commercial value of the exploration acreage.[1036]

In the UK, the Environmental Protection Agency is required to prevent hazardous substances from entering groundwater, and limit the entry to groundwater of non-hazardous pollutants, so as not to cause groundwater pollution.[1037] The Environmental Protection Agency is obliged to conduct all necessary investigations to prevent the pollution of groundwater, and must set out conditions requiring all necessary technical precautions towards that end to be observed when granting the permits.[1038] From this, it can be deduced that shale gas operations in England will not involve hazardous substances and where non-hazardous pollutants are involved such as in hydraulic fracturing fluids, these must be limited to non-polluting quantities.[1039]

In terms of the UK Onshore Operators guidelines, operators are required to undertake baseline surveys of groundwater and shallow water aquifers as part of the well

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[1033] Reg 88(7)(a) GN R.466.
[1034] Reg 88 (7)(b-c).
[1035] Reg 88 (8)(a).
[1036] Reg 88 (9).
[1037] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 297, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom); Environmental Permitting Regulations 2010, s 35(2)(p).
[1038] Ibid.
[1039] Ibid, at 298.

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planning phase.[1040] These should include: First, surface water sampling at the well site before the start of site construction.[1041] Secondly, groundwater sampling before the start of site construction.[1042] Thirdly, surface water sampling following site construction, drilling and fracturing operations.[1043] Fourthly, groundwater sampling following site construction, drilling and fracturing operations.[1044]

Operators should ensure that all water sampling and analysis is done by qualified third parties using recognized sampling and analytical methods, with water testing results disclosed in accordance with any specific planning requirements or environmental permits.[1045] Any anomalies detected that are connected with operations should be risk assessed and reported as required by the Environmental Agency or Scottish Environmental Protection Agency.[1046]

Taking into account the rapid shale gas development in British Columbia, which has tapped into groundwater resources, the Water Sustainability Act,[1047] replaced the Water Act[1048] in 2016, and includes groundwater use and management, which was not previously regulated in terms of the Water Act.[1049] The Water Sustainability Act also recognises the interconnected nature of surface water and ground water, rather than treat them as separate hydrologic resources as was previously the case.[1050]

The Water Sustainability Act includes water source wells, which are wells constructed by the industry for the purposes of their oil and gas operations, including hydraulic fracturing.[1051] The construction and operations of water source wells, and installation of monitoring wells nearby, which are regulated under the Oil and Gas Activities

[1040] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) 8.1.
[1041] Ibid, 8.1(1).
[1042] Ibid, 8.1(2).
[1043] Ibid, 8.1(3).
[1044] Ibid, 8.1(4).
[1045] Ibid.
[1046] Ibid.
[1047] Water Sustainability Act, 2016.
[1048] Water Act, 1985.
[1049] Diana M. Allen, Chelsea Notte & Nancy Olewiler 'Enhancing water security in a rapidly developing shale gas region' (2017) at 274, *Journal of Hydrology: Regional Studies* 11.
[1050] Ibid; Water Sustainability Act, 2016, s 5-6.
[1051] Diana M. Allen, Chelsea Notte & Nancy Olewiler 'Enhancing water security in a rapidly developing shale gas region' (2017) at 274, *Journal of Hydrology: Regional Studies* 11.

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Act,[1052] require permits from the British Columbia Oil and Gas Commissions (BCOGC).[1053] However, the quantity of water abstracted from these wells is not regulated.[1054] Nonetheless, the BCOGC has amended the water source application process to include new requirements for the hydrological assessment.[1055]

5.3.2.2 Assessment of Seismicity

Hydraulic fracturing has been found to induce seismic activity,[1056] as a result of the energy released in the fracturing process.[1057] Earth tremors not related to hydraulic fracturing operations were experienced in certain parts of Cape Town, South Africa, in September and November 2020.[1058] These measured 6.2 and 3.4 respectively on the Richter scale.[1059] No impact, including on infrastructure and public safety was caused by these tremors.[1060] Nonetheless, as part of the risk assessment required in terms of the South African shale gas regulations, an assessment of the seismicity of the area is required.[1061] Therefore prior to conducting hydraulic fracturing operations, the exploration right holder has to assess the potential risk of hydraulic fracturing operations inducing a seismic event.[1062] The risk assessment report must identify stressed faults that must be avoided in the fracturing process,[1063] and fracture

[1052] Oil and Gas Activities Act, 2008.
[1053] Diana M. Allen, Chelsea Notte & Nancy Olewiler 'Enhancing water security in a rapidly developing shale gas region' (2017) at 274, *Journal of Hydrology: Regional Studies* 11.
[1054] Ibid.
[1055] Ibid.
[1056] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282 Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom); David K. Smythe 'Inadequate Regulation of the Geological Aspects of Shale Exploitation in the UK' (2020) at 15, *International Journal of Environmental Research Public Health*; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 315, *Journal of World Energy Law and Business* 11.
[1057] The Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing' (2012) at 41.
[1058] Nidha Narrandes '6.2-magnitude earthquake shakes Cape Town' (2020) available from *https://www.capetownetc.com/news/6-2-magnitude-earthquake-shakes-cape-town/* accessed on 28 November 2020.
[1059] Council for Geoscience 'Seismic Events' (2020) available at *http://196.38.235.147:8070/quakeview/events/event_details/CGS2020wojk,* accessed on 28 November 2020.
[1060] Nidha Narrandes '6.2-magnitude earthquake shakes Cape Town' (2020) available from *https://www.capetownetc.com/news/6-2-magnitude-earthquake-shakes-cape-town/* accessed on 28 November 2020.
[1061] Reg 89 (1) GN R.466.
[1062] Reg 89 (1).
[1063] Reg 89 (1)(a).

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behaviour of targeted formations.[1064] Site specific seismic monitoring is to be undertaken before, during, and after the commencement of hydraulic fracturing operations.[1065]

Site specific surveys are required to be carried out by the exploration right holder prior to hydraulic fracturing, to characterize local stress regimes, and identify nearby faults.[1066] The site characterization must contain existing geological maps,[1067] seismic reflection and refraction data,[1068] and other relevant geophysical data.[1069] The risk assessment report and site-specific surveys must be submitted to the competent authority as part of the application for environmental authorization.[1070] Furthermore, the assessment of the orientation and slip tendency of faults and bedding planes may be done once faults have been identified and geological stress regimes characterized.[1071]

The risk of fault movement must be mitigated through identifying stressed faults and preventing fracturing fluids from entering stressed faults.[1072] The hydraulic fracturing of a targeted formation must first be tested using small pre-fracturing injection tests with micro-seismic monitoring.[1073] This should be followed by an investigation of whether seismic activity has occurred during the pre-injection fracturing tests to enable modification of subsequent hydraulic fracturing operations.[1074]

Seismic monitoring at the site must also be undertaken by the exploration right holder for a period of three years after the hydraulic fracturing activities have come to an end.[1075] The results of the monitoring must be included in the seismic monitoring report.[1076] The duration of only three years for the monitoring of seismic activity, and

[1064] Reg 89 (1)(b).
[1065] Reg 89 (1)(c).
[1066] Reg 89 (2).
[1067] Reg 89 (2)(a).
[1068] Reg 89 (2)(b).
[1069] Reg 89 (2)(c).
[1070] Reg 89 (3).
[1071] Reg 89 (4).
[1072] Reg 89 (5).
[1073] Reg 89 (6).
[1074] Reg 89 (7).
[1075] Reg 89 (8).
[1076] Reg 89 (8).

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five years for the monitoring of water contamination and quality is not adequate, the regulations should further indicate the responsibility of petroleum right holders should a seismic event, water contamination or environmental degradation occur after these timelines.[1077]

In the UK, minor earthquakes were triggered by hydraulic fracturing operations at Preese Hall, near Blackpool, England, and measured 1.5 and 2.3 on the Richter scale.[1078] Detailed technical investigations and independent review found that the tremors may have been caused when hydraulic fracturing fluids flowed into a geological fault.[1079] Consequently, the Royal Society and Royal Academy of Engineering recommended that first, the British Geological Survey or other appropriate bodies should carry out national surveys to characterize stresses and identify faults in the UK shales.[1080] Secondly, operators should carry out site specific surveys prior to hydraulic fracturing operations to characterize local stresses and identify nearby faults.[1081] Thirdly, once the faults have been identified and geological stresses characterized, operators are expected to assess the orientation and slip tendency of faults and bedding planes and should avoid hydraulic fracturing near faults with high slip tendency.[1082]

In Canada, more than 4,000 earthquakes are recorded each year by the Geological Survey of Canada, and only about 50 are generally felt at the surface.[1083] Larger earthquakes have occurred in Canada, for example the Val-des-Bois, Quebec

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[1077] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1467, *Potchefstroom Electronic Law Journal* 18(5).

[1078] Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing' (2012) at 41; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 282 Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom); Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 315, *Journal of World Energy Law and Business* 11; David K. Smythe 'Inadequate Regulation of the Geological Aspects of Shale Exploitation in the UK' (2020) at 15, *International Journal of Environmental Research Public Health*.

[1079] Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic fracturing' (2012) at 41.

[1080] Ibid.

[1081] Ibid, 43.

[1082] Ibid, 43.

[1083] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 12, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.

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earthquake that occurred in June 2010 and was also felt in Ontario and the United States as far as Kentucky, measured 5 on the Richter scale.[1084] The earthquake caused some damage in the epicentral region in eastern Canada, including landslides, and to buildings and roads.[1085] In British Columbia, 272 seismic events occurred near oil and gas operations, where more than 8000 hydraulic fracturing completions were performed in 2009 – 2011.[1086] No injuries or property damage resulted from the earthquakes, and only one of the earthquakes was felt at the surface.[1087] All of the earthquakes were caused by the injection of hydraulic fracturing fluids near existing geological faults.[1088]

The British Columbia Oil and Gas Commission makes the following recommendations in respect of the management of seismicity related to hydraulic fracturing operations:[1089] First, geological and seismic assessments should be performed to identify pre-existing faulting that could trigger seismicity under pressure from hydraulic fracturing fluids. Secondly, induced seismic monitoring and reporting procedures should be established and made mandatory. Thirdly, ground motion sensors are to be placed in communities near hydraulic fracturing locations to help assess ground motion risks. Fourthly, micro-seismic reports are to be required to monitor hydraulic fracturing for containment of micro fracturing and to identify existing faults. Fifth, the relationship between hydraulic fracturing parameters and seismicity should be studied in greater detail prior, during and after hydraulic fracturing operations.

[1084] Natural Resources Canada 'The 2010 Val-des-Bois Quebec Earthquake: Earthquake Summary' (2010), at 1, Geological Survey of Canada, Ottawa.
[1085] Natural Resources Canada 'The 2010 Val-des-Bois Quebec Earthquake: Earthquake Summary' (2010), at 1, Geological Survey of Canada, Ottawa.
[1086] BC Oil and Gas Commission 'Investigation of Observed Seismicity in the Horn River Basin (2012), at 3, available at *https://www.bcogc.ca/files/reports/Technical-Reports/investigation20of20observed20seismicity20in20the20horn20river20basinaug202012.pdf*, accessed on 29 November 2020.
[1087] Ibid, 28.
[1088] Ibid, 26.
[1089] Ibid.

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5.3.2.3 Minimizing Fugitive Emissions during Hydraulic Fracturing

The management of fugitive methane emissions related to hydraulic fracturing operations is crucial from an air quality perspective and to mitigate global warming.[1090] As outlined in Chapter 3 of this thesis, global warming is caused by increasing concentrations of greenhouse gases in the atmosphere.[1091] Methane gas, a potent greenhouse gas that is associated with the production of natural gas, can be emitted to the atmosphere during shale gas drilling or production through flaring, venting or leakage (also referred to as fugitive emissions).[1092] Also outlined in Chapter 3 are technologies that are already being used to reduce methane emissions from oil and gas operations and shale gas development in particular, such as leak detection and repair technologies.[1093]

Nonetheless, the South African hydraulic fracturing regulations mandate petroleum right holders to minimize the emissions associated with the venting of hydrocarbon fluids and natural gas during hydraulic fracturing operations.[1094] This should be done through routing the recovered fluids into storage vessels,[1095] with recovered gas routed into a gas gathering system or to a generator for onsite energy generation.[1096] A method other than venting is also recommended, together with employing sand traps,[1097] surge vessels, separators and tanks during cleanout operations to minimize releases to the atmosphere.[1098] If a petroleum right holder can demonstrate that it is not technically feasible to minimize the emissions associated with hydraulic fracturing

[1090] Laurence Stamford & Adisa Azapagic 'A Fractured truth' (2014), at 27, *The Chemical Engineer*; Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4).
[1091] United Nations 'United Nations Framework Convention on Climate Change' (1992) at 1.
[1092] Laurence Stamford & Adisa Azapagic *'A Fractured truth'* (2014), at 27, *The Chemical Engineer*; Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4); Shanru Tian, Kathleen M. Smits, Younki Cho, Stuart N. Riddick, Daniel J. Zimmerle and Aidan Duggan 'Estimating methane emissions from underground natural gas pipelines using an atmospheric dispersion-based method' (2022) at 1, *Elementa Science of the Anthropocene* 10(1).
[1093] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 226 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (London, Oxford University Press).
[1094] Reg 127(1) GN R.466.
[1095] Reg 127 (1)(a).
[1096] Reg 127 (1)(a)(i).
[1097] Reg 127 (1)(a)(ii).
[1098] Reg 127 (1)(b).

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operations using the methods mentioned above, the designated agency can compel the right holder to capture and direct the gas produced to a flare provided that such flaring may not cause a fire hazard or explosion.[1099]

In terms of the UK guidelines, exploration right holders are required to put mechanisms in place to minimize emissions, and to disclose emissions in line with the requisite regulations.[1100] Exploration right holders are required to eliminate any flaring and venting of natural gas, and adopt best practices from the design stage of shale gas development.[1101] They are encouraged to use green completions or reduced emissions completions, where natural gas is separated from the fracturing fluid during flow-back for beneficial use, while the remaining flow-back fluid is recycled and re-used.[1102] The guidelines recognize that this may not always be practical during the exploration and appraisal phases, therefore there is some tolerance for flaring, while venting should be avoided as much as possible even during these phases.[1103]

In Canada, the federal government set a target to reduce the country's methane emissions by 45% by 2025.[1104] This is in recognition that significant inroads in reducing methane emissions are being made by British Columbia, Alberta and Saskatchewan, the main producers of shale gas in Canada.[1105] These provinces amended their regulations to specifically provide for the management of methane emissions.[1106] The amendments include controls on flaring, venting, incinerating, and requirements for regular inspection and repair of methane leaks.[1107] In Alberta, Directives 60 and 15

[1099] Reg 127 (2).
[1100] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) 10.
[1101] Ibid.
[1102] Ibid.
[1103] Ibid.
[1104] Canada's Oil and Natural Gas Producers 'Managing Methane Emissions for Natural Gas and Oil Development' (2021) at 2, available at *https://www.capp.ca/wp-content/uploads/2021/02/Managing-Methane-Emissions-for-Natural-Gas-and-Oil-Development-386197.pdf* accessed on 23 March 2023.
[1105] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 750, *The Georgetown Envtl. Law Review* 29; Allan Ingelson and Tina Hunter 'A Regulatory Comparison of Hydraulic Fracturing Fluid Disclosure Regimes in the United States, Canada, and Australia' (2014) at 224, *Natural Resources Journal* 54(2).
[1106] Canada's Oil and Natural Gas Producers 'Managing Methane Emissions for Natural Gas and Oil Development' (2021) at 2, available at *https://www.capp.ca/wp-content/uploads/2021/02/Managing-Methane-Emissions-for-Natural-Gas-and-Oil-Development-386197.pdf* accessed on 23 March 2023
[1107] Ibid.

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are used to regulate methane emissions from natural gas and oil operations in.[1108] In British Columbia, the B.C. Drilling and Production Regulation incorporates requirements for leak detection and repair, flaring, venting, and incinerating at any well site or production facility.[1109] Amendments to Saskatchewan's Oil and Gas Conservation Act established more stringent methane emissions limits from oil and gas sites.[1110]

Efforts to advance technology for methane emissions reduction from natural gas and oil development in Canada include using solar panels to power equipment, capturing vented gas from natural gas facilities and using the gas to fuel compressor engines.[1111] A coordinated technology advancement initiative by organizations such as Natural Resources Canada, Emissions Reduction Alberta, and various universities led to a robust ground, aerial, and satellite-based methane detection network in Canada.[1112] The oil and gas industry also partnered with the Petroleum Technology Alliance of Canada (PTAC) on initiatives such as:[1113] Area methane detection using work trucks, to ensure the early detection and repair of methane leaks; Advanced methane detection, analytics and mitigation to test technologies on major methane sources; Methane abatement tool that aggregates data and generates emissions reduction offsets in Western Canada.

5.3.3 Well Design and Construction

The most significant risks to groundwater or surface waters in respect of shale gas development relates to well integrity, that is, the design and construction of wells such that leaks of gas and other fluids are avoided.[1114] During hydraulic fracturing

[1108] Ibid; Alberta Directive 60; Alberta Directive 15.
[1109] Ibid; B.C. Drilling and Production Regulation 2020.
[1110] Ibid.
[1111] Canada's Oil and Natural Gas Producers 'Managing Methane Emissions for Natural Gas and Oil Development' (2021) at 2, available at https://www.capp.ca/wp-content/uploads/2021/02/Managing-Methane-Emissions-for-Natural-Gas-and-Oil-Development-386197.pdf accessed on 23 March 2023.
[1112] Ibid.
[1113] Canada's Oil and Natural Gas Producers 'Managing Methane Emissions for Natural Gas and Oil Development' (2021) at 2, available at https://www.capp.ca/wp-content/uploads/2021/02/Managing-Methane-Emissions-for-Natural-Gas-and-Oil-Development-386197.pdf accessed on 23 March 2023.
[1114] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 6, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E; Council of Canadian Academies

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operations wells can experience significant stresses which may lead to a loss of well integrity.[1115] Compromised well integrity could lead to sub-surface impacts or the release of fluids to the surface, thereby placing the public and the environment at risk.[1116] A high degree of well integrity is therefore critical.[1117] Generally, well integrity failure results from, blowouts or sudden and uncontrolled escape of fluids from a well to the surface.[1118] Secondly, annulus leaks, which result from the poor cementation of wells allowing fluids to move vertically through the well between well casings (cemented steel sections making up the well), or between the casing and rock formation.[1119] Thirdly, radial leaks, which result from casing failures, allowing fluid to flow horizontally out of the well into the surrounding rock formation.[1120]

In South Africa, a shale gas well must be constructed, operated, suspended and decommissioned such that it can be controlled at all times.[1121] The well must be designed such that it will prevent the migration of petroleum and other fluids into un-targeted formations[1122] and the contamination of water resources.[1123] The design of the well must furthermore mitigate the risks to human health and safety.[1124] The petroleum right holder has to conform to the American Petroleum Institute (API) well construction standards when designing the wells.[1125] A petroleum right holder may adopt well construction standards other than those developed by the API,[1126] subject to submitting detailed information regarding the proposed well construction standards to the designated agency.[1127]

'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 56, available at https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf, accessed on 03/10/2020.

[1115] Alberta Energy Regulator 'Directive 083: Hydraulic Fracturing – Subsurface Integrity' (2013) s 2.1

[1116] Ibid.

[1117] Ibid; Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 56, available at https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf, accessed on 3 October 2020.

[1118] Royal Society and Royal Academy of Engineering 'Shale gas extraction in the UK: a review of hydraulic Fracturing' (2012) at 24.

[1119] Ibid.

[1120] Ibid.

[1121] Reg 95(1)(a) GN R.466.

[1122] Reg 95(1)(a).

[1123] Reg 95(1)(b).

[1124] Reg 95(1)(c).

[1125] Reg 96(1).

[1126] Reg 96(5).

[1127] Reg 96(6)(a).

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A detailed comparative assessment of the proposed standards and the standards prescribed in the regulations for petroleum exploration and production from an independent drilling engineer is also required.[1128] The assessment should demonstrate how the proposed well construction standards will ensure higher levels of well integrity relative to those prescribed.[1129] The petroleum right holder may only proceed to implement the proposed well construction standards after receiving written consent from the designated authority.[1130] Furthermore, the decommissioning of wells should be an integral part of the well planning stage, therefore be included in the application for Environmental Authorisation.[1131] To minimize the amount of land required, multiple wells, drilled horizontally and closely spaced (multi-well pads) must be considered as part of well design, provided that it is technically and environmentally sensible to do so.[1132]

In the UK, operators are required to ensure that wells are designed, modified, commissioned, constructed, equipped, operated, maintained, suspended and abandoned such that there can be no unplanned escape of fluids from the well, and the risks to health and safety are minimized.[1133] Before the design of a well, operators are required to assess the geological formation and fluids through which the well is to be drilled.[1134] Operators are also required to assess any hazards associated with the geological formation or fluids.[1135] These assessments are to inform the design and construction of the well.[1136] The Operators are furthermore required to ensure that these assessments are periodically reviewed, and if any change is observed, modifications be made to the design and construction of the well or any procedures as necessary.[1137] Furthermore, the Borehole Site Operator has to ensure that suitable

[1128] Reg 96(6)(b).
[1129] Reg 96(6)(b).
[1130] Reg 96(7).
[1131] Reg 95(2).
[1132] Reg 95(4).
[1133] Offshore Installations and Wells (Design and Construction Etc) Regulations 1996, Regulation 14, Regulation 13, s 5.
[1134] Ibid.
[1135] Ibid.
[1136] Ibid.
[1137] Ibid.

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well control equipment is used during the drilling, hydraulic fracturing, and flow-back operations.[1138]

In Canada, the provinces regulate the protection of groundwater from contamination as a result of compromised well integrity.[1139] In some provinces operators are obliged to sample and test the quality of the groundwater prior to conducting hydraulic fracturing operations.[1140] This enables an assessment of whether the quality of groundwater deteriorates after hydraulic fracturing operations have taken place.[1141] For example, in British Columbia it is mandatory that operators take samples of water wells that are within 200 metres of planned hydraulic fracturing operations before hydraulic fracturing can take place at depths shallower than 600 metres.[1142] In New Brunswick, drilling for oil and gas may not occur prior to water samples being collected and analysed from all water wells within 500 metres of the drilling site.[1143]

Furthermore petroleum right holders must design, construct, and operate their wells to ensure well integrity during hydraulic fracturing operations.[1144] Petroleum right holders are furthermore expected to manage well integrity throughout the life of the well, from construction to post abandonment.[1145] The wells must be designed with a dual-barrier system,[1146] consisting of a primary barrier capable of containing and isolating the hydraulic fracturing fluids.[1147] The dual barrier system must contain a secondary barrier, capable of providing well control in the event of a failure of the primary

[1138] Borehole Sites & Operations Regulations 1995, schedule 2 (7), section 7.2
[1139] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 6, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.
[1140] Ibid.
[1141] Ibid.
[1142] BC Oil and Gas Commission 'Oil and Gas Activity Application Manual' (2019) at 53-54, version 1.33, British Columbia, Canada.
[1143] New Brunswick Oil and Gas Commission 'Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick - Rules for Industry' (2015) at 22, New Brunswick, Canada.
[1144] Alberta Energy Regulator 'Directive 083: Hydraulic Fracturing – Subsurface Integrity' (2013) s 2.3.1 (2)
[1145] Directive 083, s 2.3.1 (2).
[1146] Directive 083, s 2.3.2.
[1147] Directive 083, s 2.3.2 (4)(a).

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barrier,[1148] and a monitoring system to detect and allow for a response to a primary barrier failure.[1149]

Well integrity failure is not unique to shale gas development.[1150] While poor well construction affects the entire oil and gas industry, shale gas development amplifies the challenge because of the high number of wells, and volume of chemicals required during hydraulic fracturing, hence ensuring well integrity becomes much more critical.[1151] Independent well examination which is discussed below enhances well integrity.

5.3.4 Independent Well Examination

Before commencing with drilling or hydraulic fracturing in South Africa, a petroleum right holder is mandated to submit a well examination plan to the designated agency.[1152] The plan must include ground water and aquifer isolation;[1153] fracture containment;[1154] related seismicity risks;[1155] fracturing and flow-back or testing programmes and operations;[1156] and an independent well examination.[1157] The designated agency may furthermore appoint an independent and competent person to undertake well examination with the cost thereof borne by the petroleum right holder.[1158]

In the UK, the independent examination of well designs must also take into account ground water and aquifer isolation, fracture containment, and induced seismic

[1148] Directive 083, s 2.3.2 (4)(b).
[1149] Directive 083, s 2.3.2 (4)(c)
[1150] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 6, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.
[1151] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 56, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf,* accessed on 3 October 2022.
[1152] Reg 107(1) GN R.466.
[1153] Reg 107(1)(a).
[1154] Reg 107(1)(b).
[1155] Reg 107(1)(c).
[1156] Reg 107(1)(d).
[1157] Reg 107(1)(e).
[1158] Reg 107(2).

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risks.[1159] Well examiners rely on documentary evidence of well integrity as the main basis to assure well operators that wells are properly designed and constructed.[1160] It is not obligatory that examiners do a physical inspection of the wells, unless the reliability of the documentary evidence is in question.[1161] Given that the UK shale gas industry has not yet gained public confidence, operators are encouraged to request their well examiners to physically inspect the well integrity during the early development stages in real-time as an additional oversight mechanism.[1162] Periodic site visits by well examiners are required to observe the operations and verify that they are executed in accordance with the approved programme, over and above ascertaining the documentary evidence.[1163]

5.3.5 Hydraulic Fracturing Operations (Production Phase)

The regulation of hydraulic fracturing operations is generally premised on the recognition that the risks posed by shale gas development to water quality often relate to operational practices.[1164] The main operational risks to surface water and groundwater are first, accidental spills of hydraulic fracturing chemicals, and other related fluids during transportation, storage, or use.[1165] Secondly, flowback or produced water spillages.[1166] Thirdly, improper storage, treatment and disposal of flowback water.[1167] Fourthly, leaks from surface ponds or other storage facilities.[1168]

In South Africa, the management of hydraulic fracturing operations entails, first, the management of drilling fluids;[1169] hydraulic fracturing equipment;[1170] mechanical integrity tests and monitoring;[1171] hydraulic fracturing fluid disclosure;[1172] and fracture

[1159] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) s 5(5.10).
[1160] Ibid.
[1161] Ibid.
[1162] Ibid.
[1163] Ibid.
[1164] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 7, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.
[1165] Ibid.
[1166] Ibid.
[1167] Ibid.
[1168] Ibid.
[1169] Reg 109 GN R.466.
[1170] Reg 111.
[1171] Reg 112.
[1172] Reg 113.

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and fracturing fluid containment.[1173] Secondly, the management of fracturing fluids,[1174] including flowback;[1175] and the transportation,[1176] and storage of the fluids.[1177] A post hydraulic fracturing report is also mandatory.[1178] Thirdly, management of water, which includes water balances;[1179] protection of water resources;[1180] and water use.[1181] Fourthly, management of waste,[1182] and pollution incidents such as spillages.[1183] Fifth, management of air quality, including fugitive emissions;[1184] dust;[1185] and noise control.[1186]

Prior to the commencement of any drilling and hydraulic fracturing operations, the petroleum right holder must obtain the necessary authorizations, permits and licenses in terms of the National Water Act, the National Environmental Management Act, and the specific environmental management Act.[1187] Furthermore, the well engineering design,[1188] and hydraulic fracturing programme and procedure must be submitted to the Petroleum Agency SA, the Department of Water and Sanitation , and to the Minister of Mineral Resources and Energy as part of the application for environmental authorization.[1189]

In the UK, the Guidelines for UK Well Operations on Onshore Shale Gas Wells are limited to the exploration and appraisal phases only.[1190] The exploration and appraisal phases are treated as a pilot, to gain experience, and ensure that high safety and environmental management standards are achieved prior to the production phase.[1191] Nonetheless, the Offshore Installations and Wells (Design and Construction Etc)

[1173] Reg 114.
[1174] Reg115.
[1175] Reg 116.
[1176] Reg 117.
[1177] Reg 118.
[1178] Reg 120
[1179] Reg 121.
[1180] Reg 122.
[1181] Reg 123.
[1182] Reg 124.
[1183] Reg 126.
[1184] Reg 127.
[1185] Reg 128.
[1186] Reg 129.
[1187] Reg 110(1).
[1188] Reg 110(2)(a).
[1189] Reg 110(2)(b).
[1190] United Kingdom Onshore Operators' Group 'UK Onshore Shale Gas Well Guidelines' (2016) s 5..
[1191] Ibid.

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Regulations 1996,[1192] and Borehole Sites & Operations Regulations 1995,[1193] are applicable to shale gas development and apply through all phases of a well's value change, including the operations phase.[1194]

In Canada, the regulation of hydraulic fracturing related operational practices include the regulation of hazardous chemicals; wastewater (which includes storage and transportation of wastewater);[1195] and fugitive emissions.[1196] The Canadian Environmental Protection Act (CEPA) requires that all chemical substances that are used in Canada be assessed for toxicity and be made public.[1197] The CEPA also regulate the chemicals used in hydraulic fracturing and oilfield, and provides for substantial fines and other penalties for violations.[1198] The disclosure of hydraulic fracturing chemicals in Canada is also regulated by the major shale gas producing provinces, Alberta, British Columbia and New Brunswick in particular.[1199] In 2012, British Columbia revised its Drilling and Production Regulation and now provides for the disclosure of fluids used in hydraulic fracturing operations.[1200] In 2013, New Brunswick also made the disclosure of hydraulic fracturing fluids mandatory, to be disclosed at least 30 days before hydraulic fracturing operations are conducted.[1201]

5.3.6 Decommissioning and Abandonment

In terms of the South African regulations this phase includes well suspension, suspended well integrity management, and well decommissioning and closure.[1202] The holder of an exploration and production right is only allowed to suspend a well upon

[1192] Offshore Installations and Wells (Design and Construction Etc) Regulations 1996
[1193] Borehole Sites & Operations Regulations 1995
[1194] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) s10.
[1195] Penny Becklumb, Jed Chong & Tim Williams 'Shale Gas in Canada: Environmental Risks and Regulation' (2015) at 7, Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.
[1196] Ibid.
[1197] Canadian Environmental Protection Act, 1999, s 68/
[1198] Canadian Environmental Protection Act, 1999, schedule 1.
[1199] Allan Ingelson and Tina Hunter 'A Regulatory Comparison of Hydraulic Fracturing Fluid Disclosure Regimes in the United States, Canada, and Australia' (2014) at 224, *Natural Resources Journal* 54(2).
[1200] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 754, *The Georgetown Envtl. Law Review* 29.
[1201] Ibid.
[1202] Reg 130 GN R.466.

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approval by the Petroleum Agency,[1203] and for a specified period.[1204] The right holder furthermore has an obligation to put in place standards and procedures for the management and monitoring of suspended wells, following drilling and hydraulic fracturing operations and prior to field development.[1205] The suspension of a well must be done in a manner that allows it to be safely and securely re-entered,[1206] while not compromising the final well abandonment.[1207] A well that will no longer be used, or has stopped production and its suspension period has lapsed, has to be plugged and decommissioned according to a decommissioning plan approved by the Petroleum Agency,[1208] and in line with the relevant provisions of the Environmental Impact Assessment Regulations.[1209]

In the UK, well suspension and abandonment are government by the Offshore Installations and Wells (Design and Construction Etc) Regulation 15 and Guidance, the Oil and Gas UK Well Abandonment Guidelines, and the Oil and Gas UK Guidelines on Qualification of Materials for the Abandonment of Wells.[1210] The UK Onshore Shale Gas Well Guidelines require that well operators ensure that a well be designed and constructed in a manner that it can be suspended and abandoned in a safe manner, and after its suspension and abandonment, there can be no unplanned escape of fluids from it or from the reservoir to which it led.[1211]

In Canada, the drilling, completion, maintenance and abandonment of oil and gas wells in federal lands are regulated through the Canada Oil and Gas Drilling and Production Regulations.[1212] Before abandoning a well or removing any part of its casing, the petroleum right holder has to notify the Oil Conservation Engineer of such intent in writing and obtain written approval thereof.[1213] It is mandatory that when abandoning wells, cement plugs be used to protect porous formations, in accordance with good oil

[1203] Reg 130 (1)(a).
[1204] Reg 130 (1)(b).
[1205] Reg 131 (1).
[1206] Reg 131 (3)(a).
[1207] Reg 131 (3)(b).
[1208] Reg 132 (1)(a).
[1209] Reg 132 (1)(b).
[1210] United Kingdom Onshore Operators' Group 'UK Onshore Shale Gas Well Guidelines' (2016) s 5(5.8).
[1211] Ibid, 4(4.1)(a).
[1212] Canada Oil and Gas Drilling and Production Regulations 2009, Reg 3.
[1213] Reg 15(1).

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field practice.[1214] Upon final abandonment, the petroleum right holder is required to restore the surface as close as possible to its original condition.[1215]

The decommissioning of shale gas wells is furthermore regulated at the provincial level,[1216] particularly in the western provinces, such as British Columbia, Alberta and Saskatchewan, where shale gas is already being produced.[1217] Wellbore integrity is as important during decommissioning and abandonment as it is during production.[1218] For example, when the venting of natural gas from suspended shale gas wells is detected at the surface (surface casing vent flows), or when there is evidence of gas seepage from a particular well, such wells need to be remediated, to reduce the gas flows to negligible levels before they are sealed as part of decommissioning and abandonment.[1219]

It is the responsibility of the petroleum right holder to remedy the leaking of gas from decommissioned wells in accordance to standards set by the regulating agencies.[1220] Provinces such as Alberta charge levies on production called 'orphan well' funds for repairing leaking wells after their decommissioning and abandonment, and when operators can no longer be found.[1221] This is because, over time, it is possible that slow gas migration can still take place from even properly decommissioned wells, which may not be detected if entering groundwater aquifers, rather than venting visibly at the surface.[1222] Nonetheless, such gas seepage rates are low and deemed relatively harmless to human health and the environment.[1223] Therefore it is only if such gas migration is detected at surface that operators are required to re-enter and re-seal the well.[1224] The long-term effects of gas leakage or seepage from abandoned shale gas

[1214] Reg 15(2).
[1215] Reg 16.
[1216] Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 7, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 3 October 2020.
[1217] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 750, *The Georgetown Envtl. Law Review* 29.
[1218] Verschuren Centre for Sustainability in Energy and the Environment 'Report of the Nova Scotia Independent Review Panel on Hydraulic Fracturing' (2014) at 211, Cape Breton University.
[1219] Ibid.
[1220] Ibid.
[1221] Ibid, at 12.
[1222] Ibid, at 12.
[1223] Ibid, at 12.
[1224] Ibid, at 12.

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wells is however not currently well understood, it is important therefore that this phenomena is thoroughly studied as part of efforts to mitigate the long-term risks associated with shale gas extraction.[1225]

5.4 Conclusions

The emergence of shale gas as a potential resource in South Africa poses a challenge for the country's petroleum law and regulators.[1226] Chapter six, which is dedicated to oil and gas exploration and production in the MPRDA was developed with offshore petroleum exploration and production in mind.[1227] Unlike in the case of shale gas which is found onshore, access to offshore oil and gas resources has until the end of 2021 not been contentious, which could be because petroleum in-situ belong to the nation, with the state custodian of both the natural resources beneath the sea and the sea itself.[1228] Public participation has proven to be critical for shale gas in the Karoo, particularly as it conflicts with the interests of landowners who's resistance have served to deter shale gas development.[1229]

The shortcomings in the current petroleum legal framework are thus: first, the integration of mineral legislation with petroleum legislation, which led to a limited focus on petroleum resources relative to mineral resources.[1230] As a result only one chapter is dedicated to petroleum in the MPRDA, demonstrating an afterthought in the law making process.[1231] This complicates the petroleum legal framework with many

[1225] Ibid, at 12.

[1226] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 252, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* Oxford, Oxford University Press.

[1227] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1441 *Potchefstroom Electronic Law Journal* 18(5).

[1228] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 3(1).

[1229] *John Douglas Stern and others vs Minister of Mineral Resources, para 3-4,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

[1230] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 253, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

[1231] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 84, in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) Claremont, Juta and Company (Pty) Ltd.

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references to the more comprehensive mineral chapters/sections within the MPRDA.[1232] Secondly, the definition of petroleum is confusing in the MPRDA.[1233] The simplification of the definition in the emerging petroleum law,[1234] and ensuring that it takes into account the existence of shale gas in the Karoo could help the interpretation of the petroleum legal framework.

Thirdly, the regulatory framework does not require consent from local communities in relation to petroleum exploration and production.[1235] This poses a challenge for shale gas development to obtain local community acceptance. Fourthly, consent from landowners to access their land for petroleum exploration and production is not required as long as they have been consulted.[1236] This invokes the question whether access to land for the purpose of petroleum exploration and production infringes on existing rights to ownership.[1237] This conundrum has the potential to continue to put applications for petroleum exploration and production and loggerheads with landowners until sufficiently clarified.[1238]

Fifth, while the MPRDA provides for the payment of compensation to landowners or lawful occupiers in the event of loss or damage to land caused by exploration and production activities,[1239] this provision might not be adequate to entice landowners to support shale gas development, thus could result in organised resistance towards shale gas development. Sixth, the MPRDA overly empowers the Minister of Mineral Resources on environmental matters pertaining to petroleum exploration and production.[1240] This is not appropriate, since environmental matters should be the

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[1232] Ibid.
[1233] Ibid, at 60.
[1234] Draft Upstream Petroleum Resources Development Bill, Government Notice R.1706 in Government Gazette No.42931 of 24 December 2019.
[1235] Mineral and Petroleum Resources Development Act, No.49 of 2008, s 5A(c).
[1236] Ibid.
[1237] Lisa Plit 'Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002' (2016) at 64, in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) Claremont, Juta and Company (Pty) Ltd.
[1238] Ibid.
[1239] Minerals and Petroleum Resources Development Act, No. 28 of 2002, s 54.
[1240] Hugo Meyer van den Berg & Hanri Mostert (2018) Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads, at 256, in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden (2018) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (University Press, Oxford).

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prerogative of the Minister responsible for environmental affairs.[1241] The natural inclination and pre-occupation of the Minister of Mineral Resources is to enable the development of mineral and petroleum resources and not necessary to safeguard that they be developed in an environmentally sustainable manner.[1242] The MPRDA does however compel the Minister of Mineral Resources to ensure that the nation's mineral and petroleum resources are developed in an orderly and economically sustainable manner while promoting justifiable social and economic development.[1243]

Seventh, the Hydraulic Fracturing Regulations provide for the hydraulic fracturing operation as though it is a production activity.[1244] Hydraulic fracturing is a well stimulation technique that largely occurs during field development, that is, the drilling and completion of wells from which gas may ultimately be produced.[1245] However, hydraulic fracturing can be used during the drilling of exploration wells, particularly as it enables the testing of the flow properties of the target formation.[1246] When used in

[1241] *John Douglas Stern and others vs Minister of Mineral Resources*, para 38, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown); Doreen Atkinson 'Fracking in a fractured environment: Shale gas mining and institutional dynamics in South Africa's young democracy' (2018) at 450, *The Extractive Industries and Society* 5.

[1242] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1466, *Potchefstroom Electronic Law Journal* 18(5); Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 257, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press, Oxford).

[1243] Section 3(3) of the MPRDA.

[1244] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 259, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) Oxford, Oxford University Press.

[1245] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, *S Afr J Sci*; 107(7/8); Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 259, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) (Oxford University Press, Oxford).

[1246] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, Doug Cole, Annette E. Götz, Claire Geel & Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, *S Afr J Sci*; 113 (9/10); Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 259, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) (Oxford University Press, Oxford).

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this fashion, such wells might not be completed into producing wells, but merely be plugged and abandoned.[1247]

The petroleum legislation and hydraulic fracturing regulations should ensure that there is no ambiguity in whether hydraulic fracturing is regulated through an exploration, development or production right.[1248] Removing this ambiguity is particularly important given the robustness of the environmental authorization process for awarding production rights, as opposed to the lesser strict process of awarding exploration rights, which is inadequate to regulate hydraulic fracturing.[1249]

Lastly, the Hydraulic Fracturing Regulations are not clear how activities that could have a detrimental impact on the environment will be monitored and enforced,[1250] and they do not impose penalties for negative environmental impact as a result of shale gas operations.[1251] This is contrary to the NEMA which creates liability for environmental damage,[1252] thus provides for the costs of remedying pollution, environmental degradation and consequent adverse health effects be paid for by those responsible for harming the environment.[1253] Nevertheless, as outlined in this chapter, and elsewhere in this thesis, the appropriate management of the risks associated with shale gas development to protect human health and the environment will require an effective petroleum and environmental legal framework.[1254] Such a legal framework must be complemented by regulatory measures based on sound science, including

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[1247] Michiel O. de Kock, Nicolas J. Beukes, Elijah O. Adeniyi, Doug Cole, Annette E. Götz, Claire Geel & Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, *S Afr J Sci*; 113 (9/10).

[1248] Hugo Meyer van den Berg and Hanri Mostert 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' (2018) at 259, in Donald Zillman, Martha Roggenkamp, Leroy Paddock, and Lee *Godden Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018) (Oxford University Press, Oxford).

[1249] Ibid.

[1250] Ibid, 260; Charissa Worthmann and Surina Esterhuyse 'A mobile application to protect groundwater during unconventional oil and gas extraction' (2022) at 14, *Royal Society Open Science* 9(220221).

[1251] W du Plessis 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) at 1465, *Potchefstroom Electronic Law Journal* 18(5).

[1252] Loretta Feris (2008) Constitutional Environmental Rights: An Under-Utilized Resource, at 36, S*AJHR* 24.

[1253] Section 2 (4)(p) of the NEMA.

[1254] S. Esterhuyse, D. Vermeulen and J. Glazewski 'Developing and enforcing fracking regulations to protect groundwater resources' (2022) at 6, *NPJ Clean Water* 5(3).

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specific rules, standards, prohibitions, mandatory reporting, inspections, and penalties.[1255]

This thesis posits that a more effective legal framework for shale gas development in South Africa should be premised on three pillars, these are: Avoidance, Mitigation and Remediation. Chapters six to eight below provide an assessment of the South African petroleum and environmental legal frameworks with those of the UK and Canada using Avoidance, Mitigation and Remediation as the comparative themes.

[1255] Ibid, Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) at 203, available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 3 October 2020.

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CHAPTER 6: AVOIDING THE ENVIRONMENTAL IMPACT OF SHALE GAS

6.1 Introduction

Countries across the world responded differently to the advent of shale gas development, particularly the use of hydraulic fracturing to exploit the resource.[1256] Numerous states allow the use of hydraulic fracturing in the US, these include hosts of the major shale gas plays, such as the Marcellus and Barnet plays, the States of Pennsylvania, Texas, West Virginia, Wyoming and Colorado who are leading the exploitation of shale gas.[1257] There are states within the US that have banned hydraulic fracturing, notably Vermont, New York, and Maryland.[1258] As is the case in the US, Australian States such as Victoria and Tasmania have banned hydraulic fracturing despite it being generally allowed in the country.[1259] Countries such as Bulgaria, Denmark, France, the Netherlands, Northern Ireland, and Scotland have also banned the use of hydraulic fracturing to extract shale gas.[1260] Furthermore, hydraulic fracturing has, from a strategic thrust perspective, and at different points in time been allowed in countries such as Australia, Brazil, Canada, China, Germany, Mexico, New Zeeland, Norway, Poland, and the United Kingdom.[1261]

[1256] Roberto Cantoni, Matthias S. Klaes, Simone I. Lackerbauer, Claudia Foltyn, Reiner Keller 'Shale tales: Politics of Knowledge and promises in Europe's shale gas discourses' (2018) at 536, *The Extractive Industries and Society* 5; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 287, *Journal of World Energy Law and Business* 11; Louise Du Toit 'Experiences from Other Jurisdictions' in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) at 17 (Claremont, Juta and Company (Pty) Ltd; Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 39, *Stellenbosch Law Review.*

[1257] Louise Du Toit 'Experiences from Other Jurisdictions' in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives'* (2016) at 17, Claremont, Juta and Company (Pty) Ltd.

[1258] DA Young Kim 'A Lesson from the Shale Revolution in the United States, Canada, and China' (2017) at 761-762, *The Georgetown Envtl. Law Review* 29; Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 287, *Journal of World Energy Law and Business* 11.

[1259] Louise Du Toit 'Experiences from Other Jurisdictions' in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives'* (2016) at 16, Claremont, Juta and Company (Pty) Ltd.

[1260] Roberto Cantoni, Matthias S. Klaes, Simone I. Lackerbauer, Claudia Foltyn, Reiner Keller 'Shale tales: Politics of Knowledge and promises in Europe's shale gas discourses' (2018) at 536, *The Extractive Industries and Society* 5 (535 – 546; Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 39, *Stellenbosch Law Review.*

[1261] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for

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As outlined in the preceding chapter, a more effective legal framework for shale gas exploration and production in South Africa should be premised on three pillars, *Avoidance*, *Mitigation* and *Remediation*. These concepts are the cornerstones of international environmental law,[1262] and give effect to Sustainable Development,[1263] outlined in 6.2 below. Their inter-relatedness is best expressed in the European Community Treaty which states that the European Community policy on the environment 'shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay'.[1264]

The focus of this chapter is a comparative assessment of the South African petroleum legal framework with those of the United Kingdom and Canada, using *Avoidance* as the comparative theme. It hence explores the possibilities offered, and the pathways closed, by adopting an avoidant approach in regulating hydraulic fracturing. Embedding avoidance in the legal framework for shale gas exploration and production is key to giving effect to South Africa's environmental law, which mandates that environmental degradation be avoided, and where it cannot be entirely avoided, be minimized and remedied.[1265] From an international law perspective, avoidance is synonymous to the principle of prevention, alternatively, the principle of prevention is at the core of avoidance,[1266] outlined in greater detail in this chapter.

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unconventional energy' (2018) at 287, *Journal of World Energy Law and Business* 11; Louise Du Toit 'Experiences from Other Jurisdictions' in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) at 16 (Juta and Company (Pty) Ltd, Claremont).

[1262] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 13 (Oxford University Press, New York); J. Glazewski & S. Posnik 'Compliance with international environmental standards and expectations: review of international developments' (2000) at 211, *The Journal of the South African Institute of Mining and Metallurgy*.

[1263] Jan Glazewski 'Sustainable development and proposed shale extraction in South Africa: prospects and challenges' at 223 in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK); Jan Glazewski & Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 195, *Stellenbosch Law Review* 26(1).

[1264] Treaty establishing the European Community, Title XIX, Article 144(2).

[1265] Section 2(4)(a)(ii) of the National Environmental Management Act, No. 107, 1998 (NEMA); Jan Glazewski 'Sustainable development and proposed shale extraction in South Africa: prospects and challenges' at 223 in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK).

[1266] Jan Glazewski & Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 195, *Stellenbosch Law Review* 26(1).

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6.2 Sustainable Development

The concept of Sustainable Development gained impetus in 1987 when it found expression in the report titled *Our Common Future*,[1267] by the World Commission on Environment and Development (WCED) then chaired by Gro Harlem Brundtland.[1268] The WCED was formed to address concerns regarding the deterioration of environmental quality and integrity.[1269] Sustainable Development is henceforth defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.[1270] Sustainable development integrates two policy objectives that cannot be avoided, development and environmental protection or restoration.[1271] Inter-generational equity is also an inherent and essential element of sustainable development, as it demands that development be sustainable for generations to come.[1272]

Sustainable Development can also be described as 'the process where the exploitation of resources, investments, technological advancement, and institutional change are in harmony and enhance the ability to meet both current and future human needs and

[1267] United Nations 'Report of the World Commission on Environment and Development: Our Common Future' (1987) available at *https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf* accessed on 1 November 2021.

[1268] John C. Dernbach 'Framing the sustainability questions' at 20, in May JR and Dernbach *JC Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK). Ms Gro Harlem Brundland was the first female Prime Minister of Norway, who served three terms (1981, 1986 – 89, and 1990 – 96). She later became Director General of the World Health Organization (1998 – 2003).

[1269] Loretta Feris 'Constitutional Environmental Rights: An Under-Utilized Resource' (2008) at 29, (24) S*AJHR*; John C. Dernbach 'Framing the sustainability questions' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 23, (Edward Elgar Publishing Limited, UK).

[1270] United Nations, 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 37, available at *https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf* accessed on 1 November 2021; Kenneth T. Kristl ' Public participation and sustainability: how Pennsylvania's shale gas program thwarts sustainable outcomes' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 126, (Edward Elgar Publishing Limited, UK); David B. Spence 'Regulating shale gas production for sustainability: federalism questions' in May JR and Dernbach JC 'Shale Gas and the Future of Energy: Law and Policy for Sustainability' (2016) at 190, (Edward Elgar Publishing Limited, UK).

[1271] John C. Dernbach 'Framing the sustainability questions' in May JR and Dernbach JC 'Shale Gas and the Future of Energy: Law and Policy for Sustainability' (2016) at 24, (Edward Elgar Publishing Limited, UK).

[1272] Paul G.W Henderson 'Some thoughts on distinctive principles of South African Environmental Law' (2001) at 152, *South African Journal of Environmental Law and Policy*, 8(2).

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aspirations'.[1273] Sustainable Development therefore treats economic development, environmental protection, and human rights in an integrated and interdependent manner.[1274] Sustainable Development as a decision-making framework and policy objective could aid shale gas development in South Africa, as it demands the integration of environmental protection and restoration, with social and economic development, using cost internalization, and the precautionary approach as core principles.[1275]

According to the system envisaged by Sustainable Development, the current generation may not, in the quest to fulfil its needs, jeopardise the ability of future generations to fulfil their needs.[1276] Furthermore, environmental problems associated with the economic and technical development of developed countries should not have the effect of minimizing the prospects of economic growth for developing countries.[1277] The law is not enough to attain sustainable development, community knowledge and support are also required, characterized by greater public participation in environmental decisions.[1278] Meaningful public participation is better served through giving local communities an effective say over the use of their natural resources and environment.[1279]

[1273] United Nations 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 37.

[1274] J. Verschuuren 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) at 8, *Potchefstroom Electronic Law Journal*.

[1275] James R. May and John C.Dernbach 'Introduction' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* at 5 (2016) (Edward Elgar Publishing Limited, UK).

[1276] J. Verschuuren 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) at 7, *Potchefstroom Electronic Law Journal;* Pamela Ko and Patricia Salkin 'Sustainable drilling through health impact assessment: understanding and planning for public health impacts' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 34, (Edward Elgar Publishing Limited, UK).

[1277] J. Verschuuren 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) at 7, *Potchefstroom Electronic Law Journal.*

[1278] United Nations, 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 49; Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 134, *Edward Elgar Publishing Limited* (Cheltenham, UK).

[1279] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 134, *Edward Elgar Publishing Limited* (Cheltenham, UK); Kenneth T. Kristl 'Public participation and sustainability: how Pennsylvania's shale gas program thwarts sustainable outcomes' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 129, (Edward Elgar Publishing Limited, UK).

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Activities that might have a high environmental impact could be better managed taking into account diverse views sourced through mandatory and meaningful public participation.[1280] This is particularly relevant to shale gas development, where reaching some form of consensus is critical to obtain community consent.[1281] Public engagement could be greatly enabled through free access to relevant information and the availability of alternative sources of technical expertise.[1282] Moreover, whenever feasible, decisions related to high environmental impact projects should be subject to prior public approval.[1283]

Among others, the WCED affirms that reliable, safe, and environmentally sound energy sources are key to sustainable development.[1284] This is of particular relevance to this thesis, which proposes that with the appropriate petroleum and environmental legal framework, shale gas development could contribute towards a more sustainable energy path in South Africa. The WECD recommends that countries develop policies that ensure sufficient energy supplies to meet national economic growth objectives.[1285] Central to such national strategies should be energy efficiency and conservation measures, to reduce the waste of natural resources, and mitigate the risks to safety that is inherent in energy sources.[1286] To be reconciled within such policies and legal frameworks should be the protection of the biosphere, pollution prevention,[1287] and climate change mitigation.[1288]

[1280] Pamela Ko and Patricia Salkin 'Sustainable drilling through health impact assessment: understanding and planning for public health impacts' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 37, (Edward Elgar Publishing Limited, UK).

[1281] Kenneth T. Kristl 'Public participation and sustainability: how Pennsylvania's shale gas program thwarts sustainable outcomes' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 129, (Edward Elgar Publishing Limited, UK).

[1282] Ibid, at 130.

[1283] Ibid.

[1284] United Nations 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 49; James R. May and John C. Dernbach 'Introduction' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* at 1 (2016) (Edward Elgar Publishing Limited, UK).

[1285] United Nations 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 49.

[1286] Ibid.

[1287] Ibid.

[1288] Ibid, at 123.

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The Experts Group on Environmental Law of the World Commission on Environment and Development proposed the General Principles, Rights and Responsibilities to give effect to Sustainable Development.[1289] These are, first, 'all human beings have a fundamental right to an environment that is adequate for their health and wellbeing'.[1290] Furthermore, States shall: Secondly, 'conserve and use the environment and natural resources for the benefit of the present and future generations'.[1291] Thirdly, 'maintain ecosystems and ecological processes that are essential for the functioning of the biosphere, preserve biological diversity, and observe the principle of optimum sustainable yield in the use of living natural resources and ecosystems'.[1292] Fourthly, 'establish adequate environmental protection standards, monitor changes and publish relevant data on environmental quality and resource use'.[1293] Fifth, 'make or require prior environmental assessments of proposed activities which may affect the environment or use of natural resources'.[1294]

Sixth, States shall: 'inform all persons likely to be significantly affected by a planned activity promptly and grant them equal access to due process in administrative and judicial proceedings'.[1295] Seventh, 'ensure that conservation is treated as an integral part of the planning and implementation of development activities and provide assistance to other States, especially to developing countries, in support of environmental protection and sustainable development'.[1296] Eighth, cooperate in good faith with other States in implementing these rights and obligations'.[1297]

The general principles, rights and responsibilities conceptualised by the Experts Group outlined above affirm the view expressed in Chapter 4 of this thesis, that to address sustainable development and concerns related to the potential impact of shale gas on

[1289] United Nations, 'Report of the World Commission on Environment and Development: Our Common Future' (1987) at 49.
[1290] United Nations, 'Report of the World Commission on Environment and Development: Our Common Future' (1987), at 235, Annexe 1: Summary of Proposed Legal Principles for Environmental Protection and Sustainable Development by the WECD Experts Group on Environmental Law.
[1291] Ibid.
[1292] Ibid.
[1293] Ibid.
[1294] Ibid.
[1295] Ibid.
[1296] Ibid.
[1297] Ibid.

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human health and the natural environment,[1298] requires a legal framework that balances procedural and administrative requirements with substantive commitments to public participation.[1299] A number of these rights were subsequently affirmed in the Rio Declaration on Environment and Development,[1300] as outlined below.

6.2.1 The Rio Declaration on Environment and Development

The United Nations Conference on Environment and Development that took place in Rio de Janeiro in 1992, embedded the concept of Sustainable Development in international environmental law and affirmed the environmental legal principles in national environmental laws and policies.[1301] To give effect to sustainable development, the Rio Declaration on Environment and Development,[1302] affirmed several principles, of which the following are specifically relevant to this thesis. Firstly, 'human beings are entitled to a healthy and productive life in harmony with nature'.[1303]

Secondly, 'the sovereign right of States to exploit their natural resources in accordance with their environmental and development policies, and the obligation of States to ensure that activities within their jurisdiction do not cause damage to the environment of other States'.[1304] Thirdly, 'the right to development should be fulfilled to meet the developmental and environmental needs of present and future generations equitably'.[1305] Fourthly, 'to achieve sustainable development, environmental protection shall constitute an integral part of the development process'.[1306] Fifth, 'States must

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[1298] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22.

[1299] Tanya Howard and Solange Teles Da Silva 'Possible legal obligations to consult' (2015) at 135, *Edward Elgar Publishing Limited (Cheltenham, UK).*

[1300] United Nations General Assembly 'Report of the United Nations Conference on Environment and Development: Rio Declaration on Environment and Development' (1992) A/CONF.151/26(1).

[1301] J. Verschuuren 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) at 1, *Potchefstroom Electronic Law Journal*; John C. Dernbach 'Framing the sustainability questions' at 24, in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK).

[1302] United Nations General Assembly 'Report of the United Nations Conference on Environment and Development: Rio Declaration on Environment and Development' (1992) A/CONF.151/26 (Vol.1).

[1303] Principle 1 of the Rio Declaration.

[1304] Principle 2 of the Rio Declaration.

[1305] Principle 3 of the Rio Declaration.

[1306] Principle 4 of the Rio Declaration; Pamela Ko and Patricia Salkin 'Sustainable drilling through health impact assessment: understanding and planning for public health impacts' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 57, (Edward Elgar Publishing Limited, UK).

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facilitate and encourage public awareness and participation by making information concerning the environment widely available, which includes providing effective access to judicial and administrative proceedings, including redress and remedy'.[1307]

Sixth, 'States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage'.[1308] Seventh, 'to protect the environment, the precautionary approach shall be widely applied by States consistent with their capabilities'.[1309] Eighth, 'States should promote the internalization of environmental costs and use of economic instruments, taking into account that the polluter should, in principle, bear the cost of pollution'.[1310] Lastly, 'environmental impact assessments should be undertaken for proposed activities that are likely to have a significant adverse impact on the environment'.[1311]

These principles are of relevance to the development of a petroleum legal framework that provides adequately for the protection of the environment against the risks posed by shale gas development in the Karoo.[1312] The principles underscore the need for the petroleum legal framework to ensure the avoidance, mitigation and remediation of environmental impacts arising from shale gas development. Guided by these principles, shale gas could be developed in an environmentally responsible manner in South Africa, to enhance energy security of supply, and reduce the country's greenhouse gas emissions.

Indeed, sustainable shale gas production requires a sophisticated and comprehensive regulatory system to protect public health and the environment, and a policy and legal framework that will ensure genuine social and economic benefits.[1313] To give further

[1307] Principle 10 of the Rio Declaration.
[1308] Principle 13 of the Rio Declaration.
[1309] Principle 15 of the Rio Declaration.
[1310] Principle 16 of the Rio Declaration; Pamela Ko and Patricia Salkin 'Sustainable drilling through health impact assessment: understanding and planning for public health impacts' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 57, (Edward Elgar Publishing Limited, UK).
[1311] Principle 17 of the Rio Declaration.
[1312] John C. Dernbach 'Framing the sustainability questions' at 30, in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK).
[1313] Ibid.

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effect to Sustainable Development, the Millennium Development Goals were adopted in 2000, those that are of specific relevance to this study are outlined in sub-section 2.2 below.

6.2.2 The Millennium Development Goals

At the beginning of the new millennium, world leaders converged at the United Nations and developed a broad vision to eliminate poverty in all its facets.[1314] The eight Millennium Development Goal (MDGs), a global framework for development,[1315] emerged as the vision that would give further effect to Sustainable Development for the period 2001 to 2015.[1316] MDG7 and MDG8 are relevant to this study which proposes the development of a more appropriate legal framework for shale gas exploration and production in South Africa, taking into account energy security of supply and climate change mitigation.

MDG7 is about ensuring environmental sustainability,[1317] while MDG8 focuses on developing a global partnership for development.[1318] Environmental sustainability is at the core of sustainable development, the key driver for achieving environmentally sustainable economic and human development.[1319] A global partnership for

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[1314] United Nations 'The Millennium Development Goals Report' (2015) at 4, available at *https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf*, accessed on 2 November 2022; Johanna Weststrate, Geske Dijkstra, Jasper Eshuis, Alberto Gianoli and Maria Rusca 'The Sustainable Development Goal on Water and Sanitation: Learning from the Millennium Development Goals' (2019) 796, *Social Indicators Research* 143(2).

[1315] Hany Besada, Lea McMillan Polonenko and Manmohan Agarwal 'Did the Millennium Development Goals work?: Meeting future challenges with past lessons' (2017) at 292 (Cambridge University Press, Great Britain); United Nations 'The Millennium Development Goals Report' (2015) at 4, available at *https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf*, accessed on 2 November 2022.

[1316] Osmar A. Dar and Mishal S. Khan 'Millennium development goals and the water target: details, definitions and debate' (2011) at 540, *Tropical Medicine and International Health* 16(5); United Nations 'The Millennium Development Goals Report' (2015) at 4, *available at https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf, accessed* on 2 November 2022.

[1317] Osmar A. Dar and Mishal S. Khan 'Millennium development goals and the water target: details, definitions and debate' (2011) at 540, *Tropical Medicine and International Health* 16(5); United Nations 'The Millennium Development Goals Report' (2015) at 62, available at *https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf*,accessed on 2 November 2022.

[1318] Ibid.

[1319] Statistics South Africa 'Millennium Development Goals, Country Report 2013' (2013) at 91, (StatsSA, Pretoria).

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development on the other hand is necessary for market access, international trade, and access to new technologies.[1320]

A lot was achieved in meeting these MDGs, for example, ozone-depleting substances were virtually eliminated by 2015, this has a positive effect on climate change.[1321] There was however regression in many other critical areas, such as carbon dioxide emissions which increased by over 50% from 1990 levels.[1322] Addressing the persistent rise in greenhouse gas emissions, and the resultant likely impacts of climate change, including altered ecosystems, extreme weather conditions, and risk to society needed more urgent steps.[1323] This marked the birth of the Sustainable Development Goals,[1324] outlined below.

6.2.3 The Sustainable Development Goals

As outlined above, the key objective of the World Commission on Environment and Development when it was established in 1983 was to recommend long-term environmental strategies to achieve sustainable development by the year 2000 and beyond.[1325] It was also to determine how the challenges associated with protecting and enhancing the environment could be addressed.[1326] The 17 Sustainable Development Goals (SDGs) seek to build on the MDGs and close the gaps that were not achieved by the MDGs.[1327] They are meant to stimulate action over the next 15 years (2016 – 2030) in areas that are critical for humanity and the planet.[1328] They are a determination to end poverty and hunger, and to ensure that all human beings can fulfil their potential in dignity and equality, and in a healthy environment.[1329] They are meant to protect the planet from degradation, including through sustainable

[1320] Ibid, at 106.
[1321] United Nations 'The Millennium Development Goals Report' (2015) at 7.
[1322] Ibid.
[1323] Ibid.
[1324] United Nations, 'Transforming our world: the 2030 Agenda for Sustainable Development' (2015) General Assembly Resolution 70/1 adopted on 25 September 2015.
[1325] United Nations, 'Report of the World Commission on Environment and Development: Our Common Future' (1987), at 6.
[1326] Ibid.
[1327] United Nations, 'Transforming our world: the 2030 Agenda for Sustainable Development' (2015) at 1, General Assembly Resolution 70/1 adopted on 25 September 2015.
[1328] Ibid.
[1329] Ibid, at 2.

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consumption and production,[1330] sustainably manage its natural resources, and taking urgent action on climate change.[1331] The SDGs are integrated and balance the economic, social and environmental dimensions of Sustainable Development.[1332]

The SDGs that are of specific relevance to this thesis are first, SDG6, which seeks to ensure availability and sustainable management of water resources.[1333] This implies improving water quality, by reducing pollution, eliminating the release of hazardous chemicals into water resources, treating wastewater, and substantially increasing recycling and reuse of wastewater.[1334] The implementation of these key elements of SDG6 in shale gas planning and development, combined with supporting and strengthening the participation of local communities in improving water management,[1335] would help address the key concerns associated with shale gas development.

Secondly, SDG 7, seeks to ensure access to affordable, reliable, sustainable and modern forms of energy.[1336] This includes international cooperation to facilitate clean energy research and technology, including advanced and cleaner fossil-fuel technology, together with investment in energy infrastructure and clean energy technology.[1337] Thirdly, SDG8, seeks to promote sustained, inclusive and sustainable economic growth.[1338] This implies countries should promote development oriented policies that support productive activities, creativity and innovation, while encouraging the formalization and growth of micro, small and medium enterprises.[1339] Fourthly, SDG9, seeks to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.[1340] This includes supporting domestic technology development, research and innovation in developing countries, including

[1330] Ibid.
[1331] Ibid.
[1332] Ibid, at 14.
[1333] SGD 6.
[1334] Ibid.
[1335] Ibid.
[1336] SGD 7; Inigo del Guayo 'The evolution of principles of energy law (a review of the content of the Journal of Energy & Natural Resources Law, 1982 – 2022) (2022) at 49, *Journal of Energy & Natural Resources Law* 40(1).
[1337] Ibid.
[1338] SGD 8.
[1339] Ibid.
[1340] SGD 9.

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by developing policies that encourage industrial diversification and local beneficiation.[1341]

Fifth, SDG12, seeks to ensure sustainable consumption and production patterns.[1342] This implies achieving sustainable management and efficient use of natural resources.[1343] It includes achieving environmentally sound management of chemicals and all wastes, and significantly reduce their release to air, water and soil, to minimize their adverse effects on human health and the environment.[1344] It also includes substantially reducing waste generation through prevention, reduction and reuse, and encouraging large and transnational companies to adopt sustainable practices and to integrate sustainability information in their reporting.[1345] Furthermore, it requires that people have the relevant information and awareness of sustainable development and lifestyles in harmony with nature.[1346]

Sixth, SDG13, which is about taking urgent action to combat climate change and its impacts.[1347] This implies mitigating environmental degradation and climate change, through accelerating the reduction of greenhouse gas emissions and addressing adaptation to the adverse impacts of climate change.[1348] Seventh, SDG17, which is about strengthening the means of implementation and the revitalization of the Global Partnership for Sustainable Development.[1349] This includes promoting the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms.[1350]

In relation to the comparative countries in this study, South Africa has adopted the concept of Sustainable Development as a core environmental management principle

[1341] Ibid.
[1342] SGD 12.
[1343] Ibid.
[1344] Ibid.
[1345] Ibid.
[1346] Ibid.
[1347] SGD13; MT Ladan 'SGDs Framework as the Blueprint for Climate Change Action and Sustainable Development in Africa: Role of Law and Parliaments' (2016) at 167, *SAJELP* 22(159).
[1348] Ibid.
[1349] SGD17.
[1350] Ibid.

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in its Constitution.[1351] As mentioned in chapter five, the South African Constitution affords everyone the right to an environment that is not harmful to their health or well-being,[1352] and to have the environment protected for the benefit of present and future generations.[1353] This must be done through reasonable legislative and other measures that prevent pollution and ecological degradation,[1354] promote conservation,[1355] and secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development.[1356]

Consequently the environmental law of South Africa,[1357] places people and their needs at the forefront of sustainable development, and advocates that environmental management should serve their physical, psychological, developmental, cultural and social interests equitably.[1358] Accordingly, development must be socially, environmentally and economically sustainable.[1359] The NEMA requires the negative impacts on the environment and people's environmental rights to be anticipated and prevented, and where such cannot be totally avoided, to be minimized and remedied.[1360]

Unlike in South Africa, the UK employs a risk-based approach to environmental regulation, which requires that the risks of an environmental incident related to oil and gas operations are reduced as low as practically possible.[1361] Petroleum right holders are encouraged to do more than just adhere to minimum standards, but to strive for

[1351] Constitution of the Republic of South Africa, 1996, s 24(b).
[1352] S 24(a) of the Constitution.
[1353] S 24(b) of the Constitution.
[1354] S 24(b)(i) of the Constitution.
[1355] S 24(b)(ii) of the Constitution.
[1356] S 24(b)(iii) of the Constitution.
[1357] National Environmental Management Act, No. 107 of 1998 (NEMA).
[1358] s 2(2) of the NEMA.
[1359] s 2(3) of the NEMA.
[1360] s 2(4)(a)(viii) of the NEMA.
[1361] Department of Energy and Climate Change 'Onshore oil and gas exploration in the UK: regulation and best practice' (2015) at 7, available at *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/503067/Onshore_UK_oil_and_gas_exploration_England_Dec15.pdf* accessed on 29 January 2023; Jill Morgan 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in James R. May and John C. Dernbach 'Shale Gas and the Future of Energy: Law and Policy for Sustainability' (2016) at 144 (Edward Elgar Publishing Limited, UK); John Pearson and Gary Lynch-Wood 'Concern and counter-concern: The challenge of fragmented fears for the regulation of hydraulic fracturing' (2017) at 673, *The Extractive Industries and Society* 4.

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continuous improvement.[1362] In Canada, the Canadian Environmental Protection Act (CEPA), the main instrument for the protection of the environment and human health,[1363] embeds sustainable development that is based on ecologically efficient use of natural, social and economic resources.[1364] It acknowledges the need to integrate environmental, economic and social factors in decision making by the State and private entities.[1365]

6.3 The Principle of Prevention

As indicated in the introduction of this chapter, this section explores the principle of prevention in international environmental law.[1366] In this thesis, the principle underlies avoidance,[1367] as one of the regulatory mechanisms to avoid negative environmental impacts from shale gas development. International environmental law was originally premised on the belief that environmental damage could be remedied by requiring those responsible to repair the damage they caused.[1368]

This line of thought, the polluter-pays principle,[1369] is dealt with in chapter 8 of this thesis. Eventually there was recognition that nature does not have endless ability to correct environmental damage caused by increasing human activity all by itself.[1370] This paradigm shift recognises the limitations of the belief that nature could be continually renewed, regenerate or cleaned up using the increased wealth and technology from the resultant economic growth.[1371] Based on the adage *prevention is*

[1362] Ibid.
[1363] Canadian Environmental Protection Act, 1999; Allan Ingelson 'Shale Gas Law and Regulation in North America' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 328, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).
[1364] Declaration of the Canadian Environmental Protection Act, 1999.
[1365] Preamble of the Canadian Environmental Protection Act, 1999.
[1366] Principle 2 of the Rio Declaration.
[1367] Leslie-Anne Duvic-Paoli 'The Prevention Principle in International Environmental Law' (2018) at 17 (Cambridge University Press: United Kingdom).
[1368] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 14 (Oxford University Press: New York); Leslie-Anne Duvic-Paoli 'The Prevention Principle in International Environmental Law' (2018) at 28 (Cambridge University Press: London).
[1369] Principle 16 of the Rio Declaration.
[1370] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 14 (Oxford University Press).
[1371] Ibid.

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better than cure it seemed logical to transition from the curative approach, towards the more sensible principle of prevention,[1372] dealt with in this chapter.

The timely prevention of environmental damage, particularly when such damage may be irreversible is more sensible than a curative model that does not compel polluters to reduce their pollution, but encourages them to internalize the associated clean-up costs.[1373] The principle of prevention therefore seeks to complement the polluter-pays principle through setting standards and adopting measures to prevent environmental damage before it occurs.[1374] The principle of prevention advocates for the anticipation of pollution, and preventing it from occurring and causing damage.[1375] It is about the elimination of environmental hazards and potential damage before they occur.[1376] The principle focuses on the protection of the environment against specific hazards and the mitigation of the associated risks before they materialize.[1377]

As stated in section 6.2.1 above, seeking to give effect to Sustainable Development, the Rio Declaration on Environment and Development reinforced the principle of prevention.[1378] It affirms the sovereign right of States to exploit their natural resources in accordance with their environmental and development policies.[1379] It also mandates States to ensure that activities within their jurisdiction do not cause damage outside of national jurisdiction.[1380] This does not imply that States must guarantee the prevention of environmental damage otherwise they could be held liable for damage caused by a source within their territory, rather, States need to exercise due care or diligence to prevent environmental damage.[1381]

[1372] Leslie-Anne Duvic-Paoli 'The Prevention Principle in International Environmental Law' (2018) at 28 (Cambridge University Press: United Kingdom).
[1373] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 61 (Oxford University Press: New York).
[1374] Ibid.
[1375] Leon Bredenhann & Linda Garlipp 'The polluter pays principle in water and environmental law' (1999) at 17, *Civil Engineering* 7(2)2.
[1376] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 194, *Stellenbosch Law Review* 26(1).
[1377] Ibid.
[1378] Principle 2 of the Rio Declaration on Environment and Development.
[1379] Ibid.
[1380] Ibid.
[1381] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 63 (Oxford University Press: New York).

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A due care or due diligence obligation implies that States must prevent activities which involve significant risks of causing environmental harm.[1382] Significance depends on the probability that a risk will materialize, and on the magnitude of the harm which might be caused.[1383] When damage is not expected to be serious, due diligence will only be required if such damage is highly likely to occur.[1384] The higher the risk, the greater the diligence required from the polluter.[1385] A risk with a low degree of probability may still be regarded as significant if it is likely to cause enormous harm.[1386] Due care comprises requirements such as environmental impact assessments, consultation, and disclosure and monitoring of activities that could potentially cause environmental damage.[1387]

The principle of prevention in essence strengthens the general obligation to take due care of natural resources and the environment.[1388] The main use of the principle is the issuing of authorizations that outline conditions for administrative control, and penalties for activities that might have a negative impact on the environment.[1389] These make use of technical specifications to determine means of operation, quantities and concentrations of pollutants that may be discharged, and protective measures to be put in place by the permit holders (setting thresholds).[1390] The permits can be based on concepts such as best available techniques, best environmental practice, clean production methods or best available technology not entailing excessive costs.[1391]

Prevention may be linked to sources of pollution or points of impact.[1392] With regards to the sources of pollution, governments may regulate manufacturing processes such that they are less damaging to the environment (make use of best available

[1382] Leslie-Anne Duvic-Paoli 'The Prevention Principle in International Environmental Law' (2018) at 181 (Cambridge University Press: United Kingdom).
[1383] Ibid, at 182.
[1384] Ibid.
[1385] Ibid.
[1386] Ibid.
[1387] Ibid.
[1388] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 63 (Oxford University Press: New York).
[1389] Ibid, at 73.
[1390] Ibid.
[1391] Ruven C. Fleming and Leonie Reins 'Shale gas extraction, precaution and prevention: A conversation on regulatory responses' (2016) at 131 *Energy Research & Social Science* 20.
[1392] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 73 (Oxford University Press: New York).

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technologies) or assess the environmental impacts of projects prior to granting their authorization (environmental impact assessment).[1393] In respect of impacts, quality standards that limit the amounts of polluting substances to be discharged may be established.[1394] Subsections 3.1 to 3.3 below outline the concepts which give effect to the preventive principle, these are: setting thresholds, making use of best available technologies, and environmental impact assessments.[1395]

6.3.1 Setting Thresholds

Governments cannot anticipate nor prohibit all forms of environmental damage.[1396] Rather, they can set thresholds beyond which environmental harm cannot be tolerated, and use these to authorize activities that may be detrimental to the environment.[1397] Environmental management through the use of thresholds is more effective when breach of such thresholds is automatically considered as contravention, leading to criminal or administrative sanction, such as the withdrawal of permits.[1398] Despite its merits, the thresholds technique has two short-comings. First, it reinforces the power of experts, thus encourages technocratic decision-making.[1399] Secondly, by legalizing a certain level of nuisance, conciliating economic development with environmental protection, it neutralises the principle of non-degradation, which calls for the prohibition of activities that damage the environment.[1400] Therefore, although constituting the vanguard of the principle of prevention, the technique of thresholds remains open to criticism, owing to its tolerance of a certain degree of damage.[1401]

[1393] Ruven C. Fleming and Leonie Reins 'Shale gas extraction, precaution and prevention: A conversation on regulatory responses' (2016) at 131 *Energy Research & Social Science* 20.
[1394] Ibid.
[1395] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 73 (Oxford University Press: New York).
[1396] Ibid, at 82.
[1397] Ibid.
[1398] Ibid, 82.
[1399] Ibid, 83.
[1400] Ibid.
[1401] Ibid.

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6.3.2 Use of Best Available Technologies

The use of best available technologies is sometimes viewed from a precautionary principle perspective.[1402] The use of best available technologies synergises better with the principle of prevention.[1403] This is because recourse to best available technologies is required when the impacts of pollution is known.[1404] In contrast, when recourse is uncertain, the obligation better links with the precautionary principle.[1405] In both cases, the requirement to use best available technology is generally related to the principle of prevention.[1406] In several international treaties, the requirement to prevent harmful releases to the environment is directly related to the obligation to apply best available technology.[1407]

The Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes states that to prevent, control and reduce transboundary impacts, the Parties must act in a way that limits for wastewater discharges stated in permits, are based on the *best available technology* for discharges of hazardous substances.[1408] According to the Agreements Concerning the Protection of the Scheldt and Meuse Rivers, among others, the Contracting Parties shall be guided by the principle of preventive action according to which, in particular, *clean technologies* shall be used, under economically acceptable conditions.[1409] In terms of the OSPAR Convention, States are obliged to use *best available techniques*, including, where appropriate, clean technology.[1410] The Baltic Convention includes a requirement to use

[1402] Ibid.
[1403] Ibid.
[1404] Ibid.
[1405] Ibid.
[1406] Ibid.
[1407] United Nations 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' article 3(c) (1992); Agreements Concerning the Protection of the Scheldt and Meuse Rivers (1994), article 3(b); OSPAR Convention (1992) Article 3(b)(i); Aarhus Protocol on Persistent Organic Pollutants to the 1979 Long-Range Transboundary Air Pollution Convention (1998) Article 3(5)(b)(i; iii); Aarhus Protocol on Persistent Organic Pollutants to the 1979 Long-Range Transboundary Air Pollution Convention (1998) Article 3(5)(b)(i;iii).
[1408] United Nations 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' article 3(c) (1992).
[1409] Agreements Concerning the Protection of the Scheldt and Meuse Rivers (1994), article 3(b).
[1410] OSPAR Convention (1992) Article 3(b)(i).

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best available technology to prevent and eliminate pollution.[1411] The Aarhus Protocol on Persistent Organic Pollutants also requires the use of *best available techniques.*[1412]

In essence, the use of best available technologies shifts the focus from downstream solutions, to the regulation of industrial processes, so as to prevent harmful discharges in the first place.[1413] Thus the best means of preventing pollution in the first place is to require the use of the most effective technologies available.[1414] Nonetheless, the use of best available technologies is not necessarily always guaranteed, because when companies consider the cost of new technologies too high, they see them as eroding value therefore not economically justified.[1415]

Environmental regulation therefore tend to balance the requirement to use best available technologies such that investment in such technologies should not entail excessive costs for project owners.[1416] This implies, the use of best available technologies should not only be technically feasible, it must also be economically viable.[1417] Thus, the obligation to use the best available technologies not entailing excessive costs, implies that costs must be balanced against the nature and volume of the discharges in question.[1418] The preventive principle therefore risks becoming considerably weakened by recourse to cost-benefit analysis.[1419] In this context, the requirement to use best available technologies is therefore not strongly preventative in character.[1420]

[1411] Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992) Article 3(3).
[1412] Aarhus Protocol on Persistent Organic Pollutants to the 1979 Long-Range Transboundary Air Pollution Convention (1998) Article 3(5)(b)(i;iii).
[1413] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 85, New York, Oxford University Press.
[1414] Ibid.
[1415] Ibid.
[1416] Ibid.
[1417] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 85, New York, Oxford University Press.
[1418] Ibid, at 86.
[1419] Ibid.
[1420] Ibid.

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6.3.3 Environmental Impact Assessments

The environmental impact assessments (EIAs) required of certain activities are core to the preventive principle.[1421] Accordingly, an environmental impact assessment, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment.[1422] Setting minimum requirements for a proper EIA is critical, and may include disclosing the Environmental Assessment Practitioner that conducted the EIA, and all the relevant information pertaining to the planned activity or project.[1423] The underlying philosophy is that when authorities are fully aware of all the environmental consequences of a planned activity they will be in a better position to consider whether such an activity be approved or not, and if so, what should be done to minimize its negative consequences.[1424]

Furthermore, EIAs ensure that administrators, project initiators, and third parties are informed and are provided with an opportunity to require fuller integration of environmental concerns into the decision-making process.[1425] A shortcoming of EIAs is that they only apply to activities that potentially have a significant impact on the environment.[1426] This implies that many activities that are deemed insignificant in terms of their potential environmental impact could be approved, with severe cumulative environmental impacts.[1427] In effect, while EIAs have the merit of providing information to the various actors concerned, they present no obstacle to the adoption of decisions that could lead to serious environmental damage.[1428]

Nonetheless, beyond setting thresholds, making use of best available technologies, and environmental impact assessments, prevention can also take the form of civil and criminal liability, together with environmental taxation.[1429] Despite its inherently

[1421] Ibid.
[1422] Principle 17 of the Rio Declaration.
[1423] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 86, New York, Oxford University Press.
[1424] Ibid.
[1425] Ibid, at 89.
[1426] Ibid.
[1427] Ibid, at 88.
[1428] Ibid, 89.
[1429] Ibid, at 73.

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curative function, civil liability is preventative since it involves loss or impoverishment for those found liable.[1430] The quantum of the resulted reparation has the effect of ensuring that potentially liable parties adapt their behaviour consistent with the likelihood of liability.[1431] Furthermore, the elimination of fault in determining responsibility for damage, which is inherent in strict liability regimes has served to reinforce the preventive dimension of civil liability.[1432] In such regimes, parties responsible for environmental damage, not being able to plead the absence of fault, have an interest in exercising extreme care for the environment.[1433] Prevention may also be enforced via fiscal means, and/or command and control instruments such as taxes.[1434] For example an increase in taxes on activities that damage the environment may compel polluters to reduce their hazardous waste.[1435]

A petroleum legal framework that is strict in terms of the prevention of environmental damage, setting thresholds that could result in the suspension or withdrawal of the petroleum rights when exceeded could significantly reduce the risk of environmental damage from shale gas development in the Karoo. The use of best available technologies, and environmental impact assessments could further ensure that inferior technologies are not utilized, and that the full potential impacts of planned activities are known upfront, with the planned activities only permitted when the mitigation measures are deemed adequate to protect the environment from the risks posed by hydraulic fracturing. Sections 4-6 below provides a comparative assessment of the application of the preventive principle in South Africa, the UK and Canada, focusing on setting thresholds, making use of best available technologies, and environmental impact assessments.

[1430] Ibid.
[1431] Ibid.
[1432] Ibid.
[1433] Ibid.
[1434] Ibid.
[1435] Ibid.

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6.4 The Application of the Preventive Principle in South Africa

Having dealt with the theory of the prevention principle above, I now turn to the application of the principle in South Africa.

6.4.1 Setting Thresholds

The obligation to avoid, mitigate and remedy pollution or environmental degradation in terms of the NEMA,[1436] has established a 'duty of care' from an environmental perspective.[1437] The duty of care imposes a duty on every person to act with due care to avoid causing damage to the environment.[1438] Therefore every person who may cause or has caused significant pollution or degradation of the environment must take reasonable steps to prevent such pollution or degradation from occurring.[1439] Where the pollution or environmental degradation is authorized by law or cannot be reasonably avoided or mitigated, to minimize and rectify such pollution or environmental degradation.[1440]

The measures to be taken include: First, 'to investigate, assess and evaluate the impact of activities on the environment'.[1441] Secondly, 'to inform and educate employees about the environmental risks associated with their work, and the manner in which they should perform their tasks to avoid causing significant environmental damage'.[1442] Thirdly, to cease, modify or control any activity that causes harm to the environment'.[1443] Lastly, 'to contain or prevent the movement of pollutants;[1444] eliminate sources of pollution;[1445] and remedy the effects thereof'.[1446]

[1436] National Environmental Management Act, No. 107 of 1998, s 2(4)(a)(ii).
[1437] Paul G.W Henderson 'Some thoughts on distinctive principles of South African Environmental Law' (2001) at 157, *South African Journal of Environmental Law and Policy*, 8(2).
[1438] Leon Bredenhann & Linda Garlipp 'The polluter pays principle in water and environmental law' (1999) at 17, *Civil Engineering*, 7 (2)2.
[1439] National Environmental Management Act, No. 107 of 1998, s 28(1).
[1440] S 28(1) of the NEMA.
[1441] S 28(3)(a) of the NEMA.
[1442] S 28(3)(b) of the NEMA.
[1443] S 28(3)(c) of the NEMA.
[1444] S 28(3)(d) of the NEMA.
[1445] S 28(3)(e) of the NEMA.
[1446] S 28(3)(f) of the NEMA.

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The potential impact of hydraulic fracturing on water resources is one of the most critical concerns regarding shale gas development in the Karoo, given its arid nature.[1447] Hydraulic fracturing is a controlled activity under the relevant provisions of the National Water Act.[1448] This implies that companies applying for shale gas exploration rights, will also have to apply for an integrated water use license at the Department of Water and Sanitation.[1449] Before the issuing of the water use license, the reserve for the specific catchment must be determined.[1450] The reserve defines the quantity and quality of water from a source, that is required to supply the basic human needs, protect aquatic ecosystems, and ensure ecologically sustainable development and use of water resources.[1451]

Consequently, companies applying for shale gas exploration licenses should be required to identify the sources of water supply within their exploration area of interest, or nearby.[1452] They will need to develop a water resource management plan, which must include mitigation of potential impacts on the water resources.[1453] The long-term monitoring of water use, together with liability obligations are to be a condition of the water use licence.[1454] Moreover, water management strategies, such as the use of alternative water sources or water withdrawal restrictions can reduce the frequency or severity of impacts on drinking water sources from shale gas development.[1455]

[1447] Academy of Science of South Africa (2016) RSA Technical Readiness for Shale Gas Extraction, at 33 (ASSAf, Pretoria).
[1448] Department of Water and Sanitation 'Declaration for the Exploration for and Production of Onshore Unconventional Oil or Gas Resources or any Activities Related Thereto Including but not Limited to Hydraulic Fracturing as a Controlled Activity, Government Gazette, No. 39299 of 16 October 2015.
[1449] Academy of Science of South Africa (2016) RSA Technical Readiness for Shale Gas Extraction, at 83 (ASSAf, Pretoria).
[1450] S 3(15) of the NWA.
[1451] Ibid.
[1452] Academy of Science of South Africa (2016) RSA Technical Readiness for Shale Gas Extraction, at 83, ASSAf, Pretoria.
[1453] Ibid.
[1454] Ibid.
[1455] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016), at 15 (Office of Research and Development, Washington DC).

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6.4.2 Use of Best Available Technologies

As stated in Chapter 5 of this thesis, the South African shale gas regulations promote the use of best available technologies.[1456] Consequently, petroleum right holders have to conform to the American Petroleum Institute (API) well construction standards when designing shale gas wells.[1457] A petroleum right holder may however adopt well construction standards other than those developed by the API,[1458] subject to the petroleum right holder submitting detailed information regarding the proposed well construction standards to the designated agency.[1459]

A detailed comparative assessment of the proposed standards, and the standards prescribed in the regulations for petroleum exploration and production from an independent drilling engineer is also required.[1460] The comparative assessment must demonstrate how the proposed well construction standards will ensure higher levels of well integrity relative to those prescribed.[1461] The petroleum right holder may only proceed to implement the proposed well construction standards after receiving written consent from the designated authority.[1462]

As stated in the preceding section, water management strategies such as the use of alternative water sources can reduce the impact of shale gas development on drinking water sources.[1463] Alternatives to the use of fresh water include recycled wastewater, groundwater and seawater, particularly in arid regions or onshore areas with water scarcity,[1464] such as the South African Karoo. Furthermore, the management of fugitive methane emissions related to hydraulic fracturing operations is crucial to

[1456] Reg 96(1) GN R.466.
[1457] Reg 96(1).
[1458] Reg 96(5).
[1459] Reg 96(6)(a).
[1460] Reg 96(6)(b).
[1461] Reg 96(6)(b).
[1462] Reg 96(7).
[1463] United States Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States* (2016), at 15, Office of Research and Development, Washington DC, available at *www.epa.gov./hfstudy*, accessed on 15 August 2018.
[1464] Daniele Costa, Joao Jesus, David Branco, Anthony Danko and Antonio Fiuza 'Extensive review of shale gas environmental impacts from scientific literature (2010 – 2015)' (2017) at 14582-14583, *Enviro Sci Pollut Res.*

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mitigate climate change.[1465] A more potent greenhouse gas than carbon dioxide,[1466] the impact of methane emissions from shale gas extraction to climate change may be more severe.[1467] A variety of technologies are available to mitigate methane emissions from hydraulic fracturing operations, such as reduced emissions completions (RECs),[1468] and Leak Detection and Repair, a technology that is used to identify leaks for repair.[1469]

In South Africa, petroleum right holders are furthermore required to minimize the emissions associated with the venting of hydrocarbon fluids and natural gas during hydraulic fracturing operations.[1470] The recovered gas should be routed into a gas gathering system or to a generator for onsite energy generation.[1471] In the event that a petroleum right holder can demonstrate that it is not technically feasible to minimize the emissions associated with the venting of hydrocarbons during hydraulic fracturing, using the methods mentioned above, the designated agency can compel the right holder to capture and direct the gas produced during hydraulic fracturing to a flare, provided that such flaring may not cause a fire hazard or explosion.[1472] South Africa should furthermore make it mandatory for petroleum right holders to make use of reduced emissions technologies in the design of shale gas wells to manage emissions from hydraulic fracturing operations.

[1465] Laurence Stamford & Adisa Azapagic 'A Fractured truth' (2014), at 27, *The Chemical Engineer*; Brett Cohen & Herald Winkler 'Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa' (2014) at 3, *S Afr J Sci*; 110(3/4).

[1466] Shanru Tian, Kathleen M. Smits, Younki Cho, Stuart N. Riddick, Daniel J. Zimmerle and Aidan Duggan 'Estimating methane emissions from underground natural gas pipelines using an atmospheric dispersion-based method' (2022) at 1, *Elementa Science of the Anthropocene* 10(1).

[1467] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

[1468] Don C Smith 'Unconventional Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies' (2018) at 228 in Donald Zillman, Martha Roggenkamp, Leroy Paddock & Lee Godden *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (London, Oxford University Press); Daniele Costa, Joao Jesus, David Branco, Anthony Danko and Antonio Fiuza, 'Extensive review of shale gas environmental impacts from scientific literature (2010 – 2015)' (2017) at 14587-14588, *Enviro Sci Pollut Res.*

[1469] Daniele Costa, Joao Jesus, David Branco, Anthony Danko and Antonio Fiuza, 'Extensive review of shale gas environmental impacts from scientific literature (2010 – 2015)' (2017) at 14587-14588, *Enviro Sci Pollut Res;* C Kemp, A Ravikumar and A Brandt 'Comparing Natural Gas Leakage Detection Technologies Using an Open-source "Virtual Gas Field" Simulator' (2016) at 1, *Environmental Science and Technology.*

[1470] Reg 127(1)(a) GN R.466.

[1471] Reg 127(1)(a)(i).

[1472] Reg 127 (2).

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As indicated in Chapter 3, Carbon capture and storage is another technology that could be utilized for the capture and safe storage of carbon dioxide emissions from hydraulic fracturing operations.[1473] The technology has been used by oil and gas companies to enhance oil recovery for decades.[1474] Furthermore, when in supercritical state, CO_2 could potentially be used as a hydraulic fracturing fluid, and simultaneously reduce the water requirements of hydraulic fracturing, and need for the long-term safe storage of carbon dioxide.[1475] However, further tests are required to determine the efficacy of the technology of using carbon dioxide as a hydraulic fracturing fluid in the field.[1476]

6.4.3 Environmental Impact Assessments

To give effect to the general objectives of integrated environmental management, South Africa's environmental law provides for the consideration, investigation and assessment of activities that may significantly impact the environment prior to their implementation, and for the reporting thereof to the organ of state responsible for the authorization of such activities.[1477] The assessment must include the potential impact of the activities that require environmental authorization on the environment;[1478] socio-economic conditions;[1479] and cultural heritage.[1480]

The environmental impact assessment is a critical aspect of environmental protection in South Africa.[1481] As stated in Chapter 4, the EIA must establish baseline data on the affected environment, to determine protection, remediation and environmental

[1473] Don C Smith 'Unconventioal Gas Development 2.0: Reducing the 'Environmental Footprint' Through New Technologies in Donald Zillman, Martha Roggenkamp, Leroy Paddock and Lee Godden *Innovation in Energy Law and Technology/Dynamic Solutions for Energy Transitions* (2018) at 232 Oxford University Press, Oxford, United Kingdom.
[1474] Ibid.
[1475] Ibid.
[1476] Daniele Costa, Joao Jesus, David Branco, Anthony Danko and Antonio Fiuza, 'Extensive review of shale gas environmental impacts from scientific literature (2010 – 2015)' (2017) at 14587-14588, *Enviro Sci Pollut Res*.
[1477] National Environmental Management Act, No. 107 of 1998, s 24(1).
[1478] S 24(1)(a) of the NEMA
[1479] S 24(1)(b) of the NEMA
[1480] S 24(1)(c) of the NEMA
[1481] Environmental Impact Assessment Regulations, 2014, in Government Notice R982, Government Gazette No. 38282 of 4 December 2014 Chapter 6.[1482] S 24(4)(a)(iii) of the NEMA.

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management objectives.[1482] It must assess, investigate and evaluate the potential impact to the environment,[1483] and socio-economic conditions of any person who might be directly affected by the proposed petroleum exploration and production.[1484] Moreover, the resultant environmental management programme must include an environmental awareness plan, describing the risks involved and how applicants for exploration and production rights intend to mitigate such risks to avoid degradation of the environment.[1485]

Applicants for petroleum exploration and production rights are furthermore required to make the prescribed financial provision for the rehabilitation or management of negative environmental impacts, before the Minister of Mineral Resources approves the environmental management plan or environmental management programme.[1486] If the holder of a petroleum right fails to rehabilitate or manage the negative environmental impact, or if such a right holder is unable to undertake the requisite rehabilitation, the Minister of Mineral Resources and Energy may, upon written notice to the right holder, use the financial provision or part thereof to rehabilitate or manage the ostensible negative environmental impact.[1487]

Nonetheless, despite the National Environmental Management Amendment Act aligning the environmental requirements in the MPRDA with the NEMA,[1488] powers on environmental matters pertaining to oil and gas exploration and production are still vested in the Minister of Mineral Resources and Energy.[1489] This was found not to be ideal for environmental protection, particularly pertaining to the use of hydraulic fracturing for shale gas exploration.[1490]

[1482] S 24(4)(a)(iii) of the NEMA.
[1483] S 24(4)(b)(i) of the NEMA.
[1484] S 23(2)(b) of the NEMA.
[1485] S 24N(3)(c) of the NEMA.
[1486] S 41(1) of the MPRDA.
[1487] S 41(1) of the MPRDA.
[1488] National Environmental Management Amendment Act, No.62 of 2008.
[1489] Ibid.
[1490] *John Douglas Stern and others vs Minister of Mineral Resources, para 58,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

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6.5 The Application of the Preventive Principle in the United Kingdom

The UK employs a risk-based approach to environmental regulation, which requires that the risks of an environmental incident related to oil and gas operations are reduced as low as practically possible.[1491] The UK Secretary of State for Energy (Department for Business, Energy and Industrial Strategy 'BEIS') on behalf of the crown issues licences for onshore and offshore petroleum exploration and production, in terms of the Petroleum Act, and the Hydrocarbons Licensing Directive Regulations.[1492] The BEIS is also responsible for enforcing environmental legislation in relation to petroleum exploration and production, and through the Office for Unconventional Gas and Oil (OUGA), to promote unconventional oil and gas resources in the UK.[1493]

The main licence for onshore exploration and development in the UK is the Petroleum Exploration and Development Licence (PEDL).[1494] This is complemented by the new licence conditions that were issued in 2014 to address the unique features of shale gas development.[1495] Once granted, holders of the PEDL have to apply for the granting of a planning permission to the local Minerals Planning Authority (MPA) in England and Wales, the Local Planning Authority (LPA) in Scotland or Department of

[1491] John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 286, *Energy & Law* 18 (Intersentia Ltd, Cambridge: United Kingdom). [1492] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 311, *Journal of World Energy Law and Business* 11; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 285, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom). Petroleum Act 1998, s 3(1); Hydrocarbons Licensing Directive Regulations 1995, s 3(1).

[1492] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 311, *Journal of World Energy Law and Business* 11; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 285, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom). Petroleum Act 1998, s 3(1); Hydrocarbons Licensing Directive Regulations 1995, s 3(1).

[1493] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 311, *Journal of World Energy Law and Business* 11.

[1494] Morgan J 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 152 (Edward Elgar Publishing Limited, UK).

[1495] Michael Burns, Charlie Reid & Justyna Bremen 'UK Shale Gas – A Policy Tug War' (2016) at 249, *Journal of Energy & Nat Resources Law* 34(2); Petroleum Licensing (Exploration and Production) (Landward Areas) Regulations 2014.

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Environment (DOE) Planning in Northern Ireland for consent to drill a well or conduct hydraulic fracturing operations.[1496]

Petroleum right holders also have to negotiate access with landowners, and obtain permission from the Coal Authority if the well is expected to intercept coal seams.[1497] Operators are also required to consult the environmental regulators: the Environmental Agency (EA) in England, Natural Resources Wales (NRW) in Wales, the Scottish Environmental Protection Agency (SEPA) in Scotland or the Northern Ireland Environmental Agency (NIEA) in Northern Ireland, who are also the statutory consultees to the relevant planning authorities (MPA/LPA/DOE) in the UK.[1498]

6.5.1 Setting Thresholds

As alluded to above, additional permits that sets thresholds, on waste; radioactive substances; the use of water; and chemicals must be obtained before hydraulic fracturing can take place in the UK.[1499] More specifically, shale gas operators must obtain a mining waste permit; a water withdrawal licence; a groundwater activity permit; a radioactive substances activity permit; and an assessment and approval of chemicals to be used for hydraulic fracturing.[1500] Furthermore, drilling permits related to the assessment of seismic hazards, monitoring of seismic activities during drilling,

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[1496] Ibid, at 158.

[1497] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 301, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

[1498] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 295, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

[1499] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 296, *Energy & Law 18* (Intersentia Ltd, Cambridge: United Kingdom).

[1500] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1.

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and mitigation plans for possible earthquakes that may be caused by hydraulic fracturing must be obtained.[1501] There is also a requirement to install a real-time trigger to cut off injection into the well, if there is a significant risk of an earthquake.[1502]

6.5.2 Use of Best Available Technologies

In terms of the use of best available technologies, UK oil and gas operators are required to ensure that shale gas wells are designed in a manner that minimizes the risks to health and safety.[1503] Before the design of a shale gas well, operators are required to assess the geological formation and fluids through which wells are to be drilled, and any hazards associated thereto.[1504] These assessments are required to be taken into account in the design and construction of wells.[1505] The Operators are furthermore required to ensure that these assessments are periodically reviewed, and if any change is observed, modifications be made to the design and construction of the well.[1506] Furthermore, the Borehole Site Operator has to ensure that suitable well control equipment is used during the drilling, hydraulic fracturing, and flow-back operations.[1507]

From a climate change mitigation perspective, the UK requires that operators put mechanisms in place to minimize emissions.[1508] Operators are required to eliminate any flaring and venting of natural gas, and adopt best practices from the design stage of shale gas development.[1509] They are encouraged to use green completions or reduced emissions completions, where natural gas is separated from the fracturing fluid during flow-back, and sold, while the remaining flow-back fluid is recycled and re-used.[1510] The guidelines recognize that this may not always be practical during the

[1501] Ibid.
[1502] Ibid.
[1503] Offshore Installations and Wells (Design and Construction Etc) Regulations 1996, Regulation 14.
[1504] Ibid.
[1505] Ibid.
[1506] Ibid.
[1507] Borehole Sites & Operations Regulations 1995, schedule 2 (7) s 7.2
[1508] The United Kingdom Onshore Operators' Group 'Guidelines for UK Well Operations on Onshore Shale Gas Wells' (2016) at 29.
[1509] Ibid.
[1510] Ibid.

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exploration and appraisal phases, therefore there is some tolerance for flaring, while venting should be avoided as much as possible even during these phases.[1511]

6.5.3 Environmental Impact Assessment

As stated above, once an applicant has been issued with a license for petroleum exploration and production in the UK, the licensee has to apply for the granting of a planning permission for consent to drill a well or conduct hydraulic fracking operations.[1512] The application for planning permission may need to be supported by an environmental impact assessment (EIA) following the EIA regulations of the relevant devolved country concerned.[1513] A mandatory EIA is required only if the Minerals Planning Authority believes that the planned operations are likely to have significant negative impact on the environment.[1514]

The Oil and Gas Authority in the UK therefore will only give consent to the drilling of shell gas wells when the minerals planning authorities have granted permission to drill, and the relevant planning conditions have been satisfied, and all the necessary permits from the relevant environmental agencies are in place.[1515] Consent to hydraulically fracture shale gas wells will also only be given after the relevant health and safety authorities have been notified and are satisfied with the well designs, following examination focussed on safety related to hydraulic fracturing by an independent well design expert.[1516] The health and safety authorities then have to monitor progress on the drilling of the well and subsequent hydraulic fracturing operations.[1517] Authorisation for hydraulic fracturing is therefore only given if the relevant agency is confident that

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[1511] Ibid.

[1512] Morgan J 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 152, Edward Elgar Publishing Limited, UK.

[1513] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 292, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

[1514] Ibid.

[1515] Michael Burns, Charlie Reid & Justyna Bremen 'UK Shale Gas – A Policy Tug War' (2016) at 249, *Journal of Energy & Nat Resources Law* 34(2).

[1516] Ibid, at 250.

[1517] Ibid.

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there will be no adverse impact to the environment.[1518] Should an operator wish to start production from a shale gas development site, they will be required to go through the same permitting process as described above.[1519]

6.6 The Application of the Preventive Principle in Canada

As mentioned in section 2.3 of this chapter, the Canadian Environmental Protection Act (CEPA) is the primary instrument for the protection of the environment in Canada.[1520] The primary purpose of the CEPA is to contribute to sustainable development through pollution prevention.[1521] Its focus is to prevent pollution from occurring, rather than the traditional approach of managing pollution after it has occurred.[1522] The CEPA requires the elimination of the release of toxic substances that take a long time to break down, collect in living organisms, and end up in the food chain.[1523] All levels of government in Canada (federal, provincial, and territorial) have authority to protect the environment.[1524] The shared nature of environmental jurisdiction makes close cooperation among the different spheres of government and Aboriginal people critical to the protection of the environment in Canada.[1525]

The CEPA is complemented by legislation such as, first, the Fisheries Act, which provides for pollution prevention of waters inhabited by fish.[1526] Secondly, the Canada Water Act, which provides for the management of water resources and the quality thereof.[1527] Thirdly, the Canadian Assessment Act which ensures that the environmental effects of projects are carefully reviewed before they are sanctioned, to avoid significant adverse environmental effects.[1528]

[1518] Ibid.
[1519] Ibid.
[1520] Canadian Environmental Protection Act, 1999; Allan Ingelson 'Shale Gas Law and Regulation in North America' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 328, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).
[1521] Declaration of the Canadian Environmental Protection Act, 1999.
[1522] Ibid.
[1523] Ibid.
[1524] Ibid.
[1525] Ibid.
[1526] Fisheries Act,1985.
[1527] Canada Water Act,1985.
[1528] Canadian Environmental Assessment Act, 2012.

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The CEPA furthermore embeds other key environmental legal principles, such as, the precautionary principle and the polluter pays principle and embody them in the administrative duties of Government.[1529] In essence, the Canadian government's measures to protect the environment and health assume a precautionary approach, as they do not put emphasis on scientific evidence to prove a causal link between pollution and effects.[1530] Furthermore, polluters are compelled to take responsibility and bear the cost commensurate with the pollution they cause.[1531] The precautionary principle and polluter pays principle are dealt with in more detail in chapter seven and eight of this thesis.

6.6.1 Setting Thresholds

The CEPA provides for the creation of science-based national environmental standards, essentially sets the thresholds for environmental protection.[1532] It encourages the use of processes, practices, materials, products, substance or energy that avoid or minimize the creation of pollutants and waste, and reduce the overall risk to the environment or human health.[1533] It provides for mechanisms to assess risks to the environment and human health.[1534] It imposes timeframes for managing toxic substances, and provides tools to manage such substances and wastes.[1535] It also ensures that the most harmful substances are phased out or are not released into the environment in any measurable quantity.[1536] Regulations under the CEPA also regulate the chemicals used in hydraulic fracturing and oilfield and provides for substantial fines and other penalties for violations.[1537]

6.6.2 Use of Best Available Technologies

The CEPA requires that science and traditional aboriginal knowledge (where available) play a central role in decision making, and that socio-economic and technical

[1529] Declaration of the Canadian Environmental Protection Act, 1999.
[1530] Ibid.
[1531] Ibid.
[1532] Ibid.
[1533] Ibid.
[1534] Ibid.
[1535] Ibid.
[1536] Ibid.
[1537] Ibid. [1538] Ibid.

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considerations form part of risk management processes.[1538] Scientific Research and Development are used to evaluate the impact of substances on the environment and human health, and to determine the extent of exposure to contaminants.[1539] This is used to guide the development of preventive and control measures, by identifying pollution prevention and technology solutions.[1540] Scientific research is also used to provide specialized sampling and analytical techniques used in compliance monitoring and enforcement.[1541]

6.6.3 Environmental Impact Assessments

Environmental impact assessments in Canada are governed by the Impact Assessment Act.[1542] The Impact Assessment Act seeks to foster sustainability,[1543] and to protect the environment, health, social and economic conditions, from adverse effects caused by a designated project.[1544] The Act is premised on the recognition that impact assessments provide an effective means of integrating scientific data, and indigenous knowledge, into decision-making processes related to designated projects.[1545] It entrenches public participation in the impact assessment process, including the planning phase.[1546] It provides for information to be made accessible to the public to enable meaningful public participation in the impact assessment process.[1547]

Furthermore, the Act seeks to ensure that an impact assessment takes into account alternative means of carrying out designated planned activities, including the use of best available technologies.[1548] Designated activities are activities or projects that may cause adverse effects to the environment, adverse incidental effects, or that may cause public concern.[1549] Such projects must be subjected to screening by the Impact

[1538] Ibid.
[1539] Ibid.
[1540] Ibid.
[1541] Ibid.
[1542] Impact Assessment Act, 2019.
[1543] S 6(1)(a) of the Impact Assessment Act, 2019.
[1544] S 6(1)(a) of the Impact Assessment Act, 2019.
[1545] S 6(1)(b) of the Impact Assessment Act, 2019.
[1546] S 6(1)(h) of the Impact Assessment Act, 2019.
[1547] S 6(1)(j).
[1548] S 6(1)(k) of the Impact Assessment Act, 2019.
[1549] S 9(1); s11(a.2) of the Impact Assessment Act, 2019.

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Assessment Agency of Canada, to determine whether they could potentially harm the environment.[1550] The Impact Assessment Agency is obliged to ensure that the public is provided an opportunity to participate meaningfully, in a manner that is appropriate to the Agency's preparations for a possible impact assessment of a designated project.[1551] This includes inviting the public to provide comments within a specified period already in the screening phase.[1552]

Following the consultation of the relevant stakeholders, including the public, the Agency is required to provide the proponents of designated projects with a summary of relevant issues to the project, including those raised by the public or any jurisdiction or Indigenous group.[1553] Project proponents are then required to provide the Agency with a notice detailing how they intend to address the issues raised, together with a detailed description of the project which includes all the prescribed information.[1554] On receipt of the notice, and if satisfied with the responses provided, and detailed project description, the Agency must take a decision on whether the designated project needs to undergo an impact assessment.[1555] If the Agency is satisfied that the proposed project will not cause adverse environmental effects within federal jurisdiction,[1556] or to the rights of the Indigenous peoples of Canada,[1557] the Agency may decide that the project does not need an impact assessment.[1558]

If the Agency decide that a proposed project does require an impact assessment, the Agency must within 180 days of taking the decision notify the project proponent of the commencement of the impact assessment.[1559] The notice must set out the information or studies required from the proponent and which the Agency considers necessary for the conduct of the impact assessment.[1560] This should include any documents that are prescribed by the relevant regulations,[1561] and plans for cooperation with other

[1550] S 11 of the Impact Assessment Act, 2019.
[1551] S 11 of the Impact Assessment Act, 2019.
[1552] S 11 of the Impact Assessment Act, 2019.
[1553] S 14(1) of the Impact Assessment Act, 2019.
[1554] S 15(1) of the Impact Assessment Act, 2019.
[1555] S 16(1) of the Impact Assessment Act, 2019.
[1556] S 16(2)(b) of the Impact Assessment Act, 2019.
[1557] S 16(2)(c) of the Impact Assessment Act, 2019.
[1558] S 16 of the Impact Assessment Act, 2019.
[1559] S 18(1)(a). of the Impact Assessment Act, 2019.
[1560] S 18(1)(a). of the Impact Assessment Act, 2019.
[1561] S 18(1)(b) of the Impact Assessment Act, 2019.

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jurisdictions, for engagement and partnership with the Indigenous peoples of Canada, for public participation and for issuance of permits.[1562]

Irrespective of whether an impact assessment needs to be carried out or not, designated project proponents are prohibited from carrying out any act that could cause a change to fish or their habitat,[1563] aquatic species,[1564] migratory birds,[1565] or any other component that is set out in Schedule 3.[1566] Project proponents are not allowed to carry out acts that would negatively impact the physical and cultural heritage of the indigenous peoples of Canada,[1567] and the current use of lands and resources for traditional purposes.[1568] They are not permitted to conduct any act that would negatively impact structures or sites of historical, archaeological, paleontological or architectural significance.[1569] Furthermore, project components are not to carry out acts that may cause a negative change in the health, social or economic conditions of the Indigenous peoples of Canada.[1570]

6.7 Conclusions

All three comparative jurisdictions provide for the sustainable development of petroleum resources that integrate social, environmental and economic factors.[1571] They require that the social, environmental and economic impacts of petroleum operations be considered, assessed and evaluated with appropriate decisions taken. South Africa's environmental law seeks to ensure that environmental degradation is avoided, and where it cannot be entirely avoided, be minimized and remedied.[1572]

[1562] S 18(1)(b) of the Impact Assessment Act, 2019.
[1563] S 7(1)(a)(i) of the Impact Assessment Act, 2019.
[1564] S 7(1)(a)(ii) of the Impact Assessment Act, 2019.
[1565] S 7(1)(a)(iii) of the Impact Assessment Act, 2019.
[1566] S 7(1)(a)(iv) of the Impact Assessment Act, 2019.
[1567] S 7(1)(c)(i) of the Impact Assessment Act, 2019.
[1568] S 7(1)(c)(ii) of the Impact Assessment Act, 2019.
[1569] S 7(1)(c)(iii) of the Impact Assessment Act, 2019.
[1570] S 7(1)(d) of the Impact Assessment Act, 2019.
[1571] National Environmental Management Act, No. 107, 1998; Environmental Protection Act, 1999; Environmental Permitting (England and Wales) Regulations, 2010; Environmental Permitting (England and Wales) (Amendment) Regulations, 2013.
[1572] S 2 (4)(a)(ii) of the NEMA.

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The UK on the other hand, employs a risk-based approach to environmental regulation, which requires that the risks of an environmental incident related to oil and gas operations are reduced as low as practically possible.[1573] Canada's focus is to avoid pollution from occurring,[1574] and all levels of government in Canada have authority to protect the environment.[1575] The shared nature of environmental jurisdiction makes close cooperation among the different spheres of government and Aboriginal people critical to the protection of the environment in Canada.[1576]

Unlike in the UK and Canada, the inclusion of environmental rights in the South African Constitution attests to the importance that South Africa places to the protection of the environment.[1577] To further give effect to environmental protection, prevention should play a central role to South Africa's quest to exploit shale gas. The petroleum regulatory framework should compel companies that are planning to exploit shale gas to ensure that they put preventative measures in place for the exploration and production of shale gas. The conditions could include the consideration of alternatives, rather the use of freshwater as the main hydraulic fracturing fluid.

[1573] Department of Energy and Climate Change (2015) Onshore oil and gas exploration in the UK: regulation and best practice, at 7, England.
[1574] Environment Canada and Health Canada, 'A Guide to Understanding the Canadian Environmental Protection Act, 1999' (2004), at 3, Ottawa, Ontario.
[1575] Canadian Environmental Protection Act, 1999, at 1.
[1576] Environment Canada and Health Canada, 'A Guide to Understanding the Canadian Environmental Protection Act, 1999' (2004), at 2, Ottawa, Ontario.
[1577] Loretta Feris 'Constitutional Environmental Rights: An Under-Utilized Resource' (2008) at 49, S*AJHR* 24.

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CHAPTER 7: MITIGATING THE NEGATIVE EFFECTS OF SHALE GAS

7.1 Introduction

As outlined in chapter five, a more effective legal framework for shale gas development in South Africa should be premised on mitigation as one of three pillars, together with prevention and remediation. Central to mitigation is the precautionary principle, which advocates for uncertainty to be factored into environmental decision-making.[1578] Undoubtedly, there is insufficient scientific evidence on the full impact of hydraulic fracturing on the environment.[1579] Equally, South Africa has limited practical knowledge of shale gas exploration and production.[1580] No exploration for shale gas has yet occurred in the country, although drilling by state owned Southern Oil Exploration Corporation (SOEKOR) in the 1960s did coincidentally discover shale gas in the Karoo.[1581] At the time, the discovered gas could not be extracted due to a lack of technology to extract the resource economically.[1582]

More recently, South Africa started paying attention to its potential shale gas resource around 2010 following applications for exploration rights by Bundu Gas and Oil Exploration (Pty) Ltd (Bundu), Falcon Oil and Gas Limited (Falcon) and Shell Exploration Company B.V (Shell).[1583] These applications triggered opposition from environmental interest groups such as the Treasure the Karoo Action Group (TKAG), the Centre for Environmental Rights (CER), and the Sustainable Alternatives to

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[1578] United Nations 'The Rio Declaration on Environment and Development' (1992), Principle 15.

[1579] Maarten J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, *S Afr J Sci* 107(7/8); Academy of Science of South Africa (ASSAf) 'South Africa's Technical Readiness to Support Shale Gas Development' (2016) at 58 (ASSAf, Pretoria).

[1580] Academy of Science of South Africa (ASSAf) 'South Africa's Technical Readiness to Support Shale Gas Development' (2016) at 58 (ASSAf, Pretoria); M Burns, D Atkinson, O Barker, C Davis, E Day, A Dunlop, S Esterhuyse, P Hobbs, I McLachlan, H Neethling, N Rossouw, S Todd, L Snyman-Van der Walt, E Van Huyssteen, S Adams, M de Jager, Z Mowzer and B Scholes 'Scenarios and Activities' (2016) at 1-12 in Robert Scholes, Paul Lochner, Greg Schreiner, Luanita Snyman-Van der Walt & Megan de Jager *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (CSIR, Pretoria).

[1581] Michiel O. de Kock; Nicolas J. Beukes; Elijah O. Adeniyi; Doug Cole; Annette E. Götz; Claire Geel and Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, *South African Journal of Science* 113(9/10).

[1582] Ibid.

[1583] *John Douglas Stern and others vs Minister of Mineral Resources, para 3&4,* 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

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Fracking and Exploration Alliance (SAFE).[1584] These environmental interests groups contend that shale gas development would cause irreparable damage to the Karoo's biodiversity.[1585]

Consistent with the precautionary principle, the Minister of Mineral Resources imposed a moratorium on shale gas exploration and established a Ministerial Task Team in December 2011, to advise government on the potential environmental impact of using hydraulic fracturing to extract shale gas in the Karoo.[1586] The Task Team produced a report recommending that normal exploration for shale gas (excluding hydraulic fracturing) be allowed under the current regulatory framework.[1587] The Task Team also recommended that the current regulatory framework be augmented, and once in place, for hydraulic fracturing operations to be allowed under strict supervision from a Monitoring Committee, which the Task Team also recommended should be constituted by the government.[1588] Cabinet approved these recommendations in September 2012 and constituted the Monitoring Committee.[1589]

In 2014 the Petroleum Agency SA notified Bundu Gas, Falcon Oil and Shell that their applications for exploration rights would be processed, however they should revise their environmental management programmes to exclude hydraulic fracturing, and embark on a further public participation process in terms of section 79(4)(a) of the MPRDA.[1590] Despite this, no exploration right for shale gas has yet been awarded in South Africa,[1591] due to the lack of an appropriate petroleum legal framework to

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[1584] Jeannie van Wyk 'Fracking in the Karoo: Approvals Required?' (2014) at 35, *Stellenbosch Law Review*.
[1585] Ibid.
[1586] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 11 (790/2018) [2019] ZASCA 99 (4 July 2019); Academy of Science of South Africa 'South Africa's Technical Readiness to Support Shale Gas Development' (2016) at 26 (ASSAf, Pretoria).
[1587] Department of Mineral Resources 'Report on Investigation of Hydraulic Fracturing in the Karoo of South Africa' (2012) at 68, *available at http://www.info.gov.za/view/DownloadFileAction?id=174015*, accessed on 5 July 2022.
[1588] Ibid.
[1589] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 14 (790/2018) [2019] ZASCA 99 (4 July 2019).
[1590] Ibid, para 15.
[1591] Ibid, para 16.

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regulate shale gas exploration and production.[1592] This chapter outlines the precautionary principle and reviews its application in South Africa, the UK and Canada to better contextualise a more effective legal framework for shale gas development in South Africa, premised on mitigation as one of three pillars.

7.2 The Precautionary Principle

The precautionary principle dates back to early civilisation and was embedded in the oral tradition of many indigenous peoples.[1593] Central to the early formulations of the principle was the notion that it is better safe than sorry, therefore better to err on the side of caution even where there is no evidence of harm.[1594] In modern day, the precautionary principle can be traced back to the German *Vorsorgeprinzip* (foresight principle).[1595] The *Vorsorgeprinzip* developed in the early 1970s as part of the domestic policy of the then Federal Republic of West Germany.[1596] In 1976, West Germany's environmental policy adopted the *Vorsorgeprinzip*, on the basis that environmental policy it was not enough for environmental policy to manageepotential hazards and elimination of damage after it had occurred.[1597] Rather, precautionary environmental policy requires that natural resources be protected, and their use carefully considered.[1598]

The West German Federal Government elaborated further on the *Vorsorgeprinzip,* as a principle to protect the environment against specific environmental hazards, particularly avoiding or minimizing environmental risks before they materialize.[1599] The

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[1592] *Minister of Mineral Resources v Stern & others* (1369/2017) and *Treasure the Karoo Action Group & another v Department of Mineral Resources and others* para 53(2)(a) (790/2018) [2019] ZASCA 99 (4 July 20219).

[1593] Mark Akunna Eze and Ifeanyi Samson Eze 'An Analysis of the Precautionary Principles and Its Adaptation in International, Regional and National Laws' (2019) at 48, *International Journal of Energy and Environmental Science* 4(3).

[1594] Ibid.

[1595] Liesl Marisa Harewood 'The importance of the precautionary principle in international environmental law' (2005) at 1, *Coventry Law Journal,*10(2); Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 194, *Stellenbosch Law Review 26(1):* Mark Akunna Eze and Ifeanyi Samson Eze 'An Analysis of the Precautionary Principles and Its Adaptation in International, Regional and National Laws' (2019) at 48, *International Journal of Energy and Environmental Science* 4(3).

[1596] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 194, *Stellenbosch Law Review* 26(1).

[1597] Ibid.

[1598] Ibid.

[1599] Ibid.

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Vorsorgeprinzip is thus closely related to the principle of prevention and pursuit of sustainable development.[1600] It evolved into a fundamental principle of German environmental law balanced by principles of economic viability.[1601]

The precautionary principle became entrenched in international environmental law following its adoption at the United Nations Conference on Environment and Development that was held in Rio de Janeiro in 1992.[1602] Principle 15 of the Rio Declaration states that '*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason to postpone cost-effective measures to prevent environmental degradation*.'[1603] The principle advocates for caution to be exercised and measures to be taken to protect the environment from exposure to harm when there is scientific uncertainty about the impact of a particular proposed development or activity.[1604] This implies there does not need to be concrete evidence of harm before measures are taken to protect the environment from the possible harm.[1605]

The Rio Declaration suggests that the precautionary principle becomes relevant when scientific evidence is inadequate, uncertain, or inconclusive, and preliminary scientific evaluations indicate that without adequate safeguards there may be reasonable grounds for concern that environmental harm may occur.[1606] The principle therefore requires that action be taken to protect the environment as long as there is threat of environmental damage, and despite scientific uncertainty with respect to the effect of

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[1600] Ibid.

[1601] Mags D. Adams 'The precautionary principle and the rhetoric behind it' (2002), at 304, *Journal of Risk Research* 5 (4); Joel Tickner, Carolyn Raffensperger and Nancy Myers 'The Precautionary Principle in Action A Handbook' (1999), at 2, *Science and Environmental Health Network.*

[1602] Mags D. Adams 'The precautionary principle and the rhetoric behind it' (2002) at 306, *Journal of Risk Research* 5(4); United Nations 'The Rio Declaration on Environment and Development' (1992) Principle 15.

[1603] Ibid.

[1604] Jan Glazewski 'Conclusion: Looking Forward' in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) at 443 (Juta and Company (Pty) Ltd, Claremont).

[1605] Erica Weir, Richard Schabas, Kumanan Wilson and Chris Mackie 'A Canadian framework for applying the precautionary principle to public health issues' (2010) at 2, *Canadian Journal of Public Health* 101(2).

[1606] Wolfgang Huber 'After Fukushima: The precautionary principle revisited' (2012) at 4, *Verbum et Ecclesia* 33(2).

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the planned activities.[1607] This does not mean science is no longer relevant in the assessment of risk or that action should be taken purely on hypothesis or theoretical assessment of risk.[1608] It is about not using science as an excuse not to act when faced with potential threats to the environment.[1609] It is a realization that no matter the level of sophistication of science and technology, there may not be a clear explanation of certain risks thus necessitating caution.[1610]

On the other hand, precaution is also about delaying the execution of projects whose risks have not been adequately identified.[1611] Precaution serves as an injunction against action when the nature of risks has not been clearly identified, and when such action threatens the environment.[1612] The precautionary principle is thus about balancing uncertainty with the irreversibility of the possible environmental effects, the potential benefits of a proposed activity, and technological advancement and scientific progress.[1613] As such, decisions cannot be taken solely on the basis of the precautionary principle, rather the principle can be used as a criterion to evaluate proposed activities and consider alternatives.[1614] The principle takes prospective responsibility seriously as a means to achieve sustainable development.[1615]

During the same year of the Rio Declaration, the United Nations Framework Convention on Climate Change obliged Parties to '*take precautionary measures to anticipate, prevent or minimize causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-*

[1607] Mark Akunna Eze and Ifeanyi Samson Eze 'An Analysis of the Precautionary Principles and Its Adaptation in International, Regional and National Laws' (2019) at 48, *International Journal of Energy and Environmental Science* 4(3).
[1608] Ibid.
[1609] Ibid.
[1610] Ibid.
[1611] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 18 (Oxford University Press, New York).
[1612] Ibid, at 19.
[1613] Wolfgang Huber 'After Fukushima: The precautionary principle revisited' (2012) at 6, *Verbum et Ecclesia* 33(2).
[1614] Ibid.
[1615] Ibid.

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effective to ensure global benefits at the lowest possible cost.'[1616] Below are other international conventions and treaties where the precautionary principle find expression.

7.3 The Precautionary Principle in International Environmental Law

The use of the precautionary principle has grown gradually in international environmental law.[1617] Marking its first clear expression in international law are the decisions that were adopted by States within the North Sea Ministerial Conferences.[1618] There is reference to the principle in the Bremen Ministerial Declaration of the First International Conference on the Protection of the North Sea of 1984,[1619] and the London Ministerial Declaration of the Second International Conference on the Protection of the North Sea of 1987.[1620] The Hague Declaration of the Third Conference on the Protection of the North Sea of 1990,[1621] and the Esbjerg Declaration of the Fourth Conference on the Protection of the North Sea of 1995,[1622] also include the principle.

The First North Sea Declaration states that '*Conscious that damage to the marine environment can be irreversible or remediable only at considerable expense and over long periods, coastal states and the CEE[1623] must not wait for proof of harmful effects before taking action*.'[1624] The Second North Sea Declaration is more explicit and states that '*in order to protect the North Sea from possible damaging effects of the most dangerous substances, a precautionary approach is necessary, which may require*

[1616] United Nations 'United Nations Framework Convention on Climate Change' (1992) Article 3(3).
[1617] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 196, *Stellenbosch Law Review 26(1).*
[1618] Bremen Declaration of the International Conference on the Protection of the North Sea (1984); London Ministerial Declaration of the Second International Conference on the Protection of the North Sea (1987); Hague Declaration of the Third Conference on the Protection of the North Sea (1990); Esbjerg Declaration of the Fourth Conference on the Protection of the North Sea (1995).
[1619] Bremen Declaration of the International Conference on the Protection of the North Sea (1984).
[1620] London Ministerial Declaration of the Second International Conference on the Protection of the North Sea (1987).
[1621] Hague Declaration of the Third Conference on the Protection of the North Sea (1990).
[1622] Esbjerg Declaration of the Fourth Conference on the Protection of the North Sea (1995).
[1623] Commission of the European Communities responsible for environmental protection.
[1624] Article 7 of the Bremen Declaration of the International Conference on the Protection of the North Sea (1984).

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action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence.'[1625]

In terms of the Third Conference on the Protection of the North Sea '*the participants will continue to apply the precautionary principle, that is, to take action to avoid potentially damaging impacts of substances that are persistent, toxic, and liable to bio-accumulate, even where there is no scientific evidence to prove a causal link between emissions and effects.*'[1626] Recognizing that there is a connection between fisheries and the marine ecosystem, and that there are gaps in the scientific knowledge of the impact of fisheries upon the ecosystem, and of the impacts of environmental changes and pollution on fisheries,[1627] the Third Conference recommended that '*the precautionary principle be applied in fisheries management policies in accordance with the existing commitments of EU Member States*.'[1628]

Furthermore, on the prevention of pollution by hazardous substances, the Ministers agreed on the objective to ensure a sustainable, sound and healthy North Sea ecosystem, and that the precautionary principle would be the guiding principle to achieve that objective.[1629] While on the prevention of pollution from ships, the Ministers affirmed that the precautionary principle also applied to shipping activities, and welcomed and supported the work by the International Maritime Organization (IMO) to develop guidelines on the implementation of the precautionary principle in all relevant IMO activities.[1630] These Ministerial Declarations on the Protection of the North Sea were spurred by the fact that the availability of a significant amount of data on the pollution of the marine environment did not lead to a better understanding of the associated risks but more concern.[1631]

[1625] London Ministerial Declaration of the Second International Conference on the Protection of the North Sea (1987).
[1626] Hague Declaration of the Third Conference on the Protection of the North Sea (1990).
[1627] Esbjerg Declaration, s 16.
[1628] Esbjerg Declaration, s 16(i).
[1629] Esbjerg Declaration, s 17.
[1630] Esbjerg Declaration, s 42(iii).
[1631] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 94 (Oxford University Press, New York).

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Complementing the declarations on the protection of the North Sea, the United Nations Environmental Programme recommended that all Governments adopt 'the principle of precautionary action' as the basis of their policy with regards to the prevention and elimination of marine pollution.[1632] Subsequently, the UN Conference on Environment and Development (UNCED) affirmed the UN recommendation and assert that a precautionary and anticipatory approach should guide efforts to prevent the degradation of the marine environment rather than react after damage has been done.[1633] This requires the adoption of precautionary measures such as environment impact assessments, clean production techniques, recycling, and waste minimization.[1634]

Other international conferences heed the call, such as the Nordic Council's Conference whose outcome states that '*taking into account the need for an effective precautionary approach, with that important principle intended to safeguard the marine ecosystem by, among other things, eliminating and preventing pollution emissions where there is reason to believe that damage or harmful effects are likely to be caused, even where there is inadequate or inconclusive scientific evidence to prove a causal link between emissions and effects*.'[1635]

The application of the precautionary principle to the marine environment outlined above is relevant to exploitation of shale gas in the Karoo. The calls for precautionary and anticipatory approaches to guide efforts to prevent the degradation of the marine environment, rather than react after damage has been done,[1636] and encouraging the adoption of precautionary measures such as environment impact assessments, clean production techniques, recycling, and waste minimization,[1637] bear direct application

[1632] UNEP 'Report of the Governing Council on the Work of its Fifteenth Session' (1989) U.N. Environment Programme, U.N. GAOR, 44th Sess., Supp No 25, 12th mtg at 153, U.N. DOC. A44/25 (1989).
[1633] United Nations 'Conference on Environment and Development' (1992) Article 17.2.1, A/CONF.151//26, Vol.II, 13 August 1992.
[1634] Ibid.
[1635] Nordic Council's International Conference on Pollution of the Seas: Final Document Agreed to, Oct. 18, 1989, in Nordic Action Plan on Pollution of the Seas, 99 apat V (1990).
[1636] United Nations 'Conference on Environment and Development' (1992) Article 17.2.1, A/CONF.151//26, Vol.II, 13 August 1992.
[1637] Ibid.

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to the use of hydraulic fracturing in shale gas development. The receival of the precautionary principle within the African context as outlined below is also instructive.

In fact, a landmark agreement for the African continent in respect of the precautionary principle is the Bamako Convention on Transboundary Hazardous Waste into Africa, which compels the Parties to adopt and implement the preventive precautionary approach to pollution problems.[1638] This entails preventing the release of substances that could cause harm to the environment and human health without waiting for scientific proof regarding such harm.[1639] The Convention further obliges the Parties to cooperate in taking appropriate measures to implement the precautionary principle to pollution prevention, through the application of clean production methods, rather than the pursuit of a permissible emissions approach based on assimilative capacity assumptions.[1640]

While the declarations and protocols outlined above focussed on the protection of the marine environment, the Montreal Protocol ushered in a new era in the climate change debate.[1641] The Montreal Protocol embeds the precautionary principle in its preamble,[1642] it states that '*Parties to the protocol are determined to protect the ozone layer by taking precautionary measures to control total global emissions of substances that deplete it equitably, with the ultimate objective of their elimination'*.[1643] This is to be achieved through development in scientific knowledge, taking into account technical and economic considerations and developmental needs of developing countries.[1644]

The Second World Climate Conference subsequently recommended that to achieve sustainable development and to meet the needs of present and future generations, precautionary measures to address the climate challenge must anticipate, prevent, attack, minimize or mitigate the adverse consequences of environmental degradation

[1638] Bamako Convention on Hazardous Wastes within Africa art. 4(3)(f), 30 ILM 773, Jan. 30, 1991.
[1639] Ibid.
[1640] Ibid.
[1641] United Nations 'Montreal Protocol on Substances that Deplete the Ozone Layer' 16 Sept 1987, Treaty Series, 1989, Vol. 1522, 1-26369.
[1642] Ibid.
[1643] Ibid.
[1644] Ibid.

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that might result from climate change.[1645] As such, where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent such environmental degradation, taking into account different socio-economic contexts.[1646] Despite its wide acclaim, the precautionary principle has its controversies. Some countries have adopted it as an accepted legal principle, while others view it as merely an approach to be taken subject to national discretion.[1647]

The fact that a number of international treaties refer to it as the precautionary *principle*, while others as the precautionary *approach* does not help in clarifying the matter.[1648] The United States in particular is opposed to recognizing it as a legal principle because it lacks specific parameters for application and the necessary rigor required of legal rules.[1649] As a result it cannot be a legal principle since it cannot operate as a source of law, rather is an approach to be taken than a principle to be applied.[1650] In terms of the inherent conflict between trade and environment protection, the United States also rejects it as a principle to be applied and calls for trade measures to be based on sound science.[1651] Other jurisdictions such as the European Union, regard the precautionary principle as a legal principle and have established minimum requirements for its application.[1652] In the context of trade, the European Commission advocates for its inclusion among the governing principles.[1653] This is a progressive and flexible approach that recognizes that uncertainty requires that each case be evaluated on its own merits and decisions be made accordingly.[1654]

[1645] Ibid.
[1646] Ibid.
[1647] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 195, *Stellenbosch Law Review* 26(1).
[1648] Ibid, at 196.
[1649] Ibid.
[1650] Ibid.
[1651] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 98 (Oxford University Press, New York).
[1652] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 196, *Stellenbosch Law Review* 26(1).
[1653] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 98 (Oxford University Press, New York).
[1654] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 196, *Stellenbosch Law Review* 26(1).

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Broadly, criticism of the precautionary principle include that its interpretation could stifle technological progress, and reduce the role of science in policy-making.[1655] Furthermore the principle is criticized for not providing guidance on the level of evidence or indication of a threat that is required for precaution to become relevant.[1656] It is limited to serious or irreversible damage, implying that threats of minor damage are not of concern.[1657] It does not make it mandatory for protective measures to be taken, but merely indicates that lack of scientific certainty cannot be used as a reason to delay precautionary measures.[1658] Protective measures could be postponed for other reasons such as economic development or poverty reduction imperatives.[1659] Furthermore, the consideration of the capabilities of states, which includes economic, governance, and technical capabilities moderates the requirement to apply the precautionary principle.[1660]

A stronger formulation of the precautionary principle emerged from the Wingspread Conference that was attended by scholars, activists, and environmentalists.[1661] The Wingspread Consensus Statement states that '*when an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically*'.[1662] In terms of the Wingspread Consensus, a criterion to evaluate the applicability of the precautionary principle is the possibility of a threat of harm of an activity in the absence of scientific certainty.[1663] The threat of harm does not have to be serious or irreversible, just the threat of harm is sufficient ground to apply precaution.[1664] Consequently, society trying to protect the environment and human health against potentially harmful activities needing to prove such harm faced with scientific uncertainty about cause and

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[1655] Erica Weir, Richard Schabas, Kumanan Wilson and Chris Mackie 'A Canadian framework for applying the precautionary principle to public health issues' (2010) at 2, *Canadian Journal of Public Health* 101(5).

[1656] Rosy Cooney 'The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An issues paper for policy-makers, researchers and practitioners' (2004) at 7, *IUCN Policy and Global Change*.

[1657] Ibid.

[1658] Ibid.

[1659] Ibid.

[1660] Ibid.

[1661] The Science and Environmental Health Network Conference 'Wingspread Statement on the Precautionary Principle (1998), Racine, Wisconsin, 23 – 25 January 1998.

[1662] Ibid.

[1663] Joel Tickner, Carolyn Raffensperger and Nancy Myers 'The Precautionary Principle in Action A Handbook' (1999), at 3, *Science and Environmental Health Network*.

[1664] Ibid.

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effect is waning.[1665] Therefore, if cause and effect can be satisfactorily determined then prevention supersedes precaution.[1666]

The Wingspread Consensus Statement affirms the precautionary principle as providing a rationale for action to be taken against activities that are potentially harmful, when there is inadequate scientific evidence as to the harmful effect of the activity.[1667] It recognizes that the burden-of-scientific-proof approach has led to risk mitigation associated with potentially harmful activities being taken only after such risks have materialized.[1668] Accordingly, the precautionary principle shifts this burden of requiring proof of negative consequences in opposing an action, to requiring proof of the absence of harm for the activity to be allowed.[1669] The Wingspread Consensus emphasizes the need for those intending to conduct potentially harmful activities to prove that such activities will not cause harm to the environment or human health.[1670]

Accordingly, those who have the power, control and resources to act and prevent harm should bear that responsibility.[1671] As such, regulations alone might not ensure precautionary behaviour, therefore market incentives such as requiring financial provisions for potential harm to the environment or human health to be made upfront, or liability for damages could further compel industry to seek ways to prevent such negative impacts.[1672] Moreover, those undertaking potentially harmful activities have the duty to monitor, investigate, inform and act on potential harm to the environment and human health.[1673] They should routinely monitor their activities, with third-party

[1665] Liesl Marisa Harewood 'The importance of the precautionary principle in international environmental law' (2005) at 2, *Coventry Law Journal* 10(2).
[1666] Joel Tickner, Carolyn Raffensperger and Nancy Myers 'The Precautionary Principle in Action A Handbook' (1999), at 3, *Science and Environmental Health Network*.
[1667] Ibid.
[1668] Ibid, at 1.
[1669] Liesl Marisa Harewood 'The importance of the precautionary principle in international environmental law' (2005) at 2, *Coventry Law Journal* 10(2).
[1670] Ibid, at 4.
[1671] Ibid.
[1672] Ibid.
[1673] Ibid.

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verification.[1674] They should have the responsibility to inform authorities and the public when a potential impact is found and act upon that knowledge.[1675]

As mentioned in the introduction, this chapter conducts a comparative assessment of the South African petroleum and environmental legal frameworks with those of the UK and Canada, using *mitigation* as the comparative theme. How these three jurisdictions provide for Mitigation of environmental harm is outlined in the following sections.

7.4 The Application of the Precautionary Principle in South Africa

South Africa has a risk-averse and cautious approach to environmental protection that takes into account the limits of current knowledge of activities that might have a detrimental impact on the environment.[1676] The NEMA advocates for the anticipation and prevention of negative impacts on the environment and people's environmental rights, and where they cannot be prevented such impacts must be minimized and remedied.[1677]

In *Fuel Retailers Association of Southern Africa v Director-General Environmental Management, Mpumalanga, and others*,[1678] the Constitutional Court affirmed the NEMA requirement of a 'risk-averse and cautious approach' to environmental protection, which takes into account the limits of current knowledge about consequences of decisions and actions.[1679] The Court determined that the precautionary principle required the authorities responsible for the protection of the environment and water resources to insist on adequate precautionary measures to safeguard against the contamination of underground water.[1680]

[1674] Ibid.
[1675] Ibid.
[1676] S 2(4)(a)(vii) of the NEMA.
[1677] S 2(4)(a)(viii) of the NEMA.
[1678] *Fuel Retailers Association of Southern Africa vs Director-General Environmental Management, Mpumalanga, and others* 2007, ZACC 67/06 [2007] ZACC13.
[1679] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 216, *Stellenbosch Law Review 26(1)*; s 2(4)(a)(vii) of the NEMA.
[1680] *Fuel Retailers Association of Southern Africa and others vs Director-General Environmental Management, Mpumalanga* 2007, para 98, ZACC 67/06 [2007] ZACC13.

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In terms of the judgment, the precautionary principle is applicable where, due to insufficient scientific knowledge there is uncertainty on the future impact of a proposed development.[1681] Accordingly, water is a precious commodity, a natural resource that needs to be protected for the benefit of present and future generations.[1682] The judgment essentially clarified the position of the South African courts on the precautionary principle, viewing it as giving effect to sustainable development which is a constitutional imperative.[1683] The application of the precautionary principle will be crucial for shale gas development in South Africa. The effects of hydraulic fracturing in the Karoo are not yet known,[1684] particularly since no exploration for shale gas has yet occurred in the country.[1685] The risks related to the use of the technology have been highlighted,[1686] such as its potential impact on water resources,[1687] and climate change,[1688] associated with uncontrolled emissions of methane gas.[1689] Moreover, shale gas development could induce seismic events.[1690] The likelihood and extent of these risks are uncertain.[1691] This attests to the need for South Africa to tread cautiously in its quest to exploit the shale gas resource.

[1681] Ibid.

[1682] Ibid.

[1683] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 216, *Stellenbosch Law Review 26(1)*.

[1684] Martin J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, *South African Journal of Science* 107(7/8).

[1685] Michiel O. de Kock; Nicolas J. Beukes; Elijah O. Adeniyi; Doug Cole; Annette E. Götz; Claire Geel and Frantz-Gerard Ossa 'Deflating the shale gas potential of South Africa's Main Karoo basin' (2017) at 1, *South African Journal of Science* 113(9/10).

[1686] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 218, *Stellenbosch Law Review 26(1);* Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law 22.*

[1687] Academy of Science of South Africa 'South Africa's Technical Readiness to Support Shale Gas Development' (2016) at 73, (ASSAf, Pretoria); Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) at 37, *Science of the Total Environment;* Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24.

[1688] Robert W. Howarth 'A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas' (2014) at 1, *Energy Science and Engineering*.

[1689] Laurence Stamford & Adisa Azapagic *A Fractured truth* (2014), at 27, *The Chemical Engineer*.

[1690] Matthew Cotton 'Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning' (2017) at 186, *Local Environment 22(2).*

[1691] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 218*, Stellenbosch Law Review 26(1)*; Martin J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, *South African Journal of Science* 107(7/8).

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7.5 The Application of the Precautionary Principle in the United Kingdom

Unlike in South Africa, the precautionary *principle* is not embedded in the UK environmental law,[1692] nor its petroleum law.[1693] A precautionary *approach* was, however, introduced in Britain's policy through the 1990 White Paper on the Environment titled 'This Common Inheritance'.[1694] In terms of the White Paper, '*where there are significant risks of damage to the environment, the government will be prepared to take precautionary action to limit the use of potentially dangerous materials or the spread of potentially dangerous pollutants, even where scientific knowledge is not conclusive, if the balance of likely costs and benefits justifies it. The precautionary principle applies particularly where there are good grounds for judging either that action taken promptly at comparatively low cost may avoid more costly damage later, or that irreversible effects may follow if action is delayed*.'[1695] This is a convenient version of the precautionary principle, emphasising a cost benefit analysis before taking action.[1696]

The 1999 strategy on sustainable development, which states that '*precautionary action requires an assessment of the costs and benefits of action, and transparency in decision-making*', demonstrated that Britain still had no intent to adopt the precautionary principle fully.[1697] The UK's posture on the precautionary principle was laid bare in *R v. Secretary of State for Trade and Industry ex parte Duddridge*.[1698] The case was a judicial review of the decision of the Secretary of State of Trade and Industry not to issue regulations to the National Grid Company plc or other licence holders, under the Electricity Act 1989, so as to restrict the risk associated with the

[1692] Environmental Protection Act, 1990; Environmental Act, 1995.
[1693] Petroleum Act, 1998.
[1694] Mags D. Adams 'The precautionary principle and the rhetoric behind it' (2002), at 305, *Journal of Risk Research* 5 (4).
[1695] Department of the Environment 'This Common Inheritance: Britain's Environmental Strategy: UK White Paper on Environmental Policy' (1990) (HMSO, London).
[1696] Mags D. Adams 'The precautionary principle and the rhetoric behind it' (2002), at 306, *Journal of Risk Research* 5(4).
[1697] Department of the Environment, Transport and the Regions 'A better quality of life: A Strategy for Sustainable Development for the United Kingdom Great Britain' (1999) (Stationery Office, London); Mags D. Adams 'The precautionary principle and the rhetoric behind it' (2002), at 306, *Journal of Risk Research* 5 (4).
[1698] The Status of the 'Precautionary Principle' in Law: *R v Secretary of State for Trade and Industry ex parte Duddridge* (1995) 7(2) *J.Envtl.L*.224. (United Kingdom Queen's Bench Division, Farquharson LJ and Smit J, 4 October 1994).

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electromagnetic fields from electric cables being laid as part of a national grid.[1699] In essence, the laying of a possible high-tension electric cable in front of a school was challenged as posing a possible risk of leukaemia to students.[1700]

The applicants argued that the Secretary of State for Trade and Industry had a legal obligation in terms of Article 130r of the European Commission Treaty (EC Treaty) as amended by the Treaty of the European Union, the Maastrict Treaty which came into effect in November 1993 to consider the project taking the precautionary principle into account.[1701] The Court considered Article 130r,[1702] however rejected the argument on the basis that it does not impose an obligation on national governments.[1703] This was a narrow approach by the UK Court, dismissing the matter on administrative grounds rather than fully applying itself on the substantive content of the precautionary principle and its applicability.

The implication of relying on procedural technicalities to avoid the precautionary approach in the UK could spill over to activities such as shale gas development, where the precautionary approach certainly needs to be a consideration given that the risks associated with hydraulic fracturing to the environment are not yet fully understood. This was taken care of in *Friends of the Earth's Application for Judicial Review*, where the Northern Ireland court recognized the need to apply the precautionary principle.[1704]

The case was an appeal against the decision of Maguire J dismissing an application for Judicial Review by Friends of the Earth Limited.[1705] The case relates to the Department of Environment refusing to issue a Stop Notice to the Shaftesbury Estate of Lough Neagh Limited, the owners of the bed of Lough Neagh (the Shaftesbury Estate) and a number of businesses involved in sand extraction from Lough Neagh (the sand traders) in 2015.[1706] Lough Neagh is a freshwater lough, where up to 1.5

[1699] Ibid, at 224.
[1700] Ibid.
[1701] Ibid, 231.
[1702] Ibid, at 231-237.
[1703] Ibid, at 238.
[1704] Friends of the Earth Ltd's Application for Judicial Review, Re, 2007 WL 03634956 (2017) *West Law* 2021, Thomson Ruiters.
[1705] Ibid, at 1.
[1706] Ibid.

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million tons of sand was extracted per year over eighty years without planning permission.[1707] Because the lough is a protected site, and an area of special scientific interest, any application for planning permission would require an environmental impact assessment and a habitat's assessment.[1708]

Upon an enquiry by the Ulster Angling Association on the status of the sand extraction in 2012, and after consultation with the relevant agencies and sand traders, in 2014, the Department of Environment informed the Shaftesbury Estate and the sand traders that the dredging of the sand was unauthorised therefore should cease.[1709] This decision was based on a report by the Department of Environment's Enforcement Group that indicated that the sand dredging had the potential to cause significant environmental impacts, therefore a precautionary approach had to be adopted in the absence of evidence proving otherwise.[1710] Operations did not cease, therefore the Department of Environment issued an enforcement notice, an Enforcement Report, and an Environmental Assessment Determination Sheet to the Shaftesbury Estate and the sand traders in 2015.[1711]

The Enforcement Report indicated that the operations were unauthorised, and that with the presence of doubt over the potential impacts of the operations on a European site, and the environment, the operations were not compliant with the EIA Directive and the Habitats Directive.[1712] The operations therefore had to cease until an Environmental Impact Assessment and a Habitats Assessment was done.[1713] The Shaftesbury Estate and sand traders appealed against the Enforcement Notice at the Planning Appeals Commission (PAC) on the grounds that planning permission ought to be granted in respect of the breach of planning control.[1714] The appeal implied that the Enforcement Notice had no effect pending its final determination.[1715] While the Minister considered to issue a Stop Notice compelling cessation of operations, he did

[1707] Ibid.
[1708] Ibid.
[1709] Ibid.
[1710] Ibid.
[1711] Ibid, at 2.
[1712] Ibid.
[1713] Ibid.
[1714] Ibid.
[1715] Ibid.

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not ultimately issue the Stop Notice against advice from Departmental officials.[1716] That advice also recommended that the Department of Environment appoint a scientific body to undertake research on the impact of the sand extraction.[1717]

In November 2015 the Minister made the decision that a Stop Notice should not be issued because it would not be an proportionate response, since there was no evidence that the dredging, which had been ongoing long before the site's designation, is having any impact on the environmental features of the lough.[1718] Accordingly it would not be in the wider public interest to risk the potential economic harm until there was an understanding of the potential environmental impact.[1719] The Minister undertook to review the matter once the relevant information was available.[1720] It is this decision of the Minister that was taken for Judicial Review by Friends of the Earth Limited.[1721] The application for Judicial Review challenged the failure of the Minister to issue a Stop Notice on the grounds that the decision was in breach of the EIA Directive and the Habitats Directive and the implementing Regulations.[1722]

In June 2016 the Department received the report titled 'Implications of Sand Extraction on the Lough Neagh and Lough Beg SPA'.[1723] The report concluded that based on available evidence no significant negative impact of moderate significance or greater had been identified during the assessment.[1724] There was however recognition that further information on these areas was required in respect of impact assessment.[1725] Handing down judgment, the Northern Ireland Court referred to Article 191(2) of the Treaty on the Functioning of the European Union, which sets out the aims and principles, but does not impose any duty.[1726] Article 19(2) states that '*the policy on the environment shall be based on certain principles, namely, the precautionary principle*

[1716] Ibid.
[1717] Ibid.
[1718] Ibid.
[1719] Ibid.
[1720] Ibid.
[1721] Ibid.
[1722] Ibid.
[1723] Ibid, at 3.
[1724] Ibid.
[1725] Ibid.
[1726] Ibid.

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and on the principles that preventative action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.'[1727]

Environmental Impact Assessments arise from Directive 2011/92/EU as implemented by the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015.[1728] The preamble to the Directive states that the policy is based on the precautionary principle, and that the effects on the environment should be taken into account at the earliest possible stage in all the technical planning and decision-making processes.[1729] Article 2 (1) of the Treaty on the Functioning of the European Union requires that Member States adopt necessary measures to ensure that projects that potentially have a significant impact on the environment be subjected to an impact assessment before consent is given.[1730]

Regulation 4(2) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland), provides that planning permission shall not be granted unless the requisite environmental information from the developer has been taken into account, together with any environmental information supplied as part of the consultation process.[1731] An environmental screening process is undertaken to determine whether an environmental impact assessment is required for a particular project.[1732]

The Northern Ireland court found that Maguire J erred in not finding that the failure of the Department to serve a Stop Notice was in breach of the Directives and Regulations.[1733] This was because in so doing the Department failed to give effect to the precautionary principle, the preventive principle, and the obligation under Article 4(3) of the Treaty of the European Union to take any appropriate measures to ensure

[1727] Article 191(2) of Treaty on the Functioning of the European Union.
[1728] Directive 2011/92/EU of the European Parliament and of the Council on the Assessment of the Effects of Certain Public and Private Projects on the Environment (13 December 2011); Regulation 4(2) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015; Friends of the Earth Ltd's Application for Judicial Review, Re, 2007 WL 03634956 (2017) at 3.
[1729] Directive 2011/92/EU of the European Parliament and of the Council on the Assessment of the Effects of Certain Public and Private Projects on the Environment (13 December 2011).
[1730] Article 2 (1) of the Treaty on the Functioning of the European Union.
[1731] Regulation 4(2) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015.
[1732] Regulation 4(2) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015.
[1733] Friends of the Earth Ltd's Application for Judicial Review, Re, 2007 WL 03634956 (2017) at 5.

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fulfilment of obligations.[1734] Nonetheless, while the UK is flipflopping on the use of hydraulic fracturing it has adopted a cautious approach to its use.[1735] As a result shale gas development in the UK has not yet taken place due to a complex regulatory framework, and strong opposition from local communities.[1736]

As stated in section 6.5 of this thesis, once an applicant has been issued with a license for petroleum exploration and production in the UK, the licensee has to apply for the granting of a planning permission for consent to drill a well or conduct hydraulic fracking operations.[1737] The application for planning permission may need to be supported by an environmental impact assessment (EIA) following the EIA regulations of the relevant devolved country concerned.[1738] A mandatory EIA is required only if the Minerals Planning Authority believes that the planned operations are likely to have significant negative impact on the environment.[1739]

Therefore, the Oil and Gas Authority in the UK is obliged to only give consent to the drilling of shale gas wells when the minerals planning authorities have granted permission to drill, and the relevant planning conditions have been satisfied, and all the necessary permits from the relevant environmental agencies are in place.[1740] Consent to hydraulically fracture shale gas wells can also only be given after the relevant health and safety authorities have been notified and are satisfied with the well designs, following examination focussed on safety related to hydraulic fracturing by an independent well design expert.[1741] The health and safety authorities then have to

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[1734] Article 4(3) of the Treaty of the European Union. Friends of the Earth Ltd's Application for Judicial Review, Re, 2007 WL 03634956 (2017) at 5.

[1735] Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) at 23, (Juta and Company (Pty) Ltd, Claremont).

[1736] Ibid.

[1737] Morgan J 'Sustainability and stakeholder participation: shale gas extraction in the United Kingdom' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) at 152, Edward Elgar Publishing Limited, UK.

[1738] Peter Cameron, Juan Felipe Neira Castro, Tomas Lanardonne and Geoffrey Wood 'Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy' (2018) at 312, *Journal of World Energy Law and Business* 1; John Paterson and Tina Hunter 'Shale Gas Law and Regulation in the United Kingdom' in Tina Hunter *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) at 292, Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

[1739] Ibid.

[1740] Michael Burns, Charlie Reid & Justyna Bremen 'UK Shale Gas – A Policy Tug War' (2016) at 249, *Journal of Energy & Nat Resources Law* 34(2).

[1741] Ibid, at 250.

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monitor progress on the drilling of the well and subsequent hydraulic fracturing operations.[1742] Authorisation for hydraulic fracturing is therefore only given if the relevant agency is confident that there will be no adverse impact to the environment.[1743] Should an operator wish to start production from a shale gas development site, they will be required to go through the same permitting process as described above.[1744]

7.6 The Application of the Precautionary Principle in Canada

The precautionary principle is embedded in Canada's legal system gradually embraced into policy,[1745] and legislation.[1746] The adoption of the Harmonisation Accord by the Canadian Council of Ministers of the Environment (excluding Quebec) in 1998 began the process of affirming the precautionary principle in the Canadian legal system.[1747] The objectives of the Accord are to enhance environmental protection, promote sustainable development, and achieve greater effectiveness, efficiency, accountability, predictability and clarity of environmental management in Canada.[1748] Through the Accord, the provinces would work together to develop and implement consistent environmental measures throughout Canada.[1749] Principle 2 of the Accord, captures Canada's then precautionary approach as follows '*where there are threats of serious or irreversible environmental damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'*.[1750]

The sub-agreements that were developed to give effect to the Harmonization Accord somewhat diluted the commitments made in the Accord because the precautionary

[1742] Ibid.
[1743] Ibid.
[1744] Ibid.
[1745] Canadian Ministers of the Environment 'A Canada-Wide Accord on Environmental Harmonization' (1998) available at *https://faolex.fao.org/docs/pdf/can83339.pdf* accessed on 24 October 2022.
[1746] Canadian Environmental Protection Act, 1999; Federal Sustainable Development Act, 2008; Canadian Environmental Assessment Act, 2012.
[1747] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 124, *Ottawa Law Review* 34(1).
[1748] Canadian Ministers of the Environment 'A Canada-Wide Accord on Environmental Harmonization' (1998) available at *https://faolex.fao.org/docs/pdf/can83339.pdf* accessed on 24 October 2022.
[1749] Ibid.
[1750] Ibid, at 2.

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approach is weakly formulated in them.[1751] For example, the Sub-agreement on Canada-Wide Environmental Standards has various qualifications that have a neutralising effect such as, standards to be developed will be based on 'sound science' and that environmental measures will be determined in a sustainable development context, taking into account socio-economic considerations.[1752]

In September 2001 the Federal Government of Canada issued a discussion document on the precautionary approach/principle, which began a process of establishing a Canadian federal framework for applying the precautionary approach.[1753] Its guiding principles include the general principles of application, such as recognizing the legitimacy for decisions to be guided by a society's chosen level of protection against risk.[1754] The document makes the following recommendations:[1755] Firstly, it recommends that sound scientific information be the basis for applying the precautionary approach, and calls for increased transparency, accountability and public involvement. Its guiding principles propose that precautionary measures put in place be subject to reconsiderations based on the evolution of science, technology and society's chosen level of protection.

Secondly, the precautionary measures should be proportional to the potential severity of the risk being addressed and to society's level of protection. Thirdly, the measures should be non-discriminatory and consistent with measures taken in similar circumstances. Fourthly, the measures should be cost-effective with the goal of generating an overall net benefit for society, at least cost and efficiency in the choice of measures. Fifth, the measures should be least trade restrictive.

While hailed as progressive, key critique of the discussion document is its strong emphasis of sound science, not addressing the burden of proof in decision-making,

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[1751] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 124, *Ottawa Law Review* 34(1).

[1752] Ibid.

[1753] Ibid; Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 206, *Stellenbosch Law Review* 26(1).

[1754] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 124, *Ottawa Law Review*, 34(1).

[1755] Ibid, at 125

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and neglecting the crucial alternatives assessment approach.[1756] Notably, Principle 3.3 requires that sound scientific information and evaluation be the basis for applying the precautionary approach.[1757] As such '*before the precautionary approach can be applied, scientific data relevant to the risk must be evaluated through a sound, credible, transparent and inclusive mechanism leading to a conclusion that expresses the possibility of occurrence of harm and the magnitude of that harm'.*[1758] This is contrary to Principle 15 of the Rio Declaration which advocates for action to be taken particularly in the face of scientific uncertainty, where there are threats of serious or irreversible environmental damage.[1759]

In terms of the burden of proof, the document suggests that when codifying the precautionary approach in statute, it may be crucial to shift the burden of proof to those planning activities that may have a detrimental effect on the environment.[1760] However it does not recommend, as a guiding principle, general burden of proof reversal.[1761] Rather, Principle 3.4 restricts the burden of proof to those who should bear the burden of producing scientific information.[1762] The document proposes that the responsibility of providing scientific information should generally rest with those planning to undertake activities that potentially cause irreversible harm to the environment, but that burden may shift depending on who, in a concrete scenario, would be in the best position to provide the information base.[1763] Similarly the alternatives assessment approach is neglected in the document.[1764] The alternatives assessment is important since it requires the consideration of alternative technologies, and result in the least environmentally damaging options being adopted.[1765]

[1756] Ibid, at 125.
[1757] Ibid, at 126.
[1758] Ibid.
[1759] United Nations 'The Rio Declaration on Environment and Development' (1992) Principle 15.
[1760] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 126, *Ottawa Law Review*, 34(1).
[1761] Ibid.
[1762] Ibid.
[1763] Ibid.
[1764] Ibid.
[1765] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 207, *Stellenbosch Law Review* 26(1).

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Relevant Canadian legislation that contains the precautionary approach include the Canadian Environmental Protection Act,[1766] the Federal Sustainable Development Act,[1767] and the Canadian Environmental Assessment Act.[1768] The Canadian Environmental Protection Act embeds the precautionary principle in the administrative duties of Government, and does not put emphasis on scientific evidence to prove a causal link between pollution and effects.[1769] The Federal Sustainable Development Act provide the legal framework for developing and implementing a Federal Sustainable Development Strategy that will make environmental decision-making more transparent and accountable to Parliament.[1770] The Act acknowledges that sustainable development in Canada is based on an ecologically efficient use of natural, social and economic resources, and the need to integrate environmental, economic and social factors in decision-making by government.[1771] As such the Sustainable Development Strategy should be based on the precautionary principle.[1772]

The Canadian Environmental Assessment Act on the other hand provides for designated projects to be considered in a careful and precautionary manner, to avoid significant adverse environmental effects.[1773] It mandates the Government of Canada to exercise its powers in the administration of the Act in a manner that protects the environment and human health and applies the precautionary principle.[1774] Another pertinent statute which has enabled the implementation of precautionary principle to be tested in Canadian courts is the Species at Risk Act.[1775] In its Preamble, the Act commits the Government of Canada *to 'conserve biological diversity and to the principle that, if there are threats of serious or irreversible damage to wildlife species, cost effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty*'.[1776]

[1766] Canadian Environmental Protection Act, 1999.
[1767] Federal Sustainable Development Act, 2008.
[1768] Canadian Environmental Assessment Act, 2012.
[1769] Canadian Environmental Protection Act, 1999.
[1770] Federal Sustainable Development Act, 2008, s 3.
[1771] Federal Sustainable Development Act, 2008, s 5(a).
[1772] Federal Sustainable Development Act, 2008, s (5)(a.1)(iii)
[1773] Canadian Environmental Assessment Act, 2012, s 4.
[1774] Canadian Environmental Assessment Act, 2012.
[1775] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 208, *Stellenbosch Law Review,* Vol 26, Issue 1.
[1776] Species at Risk Act, 2002.

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In *Spraytech v Town of Hudson*, the Court recognized the precautionary principle as part of international law.[1777] It relied on the principle for justifying the general interpretation of provincial statutory authority, allowing towns to regulate pesticides through by-laws on the basis of preventive action.[1778] In upholding the town of Hudson's by-law restricting the non-essential use of pesticides, Justice L'Heureux-Dube emphasised the importance of international legal principles in not only statutory interpretation, but also in assessing the reasonableness of discretionary administrative decisions.[1779]

A growing number of cases involving the precautionary principle related to the Species at risk Act especially, have been considered by the Federal Court of Canada.[1780] One of these cases is the *Alberta Wilderness Association v. Minister of Environment* related to the endangered Great Sage-Grouse.[1781] Another recent case is the *Environmental Defence Canada v. Minister of Fisheries & Oceans* related to the threatened Nooksack Dace fish.[1782] In all these cases the Court found the government had failed to apply the precautionary principle as provided for in the Act.[1783] In the *Nooksack Dase* case, the Court went further to not only adopt the precautionary principle as a principle of statutory interpretation, but also found it to be law in Canada, consistent with the country's international obligations and through codification in national legislation.[1784] Therefore, while hydraulic fracturing is supported at the federal level in Canada, the potential adverse environmental impacts of its use are acknowledged, and caution is strongly advised given the uncertainties associated with its use.[1785] Canada is

[1777] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 128, *Ottawa Law Review* 34(1).
[1778] Ibid.
[1779] Ibid.
[1780] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 210, *Stellenbosch Law Review* 26(1).
[1781] *Alberta Wilderness Association v. Minister of Environment,* 2009 FC 710.
[1782] *Environmental Defence Canada v. Minister of Fisheries and Oceans,* 2009 FC 878.
[1783] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 210, *Stellenbosch Law Review,* Vol 26, Issue 1; *Alberta Wilderness Association v. Minister of Environment,* 2009 FC 710; *Environmental Defence Canada v. Minister of Fisheries and Oceans,* 2009 FC 878.
[1784] Jan Glazewski and Lisa Plit 'Towards the application of the precautionary principle in South African law' (2015) at 210, *Stellenbosch Law Review,* Vol 26, Issue 1.
[1785] Jan Glazewski and Surina Esterhuyse 'Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives' (2016) at 22, Claremont, Juta and Company (Pty) Ltd.

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furthermore committed to implement management measures to minimize or mitigate negative environmental impacts throughout the shale gas lifecycle.[1786]

7.7 Conclusions

Given that the world does not know enough about the full impact of hydraulic fracturing on the environment,[1787] and with its limited practical knowledge of shale gas development,[1788] South Africa should adopt a precautionary approach to shale gas development. A precautionary approach will enable the development of the requisite knowledge, through academic research and exploration efforts. Therefore, in its quest to ascertain the shale gas potential in the Karoo, and developing the understanding of the risks associated with its extraction, South Africa should adopt an approach that presumes that the possibility of harm to the environment and human health to be adequate for precautionary measures to be put in place by those planning to conduct the potentially harmful activities, and that the threat of harm does not even have to be serious or irreversible.[1789]

Furthermore, the onus to prove that shale gas related activities in the Karoo will not cause harm to human health and the environment must be the responsibility of those planning to conduct hydraulic fracturing operations to exploit Karoo shale gas.[1790] Similarly the alternatives assessment approach, which requires the consideration of alternative technologies in search for the least environmentally damaging options,[1791] should be an integral part of South Africa's approach to shale gas development.

[1786] Ibid.

[1787] Martin J.de Wit 'The great shale gas debate in the Karoo' (2011) at 1, South African Journal of Science, Vol 107, No. 7/8.

[1788] Martin J.de Wit 'The great shale gas debate in the Karoo' (2011) at 2, South African Journal of Science, Vol 107, No. 7/8.

[1789] The Science and Environmental Health Network Conference 'Wingspread Statement on the Precautionary Principle (1998), Racine, Wisconsin, 23 – 25 January 1998.

[1790] Joel Tickner, Carolyn Raffensperger and Nancy Myers 'The Precautionary Principle in Action A Handbook' (1999), at 1, *Science and Environmental Health Network*, 1st edn.

[1791] David L. Vanderzwaag, Susanna D. Fuler and Ransom A. Myers 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) at 126, *Ottawa Law Review* 34(1).

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CHAPTER 8: REMEDIATING THE ENVIRONMENTAL IMPACT OF SHALE GAS

8.1 Introduction

Environmental law was originally premised on the notion that environmental damage, such as the contamination of water or pollution of the air, could be remedied by requiring those responsible to repair the damage they have caused.[1792] Curative measures, such as the rehabilitation of areas impacted by industrial activities may remediate environmental damage however may be too late to deter such damage.[1793] A case in point is shale gas development, where the impact on the environment may be irreversible.[1794] As a means of remediation, the polluter-pays principle requires polluters to take responsibility for the costs associated with the pollution they cause.[1795]

This chapter provides a comparative assessment of the application of the polluter-pays principle in South Africa, the United Kingdom and Canada. The objective is to ascertain whether the principle could be used as a mechanism to discourage or remediate environmental harm that may arise from shale gas development in South Africa. Section 8.2 below defines pollution, while section 8.3 traces the origin of the polluter pays principle, and its application in international environmental law. Section 8.4

[1792] Julie Adshead 'The Application and Development of the Polluter-Pays Principle across Jurisdictions in Liability for Marine Pollution: The Tales of the Erika and the Prestige' (2018) at 432, *J.Envtl 30*; Jan-Henrik Meyer 'Who should pay for pollution? The OECD, the European Communities and the emergence of environmental polity in the early 1970s' (2017) at 382, *European Review of History: Revue européenne d'histoire* 24:3; Mizan R. Khan 'Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change' (2015) at 639, *Law*s 4.

[1793] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 61 (New York, Oxford University Press).

[1794] Michael Esposito 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) at 172, *Tulane Journal of International & Comparative Law* 22; Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) at 37, *Science of the Total Environment;* Daniele Costa, Joao Jesus, David Branco, Anthony Danko & Antonio Fiuza 'Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)' (2017) at 14583, *Environ Sci Pollut Res* 24; Matthew Cotton 'Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning' (2017) at 186, *Local Environment* 22(2).

[1795] Friedrich Soltau 'The National Environmental Management Act and Liability for Environmental Damage' (1999) at 43, *SAJELP* 6; Willemien du Plessis 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) at 180, *Stell LR* 1.

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undertakes the comparative analysis, indicating how these principles are heeded in the three jurisdictions that form part of this study.

8.2 Defining Pollution

There are two main schools of thought as to what constitutes pollution, traditionally, pollution was defined as the emission of a substance beyond the regulatory threshold established to avoid environmental damage.[1796] Therefore, to be considered pollution, the emission of a substance that is released to the environment have to exceed regulated discharge or quality standards.[1797] Consequently, as long as there is compliance with the regulatory threshold, the discharger or emitter of the substance in question is not subject to the polluter-pays principle.[1798] This implies the environmental effects that are authorised by public authorities do not give rise to financial liability.[1799]

In terms of the contemporary view, pollution is the impact of a given activity on the environment to a point of damage.[1800] This implies those responsible for environmental damage are obliged to bear the consequences of the pollution they cause even if they complied with the regulated pollution standards or thresholds.[1801] In South Africa, pollution is defined as 'the emission of substances radioactive or other waves, noise, odours, dust or heat into the environment, which causes a change in the environment'.[1802] 'Such emissions must have adverse effect on human health or well-being or on the composition, resilience and productivity of natural and managed ecosystems, or on materials useful to people, or will have such an effect in the future'.[1803] In the United Kingdom, environmental pollution means the 'depositing, keeping or disposal of any substance into the air, water or land which may give rise to

[1796] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 38, New York, Oxford University Press; Nicholas der Sadeleer 'Environmental Principles: From Political Slogans to Legal Rules' (2020) (2nd edn) at 47 (Oxford University Press, United Kingdom).
[1797] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 38, New York, Oxford University Press.
[1798] Ibid.
[1799] Ibid.
[1800] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 38, New York, Oxford University Press; Nicholas der Sadeleer 'Environmental Principles: From Political Slogans to Legal Rules' (2020) (2nd edn) at 47 (Oxford University Press, United Kingdom).
[1801] Ibid.
[1802] National Environmental Management Act, No.107 of 1998, s (1)(1)(xxiv).
[1803] S (1)(1)(xxiv) of the NEMA.

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any harm'.[1804] 'It includes pollution caused by noise, heat or vibrations or any kind of release of energy'.[1805]

In Canada, pollution means 'a condition arising wholly or partly from the presence of any substance that has certain enumerate negative consequences'.[1806] The consequences include, first, the pollution directly or indirectly endangers the health, safety, or welfare of humans.[1807] Secondly, it interferes with the normal enjoyment of life or property.[1808] Thirdly, it puts the health of animal at risk'.[1809] Fourthly, it causes damage to plants or property.[1810] Fifth, it degrades the ecosystem to an extent that is detrimental to its use to humans, animals or plants.[1811]

The traditional school of thought views pollution in the context of exceeding a particular threshold, without due regard for the damage caused.[1812] The contemporary view emphasises environmental effect, irrespective of whether it is legally allowed or not.[1813] Consequently pollution results from the impact of emissions on the environment, the effect, not the cause.[1814] The author of this thesis aligns with the contemporary view of pollution, which is premised on environmental effect, because it seems fair, and appropriate and may have legal coherence.[1815] It is not ideal to limit financial liability only to cases of pollution caused by unlawful discharges, because the cost to

[1804] Pollution Prevention and Control Act 1999, s 2(b).
[1805] S 2(b)(a) of the Pollution Prevention and Control Act 1999.
[1806] Canadian Environmental Protection Act, 1999, s 3(1)(a).
[1807] Canadian Environmental Protection Act, 1999, s 3(1)(a).
[1808] S 3(1)(b) of the Canadian Environmental Protection Act 1999.
[1809] S 3(1)(c) of the Canadian Environmental Protection Act 1999.
[1810] S 3(1)(d) of the Canadian Environmental Protection Act 1999.
[1811] S 3(1)(e) of the Canadian Environmental Protection Act 1999.
[1812] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 40, New York, Oxford University Press; Nicholas der Sadeleer 'Environmental Principles: From Political Slogans to Legal Rules' (2020) (2nd edn) at 47 (Oxford University Press, United Kingdom).
[1813] Ibid.
[1814] Friedrich Soltau 'The National Environmental Management Act and Liability for Environmental Damage' (1999) at 49, *SAJELP* 6; Tracy Field 'Liability to Rectify Asbestos Pollution' (2006) at 492, *Journal of Environmental Law* 18(3); Willemien du Plessis 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) at 180, *Stell LR* 1; Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 11, *IJLBE* 8.1.
[1815] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 40, New York, Oxford University Press.

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remediate damage caused by such discharges is often borne by the broader society or local communities which contradicts the polluter-pays principle.[1816]

It is also not appropriate to limit the application of the polluter-pays principle to cases of pollution caused by unlawful discharges, since the objective of the principle is to also encourage polluters who may be compliant to emission standards or thresholds to reduce the harmfulness or quantity of their polluting emissions.[1817] It would furthermore dilute the complementarity to the principle of prevention if the polluter-pays principle did not cover every damage to the environment.[1818]

8.3 The Polluter Pays Principle

The polluter-pays principle can be traced back to the British economist Arthur Pigou, who hypothesised that adverse transaction costs on third parties or the environment, the so-called external market costs*,* could be internalised through a tax system.[1819] The polluter-pays principle is a means to internalise the costs of pollution, as it requires polluters to take responsibility for the costs associated with the pollution they cause.[1820] The principle has evolved to become a fundamental principle of international environmental law.[1821] The sections below discuss the adoption of this principle at the international level, and the challenges posed by the principle.

[1816] Ibid.
[1817] Ibid.
[1818] Ibid.
[1819] Mizan R. Khan 'Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change' (2015) at 639, 4 *Law*s; Julie Adshead 'The Application and Development of the Polluter-Pays Principle across Jurisdictions in Liability for Marine Pollution: The Tales of the Erika and the Prestige' (2018) at 428, 30 *J.Envtl;* Arthur C.Pigou 'The Economics of Welfare (London: Macmillan and Co, Limited. 1932).
[1820] Julie Adshead 'The Application and Development of the Polluter-Pays Principle across Jurisdictions in Liability for Marine Pollution: The Tales of the Erika and the Prestige' (2018) at 427, 30 *J.Envtl*; Ayobami Loaniyan 'Imposing Liability for Oil Spill Clean-Ups in Nigeria: An Examination of the Role of the Polluter-Pays Principle' (2015) at 75, *Journal of Law, Policy and Globalization* 40; Willemien du Plessis 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) at 180, Stell LR 1.
[1821] Paul G W Henderson 'Some Thoughts on Distinctive Principles of South African Environmental Law' (2001) at 173, 8 *SAJELAT*; Mizan R. Khan 'Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change' (2015) at 640, *Laws 4*.

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8.3.1 The Polluter Pays Principle in International Environmental Law

In terms of its formal status at an international level, the polluter-pays principle dates back to 1972, when it was adopted by the Organisation for Economic Co-operation and Development (OECD) Council.[1822] Accordingly, 'the polluter-pays principle would be used for allocating the costs of preventing pollution, and measures to ensure that environmental resources are used rationally. This implies that the polluters would bear the costs of pollution prevention and associated measures to ensure that the environment was in an acceptable state. Consequently, the cost of these measures should be reflected in the price of goods and services that cause pollution. States would have to desist from subsidising the production of such goods and services, since such subsidies would distort international trade and investment'.[1823]

The following are examples of international conventions and treaties that contain the polluter-pays principle:[1824]

(a) The Stockholm Declaration affirms that states have the sovereign right to exploit their resources in accordance with their national environmental policies, and a responsibility to ensure that activities within their jurisdictions do not cause environmental in other States.[1825]
(b) The International Convention on Oil Pollution Preparedness, Response and Cooperation declares the polluter-pays principle as a 'general principle of international environmental law, which applies along existing civil liability and compensation schemes for damages inflicted'.[1826]
(c) The Rio Declaration on Environment and Development calls on 'National authorities to endeavour to promote the internationalisation of environmental costs and the use of economic instruments, taking into account the approach that

[1822] OECD, Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies' (1972) OECD/LEGAL/0102.
[1823] OECD, Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies' (1972) OECD/LEGAL/0102 (A)(4).
[1824] Mizan R. Khan 'Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change' (2015) at 641-642, *Law*s 4.
[1825] United Nations Environmental Programme 'Stockholm Declaration' (1972) Principle 21, *Environmental Law Guidelines and Principles*.
[1826] International Convention on Oil Pollution Preparedness, Response and Cooperation (1990), *United Nations Treaty Series* 89.

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the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment'.[1827]

(d) The Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area, obliges the contracting parties to apply the polluter-pays principle'.[1828]

(e) The OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic calls on the Contracting Parties to 'apply the polluter pays principle, where the costs of measures to prevent, control and reduce pollution will be borne by the polluter'.[1829]

(f) The Bamako Convention on the Ban of the Import into Africa and Control of Transboundary Movement and Management of Hazardous Waste within Africa, calls for a protocol setting out appropriate rules and procedures with regards to liabilities and compensation for environmental damage caused by the transboundary movement of hazardous waste'[1830]

Although the polluter-pays principle gained more prominence in international law when it was incorporated as Principle 16 in the Rio Declaration on Environment and Development,[1831] it is formulated as soft law in the Rio Declaration.[1832] It is not mandatory on the States, as demonstrated by the phrases it uses such as '*endeavour to promote*' and '*should in principle*'.[1833] Furthermore, economic requirements, such as *not distorting international trade and investment* must be taken into account, within a national context.[1834] Consequently, despite the progressive acceptance of the polluter-pays principle as a general principle of international environmental law, with most of the binding provisions of the principle incorporated in recent instruments at a

[1827] United Nations General Assembly 'Rio Declaration on Environment and Development' (1992) Principle 16, A/CONF 1: 151/26.
[1828] Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992) Article 3.4.
[1829] Convention for Protection of the Marine Environment of the North-East Atlantic (1992) Article 2b.
[1830] Bamako Convention on the Ban of the Import into Africa and Control of Transboundary Movement and Management of Hazardous Waste Within Africa (1991) Article 12.
[1831] United Nations General Assembly 'Rio Declaration on Environment and Development' (1992) Principle 16, A/CONF. 151/26/(Vol.1).
[1832] Julie Adshead 'The Application and Development of the Polluter-Pays Principle across Jurisdictions in Liability for Marine Pollution: The Tales of the Erika and the Prestige' (2018) at 428, 30 J.Envtl.
[1833] Ibid.
[1834] Ibid.

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regional level, there are still questions whether the principle constitutes a rule of customary international law.[1835]

8.3.2 Critical Assessment

In effect, the polluter-pays principle was a mechanism to internalise the costs of pollution emanating from industrial activities, to harmonise economic markets through ensuring that countries did not bear the cost of pollution that should be borne by the industries responsible for such pollution.[1836] Such costs had to be reflected in the price of the products produced to ensure that they were not priced cheaper than their equivalent in countries were the costs of pollution were not subsidised by the State.[1837]

The traditional approach to the polluter-pays principle disregarded environmental consequences that might last for generations, whose costs would have to be borne by future generations, if the polluters were not immediately held responsible for such future effects.[1838] The evolving view is that, in addition to the cost of pollution prevention and control measures, the polluter must bear the cost of ecological damage he causes in its entirety.[1839] This is consistent with the 1991 OECD Recommendation on the Use of Economic Instruments in Environmental Policy, which takes into account that 'a sustainable and economically efficient management of environmental resources requires, inter alia, the internalisation of pollution prevention, control and damage costs'.[1840] It is also consistent with the Rio Declaration on Environment and Development, which requires the polluter to bear the cost of pollution, rather than just the cost of pollution prevention and control measures.[1841]

[1835] Ibid.
[1836] Mizan R. Khan 'Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change' (2015) at 639, *Law*s 4.
[1837] Ibid, at 641.
[1838] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 43 (New York, Oxford University Press).
[1839] Ibid.
[1840] OECD, Recommendation of the Council on the Use of Economic Instruments in Environmental Policy' (1991) OECD/LEGAL/0258.
[1841] United Nations General Assembly 'Rio Declaration on Environment and Development' (1992) Principle 16, A/CONF. 151/26/(Vol.1).

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Nonetheless, the implementation of the polluter-pays principle is not as simple as it appears at face value, merely requiring polluters to bear the cost of the pollution they cause.[1842] First, there is sometimes difficulty in identifying the actual polluter.[1843] Is it the owners of land, persons in control of the land, or persons who have a right to use the land or premises in which an activity or process that has caused pollution was performed?[1844] Secondly, there can be disagreement on the calculation of the costs of remediating pollution,[1845] such as how much of the cost was directly caused by the polluter.[1846] Thirdly, assessing the worth of the environment or ascribing a monetary value to it, such as the price of air, water in its natural state, plants and animals can also be quite complex.[1847]

Given its limitations, the polluter-pays principle cannot operate effectively by itself, therefore should serve to complement the preventive and other anticipatory approaches such as the pre-cautionary principle.[1848] The preventive and precautionary principles are more capable of averting irreparable damage, while the polluter-pays principle could be applied effectively to reversible damages/and or to repair repairable damage.[1849] The application of the polluter-pays principle in the petroleum and environmental legal frameworks of South Africa, the United Kingdom and Canada is assessed in sections 8.4 - 8.6 below.

8.4 Environmental Remediation in South Africa

In South Africa, the polluter-pays principle is at the core of environmental remediation and find expression in the National Environmental Management Act,[1850] the Minerals and Petroleum Resources Development Act ,[1851] and the National Water Act .[1852]

[1842] Environmental Law Centre (Alberta) 'The Polluter Pays Principle in Alberta Law' (2019) at 1, *CanLIIDocs* 3671.
[1843] Ibid.
[1844] S 28(2) of the NEMA.
[1845] Environmental Law Centre (Alberta) (2019) at 1.
[1846] Bareki NO and Another v Gencor Ltd and Others, 2006 (1) para 20, SA 432 (T) (South Gauteng High Court).
[1847] Environmental Law Centre (Alberta) (2019) at 1.
[1848] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 41, New York, Oxford University Press.
[1849] Ibid.
[1850] National Environmental Management Act, No.107 of 1998, s 2(4)(p)
[1851] Mineral and Petroleum Resources Development Act, No.28 of 2002, s 46 (2).
[1852] National Water Act, No. 36 of 1998, Chapter 5, Part 1, Chapter 16, s 151(1)(i); s 151(2); s 153.

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This legislation is the most relevant to shale gas development and its associated potential environmental impact.

8.4.1 Environmental Remediation in terms of the NEMA

The NEMA provides that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.[1853] Consequently, and as a duty of care, the NEMA holds 'every person who causes significant environmental degradation liable, and requires that they take reasonable steps to prevent such pollution from occurring'.[1854] 'Where such pollution is authorised by law, or cannot reasonably be avoided or stopped those responsible must minimise and rectify such pollution.[1855]

Therefore, an applicant for an environmental authorisation relating to petroleum exploration or production must make the prescribed financial provision for the rehabilitation, closure and ongoing post decommissioning management of negative environmental impacts before the Minister of Mineral Resources and Energy issues the environmental authorisation.[1856] If any holder of an exploration or production right or old order petroleum right fails to rehabilitate or manage, or is unable to undertake such rehabilitation or manage any negative impact on the environment, the Minister of Mineral Resources and Energy may, upon written notice to such holder, use all or part of the financial provision to rehabilitate or manage the negative environmental impact in question.[1857] Holders of exploration or production rights must assess their environmental liability in a prescribed manner and increase the financial provision annually to the satisfaction of the Minister,[1858] And submit an audit report on the adequacy of the financial provision from an independent auditor to the Minister.[1859]

[1853] S 2(4)(p) of the NEMA.
[1854] S 28(1) of the NEMA.
[1855] S 28(1) of the NEMA.
[1856] S 24P(1) of the NEMA.
[1857] S 24P(2) of the NEMA.
[1858] S 24P(3)(a) of the NEMA.
[1859] S 24P(3)(b) of the NEMA.

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If the Minister is not satisfied with the assessment and financial provision by the right holder, the Minister may appoint an independent assessor to conduct the assessment and determine the financial provision,[1860] 'The requirement to maintain and retain the financial provision remains in force until the Minister of Mineral Resources and Energy issues a closure certificate in terms of s 43 of the MPRDA, to such a holder or owner concerned.[1861] The Minister may retain a portion of the financial provision as may be required to rehabilitate the closed petroleum exploration and mining activity in respect of latent or residual environmental impacts.[1862] Nonetheless, the long awaited revised financial provisions were published for public comment in 2022.[1863] A key change in the new regulations is that, applicants for exploration or production rights will now only need to provide proof of the arrangements made to secure the financial provision prior to the issuing of the EIA, as opposed to providing proof that the financial provision was already available.[1864]

The NEMA extends environmental liability to the owners of land or premises, persons in control of land or premises, or persons who have a right to use the land or premises on which or in which an activity or process that causes, has caused or is likely to cause significant pollution or environmental degradation was performed.[1865] This complicates the application of the polluter pays principle in South Africa, since liability may be imposed based on land ownership and control instead of causation or fault.[1866] In the context of shale gas development in South Africa, the polluter is unlikely to be the owner of the land nor person in control of the land, but rather a petroleum right holder who is entitled to access the land for the purpose of exploring for oil and gas in the sub-surface and the production thereof.[1867]

[1860] S 24P(4)(a) of the NEMA.
[1861] S 24P(5) of the NEMA.
[1862] S 24P(5) of the NEMA.
[1863] Proposed Regulations Pertaining to the Financial Provisioning for the Mitigation and Rehabilitation of Environmental Damage caused by Reconnaissance, Prospecting, Exploration, Mining or Production Operations, Government Notice R.2272 in Government Gazette No.47112 of 11 July 2022.
[1864] Financial Provisioning Regulation 9.
[1865] S 28(2) of the NEMA.
[1866] Paul G W Henderson 'Some Thoughts on Distinctive Principles of South African Environmental Law' (2001) at 174, *SAJELAT* 6.
[1867] Minerals and Petroleum Resources Development Act, No. 28, 2002, s 5(3)(b)

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Nonetheless, the costs to clean up pollution can be recovered first, from any person who is responsible for the pollution.[1868] Secondly, the owner of the land at the time the pollution occurred or that owner's successor in title.[1869] Thirdly, the person in control of the land or any person who has or had a right to use the land when the pollution occurred.[1870] Fourthly, any person who negligently failed to prevent the pollution.[1871] Fault has to be proved in the case of the owners of land, persons in control of the land or person who has the right to use the land.[1872] Proving fault in the case of successors-in-title, where liability is strict is not straight forward.[1873] This is because in terms of strict liability the authorities do not have to prove fault to recover costs on the basis that the alleged polluter failed to take reasonable measures to prevent such pollution or environmental degradation.[1874]

Alleged offenders on the other hand may insist that they undertook the required reasonable measures,[1875] therefore are not liable for the clean-up costs incurred by the authorities.[1876] Depending on the polluter, causation may not be an issue when the authorities wish to recover the costs incurred when remedying the situation.[1877] For example, where it is alleged that it is the owner of the land or successor-in-title that is the potential polluter,[1878] all that needs to be proved is that they failed to take the requisite reasonable measures.[1879]

On the other hand, causation is relevant where it is alleged that the pollution or degradation was caused by any person.[1880] In essence, the NEMA does not create any presumptions in terms of causation, needless to say, the existence of significant

[1868] S 28(8)(a) of the NEMA.
[1869] S 28(8)(b) of the NEMA.
[1870] S 28(8)(c) of the NEMA.
[1871] S 28(8)(d) of the NEMA.
[1872] Friedrich Soltau 'The National Environmental Management Act and Liability for Environmental Damage' (1999) at 48, *SAJELAT* 6.
[1873] Ibid.
[1874] Ibid.
[1875] S 28(1) of the NEMA.
[1876] Ibid; s 28(1) of the NEMA.
[1877] Ibid.
[1878] Ibid; s 28(8)(b) of the NEMA.
[1879] Ibid; s 28(1) of the NEMA.
[1880] Friedrich Soltau 'The National Environmental Management Act and Liability for Environmental Damage' (1999) at 49, *SAJELAT* 6.

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pollution or degradation has to be proved in each case.[1881] Moreover, if more than one person is liable for the pollution or environmental degradation,[1882] liability must be apportioned among those concerned and according to the degree to which they might have contributed to the environmental harm.[1883]

The NEMA furthermore provides for the control of emergency incidents in respect of environmental liability,[1884] by imposing certain duties on responsible persons.[1885] It defines incidents as unexpected sudden occurrences, including a major emissions, fires or explosions leading to serious danger to the public or potentially serious pollution or detriment to the environment, whether immediate or delayed.[1886] The responsible persons include, first, the person who is responsible for the incident,[1887] secondly, a person who owns any hazardous substance involved in the incident,[1888] thirdly, a person who was in control of any hazardous substance involved in the incident at the time of the incident.[1889] The responsible persons are to take all reasonable measures to contain and minimise the effects of the incident,[1890] undertake clean-up procedures,[1891] remedy the effects of the incident,[1892] and assess the immediate and long-term effects of the incident on the environment and public health.[1893]

The NEMA also provides for criminal proceedings against offenders found to have caused loss or damage to any organ of state or other person, including the cost incurred or likely to be incurred by the an organ of state in rehabilitating the environment or preventing damage to the environment.[1894] Based on a written request by the authorities or other person concerned, the court can inquire summarily

[1881] Ibid.
[1882] Ibid; s 28(1) of the NEMA.
[1883] Ibid; s 28(11) of the NEMA.
[1884] S 30 of the NEMA.
[1885] S 30(4) of the NEMA.
[1886] S 30(a) of the NEMA.
[1887] S 30(b)(i) of the NEMA.
[1888] S 30(b)(ii) of the NEMA.
[1889] S 30(b)(iii) of the NEMA.
[1890] S 30(4)(a) of the NEMA.
[1891] S 30(4)(b) of the NEMA.
[1892] S 30(4)(c) of the NEMA.
[1893] S 30(4)(d) of the NEMA.
[1894] S 34(1) of the NEMA.

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and without pleadings into the amount of the loss of the damage caused.[1895] Upon proof of such an amount, the court may give judgment in favour of the authorities or other person concerned, and such judgment has the same force and effect as a civil action that has been duly instituted before a competent court.[1896]

The application of the polluters-pay principle as a mechanism to hold polluters liable for the pollution they caused as provided for in the NEMA,[1897] was tested in *Bareki v Gencor*.[1898] In this case, the first plaintiff, a traditional leader, brought action in his own interest, the interest of his tribe, and the inhabitants of the Heuningvlei community in the North West Province.[1899] The second plaintiff is a group concerned with the protection of the environment.[1900] The defendants are mining companies, Gencor Ltd (Gencor) is the first defendant, Griqualand Exploration and Finance Co (Pty) Ltd (Gefco) the second defendant, and Hanova Mining Holdings, the third defendant.[1901] The Government South Africa is the fourth defendant, the Minister of Minerals and Energy the fifth defendant and Minister of Environmental Affairs and Tourism the sixth defendant.[1902]

The plaintiffs allege that Gefco, majority owned by Gencor, caused significant pollution and degradation of the environment in the surrounding areas through their mining of asbestos at the Bute Asbestos Mine between 1976 and 1981.[1903] The remains of mining were still present after the mining activities had ceased, in the form of asbestos dumps, a beneficiation plant, a mill and a haul road between the mine and the beneficiation plant.[1904] Consequently, the pollution and degradation present a serious health risk to the local communities, and a significant threat to the environmental integrity of the region.[1905] In effect, the plaintiff alleged that significant pollution in the

[1895] S 34(1) of the NEMA.
[1896] S 34(2) of the NEMA.
[1897] S 28 of the NEMA.
[1898] Tracy Field 'Liability to Rectify Asbestos Pollution' (2006) at 489, Vol 18(3) *Journal of Environmental Law* 18(3).
[1899] *Bareki NO and Another v Gencor Ltd and Others*, 2006 (1) para 1, SA 432 (T) (South Gauteng High Court).
[1900] Ibid, para 2.
[1901] Ibid.
[1902] Ibid.
[1903] Ibid.
[1904] Ibid.
[1905] Ibid, para 16.

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area was caused by the distribution of asbestos fibres.[1906] Therefore Gencor and Gefco were required in terms of section 28 (1) read with sections 2 and 3 of the NEMA to take reasonable measures to rectify the pollution and environmental degradation in the area.[1907]

Accordingly, Gencor and Gefco remained responsible to take such reasonable measures even though the NEMA only came into effect after the actual mining operations had ceased.[1908] Equally, the plaintiff alleged that the Government as owner of the land, is also obliged, in terms of section 28(1) read with sections 2 and 3 of the NEMA to take reasonable measures to rectify the pollution and degradation,[1909] which it failed to do.[1910] Furthermore, the Director-General of the Department of Environment Affairs and Tourism was obliged in terms of section 28(7) and (8) of the NEMA to effect the rehabilitation and claim the costs of rehabilitation from the defendants.[1911] The plaintiffs therefore required the court to make such an order.[1912] The intervention of the Director-General of the Department of Environmental Affairs and Tourism was required because the defendants were not willing to accept liability for the costs of rehabilitation.[1913] Furthermore, the defendants disputed the costs of the envisaged reasonable measures to rectify the pollution or degradation which the plaintiffs estimated to be R64 million, while the defendants estimated the costs to be between R18 million and R24 million.[1914] With the differing costs estimates, the defendants were unlikely to effect such remedial action.[1915]

The court found that the provisions of section 28 of the NEMA are not retrospective, therefore the obligation to take corrective measures does not apply where the pollution and environmental degradation were caused prior to the NEMA coming into effect, as was the case in this instance.[1916] According to the judgment, that retrospectivity would

[1906] Ibid, para 12.
[1907] Ibid, para 14.
[1908] Ibid, para 14.
[1909] Ibid, para 18.
[1910] Ibid, para 19.
[1911] Ibid, para 20.
[1912] Ibid.
[1913] Ibid.
[1914] Ibid.
[1915] Ibid.
[1916] Ibid.

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entail an unfairness that Parliament could not have intended is apparent from the fact that the duty or obligation created in section 28 is a strict, and arguably, in some cases even absolute one.[1917] Furthermore, there is no monetary limit to such liability, and no statutory defences in favour of the person who caused the pollution.[1918]

The court got it wrong in finding that section 28 of the NEMA did not apply retrospectively.[1919] The court heavily relied on the 'elementary considerations of fairness' in terms of the common law principle which assumes that statute does not apply retrospectively unless rebutted expressly or by implication, rather than the consideration of section 28 of the NEMA within the broader context of the South African Constitution.[1920] This is because strict or 'risk' liability does not honour the general South African legal principle that for harm to be recovered by delictual action conduct causing such harm must be both faulty and unlawful.[1921]

In essence, strict liability in terms of section 28 of the NEMA does not require fault to be established.[1922] The interpretation of absolute liability as the preclusion of fault and unlawfulness is another problematic area in De Villiers J's ruling, since strict liability provides for defences, albeit limited, while absolute liability does not provide for blame to be apportioned.[1923] Actually, both strict and absolute liability are centred on the absence of blame, the main difference is whether the exclusion of the need to prove fault can be refuted.[1924] Furthermore, the NEMA does create statutory defences to the duty established by sections 28(1) and (2) upon a closer examination of how the duty

[1917] Ibid.
[1918] Ibid.
[1919] Tracy Field 'Letting polluters off the hook? The impact of Bareki NO vs Gencor Ltd 2006 (1) SA 432 (T) on the reach of s 28 of the National Environmental Management Act 107 of 1998' (2007) at 115, *SALJELP*; Willemien du Plessis 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) at 162, *Stell LR* (1).
[1920] Tracy Field 'Liability to Rectify Asbestos Pollution' (2006) at 490, Vol 18(3) *Journal of Environmental Law*, 479-494.
[1921] Tracy Field 'Letting polluters off the hook? The impact of Bareki NO vs Gencor Ltd 2006 (1) SA 432 (T) on the reach of s 28 of the National Environmental Management Act 107 of 1998' (2007) at 115, *SALJELP.*
[1922] Friedrich Soltau 'The National Environmental Management Act and Liability for Environmental Damage' (1999) at 48, 6 *SAJELP*; Tracy Field 'Letting polluters off the hook? The impact of Bareki NO vs Gencor Ltd 2006 (1) SA 432 (T) on the reach of s 28 of the National Environmental Management Act 107 of 1998' (2007) at 115, *SALJELP.*
[1923] Tracy Field (2007) at 115.
[1924] Ibid.

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has been framed.[1925] For example, persons directed to take reasonable measures by the Director-General in terms of s (28)(1) could maintain that the pollution or degradation they have caused is not significant, and that they had already taken reasonable measures, and the same could apply to the persons contemplated in s (28)(2).[1926] Therefore, it can be concluded that section 28(1) and (2) do not establish absolute liability.[1927] Accordingly, a proper consideration of fairness, testing whether the legislature intended rebutting the retrospective presumption and going against the essence of fairness would have been to determine the nature of the duty or form of liability envisaged by section 28(1) and (2).[1928]

Furthermore, had the Court properly considered and applied the polluter-pays principle as it relates to the case, it might have found that indeed section 28 did apply retrospectively.[1929] The Court should also have paid more attention to the life-cycle responsibility principle,[1930] which commands that a person initially responsible for producing a dangerous or toxic substance should remain responsible for such substance until it has been properly disposed of.[1931] The retrospective application of section 28 of the NEMA has been settled by the insertion after section (1) of subsection (1A), which clarifies that section 28(1) of the NEMA also applies to significant pollution or degradation that occurred before the commencement of this Act.[1932] The amendment furthermore clarifies that section 28(1) applies to significant pollution or degradation that arises or is likely to arise at a different time from the actual activity that caused the contamination,[1933] or arises through an act or activity of a person that results in a change to pre-existing contamination.[1934] Section 28 of the NEMA was

[1925] Ibid.
[1926] Ibid.
[1927] Ibid.
[1928] Tracy Field 'Liability to Rectify Asbestos Pollution' (2006) at 490, Vol 18(3) *Journal of Environmental Law* 18(3).
[1929] Willemien du Plessis 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) at 179, *Stell LR* 1.
[1930] Ibid. at 184.
[1931] Paul GW Henderson 'Some Thoughts on Distinctive Principles of South African Environmental Law' (2001) at 166, *SAJELAT* 8.
[1932] National Environmental Laws Amendment Act, No.14 of 2009, s 12(a)(a); NEMA, s 28(1)(1A)(a)
[1933] 12(a)(b) of the NEMLAA; NEMA, s 28(1)(1A)(b)
[1934] S12(a)(c) of the NEMLAA; NEMA, s 28(1)(1A)(c)

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subsequently amended and now clearly stipulates the retrospective application of the section.

8.4.2 Environmental Remediation in terms of the MPRDA

In terms of the MPRDA, 2002 'an applicant for a petroleum exploration or production right must make the prescribed financial provision for the rehabilitation and management of negative environmental impacts before the Minister approves the environmental management plan or environmental management programme'.[1935] 'If the holder of the exploration or production right fails to rehabilitate or manage, or is unable to undertake such rehabilitation or manage any negative impact on the environment, the Minister may, upon written notice to such holder, use all or part of the financial provision to rehabilitate or manage the negative environmental impact in question'. [1936] 'The holder of an exploration or production right must assess his or her environmental liability and increase the financial provision annually to the satisfaction of the Minister'.[1937]

'If the Minister is not satisfied with the assessment and financial provision by the right holder, the Minister may appoint an independent assessor to conduct the assessment and determine the financial provision'.[1938] 'The requirement to maintain and retain the financial provision remains in force until the Minister issues a closure certificate,[1939] to such a holder, but the Minister may retain such portion of the financial provision as may be required to rehabilitate the closed petroleum exploration and mining activity in respect of latent or residual environmental impacts'.[1940] Moreover, the MPRDA accords the Minister powers to recover costs, when measures to remediate pollution or environmental damage caused by exploration or production activities which may be harmful to people's health or well-being are required urgently.[1941]

[1935] S 41(1) of the MPRDA.
[1936] S 41(2) of the MPRDA.
[1937] S 41(3) of the MPRDA.
[1938] S 41(4) of the MPRDA.
[1939] In terms of s 43 of the MPRDA.
[1940] S 41(5) of the MPRDA.
[1941] S 45(1) of the MPRDA.

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Furthermore, the Minister may instruct the relevant Regional Manager to take necessary measures to prevent further pollution or environmental degradation, or to rehabilitate the affected area where the mineral or petroleum right holder has not done so.[1942] This is to be done utilising the financial provision made by the holder of the relevant mineral or petroleum right, and if there is no such provision, or if it is inadequate to do so, from money appropriated by parliament for that purpose.[1943] Should the Minister direct that measures be taken to prevent environmental degradation, or to rehabilitate an affected area, but establishes that the mining or petroleum right holder is either deceased or cannot be traced, the Minister may instruct the Regional Manager concerned to take the necessary measures to prevent further environmental impact or to make the area safe.[1944]

Such measures are to be funded from the financial provision made by the mining or petroleum right holder, or from money appropriated by Parliament, if there is no such provision or the provision is inadequate.[1945] Upon completion of the remedial measures, the Regional Manager must apply to the registrar concerned that the title deed of the rehabilitated land be endorsed to the effect that such land had been remedied.[1946] Upon receipt of the application the registrar must make such endorsements so as to give effect that such land had been remedied.[1947]

8.4.3 Environmental Remediation in terms of the National Water Act

The National Water Act,[1948] provides for 'measures to finance the provision of water management services, support the beneficial use of water, and for the protection and conservation of water resources'.[1949] Accordingly, water use charges may be used to ensure compliance with prescribed standards and water management practices according to the user pays and polluter pays principles.[1950] Furthermore, where any person is convicted of an offence in terms of the Act, and damage has been caused

[1942] S 46(1) of the MPRDA.
[1943] S 46(2) of the MPRDA.
[1944] S 46(1) of the MPRDA.
[1945] S 46(2) of the MPRDA.
[1946] S 46(3)(a) of the MPRDA.
[1947] S 46(3)(b) of the MPRDA.
[1948] National Water Act, No.36 of 1998.
[1949] Chapter 5 of the NWA.
[1950] Part 1 of the NWA.

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to another person,[1951] or water resource,[1952] the Court may, at the written request of the person who suffered harm,[1953] or the Minister of Water and Sanitation,[1954] and in the presence of the convicted person,[1955] enquire without pleadings into the harm, loss or damage and determine the extent thereof.[1956] After making a determination in terms of section 152, the Court may award damages for the loss or harm suffered,[1957] or order the accused to pay for the cost of any remedial measures implemented or to be implemented.[1958]

Nonetheless, the NWA, 1998 provides for the prevention and remedying of the effects of pollution.[1959] Accordingly, the owner of land, a person in control of land or a person who occupies or uses the land on which an activity which causes, has caused or is likely to cause pollution of a water resources, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring'.[1960] Such measures may include stopping, modifying or controlling any activity or process causing the pollution and remedying the effects of the pollution.[1961] A catchment management agency may also direct any person who fails to take the measures required to commence the undertaking of such measures before a specified date, diligently continue with such measures and complete them before a specified date.[1962] Should a person fail to comply or comply inadequately with a directive by the catchment management agency, the catchment management agency may take the measures necessary to remedy the situation.[1963] The catchment management agency may recover the costs from those responsible or contributed to the pollution or potential pollution,[1964] the owner of the land at the time when the pollution or the potential for pollution occurred,[1965] or the person in control of the land or any person who has a right to use the land.[1966]

[1951] S 152(a) of the NWA.
[1952] S 152(b) of the NWA.
[1953] S 152(b)(i) of the NWA.
[1954] S 152(b)(ii) of the NWA.
[1955] S 152(b)(iii) of the NWA.
[1956] S 152 of the NWA.
[1957] S 153(a) of the NWA.
[1958] S 153(b) of the NWA.
[1959] S 19 of the NWA.
[1960] S 19(1) of the NWA.
[1961] S 19(2) of the NWA.
[1962] S 19(3) of the NWA.
[1963] S 19(4) of the NWA.
[1964] S 19(5)(a) of the NWA.
[1965] S 19(5)(b) of the NWA.
[1966] S 19(5)(c) of the NWA.

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The polluter-pays principle as provided for in the NWA,[1967] complemented by sections 153(a) and (b), are particularly relevant to this study, which is concerned with the production of shale gas in the Karoo utilizing hydraulic fracturing, a process that uses a lot of water,[1968] and chemicals that could potentially contaminate ground and surface water resources.[1969]

8.5 Environmental Remediation in the United Kingdom

In the UK, the polluter pays principle finds expression in the Environmental Act.[1970] In terms of the Act, primary environmental liability is imposed on the person that 'caused' or knowingly permitted a contaminating substance to be in, on or under the land in question.[1971] The Act defines contaminated land as any land where according to the local authority, significant harm is being caused, or there is a significant possibility of such harm being caused by substances in, on or under the land,[1972] or where pollution of controlled waters is being caused or is likely to be caused.[1973] The harm to be avoided is to the health of living organisms or other interference with the ecological system, and includes to property in the case of man.[1974] The Act provides for the determination of 'significant' harm,[1975] whether the possibility of significant harm being

[1967] Part 1 of the NWA.

[1968] Academy of Science of South Africa *South Africa's Technical Readiness to Support Shale Gas Development* (2016) at 77.; M Burns, D Atkinson, D, O Barker & C Davis et al 'Scenarios and Activities' (2016) at 1-62, in R Scholes, P Lochner, G Schreiner & L Snyman-Van der Walt (eds.) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016), Pretoria: CSIR.

[1969] Jake Hays, Madelon L. Finkel, Michael Depledge, Adam Law & Seth B.C. Shonkoff 'Considerations for the development of shale gas in the United Kingdom' (2015) at 37, *Science of the Total Environment;* Terence J. Centner and Ludivine Petetin 'Permitting program with best management practices for shale gas wells to safeguard public health' (2015) 163 *Journal of Environmental Management 174-183;* P Hobbs, E Day, P Rosewarne, S Esterhuyse, R Schulze, J Day, J Ewart-Smith, M Kemp, N Rivers-Moore, H Coetzee, D Hohne, A Maherry, A Mosetsho and M de Jager (eds) 'Water Resources" (2016) at 5-9, in R Scholes, P Lochner, G Schreiner, L Snyman-Van der Walt G, and M de Jager (eds.) 'Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks' (2016), Pretoria: CSIR.

[1970] Environmental Act 1995.

[1971] Environmental Act 1995, Part IIA, s 78F(2).

[1972] S 78A(2)(a) of the Act.

[1973] S 78A(2)(b) of the Act.

[1974] S 78A(4) of the Act.

[1975] S 78A(5)(a) of the Act.

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caused is significant,[1976] or whether the pollution of controlled waters is being, or is likely to be caused.[1977]

The main objectives of the provision on contaminated land, are to identify and remove unacceptable risks to human health and the environment, and ensure that contaminated land is made suitable for use.[1978] Consequently, primary liability is imposed on the person that 'caused' or knowingly permitted a contaminating substance to be in, on or under the land in question.[1979] The meaning of 'causing' and 'knowingly permitted' are however not defined, the broad meaning of these can however be discerned from case law.[1980]

In *Crest Nicholson Residential Ltd v Secretary of State for Environment, Food & Rural Affairs,* where the Claimant (Crest) was applying for permission to bring judicial review proceedings to challenge a remediation notice that was issued against the Claimant by the Secretary of State,[1981] Justice Sales clarified the meaning of 'causing' and 'knowingly permitted'.[1982] The remediation notice related to land at St Leonard's Court, Sandridge, Hertfordshire (the site) that was contaminated with bromide and bromate in the soil that was entering the local water course when raining.[1983] The notice identified Crest as an 'appropriate person' therefore liable for certain remedial costs because Crest had caused or knowingly permitted bromide and bromate to contaminate the land.[1984] The notice required Crest to assess or monitor the impact of bromide and bromate in local water supplies.[1985] It also required Crest to contribute to the cost of pumping and treatment of contaminated ground water by Veolia Water

[1976] S 78A(5)(b) of the Act.
[1977] S 78A(5)(c) of the Act.
[1978] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 11, *IJLBE,* 8.1.
[1979] Environmental Act 1995, Part IIA, s 78F(2).
[1980] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 11, *IJLBE*, 8.1; *R Crest Nicholson Residential Ltd v Secretary of State for Environment, Food & Rural Affairs* [2010] EWHC 561 (Admin) [2011] Env. L.R.1; *Walker and Son (Hauliers) Ltd v. Environment Agency* [2014] EWCA Crim 100; [2014] PTSR 929 [CA (Crim Div)].
[1981] In terms of Section 78E of the Environmental Protection Act 1990 (as amended).
[1982] *R Crest Nicholson Residential Ltd v Secretary of State for Environment, Food & Rural Affairs* [2010] EWHC 561 (Admin) [2011] Env. L.R.1.
[1983] *R Crest Nicholson Residential Ltd v Secretary of State for Environment, Food & Rural Affairs* [2010] para 2, EWHC 561 (Admin), [2011] Env. L.R.1.
[1984] Ibid.
[1985] Ibid.

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Central Ltd (the local water supply company) and to the cost of disposing of such water by Thames Water Utilities Ltd (the local sewage company).[1986]

In his judgment, Justice Sales reflected on the fact that from the 1950s to about 1980 activities by Redland Minerals Ltd ('Redland') produced chemicals on the site in buildings erected on hardstanding, with sump holes used to collect the waste bromide and bromate generated by the chemical processes.[1987] There was some leakage into the soil at the Site during that period, essentially causing all the bromide and bromate at the site.[1988] In September 1983, after the cessation of Redland's chemical production operations, Crest, a developer of residential properties, identified the site as a potential development site, carried out some testing therefore and acquired it from Redland.[1989]

In early 1984, Crest demolished the existing buildings and broke up the hardstanding, but did not carry out construction works for about two-and-a-half years.[1990] Crest subsequently carried out the residential development in 1986 and 1987 and sold off the land and properties.[1991] During the two-and-a-half year break period the site was exposed, the removal of the buildings and hardstanding allowed rain to wash bromide and bromate down into the soil than would otherwise have been the case.[1992] Before Crest commenced development works in 1986, it excavated and disposed of a shallow layer of soil of between 1 to 1.5 metres deep across the site and dug out the sumps, as a means of removing any soil contaminated with bromide.[1993] The excavations by Crest were too shallow and failed to remove all the contaminants in the soil at the site, as a result, the bromide and bromate remaining in the ground gradually found its way into the local water course, thereby contaminating water supplies.[1994]

[1986] Ibid, para 3.
[1987] Ibid, para 4.
[1988] Ibid.
[1989] Ibid, para 5.
[1990] Ibid, para 6.
[1991] Ibid, para 6.
[1992] Ibid, para 7.
[1993] Ibid, para 8.
[1994] Ibid, para 9.

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Justice Sales clarified the meaning of 'causing' and 'knowingly permitted' when he ruled that the land was affected by both Redland and Crest activities as causes of the contamination of the land.[1995] This was consistent with the fact that the Environmental Protection Act of 1990 was amended by the Environment Act of 1995, introducing a regime requiring remedial works to be carried out to contaminated land, effective from 1 April 2000.[1996] Therefore, while the polluter-pays principle in the UK is primarily premised on strict liability, the intent is not to limit the liability only to the polluter if there may be other potentially liable persons.[1997] Causal liability in the UK therefore involves fault, is strict, and imposed on the polluter.[1998]

If the polluter cannot be found, the owner or occupier of the land in question may be liable.[1999] The owner or occupier of the land is responsible for the remediation of the land by virtue of their legal rights to the land, or because they occupy and control the land in question.[2000] This secondary liability is not based on fault or causation but the mere ownership or occupancy of land.[2001] In fact, the rules on contaminated land are primarily concerned with the remediation of the environmental damage caused on the land, rather than focussed on ensuring that the polluters pay for the environmental damage they have caused.[2002]

Accordingly, the enforcing authority, Environmental Agency in the case of England and Wales,[2003] and Scottish Environmental Protection Agency in the case of Scotland,[2004] may serve a remediation notice to the person that 'caused' or 'knowingly permitted' the contamination of land.[2005] Should a person who has been served with a remediation notice fail to comply with the requirements thereof without reasonable grounds he shall be guilty of an offence.[2006] Where the contaminated land to which the

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[1995] Ibid, para 31.
[1996] *R Crest Nicholson Residential Ltd v Secretary of State for Environment, Food & Rural Affairs* [2010] para 11, EWHC 561 (Admin) [2011] Env. L.R.1; Environmental Act 1995, Part IIA, s 78A.
[1997] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 11, *IJLBE*, 8.1.
[1998] Ibid.
[1999] Environmental Act 1995, Part IIA, s 78F(4).
[2000] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 11, *IJLBE*, 8.1.
[2001] Ibid.
[2002] Ibid.
[2003] Environmental Act 1995, s 1.
[2004] Environmental Act 1995, s 20.
[2005] Environmental Act 1995, Part IIA, s 78M(1).
[2006] Environmental Act 1995, Part IIA, s 78M(1).

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remediation notice relates is industrial, trade or business premises, the offender shall be summarily liable to a fine not exceeding GBP20,000.[2007]

8.6 Environmental Remediation in Canada

In Canada, the polluter pays principle finds expression in the Canadian Environmental Protection Act (CEPA), the overarching environmental law at the federal level.[2008] In terms of the preamble to the Act, 'the Government of Canada recognizes the responsibility of users and producers of toxic substances, pollutants and wastes, and has thus adopted the polluter pays principle'.[2009] Accordingly, the protection of the environment in Canada takes precedence over ascertaining who is responsible for alleged pollution, therefore should be held accountable through the polluter-pays principle.[2010] The application of the polluter pays principle in Canada thus seeks to strengthen the protection of the environment, while safeguarding against the notion that, polluters can pollute, as long as they will bear the cost of remediation.[2011]

In *Kawartha Lakes (City) v. Ontario (Environment)* Judge Goudge J.A of the Court of Appeal for Ontario demonstrated this when he dismissed the City of Kawartha Lakes' appeal against the ruling of the Divisional Court, which upheld a ruling of the Environmental Review Tribunal.[2012] The case relates to a fuel oil spill that occurred on a residential property that is privately owned by the Gendrons.[2013] The Gendron property is adjacent to a road that is owned by the City of Kawartha Lakes, which is in turn adjacent to the shore of Sturgeon Lake.[2014] The fuel oil was delivered to the Gendrons by Thompson Fuels Ltd on 18 December 2008.[2015] The fuel oil subsequently migrated onto the appellant's property and into the Surgeon Lake.[2016] On 30 December

[2007] Environmental Act 1995, Part IIA, s 78M(4).
[2008] Canadian Environmental Protection Act, 1999.
[2009] Ibid.
[2010] *Kawartha Lakes (City) v. Ontario (Environment)* 2013 ONCA 310.
[2011] Ibid.
[2012] *Kawartha Lakes (City) v. Ontario (Environment)* para 21, 2013 ONCA 310.
[2013] Ibid, para 1.
[2014] Ibid.
[2015] Ibid.
[2016] Ibid, para 2.

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2008, the Ministry of the Environment issued an order for the Gendrons to 'prevent, eliminate and ameliorate' the adverse effects of the spill, as they were at fault.[2017]

The Gendrons accepted responsibility and commenced remediation by hiring a clean-up company, however they ran out of funds three months later therefore could not continue any remediation off site, that is, on the appellant's property.[2018] Consequently the Ministry of the Environment ordered the appellant to remediate the adverse effects of the spill on his property.[2019] The appellant appealed unsuccessfully to the Environmental Review Tribunal,[2020] and subsequently to the Divisional Court, which upheld ruling of the Environmental Tribunal.[2021] Goudge J.A of the Divisional Court ruled that, while all agreed that the appellant was innocent of any fault related to the fuel oil spill, the order for the appellant to clean up the damage caused by the spill was not premised on finding fault on the part of the appellant, but rather on the need to serve the environmental protection objective of the Canadian environmental legislation.[2022] The Environmental Tribunal was therefore correct in not revoking the order by the Ministry of the Environment for the appellant to clean up the fuel oil spill, as that would not serve environmental protection, the primary objective of the Canadian environmental law.[2023]

In *Imperial Oil v Quebec (Minister of Environment)* the Canadian Supreme Court of Appeal noted that the polluter-pays principle is entrenched in Canadian environmental law and is found in almost all federal and provincial environmental legislation.[2024] The Court affirmed the role of the principle in Canada, pronouncing that it encouraged sustainable development, hence assigns the responsibility of remedying contamination to those responsible for such pollution, and imposes on them the direct and immediate costs of pollution.[2025] Consequently, polluters are required to pay more

[2017] Ibid, para 5.
[2018] Ibid, para 6.
[2019] Ibid, para 7.
[2020] Ibid, para 12.
[2021] Ibid, para 13.
[2022] Ibid, para 19.
[2023] Ibid, para 21.
[2024] *Imperial Oil v Quebec (Minister of Environment)* para 24 [2003] 2 SCR 624.
[2025] Ibid.

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attention to the need to protect ecosystems in the course of their economic activities.[2026]

This case arose when contamination at a site that was previously operated by Imperial Oil caused problems, and Quebec's Minister of the Environment (Minister) ordered Imperial Oil to prepare a site characterisation study that includes appropriate decontamination measures for the observed contamination for submission to the Minister.[2027] Imperial Oil challenged the order, on the basis that the Minister was conflicted because he was involved in the earlier decontamination work on the site and was now being sued by the present owners of the land.[2028] Imperial Oil argued that the Minister was therefore in violation of the rules of procedural fairness.[2029]

Dismissing the appeal, the Supreme Court of Appeal ruled that the Minister had the authority to issue the order under the Environmental Quality Act.[2030] In terms of the ruling, section 31.42 of the Environmental Quality Act, which set out the polluter-pays principle, allowed for the use of a broad discretion by the Minister.[2031] In terms of that provision, the Minister could impose an obligation on the parties responsible for the contamination of the environment, to conduct the studies required to ascertain the nature of the problem, to submit a remedial plan, and where applicable, to remediate the site at their expense.[2032] The Supreme Court of Canada further affirmed the polluter-pays principle as a well-recognized tenet of Canadian environmental law.[2033] It reiterated that the principle 'assigns polluters the responsibility for remedying environmental damage for which they are responsible, thereby incentivising companies to pay attention to the environment in the course of their economic activities'.[2034]

[2026] Ibid.
[2027] Ibid, para 1.
[2028] Ibid.
[2029] Ibid.
[2030] Ibid.
[2031] Ibid, para 25.
[2032] Ibid.
[2033] *Orphan Well Association v Grant Thornton Ltd.*, 2019 SCC 5, para 29.
[2034] Ibid.

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8.7 Conclusions

The review of the polluter-pays principle reveals two possible interpretations of the principle as a justification for environmental liability and remediation.[2035] On the one hand, the principle can be interpreted as requiring only the polluters to pay for damage caused by their activities.[2036] In terms of this interpretation, if anyone else is made to pay for environmental damage caused by polluting activities, the cost of the pollution is not fully internalised.[2037] This is consistent with the original objective of the polluter-pays principle as an economic principle to advance free trade, taking into account incoherent environmental protection legislation.[2038] On the other hand, the polluter-pays principle can be interpreted as going beyond economic rationale, and towards environmental justice.[2039] While it is fair that the polluters should pay for the damage they cause,[2040] it may be in the interest of environmental protection, therefore fair for another person or the State to pay to remediate such environmental damage.[2041] There is a contradiction in the two approaches, the first approach excludes liability for others, while the second approach provides for others to be held liable in the interest of environmental justice.[2042]

In all the three comparative jurisdictions of this study the polluter pays principle does not apply strictly,[2043] although primarily allocates environmental liability to those who have caused contamination.[2044] These jurisdictions furthermore impose secondary liability to the owners or occupiers of contaminated land, when the polluter cannot be found or has insufficient funds to meet the cost of remediation.[2045] The application of the polluter-pays principle in all three jurisdictions is limited to the actual existence of environmental damage. This limited application of the polluter-pays principle lacks the

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[2035] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 6, *IJLBE*, 8.1
[2036] Ibid.
[2037] Ibid.
[2038] Ibid, Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 34 (Oxford University Press, New York).
[2039] Emma Lees 'The Polluter Pays Principle and the Remediation of the Land' (2016) at 6, IJLBE, 8.1.
[2040] Ibid.
[2041] Ibid.
[2042] Ibid.
[2043] Tracy Field 'Letting polluters off the hook? The impact of Bareki NO vs Gencor Ltd 2006 (1) SA 432 (T) on the reach of s 28 of the National Environmental Management Act 107 of 1998' (2007) at 115, *SALJELP.*
[2044] Section 2(4)(p) of the NEMA; Environmental Act 1995, Part IIA, s 78F(2); *Imperial Oil v Quebec (Minister of Environment)*, [2003] 2 SCR 624 at para 24.
[2045] Section 28(2) of the NEMA; Environmental Act 1995, Part IIA, s 78F(4).

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foresight required to ensure that the principle also serve to reinforce precautionary measures to mitigate potential environmental damage. For example, the OECD, Recommendation on the application of the Polluter-Pays Principle to Accidental Pollution require potential polluters to make financial contributions to preventive measures put in place by public authorities, therefore is forward looking in its avoidance of potential pollution.[2046]

As it considers the optimal approach to shale gas development, consistent with the polluter-pays and precautionary principles, South Africa should, as a licence condition, require shale gas petroleum right holders to make financial contributions to preventative measures put in place by the relevant government agencies or for the monitoring of their activities for possible environmental damage. South Africa should affirm the polluter-pays principle as going beyond economic rationale, and towards environmental justice, to ensure that the environment in the Karoo is protected against the risks associated with shale gas development. Furthermore, given that the polluter-pays principle cannot operate effectively by itself, in relation to shale gas development, South Africa, should ensure that it serves to complement the preventive and pre-cautionary principles, because these principles are more capable of averting irreparable damage, while the polluter-pays principle could be applied effectively to reversible damages/and or to repair repairable damage.[2047]

[2046] OECD 'Recommendation on the Application of the Polluter-Pays Principle to Accidental Pollution' (1989) OECD/LEGAL/0251.
[2047] Nicholas der Sadeleer 'Environmental Principles – From Political Slogans to Legal Rules' (2002) at 43, New York, Oxford University Press.

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CHAPTER 9: CONCLUSIONS

South Africa potentially contains vast amounts of shale gas, a cleaner energy source than crude oil or coal. Despite this potential endowment in natural gas, trapped in the Karoo shales, the country relies on coal as a primary energy source for power generation and production of fuels, such as petrol, diesel, and paraffin. Consequently, South Africa has high carbon dioxide emissions, therefore is a significant contributor to climate change. If found to exist in commercial quantities and produced, shale gas could enhance the country's energy security of supply and aid its efforts to mitigate climate change, and transition towards renewable energy sources, such as wind and solar. The exploitation of shale gas requires the use of hydraulic fracturing, a technology that has generated controversy globally due to its potential risks to the environment and human health.

This thesis investigates whether South Africa's petroleum legal framework provides adequately for the protection of the environment against the risks posed by shale gas development in the karoo. It finds that the country does not have an effective legal framework to regulate the exploration and production of shale gas using this technology. To start with, the petroleum chapter within the Minerals and Petroleum Resources Development Act of 2002 does not provide for hydraulic fracturing, since it was developed with conventional oil and gas exploration and production in mind. In fact, the lack of effective public engagement related to shale gas as a new potential energy source in South Africa and hydraulic fracturing in particular led to the halting of exploration for shale gas in the Karoo before it even began.

The review of the petroleum legal framework, including the most recent case law on public participation related to the exploration and production of oil and gas in South Africa reveals that the societal acceptance of shale gas development will need to be earned through meaningful public participation. This implies the substantive engagement of local communities and other relevant stakeholders at every stage of shale gas development. This will require the applicants and holders of permits and rights for shale gas exploration and exploitation to share pertinent project information, such as the technical aspects of the shale gas development, the associated risks, and

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mitigation measures to be put in place to protect the environment with the relevant stakeholders or interested and affected parties, even at the planning stages of the shale gas projects.

Meaningful public participation also means giving the public access to independent experts to help them with in-depth analysis of the hydraulic fracturing process. Furthermore, there should be openness to adopt processes or project implementation plans in alignment with public concerns, perspectives, and expectations. This should be premised on the recognition that stakeholders have legitimate interests in procedural or substantive aspects of industrial activity, and that these interests have intrinsic value. Accordingly, the petroleum right holders should provide sufficient opportunity for comment on plans, operations, and performance, listen to concerns, and respond appropriately and promptly. Petroleum right holders will have to develop strategies and plans of engagement in accordance with the requirements of the National Environmental Management Act and related Environmental Impact Assessment regulations.

Participatory approaches to addressing environmental challenges have the potential to facilitate knowledge sharing, lessen contradictions, and build trust among key stakeholders leading to support for industrial activities such as shale gas extraction. A requirement for consent by landowners or persons in control of the land over which a petroleum right has been awarded would go a long way to ensure support for shale gas development in the Karoo. In essence, public participation in relation to shale gas exploration and production in the Karoo should be about ensuring that the interests of diverse stakeholders are coordinated in a way that could lead to amicable outcomes.

Moreover, to further aid the societal acceptance of shale gas development, petroleum right holders should strive towards maximizing the economic benefits to local communities from their operations, for example through investing in the education of local people, skills development, creating employment opportunities, investment in social infrastructure such as schools, clinics, roads and other infrastructure that will be required in support of the industry, while also enjoyed by local people, and utilizing locally-based contractors, where possible.

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Key shortcomings in the current petroleum legal framework are: first, the integration of mineral legislation with petroleum legislation, which led to a limited focus on petroleum resources relative to mineral resources. As a result, only one chapter is dedicated to petroleum in the MPRDA, demonstrating an afterthought in the law-making process. This complicates the petroleum legal framework with many references to the more comprehensive mineral chapters/sections within the MPRDA. Secondly, the definition of petroleum as it relates to petroleum is confusing in the MPRDA. The simplification of the definition in the emerging petroleum law, to consider the existence of shale gas in the Karoo could help the interpretation of the petroleum legal framework.

Thirdly, the petroleum regulatory framework does not require consent from local communities/and or interested and affected parties in relation to petroleum exploration and production, this poses a challenge for the local community's acceptance of shale gas development, a key stakeholder. Fourthly, the MPRDA does not require consent from landowners to access their land for petroleum exploration and production, it merely requires that they be consulted. This invokes the question whether access to land for the purpose of petroleum exploration and production infringes on existing rights to ownership. This conundrum has could continue to put applicants for petroleum exploration and production and loggerheads with landowners until sufficiently clarified.

Fifth, while the MPRDA provides for the payment of compensation to landowners or lawful occupiers in the event of loss or damage to land caused by exploration and production activities, this is not enough to persuade landowners to support shale gas development. Sixth, the MPRDA overly empowers the Minister of Mineral Resources and Energy on environmental matters pertaining to petroleum exploration and production. This is not appropriate since environmental matters should be the prerogative of the Minister of Forestry, Fisheries and the Environment. The natural inclination of the Minister of Mineral Resources and Energy is to enable the development of mineral and petroleum resources, and not necessary to safeguard that they be developed in an environmentally sustainable manner. Granted, the MPRDA does compel the Minister of Mineral Resources and Energy to ensure that the nation's mineral and petroleum resources are developed in an orderly and economically sustainable manner while promoting justifiable social and economic development.

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Seventh, the Hydraulic Fracturing Regulations provide for the hydraulic fracturing operation as though it is a production activity. Hydraulic fracturing is a well stimulation technique that largely occurs during field development, that is, the drilling and completion of wells from which gas may ultimately be produced. However, hydraulic fracturing can also be used during the drilling of exploration wells, particularly as it enables the testing of the flow properties of the target formation. When used in this fashion, such wells might not be completed into producing wells, but merely be plugged and abandoned. The petroleum legislation and hydraulic fracturing regulations should ensure that there is no ambiguity in whether hydraulic fracturing is regulated through an exploration, development, or production right. Removing this ambiguity is particularly important given the robustness of the environmental authorization process for awarding production rights, as opposed to the lesser strict process of awarding exploration rights, which is inadequate to regulate hydraulic fracturing.

Lastly, the Hydraulic Fracturing Regulations are not clear how activities that could have a detrimental impact on the environment will be monitored and enforced, and they do not impose penalties for negative environmental impact because of shale gas operations. This is contrary to the NEMA which creates liability for environmental damage, thus provides for the costs of remedying pollution, environmental degradation and consequent adverse health effects be paid for by those responsible for harming the environment.

Indeed, the appropriate management of the risks associated with shale gas development to protect human health and the environment will require an effective petroleum and environmental legal framework. Such a legal framework must be complemented by regulatory measures based on sound science, including specific rules, standards, prohibitions, mandatory reporting, inspections, and penalties. To that effect, this thesis finds that a more effective legal framework for shale gas development in South Africa would be best premised on the principles of avoidance, mitigation, and remediation. These principles are already embedded in the South African environmental law as demonstrated in this thesis. This thesis finds that all three jurisdictions in the comparison provide for the sustainable development of petroleum resources that integrates social, environmental, and economic factors. They require

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that the social, environmental, and economic impacts of petroleum operations be considered, assessed, and evaluated with appropriate decisions taken.

South Africa's environmental law derives its mandate on the prevention of pollution and environmental degradation from the Constitution. The NEMA seeks to ensure that environmental degradation is avoided, and where it cannot be entirely avoided, be minimized and remedied. In South Africa, every person who may cause or has caused significant pollution or degradation of the environment must take reasonable steps to prevent such pollution or degradation from occurring. The UK on the other hand, employs a risk-based approach to environmental regulation, which requires that the risks of an environmental incident related to oil and gas operations are reduced as low as practically possible. Canada's focus is to avoid pollution from occurring, and all levels of government in Canada have authority to protect the environment. The shared nature of environmental jurisdiction makes close cooperation among the different spheres of government and Aboriginal people critical to the protection of the environment in Canada.

Environmental Impact Assessments are mandatory in South Africa. The NEMA provides for the consideration, investigation and assessment of activities that may significantly impact the environment prior to their implementation. The assessment must include the potential impact on the environment; socio-economic conditions; and the cultural heritage, of the activities that require environmental authorization. In the UK, a mandatory EIA is required only if the Minerals Planning Authority believes that the planned operations are likely to have significant negative impact on the environment. In such circumstances, the applicant can request a scoping opinion to agree what issues should be included within the EIA process. In Canada oil and gas projects are subject to environmental screening by the Canadian Environmental Assessment Agency, who may decide that no environmental assessment is required, or that an environmental assessment study should be done.

Unlike in the UK and Canada, the inclusion of environmental rights in the Constitution, alongside other universally accepted rights, such as the right to equality, dignity and the right to life, attests to the importance that South Africa places to the protection of

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the environment. To further give effect to environmental protection, prevention should play a central role to South Africa's quest to exploit shale gas. Therefore, the petroleum regulatory framework should compel companies that are planning to exploit shale gas to ensure that they put preventative measures in place for the exploration and production of shale gas. The conditions could include the need for complete disclosure and use of less harmful chemicals in the hydraulic fracturing process, and the consideration of alternatives, rather the use of freshwater as the main hydraulic fracturing fluid.

Given that the world does not know enough about the full impact of hydraulic fracturing on the environment, and with its limited practical knowledge of shale gas development, it is prudent that South Africa adopts a precautionary approach to shale gas exploration and production in the Karoo. A precautionary approach will enable the development of the requisite knowledge, through academic research and exploration efforts. In its quest to ascertain the shale gas potential in the Karoo and developing the understanding of the risks associated with its extraction, South Africa should align with the interpretation that the possibility of harm to the environment and human health alone should be adequate for precautionary measures to be demanded from those planning to conduct the potentially harmful activities, and that the threat of harm does not even have to be serious or irreversible.

Therefore, the approach should not be about a perfect understanding of the risks associated with shale gas extraction in the Karoo, but the mere awareness of the potential risks should ensure that precautionary measures are put in place. Furthermore, the onus to prove that shale gas related activities in the Karoo will not cause harm to human health and the environment must not be negotiable and must fall on those planning the potentially harmful activities. Similarly, the alternatives assessment approach, which requires the consideration of alternative technologies, in search for the least environmentally damaging options, should be an integral part of South Africa's approach to shale gas development.

The review of the polluter-pays principle reveals two possible interpretations of the principle as a justification for environmental liability and remediation. On the one hand,

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the principle can be interpreted as requiring only the polluters to pay for damage caused by their activities. In terms of this interpretation, if anyone else is made to pay for environmental damage caused by polluting activities, the cost of the pollution is not fully internalised. This is consistent with the original objective of the polluter-pays principle as an economic principle to advance free trade, taking into account incoherent environmental protection legislation. On the other hand, the polluter-pays principle can be interpreted as going beyond economic rationale, and towards environmental justice. While it is fair that the polluters should pay for the damage they cause, it may be in the interest of environmental justice, therefore fair for another person or the State to pay to remediate such environmental damage. There is a contradiction in the two approaches, the first approach excludes liability for others, while the second approach provides for others to be held liable in the interest of environmental justice.

In all the three comparative jurisdictions of this study the polluter pays principle does not apply strictly, although primarily allocates environmental liability to those who have caused contamination. These jurisdictions impose secondary liability to the owners or occupiers of contaminated land, when the polluter cannot be found or has insufficient funds to meet the cost of remediation. The application of the polluter-pays principle in these jurisdictions is limited to the actual existence of environmental damage. This limited application of the polluter-pays principle lacks the foresight required to ensure that the principle also serve to reinforce precautionary measures to mitigate potential environmental damage. For example, the OECD, Recommendation on the application of the Polluter-Pays Principle to Accidental Pollution require potential polluters to make financial contributions to preventive measures put in place by public authorities, therefore is forward looking in its avoidance of potential pollution.

As it considers the optimal approach to shale gas development, consistent with the polluter-pays and precautionary principles, South Africa should, as a licence condition, require shale gas petroleum right holders to make financial contributions to preventative measures put in place by the relevant government agencies or for the monitoring of their activities for possible environmental damage. Furthermore, South Africa should affirm the polluter-pays principle as going beyond economic rationale,

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and towards environmental justice, to ensure that the environment in the Karoo is protected against the risks associated with shale gas development. Furthermore, given that the polluter-pays principle cannot operate effectively by itself, in relation to shale gas development, South Africa, should ensure that it serves to complement the preventive and pre-cautionary principles, because these principles are more capable of averting irreparable damage, while the polluter-pays principle could be applied effectively to reversible damages/and or to repair repairable damage.

In sum, the use of hydraulic fracturing to enhance the production of oil and gas is a well-established practice in the international petroleum industry, and dates back at least seven decades. Refinements of the hydraulic fracturing technology, especially the combination of hydraulic fracturing with horizontal drilling, and the emergence of technology to better image the sub-surface was an innovative breakthrough, that ultimately led to the US shale gas revolution. Approached correctly and with the protection of the environment as a key priority, the exploitation of shale gas could enhance South Africa's energy security of supply and reduce its carbon dioxide emissions.

It will take at least 10 years for shale gas to be produced commercially in the Karoo. The South African government therefore have the opportunity to integrate best practice in the regulation of shale gas development. Lessons learned from the US and Canada as leaders in shale gas development, together with the UK as an aspirant shale gas producer, can be adapted to a South African context. Collaborations between the relevant governmental authorities, and agencies such as the Petroleum Agency SA, Council for Geoscience, industry, key stakeholders, and the public could lead to innovative solutions for the protection of the environment and human health against the risks posed by shale gas development in the Karoo.

This thesis has been written amidst uncertainty as to whether the South African Karoo indeed contain shale gas resources in quantities that would justify the development thereof commercially. Key to the assessment of the commercial viability of shale gas development is the use of hydraulic fracturing to ascertain whether shale gas could be liberated from the shales and flow at sufficient rates to render it commercially viable.

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Hydraulic fracturing has never been used in South Africa, therefore what it would take to mobilise and use such technology is not yet fully understood. For example, where would the water and sand required for hydraulic fracturing come from? Assuming such water and sand would be transported using trucks initially, would the current road infrastructure be able to carry such increased traffic of trucks etcetera. More research in this area would enrich existing research and provide further insights that this thesis has not been able to provide.

Furthermore, the country also does not have a sense of the speed with which shale gas development could take place in the Karoo, given that most of the enablers that ensured the rapid development of shale gas in the US and Canada are absent in the Karoo, such as existing gas pipeline networks, supporting services and a gas market. This thesis also does not address this area given its focus on the legal framework. Further research could close this blind spot, which have a bearing on the speed with which the appropriate legislation to regulate shale gas development needs to be in place, recognizing that secondary legislation/and or hydraulic fracturing regulations and related water use regulations might be gazetted by the Department of Forestry, Fisheries and the Environment and Department of Water and Sanitation framework in 2023. At the core of an appropriate legislative framework for shale gas development would be the rigorous review of the primary legislation through the multi-party parliamentary system, which regulations do not necessarily fully benefit from. More thorough research as to what would constitute a social licence to operate for shale gas in the Karoo would also be of great benefit for South Africa.

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BIBLIOGRAPHY

Legislation

Canada Constitution Act, 1982.

Canadian Environmental Assessment Act, 2012.

Canadian Environmental Protection Act, 1999.

Canada Petroleum Resources Act, 1985.

Canada Water Act,1985.

Constitution of the Republic of South Africa, No.108 of 1996.

Environmental Protection Act 1990 (UK).

Federal Sustainable Development Act, 2008 (Canada).

Fisheries Act,1985 (Canada).

Impact Assessment Act, 2019 (Canada).

Minerals and Petroleum Resources Development Act, No. 28 of 2002.

Mining Titles Registration Act, No. 16 of 1967.

National Environmental Management Act, No.107 of 1998.

National Environmental Management: Waste Act, No. 59, 2008.

`

National Water Act, No.36 of 1998.

National Water Amendment Act, No.27 of 2014.

Oil and Gas Activities Act, 2008 (Canada).

Petroleum Act, 1998 (UK).

Species at Risk Act, 2002 (Canada).

Upstream Petroleum Resources Development Bill, Government Notice R.1706 in Government Gazette No.42931 of 24 December 2019.

Water Act, 1985 (Canada).

Water Sustainability Act, 2014 (Canada).

Regulations and Government Notices

Alberta Energy Regulator, Directive 083: Hydraulic Fracturing – Subsurface Integrity, 2013.

Alberta Energy Regulator, Directive 59: Well Drilling and Completion, 2012.

British Columbia, Drilling and Production Regulation, 2012.

Borehole Sites & Operations Regulations, 1995 (UK).

Canada Oil and Gas Drilling and Production Regulations, 2009.

`

Department of Water and Sanitation 'Declaration of the Exploration for and Production of Onshore Unconventional Oil or Gas Resources or any Activities Related Thereto Including but not Limited to Hydraulic Fracturing as a Controlled Activity, Government Gazette, No. 39299 of 16 October 2015.

Environmental Impact Assessment Regulations, 2014, in GN R982 GG 38282.

Environmental Impact Assessment Regulations, 2014, in GN R517 GG 44701.

Environmental Permitting Regulations 2010 (UK).

Environmental Permitting (England and Wales) Regulations, 2010.

Environmental Permitting (England and Wales) (Amendment) Regulations, 2013.

Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992).

Offshore Installations and Wells (Design and Construction Etc) Regulations 1996 (UK).

Oil and Gas Well Abandonment Guidelines, 2015 (UK).

Regulations for Petroleum Exploration and Production, Government Notice R.466 in Government Gazette No.38855 of 3 June 2015.

The Borehole Sites and Operations Regulations, No. 2038 of 1995 (UK).

The Hazardous Waste (England and Wales) Regulations, No.894 of 2005.

The Offshore Installation and Wells (Design and Construction etc) Regulations

`

The United Kingdom Onshore Operators' Group (2016) Guidelines for UK Well Operations on Onshore Shale Gas Wells, Issue 4.

UK Borehole Sites & Operations Regulations, 1995.

UK Offshore Installations and Wells (Design and Construction Etc) Regulations 1996.

UK Hydrocarbons Licensing Directive Regulations, 1995.

Upstream Petroleum Resources Development Bill (B13-2021) Government Gazette No. 44694 of 11 June 2021.

United States Clean Air Act 1970.

The Dangerous Substances and Explosive Atmospheres Regulations, No.2776 of 2002 (UK).

Petroleum Licensing (Exploration and Production) (Landward Areas) Regulations 2014 (UK).

Proposed Regulations Pertaining to the Financial Provisioning for the Mitigation and Rehabilitation of Environmental Damage caused by Reconnaissance, Prospecting, Exploration, Mining or Production Operations, Government Notice R.2272 in Government Gazette No.47112 of 11 July 2022.

Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015.

Cases

Agri South Africa v Minister of Minerals and Energy, 2013, Case No: CCT 51/12 (ZACC9).

`

Anglo Operations Ltd v Sandhurst Estates (Pty) Ltd, 2006, Case No: 634/05 (ZASCA 146).

Alberta Wilderness Association v. Minister of Environment, 2009 FC 710.

Bareki NO and Another v Gencor Ltd and Others, 2006 (1), SA 432 (T) (South Gauteng High Court).

Border Deep Sea Angling Association and others v Minister of Mineral Resources and Energy and others, 2021 SA 3865/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (3 December 2021).

Christian John Adams and Others v Minister of Mineral Resources and Energy and others, 2022 SA 1306/22 (High Court of South Africa, Western Cape Division, Cape Town) (1 March 2022).

Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others, (65662/16) ZAGPPHC 58; [2017] 2 All SA 519 (GP).

Environmental Defence Canada v. Minister of Fisheries and Oceans, 2009 FC 878.

Fuel Retailers Association of Southern Africa vs Director-General Environmental Management, Mpumalanga, and others, 2007, ZACC 67/06 [2007] ZACC13.

Haida Nation v. British Columbia (Minister of Forests) 2004, File No.: 29419.

John Douglas Stern and others vs Minister of Mineral Resources, 2015 SA 5672/2015 (High Court of South Africa, Eastern Cape Division, Grahamstown).

Mikisew Cree First Nation v. Canada (Minister of Canadian Heritage) 2005 SCC 69 (30246).

`

Minister of Mineral Resources v Stern & others (1369/2017) and Treasure the Karoo Action Group & another v Department of Mineral Resources and others (790/2018) [2019] ZASCA 99 (4 July 2019).

Peralta Judgment of the Court, 14 July 1994, in Case C-379/92.

Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy and Others, 2021 SA 3491/2021 (High Court of South Africa, Eastern Cape Division, Grahamstown) (28 December 2021).

R v. Secretary of State for Trade and Industry ex parte Duddridge, October 4, 1994, United Kingdom Queens Bench Division, Vol. 7 No. 2, 224.

Supreme Court of Canada in 114957 Canada Ltée v Hudson [2001] 2 S.C.R.

West Virginia et al. v. Environmental Protection Agency et al. Supreme Court of the United States Certiorari to the United States Court of Appeals for the District of Columbia Circuit, No.20-1530, June 30, 2022.

Treaties and Conventions

Aarhus Protocol on Persistent Organic Pollutants to the 1979 Long-Range Transboundary Air Pollution Convention (1998).

Agreements Concerning the Protection of the Scheldt and Meuse Rivers (1994).

Bamako Convention on the Ban of the Import into Africa and Control of Transboundary Movement and Management of Hazardous Waste Within Africa (1991).

Bremen Declaration of the International Conference on the Protection of the North Sea (1984).

`

Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992).

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (1983).

Convention for Protection of the Marine Environment of the North-East Atlantic (1992).

Directive 2011/92/EU of the European Parliament and of the Council on the Assessment of the Effects of Certain Public and Private Projects on the Environment (13 December 2011).

Esbjerg Declaration of the Fourth Conference on the Protection of the North Sea (1995).

International Convention on Oil Pollution Preparedness, Response and Cooperation (1990) United Nations Treaty Series 1891.

Nordic Council's International Conference on Pollution of the Seas: Final Document Agreed to, Oct. 18, 1989, in Nordic Action Plan on Pollution of the Seas, 99 app. V (1990).

OSPAR Convention (1992).

OECD ‘Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies’ (1972) OECD/LEGAL/0102.

OECD ‘Recommendation of the Council on the Implementation of the Polluter-Pays Principle’ (1974) OECD/LEGAL/0132.

OECD ‘Recommendation on the Application of the Polluter-Pays Principle to Accidental Pollution’ (1989) OECD/LEGAL/0251.

`

OECD ‘Recommendation on the Uses of Economic Instruments in Environmental Policy’ (1991) OECD/LEGAL/0258.

Treaty establishing the European Community, Title XIX, Article 144(2).

Treaty on the Functioning of the European Union.

United Nations ‘Conference on Environment and Development’ (1992) Article 17.2.1, A/CONF.151//26, Vol.II, 13 August 1992.

United Nations ‘Convention on the Protection and Use of Transboundary Watercourses and International Lakes’ (1992).

United Nations ‘Doha amendment to the Kyoto Protocol’ (2012).

United Nations General Assembly ‘Rio Declaration on Environment and Development’ (1992) Principle 16, A/CONF. 151/26/(Vol.1).

UN, General Assembly resolution 1803 (XVII) ‘Permanent Sovereignty over Natural Resources’ (1962)

United Nations ‘United Nations Framework Convention on Climate Change’ (1992).

United Nations ‘Kyoto Protocol to the United Nations Framework Convention on Climate Change’ (1997).

United Nations ‘Paris Agreement’ (2015).

United Nations ‘Report of the Conference of the Parties on its seventeenth session’ (2012) held in Durban from 28 November to 11 December 2011.

`

United Nations ‘Report of the World Commission on Environment and Development: Our Common Future’ (1987).

United Nations ‘The Millennium Development Goals Report’ (2015) United Nations, New York.

United Nations ‘Transforming our world: the 2030 Agenda for Sustainable Development’ General Assembly Resolution 70/1, United Nations, New York.

United Nations ‘Montreal Protocol on Substances that Deplete the Ozone Layer’ (1989) 16 Sept 1987, Treaty Series, 1989, Vol. 1522, 1-26369.

UNEP ‘Report of the Governing Council on the Work of its Fifteenth Session’ (1989) U.N. Environment Programme, U.N. GAOR, 44th Sess., Supp

United Nations ‘Conference on Environment and Development’ (1992) Article 17.2.1, A/CONF.151//26, Vol.II, 13 August 1992.

United Nations Environmental Programme ‘Stockholm Declaration’ (1972).

Books and Journals

Academy of Science of South Africa *South Africa’s Technical Readiness to Support Shale Gas Development* (2016) (ASSAf, Pretoria).

Adams MD ‘The precautionary principle and the rhetoric behind it’ (2002) *Journal of Risk Research* 5 (4).

Adshead J ‘The Application and Development of the Polluter-Pays Principle across Jurisdictions in Liability for Marine Pollution: The Tales of the Erika and the Prestige’ (2018) *J.Envtl* 30.

`

Albrecht E and Schneemann D ‘Fracking in the United Kingdom: Regulatory Challenges between Resource Mobilisation and Environmental Protection’ (2014) *Carbon & Climate Law Review* 8(4).

Alexander MD, Qian L, Ryan TA & Herron J ‘Considerations for Responsible Gas Development of the Frederick Brook Shale in New Brunswick’ (2011) Fundy Engineering and Atlantica Centre for Energy.

Aledeitan L & Nwosu C ‘Shale Gas Development: Their Gain, Our Pain and the Cost’ (2013) *Journal of Politics and Law* 3(6).

Diana M. Allen, Chelsea Notte & Nancy Olewiler ‘Enhancing water security in a rapidly developing shale gas region’ (2017) *Journal of Hydrology: Regional Studies* 11.

Arthur JD, Bohm B David Cornue D ‘Environmental Considerations of Modern Shale Gas Development’ (2009) SPE Paper No. 122931, Presented at SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 4-7 October 2009.

Atkinson D ‘Fracking in a fractured environment: Shale gas mining and institutional dynamics in South Africa’s young democracy’ (2018) *The Extractive Industries and Society* 5.

Badenhorst PJ ‘Ownership of Minerals In situ in South Africa: Australian Darning to the Rescue’ (2010) *SALJ* 127(4).

Barton B ‘The Common Law of Subsurface Activity’ in Zillman DN, McHarg A, Barrera-Hernandez L & Bradbrook A *The Law of Energy Underground: Understanding New Developments in Subsurface Production, Transmission and Storage* (2014) (Oxford University Press, Oxford).

`

Bates F ‘Comparative common law: a justification’ (1981) *Comparative and International Law Journal of Southern Africa* 14(3).

Baxter LG ‘Pure comparative law and legal science in a mixed legal system’ (1983) *Comparative and International Law Journal of Southern Africa*, 16.

Besada H, McMillan L Polonenko L and Agarwal M ‘Did the Millennium Development Goals work?: Meeting future challenges with past lessons’ (2017) (Cambridge University Press, Great Britain).

Benson SM & Friedmann SJ ‘Carbon Capture, Utilization, and Storage: An Important Part of a Response to Climate Change’ in *The Bridge* (2014) (National Academy of Engineering, Washington).

Bernhard H, Krooss M, Littke R ‘Petrophysical and geochemical characterization of potential unconventional gas shale reservoirs in the southern Karoo Basin, South Africa’ (2019) *International Journal of Coal Geology* 212.

Black DE, Booth PWK & de Wet MJ ‘Petrographic, geochemical and petro-physical analysis of the Collingham Formation near Jansenville, Eastern Cape, South Africa – potential cap rocks to shale gas in the Karoo’ (2016) *South African Journal of Geology* 119.1.

Bodansky D ‘The United Nations Framework Convention on Climate Change: A Commentary’ (1993) *Yale Journal of International Law* (18)451.

Bodansky D ‘The Copenhagen Climate Change Conference: A Postmortem’ (2010) *The American Journal of International Law* 230.

Bodansky D ‘The Paris Climate Change Agreement: A New Hope’ (2016) The *American Journal of International Law* 110(269).

`

Bodle R, Donat L & Duwe M ‘The Paris Agreement: Analysis, Assessment and Outlook’ (2016) *CCLR* 1.

Branco M.C & Rodrigues L.L ‘Positioning Stakeholder Theory within the Debate on Corporate Social Responsibility’ (2007) *Electronic Journal of Business Ethics and Organization Studies* 12 (1).

Brewer MK ‘Corporate Social Responsibility in the Age of Hydraulic Fracturing in the United States and the United Kingdom’ (2018) *Creighton Law Review* 51.

Brinks, J. and Fanchi, J ‘Geologic Sequestration: Modeling and Monitoring Injected CO2 (2011) SPE paper 66749, proceedings of 2001 SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, 26-28 February 2001.

Burns M, Reid C & Bremen J ‘UK Shale Gas – A Policy Tug War’ (2016) *Journal of Energy & Nat Resources Law* 34(2).

Burns M, Atkinson D, Barker O, Davis C & Day E et al ‘Scenarios and Activities’ in Scholes R, Lochner P, Schreiner G & Snyman-Van der Walt L (eds) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) (CSIR, Pretoria).

Bredenhann L & Garlipp L ‘The polluter pays principle in water and environmental law’ (1999) *Civil Engineering* 7 (2)2.

Cameron P, Castro JFN, Lanardonne T and Wood G ‘Across the universe of shale resources – a comparative assessment of the emerging legal foundations for unconventional energy’ (2018) *Journal of World Energy Law and Business* 11.

Canete MA ‘Paris is Much More Than the Deal’ (2015) *New Scientist* 234 (3129).

`

Cantoni R, Klaes MS, Lackerbauer SI & Foltyn C et al, ‘Shale tales: Politics of Knowledge and promises in Europe’s shale gas discourses’ (2018) *The Extractive Industries and Society* 5.

Cawood FT & Minnitt RCA ‘A historical perspective on the economics of the ownership of mineral rights ownership’ (1998) *The Journal of The South African Institute of Mining and Metallurgy*.

Centner TJ & Petetin L ‘Permitting program with best management practices for shale gas wells to safeguard public health’ (2015) *Journal of Environmental Management* 163.

Chapman, Wait R and Kleynhans E ‘The governance of shale gas production in South Africa’ (2015) *South African Journal of International Affairs* 23(1).

Chasek P ‘The Paris Negotiations: Background and Context’ (2021) in Jepsen H, Lundgren M, Monheim K and Walker H (Eds) ‘Negotiating the Paris Agreement: The Insider Stories’ (2021) (Cambridge University Press, United Kingdom).

Cohen B & Winkler H ‘Greenhouse gas emissions from shale gas and coal for electricity generation in South Africa’ (2014) *S Afr J Sci*110(3/4).

Costa D, Jesus J, Branco D, Danko A & Fiuza A ‘Extensive Review of Shale Gas Environmental Impacts from Scientific Literature (2010 – 2015)’ (2017) *Environ Sci Pollut Res* 24.

Cooney R ‘The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An issues paper for policy-makers, researchers and practitioners’ (2004) IUCN Policy and Global Change (IUCN, Gland, Switzerland and Cambridge, UK).

`

Cotton M ‘Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning’ (2017) *Local Environment* 22(2).

Cotton M ‘Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning’ (2017) *Local Environment* 22(2).

Craig RK ‘Mitigation and Adaptation’ in Johansen E, Busch SV, Jakobsen IU (eds) *The Law of the Sea and Climate Change: solutions and constraints* (2021) (University Printing House, Cambridge).

Dar OA and Khan MS ‘Millennium development goals and the water target: details, definitions and debate’ (2011) *Tropical Medicine and International Health* 16(5).

Del Guayo I ‘The evolution of principles of energy law (a review of the content of the Journal of Energy & Natural Resources Law, 1982 – 2022) (2022) *Journal of Energy & Natural Resources Law* 40(1).

Dayal AM ‘Shale’ in Dayal AM & Mani D *Shale Gas: Exploration and Environmental and Economic Impacts* (2017) (Elsrivier, Oxford, United Kingdom).

De Cruz P *Comparative law in a changing world* (1999) 2nd ed (Cavendish Publishing Ltd: London).

De Kock MO, Beukes NJ, Adeniyi EO & Cole D, et al ‘Deflating the shale gas potential of South Africa’s Main Karoo basin’ (2017) *S Afr J Sci*; 113 (9/10).

De Wit MJ ‘The great shale gas debate in the Karoo’ (2011) *S Afr J Sci*; 107(7/8).

Deese B ‘Paris Isn’t Burning’ (2017) 96(4) *Foreign Affairs*.

Dignum M, Correlje A, Cuppen E, Pesch U & Taebi B ‘Contested Technologies and Design for Values: The Case of Shale Gas’ (2015) *Sci Eng Ethics* 22.

`

Der Sadeleer N *Environmental Principles – From Political Slogans to Legal Rules* (2002) (Oxford University Press: New York).

Der Sadeleer N *Environmental Principles: From Political Slogans to Legal Rules* (2020) (2nd edn) (Oxford University Press: United Kingdom).

Donaldson T & Preston LE 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications' (1995) *Academy of Management Review*.

Du Plessis W 'Absolving Historical Polluters from Liability Through Restrictive Judicial Interpretation: Some Thoughts on Bareki NO v Gencor Ltd' (2007) *Stell LR* 1.

Du Plessis W 'Regulation of Hydraulic Fracturing in South Africa: A Project Lifecycle Approach' (2015) *Potchefstroom Electronic Law Journal* 18(5).

Du Toit L 'Experiences from Other Jurisdictions' in Glazewski J and Esterhuyse S *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) (Juta and Company (Pty) Ltd, Claremont).

Duvic-Paoli L *The Prevention Principle in International Environmental Law* (2018) (Cambridge University Press: London).

Eckersley R 'The common but differentiated responsibilities of states to assist and receive climate refugees' (2015) *European Journal of Political Theory* 14(4).

Environmental Law Centre (Alberta) 'The Polluter Pays Principle in Alberta Law' (2019) *CanLIIDocs* 3671.

Esposito M 'Water Issues Set the Pace for Fracking Regulations and Global Shale Extraction' (2013) *Tulane Journal of International & Comparative Law* 22.

`

Esty DC and Adler DP ‘Changing International Law for a Changing Climate’ (2018) *American Journal of International Law* 112.

Esterhuyse S, Vermeulen D and Glazewski J ‘Developing and enforcing fracking regulations to protect groundwater resources’ (2022) *NPJ Clean Water* 5(3).

Eze MA & Eze IS ‘An Analysis of the Precautionary Principles and Its Adaptation in International, Regional and National Laws’ (2019) *International Journal of Energy and Environmental Science* 4(3).

Farah PD & Tremolada R ‘A Comparison between Shale Gas in China and Unconventional Fuel Development in the United States: Water, Environmental Protection, and Sustainable Development’ (2016) 41 *Brook. J. Int’l L.* 579.

Finkel ML, Depledge M, Law A & Seth C, Shonkoff SBC ‘Considerations for the development of shale gas in the United Kingdom’ (2015) *Science of the Total Environment*.

Fleming RC and Reins L ‘Shale gas extraction, precaution and prevention: A conversation on regulatory responses’ (2016) *Energy Research & Social Science* 20.

Fløttum K & Gjerstad Ø ‘The Role of Social Justice and Poverty in South Africa’s National Climate Change Response White Paper’ (2014) *South African Journal of Human Rights* 29.

Ford J, Maillet M, Pouliot V, Meredith T and Cavanaugh A ‘Adaptation and Indigenous Peoples in the United Nations Framework Convention on Climate Change’ (2016) *Climate Change* 139.

Gao Y, Gao X, Zhang X ‘The 2 °C Global Temperature Target and the Evolution of the Long-Term Goal of Addressing Climate Change - From the United Nations Framework Convention on Climate Change to the Paris Agreement’ (2017) *Engineering* 3.

`

Grafton RQ, Gronshaw IG & Moore MC *Risks, Rewards and Regulation of Unconventional Gas: A Global Perspective* (2017) (Cambridge University Press, UK).

Geel C, de Wet M, Booth P, Schulz HM & Horsfield B 'Palaeo-Environment, Diagenesis and Characteristics of Permian Black Shales in the Lower Karoo Supergroup Flanking the Cape Fold Belt Near Jansenville, Eastern Cape, South Africa: Implications for the Shale Gas Potential of the Karoo Basin' (2015) *Geological Society of South Africa*.

Glazewski J 'Sustainable development and proposed shale extraction in South Africa: prospects and challenges' in May JR and Dernbach JC *Shale Gas and the Future of Energy: Law and Policy for Sustainability (*2016) (Edward Elgar Publishing Limited, UK).

Glazewski J & Plit L 'Towards the application of the precautionary principle in South African law' (2015) *Stellenbosch Law Review* 26(1).

Glazewski J & Esterhuyse S *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) (Claremont, Juta and Company (Pty) Ltd).

Glazewski J and Posnik S 'Compliance with international environmental standards and expectations: review of international developments' (2000) *The Journal of The South African Institute of Mining and Metallurgy*.

Groat CG & Grimshaw TW 'A Fact-Based Regulation for Environmental Protection in Shale Gas Development' (2012) (Energy Institute - The University of Texas at Austin).

Hadden S, Moyer JD & Rettig J 'Fracking for shale gas in South Africa: blessing or curse?' (2013) *Institute for Security Studies*.

Hague Declaration of the Third Conference on the Protection of the North Sea (1990).

`

Harewood LM ‘The importance of the precautionary principle in international environmental law’ (2005) *Coventry Law Journal* 10(2).

Hausberger O, Högn LA & Soliman K ‘Management Decision Matrix for Shale Gas Projects in Europe’ (2012) SPE Paper No. 162921, Presented to the SPE Hydrocarbon, Economics, and Evaluation Symposium, Alberta, Calgary, 24 - 25 October 2012.

Hays J, Finkel ML, Depledge M, Law A & Shonkoff BC ‘Considerations for the development of shale gas in the United Kingdom’ (2015) *Science of the Total Environment.*

Henderson PGW ‘Some thoughts on distinctive principles of South African Environmental Law’ (2001) *South African Journal of Environmental Law and Policy* 8(2).

Hobbs P, Day E, Roserwarne P & Esterhuyse S et al ‘Water Resources’ in Scholes R, Lochner P, Schreiner G & Snyman-Van der Walt L et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) (CSIR, Pretoria).

Houghton JT, Jenkins GJ & Ephraums JJ *Climate Change: The IPCC Scientific Assessment* (1990) (Cambridge University Press, Cambridge).

Howard T & Da Silva ST *Possible legal obligations to consult* (2015) (Edward Elgar Publishing Limited, United Kingdom).

Howarth RW ‘A bridge no nowhere: methane emissions and the greenhouse gas footprint of natural Gas’ (2014) *Energy Science and Engineering*.

Howarth RW, Santoro R & Ingraffea A ‘Methane and the greenhouse gas footprint of natural gas from shale formations’ (2011) *Climate Change Letter*.

`

Hunter T (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

Hunter T 'Legal Regulatory Framework for the Sustainable Extraction of Australian Offshore Petroleum Resources – A Critical Functional Analysis' (2010) PhD Thesis, University of Bergen.

Huber W 'After Fukushima: The precautionary principle revisited' (2012) *Verbum et Ecclesia* 33(2).

Ingelson A 'Shale Gas Law and Regulation in North America' in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

Ingelson A & Hunter T 'A Regulatory Comparison of Hydraulic Fracturing Fluid Disclosure Regimes in the United States, Canada, and Australia' (2014) Natural Resources Journal 54(2).

Jones P, Hillier D & Daphne Comfort D 'Fracking and public relations: rehearsing the arguments and making the case' (2013) *J. of Public Affairs* 13.

Kemp C, Ravikumar A and Brandt A 'Comparing Natural Gas Leakage Detection Technologies Using an Open-source "Virtual Gas Field" Simulator' (2016)*Environmental Science and Technology*.

Ketzer JM, B. Carpentier B, Le Gallo Y, & Le Thiez P 'Geological Sequestration of CO2 in Mature Hydrocarbon Fields: Basin and Reservoir Numerical Modelling of the Forties Field, North Sea' (2005) *Oil & Gas Science and Technology* 60(2)..

`

Khan MR ‘Polluter-Pays-Principle: The Cardinal Instrument for Addressing Climate Change’ (2015) *Laws* 4.

Khan MR & Sirazoom Munira ‘Climate change adaptation as a global public good: implications for financing’ (2021) *Climate Change* 167(50).

Kind P & Reddell C ‘Public Participation and Water Use Rights’ (2015) *PER/PELJ* 4(18).

Ko P and Salkin P ‘Sustainable drilling through health impact assessment: understanding and planning for public health impacts’ in May JR and Dernbach JC (eds) *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK).

Kristl KT ‘Public participation and sustainability: how Pennsylvania’s shale gas program thwarts sustainable outcomes’ in May JR and Dernbach JC (eds) *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, UK).

Ladan MT ‘SGDs Framework as the Blueprint for Climate Change Action and Sustainable Development in Africa: Role of Law and Parliaments’ (2016) p.167, SAJELP 22(159).

Le M ‘An assessment of the potential for the development of the shale gas industry in countries outside of North America’ (2018) *Helyon* 4.

Lees E ‘The Polluter Pays Principle and the Remediation of the Land’ (2016) *IJLBE* 8.1.

Li A ‘Hopes of Limiting Global Warming? China and the Paris Agreement on Climate Change’ (2016) *China Perspectives* 1.

`

Loaniyan A ‘Imposing Liability for Oil Spill Clean-Ups in Nigeria: An Examination of the Role of the Polluter-Pays Principle’ (2015) *Journal of Law, Policy and Globalization* 40.

May JR and Dernbach JC ‘Introduction’ in May JR and Dernbach JC (eds) *Shale Gas and the Future of Energy: Law and Policy for Sustainability* (2016) (Edward Elgar Publishing Limited, United Kingdom).

Maljean-Dubois S ‘The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in Climate Regime?’ (2016) *Review of European Community & International Environmental Law* 25(2).

Matsui Y ‘Some Aspects of the Principle of Common but Differentiated Responsibilities’ (2012) *International Environmental Agreements: Politics, Law and Economics* 2.

Matthew C ‘Fair fracking? Ethics and environmental justice in the United Kingdom shale gas policy and planning’ (2017) *Local Environment* 22(2).

McGranahan DA and Kirkman KP ‘Be proactive on energy sprawl: South Africa must anticipate surface impacts of fracking in rural areas’ (2021) *Resources Policy* 72..

Meyer J ‘Who should pay for pollution? The OECD, the European Communities and the emergence of environmental polity in the early 1970s’ (2017) *European Review of History: Revue européenne d'histoire*, 24:3.

Mesarovic M.M, ‘Scientific Uncertainties Feed Scepticism on Climate Change’ (2015) *Thermal Science* 19(2).

Moore MC ‘Regulation of Unconventional Hydrocarbons in Alberta, Canada’ in Grafton RQ, Gronshaw IG & Moore MC (eds) *Risks, Rewards and Regulation of Unconventional Gas: A Global Perspective* (2017) (Cambridge University Press, UK).

`

Morgan J ‘Sustainability and stakeholder participation: shale gas extraction in the United Kingdom’ in May JR and Dernbach JC (eds) *Shale Gas and the Future of Energy: Law and Policy for Sustainability’*(2016) (Edward Elgar Publishing Limited, United Kingdom).

Mostert H ‘Land as a “National Asset” Under the Constitution: The System Change Envisaged by the 2011 Green Paper on Land Policy and What This Means for Property Law Under the Constitution’ (2014) *PELJ* (17)2.

Moyo T ‘Low Carbon and Climate Resilient Investments – Is South Africa Doing Enough?’ (2016) *Africa Insight* 45(4).

Nguyen DN ‘Geological Sequestration: Technical and Economic Review’ (2003) SPE paper 81199, proceedings of 2003 SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, 10-12 March 2003.

Oettle N, Lindeque L, du Toit J & Samuels I et al ‘Impacts on Agriculture’ in Scholes R, Lochner P, Schreiner G & Snyman-Van der Walt L et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) (Pretoria, CSIR).

Ougier-Simonin A, Renard F, Boehm C & Vidal-Gilbert S ‘Microfracturing and microporosity in shales’ (2016) *Earth Science Reviews*.

Palani M and Sweet J (2017) SA’s ‘first climate change court case’ *Without Prejudice* 17(4).

Paterson J and Hunter T 'Shale Gas Law and Regulation in the United Kingdom’ in Tina Hunter (ed) *Handbook of Shale Gas Law and Policy: Economics, Access, Law and Regulation in Key Jurisdictions* (2016) Energy & Law 18 (Intersentia Ltd, Cambridge: United Kingdom).

`

Pearson J and Lynch-Wood G ‘Concern and counter-concern: The challenge of fragmented fears for the regulation of hydraulic fracturing’ (2017) *The Extractive Industries and Society* 4.

Pigou AC *The Economics of Welfare* (1932) (Macmillan and Co, Limited, London).

Plit L ‘Regulating Petroleum Extraction: The Provisions of the Mineral and Petroleum Resources Development Act 28 of 2002’ in Jan Glazewski and Surina Esterhuyse *Hydraulic Fracturing in the Karoo: Critical legal and Environmental Perspectives* (2016) (Claremont, Juta and Company (Pty) Ltd).

Radovanovic MM, Ducic V & Mukherjee S ‘Climate Changes Instead of Global Warming’ (2014) *Thermal Science* 18(3).

Reed MS, Vella S, Challies E & de Vente J et al ‘A theory of participation: what makes stakeholder and public engagement in environmental management work?’ (2018) *Restoration Ecology* 26.

Reins L ‘The Shale Gas Extraction Process and Its Impacts on Water Resources’ (2011) *Review of European Community & International Environmental Law* 20 (3).

Rowe B ‘Paris climate deal exit ‘deeply troubling’ to Catholic leaders’ (2017), *National Catholic Reporter*, 16 June 2017.

Scholtz W ‘The promotion of regional environmental security and Africa’s common position on climate change’ (2010) *African Human Rights Law Journal*.

Scholes B, Lochner P, Schreiner G & Snyman-Van der Walt L et al (eds) *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) (Pretoria: CSIR).

`

Shaw JC, Reynolds MM, Burke LH ‘Shale Gas Production Potential and Technical Challenges in Western Canada’ (2006) Paper 2006-193, presented to the Petroleum Society’s 7th Canadian International Petroleum Conference, Calgary, Alberta, Canada, 13-15 June.

Smith DC ‘Unconventional Gas Development 2.0: Reducing the ‘Environmental Footprint’ Through New Technologies’ in Zillman D, Roggenkamp M, Paddock L & Godden L *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions’* (2018) (Oxford University Press, London).

Smythe DK ‘Inadequate Regulation of the Geological Aspects of Shale Exploitation in the UK’ (2020) at 15, *International Journal of Environmental Research Public Health*.

Soliman MY, Daal J & East L ‘Impact of Fracturing and Fracturing Techniques on Productivity of Unconventional Formations’ (2012) SPE Paper No. 150949, Presented at the SPE/EAGE European Unconventional Resources Conference and Exhibition, Vienna, Austria, 20-22 March.

Spence B ‘Regulating shale gas production for sustainability: federalism questions’ in May JR and Dernbach JC ‘Shale Gas and the Future of Energy: Law and Policy for Sustainability’ (2016) (Edward Elgar Publishing Limited, UK).

Stern PC, Webler T & Small MJ ‘Special Issue: Understanding the Risks of Unconventional Shale Gas Development’ (2014) *Environmental Science & Technology*.

Stamford L & Azapagic A ‘A Fractured truth’ (2014) *The Chemical Engineer*.

Scholtz W ‘The promotion of regional environmental security and Africa’s common position on climate change’ (2010) *African Human Rights Law Journal* 10(1).

`

Sonpar K, Pazzaglia F & Kornijenko J ‘The Paradox and Constraints of Legitimacy’ (2010) *Journal of Business Ethics* 95.

Soltau F ‘The National Environmental Management Act and Liability for Environmental Damage’ (1999) *SAJELP* 6.

Stern PC, Webler T & Small MJ ‘Special Issue: Understanding the Risks of Unconventional Shale Gas Development’ (2014) *Environmental Science & Technology*.

Tan H, Wong-Parodi G, Zhang S & Xu J ‘Public risk perceptions of shale gas development: A comprehensive review’ (2022) *Energy Research & Social Science* 89.

Tawonezvi J ‘The Legal and Regulatory Framework for the EU’s Shale Gas Exploration and Production Regulating Public Health and Environmental Impacts’ (2017) *Energy.Ecol.Environ* 2(1).

Tian S, Smits KM, Cho Y, Riddick SN, Zimmerle DJ and Duggan A ‘Estimating methane emissions from underground natural gas pipelines using an atmospheric dispersion-based method’ (2022) *Elementa Science of the Anthropocene* 10(1).

Thomas M, Pidgeon N and Bradshaw M ‘Shale development in the US and Canada: A review of engagement practice’ (2018) *The Extractive Industries and Society* 5.

Tracy Field ‘Liability to Rectify Asbestos Pollution’ (2006) *Journal of Environmental Law* 18(3).

Tracy Field ‘Letting polluters off the hook? The impact of Bareki NO vs Gencor Ltd 2006 (1) SA 432 (T) on the reach of s 28 of the National Environmental Management Act 107 of 1998’ (2007) *SALJELP*.

`

Van den Berg & Mostert H 'Challenges to Regulating Hydraulic Fracturing in South Africa: Technological Innovation and Law Making for Climate Change at the Crossroads' in Zillman D, Roggenkamp M, Paddock L & Godden L (eds) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (2018), (London, Oxford University Press).

Van der Schyff E 'South African mineral law: A historical overview of the State's regulatory power regarding the exploitation of minerals' (2012) *New Contree* 64.

Van der Schyff E 'Who "owns" the country's mineral resources? The possible incorporation of the public trust doctrine through the Mineral and Petroleum Resources Development Act' (2008) *TSAR 4*.

Van Zyl H, Fakir S, Leiman T & Standish B 'Impact on the Economy' in Scholes R, Lochner P, Schreiner G & Snyman-Van der Walt L et al *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks* (2016) (CSIR, Pretoria).

Van Wyk J 'Fracking in the Karoo: Approvals Required?' (2014) *Stellenbosch Law Review*.

Verschuuren J 'Sustainable Development and the Nature of Environmental Legal Principles' (2007) *Potchefstroom Electronic Law Journal* 1.

Vanderzwaag DL, Fuler SD & Myers RA 'Canada and the Precautionary Principle/Approach in Ocean and Coastal Management: Wading and Wandering in Tricky Currents' (2002) *Ottawa Law Review* 34(1).

Von Stein J 'The International Law and Politics of Climate Change: Ratification of the United Nations Framework Convention and the Kyoto Protocol' (2008) *The Journal of Conflict Resolution* 52(2).

`

Wait R & Rossouw R ‘A Comparative Assessment of the Economic Benefits from Shale Gas Extraction in the Karoo, South Africa’ (2014) *Southern African Business Review* 18(2).

Weir E, Schabas R, Wilson K & Mackie C ‘A Canadian framework for applying the precautionary principle to public health issues’ (2010) *Canadian Journal of Public Health* 101(5).

Weststrate J, Dijkstra G, Eshuis J, Gianoli A and Rusca M ‘The Sustainable Development Goal on Water and Sanitation: Learning from the Millennium Development Goals’ (2019) *Social Indicators Research* 143(2).

Williams L & Sovacool BK ‘The discursive politics of ‘fracking’: Frames, storylines, and the anticipatory contestation of shale gas development in the United Kingdom’ (2019) *Global Environmental Change* 58.

Worthmann C and Esterhuyse S ‘A mobile application to protect groundwater during unconventional oil and gas extraction’ (2022) *Royal Society Open Science* 9..

Young Kim DA ‘A Lesson from the Shale Revolution in the United States, Canada, and China’ (2017) *The Georgetown Envtl. Law Review* 29.

Yuan J, Luo D & Feng L ‘A review of technical and economic evaluation techniques for shale gas development’ (2015) *Applied Energy* 184..

Zajtay I ‘Aims and methods of comparative law’ (1974) *Comparative and International Law Journal of Southern Africa*07.

Zhang Z, Evan D. Sherwin ED, Varon DJ and Brandt AR ‘Detecting and quantifying methane emissions from oil and gas production: algorithm development with ground-truth calibration based on Sentinel-2 satellite imagery’ (2022) *Atmospheric Measurements Techniques* 15.

`

Ziervogel G, et al ‘Climate change in South Africa – how are we tackling this?’ (2015) *Quest* 11.

Zoback MD & Arent DJ ‘Shale Gas Development: Opportunities and Challenges’ in *The Bridge* (2014) (Washington, National Academy of Engineering, Washington 44(1).

Electronic Sources

Administration of Donald J. Trump ‘Remarks Announcing United States Withdrawal from the United Nations Framework Convention on Climate Change Paris Agreement (2017) Authenticated U.S. Government Information (GPO) - Daily Compilation of Presidential Documents.

BC Oil and Gas Commission ‘Investigation of Observed Seismicity in the Horn River Basin (2012), available at *https://www.bcogc.ca/files/reports/Technical-Reports/investigation20of20observed20seismicity20in20the20horn20river20basinaug202012.pdf*, accessed on 29 November 2022.

BC Oil and Gas Commission ‘Oil and Gas Activity Application Manual’ (2019) British Columbia, Canada.

Becklumb P, Chong J & Williams T ‘Shale Gas in Canada: Environmental Risks and Regulation’ (2015) Economics, Resources and International Affairs Division, Parliamentary Information and Research Service, Publication No.2015-18-E.

Canadian Ministers of the Environment ‘A Canada-Wide Accord on Environmental Harmonization’ (1998) available at *https://faolex.fao.org/docs/pdf/can83339.pdf*, accessed on 24 October 2022.

Canada’s Oil and Natural Gas Producers ‘Managing Methane Emissions for Natural Gas and Oil Development’ (2021) available at *https://www.capp.ca/wp-*

`

content/uploads/2021/02/Managing-Methane-Emissions-for-Natural-Gas-and-Oil-Development-386197.pdf accessed on 23 March 2023.

Canada's Oil and Natural Gas Producers 'Guiding Principles for Hydraulic Fracturing Activities' (2019) Calgary (AB): CAPP.

Centre for Sustainability in Energy and the Environment 'Report of the Nova Scotia Independent Review Panel on Hydraulic Fracturing' (2014) Cape Breton University.

Council of Canadian Academies 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) available at *https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf*, accessed on 3 October 2022.

Council of Canadian Academies/The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction 'Environmental Impacts of Shale Gas Extraction in Canada' (2014) Ottawa (ON).

Council for Geoscience 'Seismic Events' (2020) available at *http://196.38.235.147:8070/quakeview/events/event_details/CGS2020wojk*, accessed on 28 November 2022.

Department of Energy and Climate Change (2015) Onshore oil and gas exploration in the UK: regulation and best practice, England.

Department of Mineral Resources and Energy 'Integrated Resource Plan' (2019) available at *http://www.energy.gov.za/IRP/2019/IRP-2019.pdf*, accessed on 27 June 2022.

Department of Mineral Resources 'Report on Investigation of Hydraulic Fracturing in the Karoo of South Africa' (2012), available at *http://www.info.gov.za/view/DownloadFileAction?id=174015*, accessed on 5 May 2022.

`

Department of Environmental Affairs ‘National Climate Change Response White Paper’ (2011) available at *https://www.gov.za/sites/default/files/gcis_document/201409/nationalclimatechangeresponsewhitepaper0.pdf* accessed on 2 July 2022.

Department of Environment, Forestry and Fisheries ‘South Africa First Nationally Determined Contribution under the Paris Agreement: Updated September 2021’ (2021) available at *https://unfccc.int/sites/default/files/NDC/2022-06/South%20Africa%20updated%20first%20NDC%20September%202021.pdf* accessed on 31 October 2022.

Department of the Environment ‘This Common Inheritance: Britain's Environmental Strategy: UK White Paper on Environmental Policy (London: HMSO, 1990).

Department of the Environment, Transport and the Regions ‘A better quality of life: A Strategy for Sustainable Development for the United Kingdom Great Britain’ (London: Stationary Office, 1999).

Earthjustice & Evergreen Action ‘What Does West Virginia v. EPA Mean for Climate Action?’ (2022) July 6, 2022, available at *https://earthjustice.org/blog/2022-july/what-does-west-virginia-v-epa-mean-for-climate-action*, accessed on 9 July 2022.

Environment Canada and Health Canada ‘A Guide to Understanding the Canadian Environmental Protection Act, 1999’ (2004), Ottawa, Ontario.

Environmental Protection Agency ‘Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units: Finale Rule’ (2015) Federal 80(205) Register, October 23, 2015.

European Commission ‘United States of America -Global Methane Pledge’ 2021 available at *https://www.ccacoalition.org/en/resources/global-methane-pledge* accessed on 30 September 2022.

`

FracFocus Chemical Disclosure Registry, available at *http://www.fracfocus.ca/en/welcome*, accessed on 26 November 2022.

Government of Canada 'A Canadian Perspective on the Precautionary Approach/Principle Discussion Document' (2001).

Government of Canada 'Natural Resources Canada: Exploration and Production of Shale and Tight Resources' (2016) available at *https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/clean-fossil-fuels/natural-gas/shale-tight-resources-canada/exploration-and-production-shale-and-tight-resources/17677*, accessed on 9 February 2022.

Intergovernmental Panel on Climate Change 'Global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty' (2018).

International Energy Agency 'Africa Energy Outlook: World Energy Outlook Special Report' (2022) available at *https://iea.blob.core.windows.net/assets/6fa5a6c0-ca73-4a7f-a243-fb5e83ecfb94/AfricaEnergyOutlook2022.pdf*, accessed on 18 July 2022.

International Energy Agency 'Energy Policies of IEA Countries: Canada 2015 Review' (2016) available at *https://iea.blob.core.windows.net/assets/e9e4c6be-dc28-44a8-8bcc-7e0af3a8f19e/EnergyPoliciesofIEACountriesCanada2015Review.pdf* accessed on 25 July 2022.

IPCC 'Climate Change 2014: Synthesis Report – Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2014) IPCC, Geneva, Switzerland.

IPCC 'Sixth Assessment Report on Climate Change 2022: Mitigation of Climate Change - Contribution of Working Group III Contribution to the Sixth Assessment

`

Report of the Intergovernmental Panel on Climate Change' (2022) IPCC, Geneva, Switzerland.

London Ministerial Declaration of the Second International Conference on the Protection of the North Sea (1987).

Marthinus Cloete 'Atlas on geological storage of carbon dioxide in South Africa (2010).

Morton MQ 'Unlocking the Earth – A Short History of Hydraulic Fracturing' (2013) 10(6) GEOExPro, available at http://www.geoexpro.com/articles/2014/02/unlocking-the-earth-a-short-history-of-hydraulic-fracturing, accessed on 31 August 2022.

National Energy Board 'Filling Requirements for Onshore Drilling Operations Involving Hydraulic Fracturing' (2013) Calgary, Alberta, Canada.

Natural Resources Canada 'The 2010 Val-des-Bois Quebec Earthquake: Earthquake Summary' (2010) Geological Survey of Canada, Ottawa.

National Planning Commission 'National Development Plan 2030: Our future - make it work' (2011) available at *https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf*, accessed on 28 May 2022.

Narrandes N '6.2-magnitude earthquake shakes Cape Town' (2020) available from *https://www.capetownetc.com/news/6-2-magnitude-earthquake-shakes-cape-town/* accessed on 28 November 2022.

New Brunswick Oil and Gas Commission 'Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick - Rules for Industry' (2015) New Brunswick, Canada.

`

PetroSA ‘Annual Report 2020, available at *http://www.petrosa.co.za/discover_petroSA/Documents/PetroSA%20AR%202020%20Final.pdf*, accessed on 25 June 2022.

Petroleum Services Commission of Canada ‘Code of Conduct for Hydraulic Fracturing Operations’ (2019) available at *https://www.psac.ca/wp-content/uploads/2019/08/WEC-Code.pdf*, accessed on 15 November 2022.

SABINET Law ‘Comment Sought on Upstream Petroleum Resources Development Bill’ (13 July 2022) available at *https://legal.sabinet.co.za/articles/comment-sought-on-upstream-petroleum-resources-development-bill/* accessed on 6 August 2022.

South African National Energy Development Institute ‘A Study of Surface Issues and Geography of Potentially Suitable Gas Exploitation (2015) unpublished report.

South African Government ‘Revised Nationally Determined Contributions’ (2021).

Statistics South Africa ‘Millennium Development Goals, Country Report 2013’ (StatsSA, Pretoria).

Taku River Tlingit First Nation v. British Columbia (Project Assessment).

Tickner J, Raffensperger C & Myers N ‘The Precautionary Principle in Action A Handbook’ (1999) Science and Environmental Health Network, 1st edn.

The Royal Society and Royal Academy of Engineering ‘Shale gas extraction in the UK: a review of hydraulic fracturing’ (2012) available at *https://royalsociety.org/-/media/policy/projects/shale-gasextraction/2012-06-28-shale-gas.pdf*, accessed on 3 August 2022.

The Science and Environmental Health Network Conference ‘Wingspread Statement on the Precautionary Principle (1998) Racine, Wisconsin, 23 – 25 January 1998.

`

Tracy-Lynn Humby ‘A landmark case on climate change in SA’ (2017) available at *https://www.wits.ac.za/gci/media/a-landmark-case-on-climate-change-in-sa/* accessed on 21 March 2018.

UCT ‘South Africa’s “fare share”: mitigation targets in the updated first NDC in an international context’ (2021) Energy Systems Research Group (University of Cape Town, Cape Town).

United Kingdom Department of Energy and Climate Change ‘Fracking UK shale: water’ (2014), available at *http://www.programmeofficers.co.uk/Cuadrilla/CoreDocuments/CD41/CD41.53.pdf*, accessed on 10 June 2022.

United Nations ‘United Nations Framework Convention on Climate Change ‘Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021.

United Nations Framework Convention on Climate Change ‘Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021’ (2022) “Glasgow Climate Pact” available at *https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf* accessed on 2 July 2022.

United Nations ‘United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session’ held in Copenhagen from 7 to 19 December 2009.

United Nations ‘Report of the World Commission on Environment and Development: Our Common Future’ (1987) available at *https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf* accessed on 1 November 2021.

`

United Nations General Assembly ‘Report of the United Nations Conference on Environment and Development: Rio Declaration on Environment and Development’ (1992) A/CONF.151/26 (Vol.1).

United States Environmental Protection Agency ‘Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States’ (2016), Office of Research and Development, Washington DC, available at *www.epa.gov./hfstudy*, accessed on 31 August 2022.

U.S. Energy Information Administration ‘Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries outside the United States’ (2013) available at *https://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf*, accessed on 14 May 2022.

US House of Representatives Committee on Energy and Commerce ‘Chemicals used in hydraulic Fracturing’ (2011) available at *http://ecolo.org/documents/documents_in_english/gas-_Hydraulic-Fract-chemicals-2011-report.pdf* accessed on 31 May 2022.

White House – Statements and Releases ‘Statement by President Joe Biden on Supreme Court Ruling on West Virginia v. EPA’ (2022) June 30, available at *https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/30/statement-by-president-joe-biden-on-supreme-court-ruling-on-west-virginia-v-epa/* accessed on 9 July 2022.

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