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TO FRAGMENT OR TO CONSOLIDATE: AN EVALUATION OF THE EFFICACY OF THE SOUTH AFRICAN REGULATORY FRAMEWORK FOR TAILINGS DAMS

By

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ABSTRACT

In the past 30 years, the number of large tailings dam failures around the world has increased, causing irreparable environmental degradation, loss of life and socio economic hardships. This has resulted in mining countries questioning the laws applicable to TSF's and their contribution in the failure of TSF's. The common reasons for failure is that dams are not operated accordingly to their design criteria; water balance and construction are not managed properly or there is a general lack of understanding of the features that control safe operations. As a result, well organised and functioning TSF legislation and regulations are of paramount importance.

The objectives of this study are to examine the concept of tailings and identify the technical characteristics of TSF's; examine the current state of tailings dam laws and to determine its effectiveness in minimizing tailings dam failures; and to determine the advantages and disadvantages of fragmented and consolidated TSF legislation.

The study focuses on issues concerning legislation and regulations pertain to TSF's in South Africa and British Columbia, Canada. In conclusion, of this study it was determined that the best TSF legislative framework and regulatory framework for South Africa is a consolidated one. Furthermore, suggestions for new regulations on TSF and how to strengthen legislation are made.

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LIST OF ACRONYMS

TSF	Tailing Storage Facility
AMD	Acid Mine Drainage
MEM	Ministry of Energy and Mines
MPRDA	Mineral and Petroleum Resource Development Act
NEMA	National Environmental Management Act
NEMWA	National Environmental Management Waste Act
NEMAQA	National Environmental Management Air Quality Act
NWA	National Waste Act
MHSA	Mine Health and Safety Act
NRWDIA	National Radioactive Waste Disposal Institute Act
NEA	Nuclear Energy Act
NFA	National Forest Act
NHRA	National Heritage Resource Act
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
NDCR	National Dust Control Regulations
NAAQS	National Ambient Air Quality Standards
IAEA	International Atomic Energy Agency
RWMPS	Radio Waste Management Policy and Strategy
CPMRD	SABS Code of Practice for Mine Residue Deposit
HIA	Heritage Impact Assessment
DEA	Department of Environmental Affairs
SAHRA	South African Heritage Resource Agency
NEMBA	National Environmental Management Biodiversity Act
DWAF	Department of Water Affairs and Forestry
NNRA	National Nuclear Regulator Act
NNR	National Nuclear Regulator
SSRP	Safety Standards and Regulatory Practice
CNSC	Canadian Environmental Protection Commission
CEPA	Canadian Environmental Protection Act
NSCA	Nuclear Safety and Control Act
CEAA	Columbia Environment Assessment Act
DWS	Department of water and Sanitation

DMR	Department of Mineral Resources
DWAF	Department of water affairs and forestry

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KEYWORDS

Tailings Storage Facilities (TSF's), tailings, tailings dam, legislative framework, fragmentation, consolidation.

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CHAPTER 1

INTRODUCTION, BACKGROUND AND RESEARCH METHODOLOGY

1.1 INTRODUCTION

The global extractive mining industries is the economic backbone of many countries .It is unavoidable and inherently environmentally disruptive.[1] Without the extractive industries, modern society could not function.[2] The mining industry is responsible for the buy products society needs to function, such as: airplanes, construction material, paint, metals, ceramics and computers.[2] On a global scale the mining industry provides direct employment for over 40 million people, and indirectly to 200-250 million people.[4]

Despite these obvious benefits, the demand for products is growing and to keep up with the demand, mining companies have to extract more ore than ever before. [3]As a result, large volumes of waste material are produced after the economic material has been processed .the waste that remains behind is called tailings and are estimated to be produced at a rate between five to fourteen billion tons per year .[4] Due to the chemically hazardous nature of tailings, they are typically stored in impoundments behind dam's .these dams often fail and can catastrophically affect any or all of the following:

- Extended mine production interruption
- Loss of life
- Irreversible environmental damage
- Loss of livelihood for the affected communities, and
- Economic loss for the mine and affected communities.[5]

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[1] Schoenberger ''Environmentally sustainable mining: The case of tailings storage facilities'' 2016 *Resources Policy* 119. 2 Kossoff ''Mine tailings dams: Characteristics, failure, environmental impacts, and remediation'' 2014 *Applied Geochemistry* 229-230.
[2] See *id* at 230. 4 Azapagic ''Developing a framework for sustainable development indicators for the mining and minerals industry'' 2004 *Journal of Cleaner Production* 639–662.
[3] Schoenberger 2016 *Resource Policy* 229.
[4] See *id* at 229.
[5] Davies *et al* ''Mine tailings dams: when things go wrong'' research gate website accessed on 20 July 2018 p 5.

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Mining related environmental disasters resulting from tailings dam failures account for about three-340 deaths from 2008 to 2017.[6]TSF are expected to provide a secure storage for tailings in perpetuity but recent failure of large tailing dams is evident that some mining companies have failed to provide safe storage.[7]For example, 19 deaths were a result of the

2015 Samarco mine tragedy in Brazil and more than 100 kilometres of river were polluted.[8] The causes of tailings dam failures have been attributed to the inadequate commitment to safe storage combined with poor management.[9]However, it is widely accepted that legislation and regulation are the core root cause shaping severity of failure.[10]The current trend amongst developing countries is that legislative codes and regulations in respect to TSF's are gradually becoming 'consolidated' in the hopes to reduce the severity and failure of tailing dams.

In this study I am going to analyse whether tailings dam legislation in a fragmented or consolidated state is best suited for South Africa's extractive industry. This will involve answering the core question posed by this study by exploring the characteristics of both fragmented and consolidated legislation, the role each plays in reducing the severity and failure of tailings dams and how effective legislation is in its fragmented or consolidated state.

1.2 BACKGROUND TO RESEARCH PROBLEM

Tailings dam legislation is the basis from which regulations and codes dealing with tailing dams are derived. Over the past 10 years the annual number of tailing dam failures has declined but the number of serious dam failures has increased.[11] To combat this to introduce new legislation and regulations .in developed countries the legislation and regulations are being consolidated rather than being fragmented.

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[6] Sullivan (2017) ''Mine tailings dam failures major cause of environmental disasters report'' 19 December 2017 (accessed 29nth July 2018).

[7] Roche *et al* ''Mine tailings storage: Safety is no accident' (2017). A UNEP Rapid Response Assessment .United Nations Enviroment Programme and GRID -Arendal, Nairobi and Arendal.

[8] Phillips D (2016) ''Samarco dam collapse: one year on from Brazil's worst environmental disaster'' 15nth October 2016 *The Guardian.*

[9] Roche *et al* (2017) p10.

[10] Newland *et al* (2016)''Root Causes of Tailings Dam Overtopping: The Economics of Risk & Consequence'' 7-9

September 2016 (accessed on 25th July 2018)

[11] Roche *et al* (2017) p6.

South Africa currently has Fragmented tailings dam legislation and has not suffered a major tailing dam disaster since the 1994 Merriespuit tailings dam failure.[12]However, we must bear in mind that minor tailing dam failures occur regularly but go unreported. The question then arises, whether fragmented or consolidated legislation is best for tailing dams in reducing the severity and frequency of tailing dam failures in South Africa.

1.3 RESEARCH QUESTIONS

The primary question this study will explore is whether it is better to have fragmented or consolidated tailings storage facility (TSF) legislation in South Africa's extractive industry. While critically analysing the primary question, the study will further aim to unearth answers to the following secondary questions:

- What are tailings and what are the technical aspects of tailings dams?
- What is the current state of law with regards to TSF's in the extractive industry of South Africa?
- What are the associated advantages and disadvantages of fragmented and consolidated TSF Regulatory framework?

1.4 RESEARCH AIMS AND OBJECTIVES

In pursuing the answer to the research questions posed above, the aims and objectives of this study are:

- To examine the concept of tailings and identify the technical characteristics of TSF's.
- To examine the current state of tailings dam laws and to determine its effectiveness in minimizing tailings dam failures.
- To determine the advantages and disadvantages of fragmented and consolidated TSF legislation.
- Draw a conclusion on whether fragmented or consolidated legislation is best for South Africa's TSF's.

1.5 RESEARCH METHODOLOGY

This research study is based on the critical analysis approach. Comprehensive sources from various disciplines will be used. The research will commence with the literature review of

[12] Retrieved from tailings.info website(accessed on 15/07/2018)

textbooks, legal journals, legislation and academic publications and research to structure the background, development and technical content of TSF's.

A further critical investigation will be done on the current status of TSF's law in South Africa's extractive industry and the effectiveness in minimizing TSF's failures. Furthermore, the study will attempt to highlight the main advantages and disadvantages of fragmented and consolidated TSF legislation with a case study to further illustrate.

Finally, the study will end with a conclusion and recommendations.

1.6 RELEVANCE OF STUDY

The study is important because legislation is at the core and first point of reference in the event of a TSF breach. Regulations and management codes stem from legislation and without it more TSF failures will occur. It is important to determine the form legislation will take because it has the ability to determine how TSF legislation is interpreted and applied.

By determine the most suitable form (fragmented or consolidated) TSF legislation must take, South Africa can make the necessary transition or retain tailings dam legislation in its current form, for the benefit of the communities and the environment. The conclusion reached in this study can effectively be used in other countries to strengthen TSF legislation and its effectiveness.

1.7 LIMITATIONS

This study will be limited to applicable TSF legislation on the 31st July 2018 .Any amendments to the legislation after this date will not be considered for the purpose of this study. The study will focus only on sever tailings dam failures. The reason for this is the lack of information pertaining to reported small and midsize dam failures. I am aware that there are other contributing factor influencing the failure of tailing dams but they will not be discussed in detail for the purpose of this study. Furthermore, there is a lack of research specific to fragmentation or consolidation of TSF legislation and regulations .As a result, this hinders the possibility to frame specific recommendations .Other forms of tailings storage will not be considered.

1.8 CONCLUSION

This chapter is designed to illustrate a brief overview of the study. The introduction to this study is a brief synopsis of the study, followed by an explanation of the research questions, the aims and objectives of the research, the methodology, the relevance of this study and the limitations thereof.

The core question forming this study is whether it is better to have fragmented or consolidated tailings dam legislation in South Africans extractive industry. The secondary questions that follow form the body of the study.

The answers to the questions posed by the study are reached by applying a critical analysis approach. All sources from various disciplines are used to come to a critical conclusion. To achieve this, the answers to the secondary questions will be tested against themselves and a conclusion will be reached answering the primary question.

The next chapter is an overview of the technical aspects of tailings and the introduction to the case study. Emphasis will be placed on the characteristics of tailings and TSF’s.

CHAPTER 2

A TECHNICAL DISCUSSION OF TAILING DAMS

2.1 INTRODUCTION

Dams are structural barriers mainly constructed for a specific purpose such as hydro electrical power production, irrigation , water reservoir storage, flood control ,navigation ,sedimentation control or the storage of processed mine waste .[13] In the extractive industries the chief waste product is known as tailings and various countries use, *enter alia*, TSF's to store and manage mill and waste tailings as a result of mining activities.[14] The extractive industry on average processes more than some several thousand million tonnes of tailings annually[15] and this number is set to rise with the insatiable demand for raw materials and a world population estimated to be 8.5 billion by 2030.[16] the increased number of large catastrophic TSF failures causing the loss of life; the negative impact on human and economic wellbeing; and environmental degradation in perpetuity; undeniably undermined the credibility of the mining industry ;and has given rise to questions over the safety and management of TSF's. As a result, this has led the extractive industries in many countries to commit to improving the quality and the management of TSF's. Despite this, TSF's failures continue to plague the extractive industries.[19]

2.2 WHAT ARE TAILINGS?

Mine tailings are the heterogeneous ore waste and processing fluids emanating from mills, washers or concentrations that remain after the beneficiation of the economic ore from the mine resources.[17] Tailings can be in the form of liquid, solid, or slurry of fine particles (**Figure 1**). They inherently contain all other constituents of the ore, like heavy metals and other toxic substances, which require them to be kept perpetually isolated from the environs.[18] The characteristics of tailings are synonymous with the mining method utilized thus giving various types of tailings such as:

[13] Rico et al ''Floods from tailings dam failures'' (2008) *Journal of Hazardous Material (JHM)* 79.
[14] Rico et al (2008) *JHM* 79 at 80.
[15] Fyfe ''the environmental crisis: quantifying geosphere interactions'' (1981) *Science* 105.
[16] United Nations DESA (2015).'' World population projected to reach 9.7 billion by 2050'' 29 July 2015 United Nations. [19] Blight (2009) 1.
[17] Kossoff *et al* ''Mine tailings dams: Characteristics, failures ,environmental impacts ,and remediation'' (2014) *Applied Geochemistry* 230.
[18] Coil *et al* ''Mine tailings'' (accessed website 15/08/2018) 1.

- Gravity process tailings
- Flotation process tailings
- Leach process tailings
- Includes, *inter alia*, tailings from copper, gold, iron, lead, rare earth, phosphate, platinum group, silver, uranium and zinc processing.
- Note (waste rock and overburden are not classified as tailings)[19]

The scale and pace at which tailings is produced is immense, and as such, the tailings to concentrate ratio is 200:1.[20] The ratio is susceptible to changes when peak metal production surpasses as lower grade ores are being mined for longer periods of time than usual.[24]This is evident that the extractives industries will most likely be over burdened by more problems as it will be producing more tailings than it can manage to store safely as a result of the high demand of metal ores and over supply of low grade ores.

Figure 1: Single point discharge of tailings. (Image by Jon Engels at tailings.info)

[19] ''Mine Tailings Fundamentals: current technology and practice for mine tailings facilities operations and closure part 1- Mine tailings facility design and operations'' U.S. EPA Contaminated Site Clean-Up Information Webinar Series May 19-20, 2015.

[20] Lottermoser (2007) 35. [24] Mason *et al* ''Availability, addiction and alternatives: three criteria for assessing the impact of peak minerals on society'' (2010) *J. Cleaner Prod* 966.

Figure 2: nickel mine tailings. (Image by Edward Burtynsky)

2.2.1 Nature of tailings

The beneficiation of mineral ores and storage In TSF's exposes the tailings to sulphides, which in turn can get exposed to water and air, and in addition cause accelerated weathering and an increased mobilization rates.[21] Beneficiation can include chemical separation techniques such as gravity concentration, amalgamation and leaching.[26] The addition of chemical reagents in the beneficiation process may also change the characteristics of the processed minerals and as a result the properties associated with the tailings and waste rock (**Figure 2**). Mine residues, which contain heavy metals and foreign substances, are usually inherently toxic in nature and to the natural ecosystem of a particular area.[22] It is for this reason that the safe storage of tailings is such an important and integral part of the mining process.

2.2.2 Production of tailings

In order to determine how tailings are produced, the techniques used during the processing phase of mineral ores must be understood. Once the mineral ores have been mined from the ground the next step is to grind and separate the economic minerals from the noneconomic

[21] Retrieved from tailings.info website (accessed 20 August 2018) [26]

About time Publishing (2010) 10.

[22] Wood (2012) Chapter 12.

ore in a process called Beneficiation. The milling phase during beneficiation results in very fine particles that allow for the precious metal to be separated from the impurities.[23] The separation can be achieved through the application of typical techniques such as:

- Comminution
- Screening and hydro-cycloning
- Gravity concentration
- Magnetic separation
- Selective flocculation
- Electrostatic separation
- Flotation
- Leaching
- Thickening
- Filtration[24]

The use of these techniques has an effect on the characteristics of tailings. For example, the use of cyanide in the leaching technique, usually applied to gold, silver and copper ores, renders the Tailings toxic and a hazard to the environment and human life.[25] It is therefore no surprise that 450 million metric tons of tailings is generated from iron, copper, taconite, lead and zinc ores, uranium refining and other ores such as barite, feldspar, gold, molybdenum, nickel and silver each year.[26] The disposal of tailings slurry is of paramount importance to all stakeholders.

2.2.3 Geotechnical properties of tailings

Tailings grain sizes depend on the ore type and are often difficult to generalize. Despite this, they may contain particles such as quartz, mica, talk, chlorite, arsenoprytie and pyrite.[27] The density of tailings, which varies according to the parent rock type, can be identified in the form of porosity, void ratio or dry density. The extractives industry has accepted the general range

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[23] National mining association ''User guidelines for waste and by product materials in pavement construction'' retrieved from fhwa government website.

[24] Tailings and waste rock RJC Guidance draft.

[25] European Commission. ''Management of tailings and waste-rock in mining activities'' (Website Accessed 20 August 2018) p IV.

[26] About Time Publishers (2010) p10 to 11.

[27] Bhanbhro *Mechanical Properties of Tailings: basic description of a tailings material from Sweden* (PHD dissertation 2014 Lulea University of Technology) 7.

for tailings bulk density as 1.8-1.9 tm^3 and a gravity of 2.6-2.8.[28] The moisture content value of tailings is said to be between 10-18 percent with permeability values ranging from 10^2 to 10^4 cm/sec. Most dry rodded tailings weight ranges from 1450 to 2200kg/m^3 with a variable moisture content.[34]

It has long been proven that the properties associated with tailings depends on their source and level of compaction, therefore tailings generally have:

- high concentrations of water
- low to moderate hydraulic conductivity
- low plasticity
- low to moderate shear strength
- high porosity
- Compared to natural geological materials, tailings material has moderate to high shear strength in relation to particle size and porosity.[29]

Furthermore, the properties associated with tailings generally are of particle size less than 0,01- 0,1 mm.[30] Larger sand particles in tailings usually occupy 15-50% of tailings body but this varies from mine to mine and beneficiation process.[37]

2.2.4 Hazardous properties of tailings

Toxic chemicals used during the beneficiation of meterliphic ores, such as cyanide in gold tailings or rock which naturally contain heavy metals like Mercury or arsenic ,are hazardous to the environment and surrounding communities due to the leaching of dust and water erosion of sediments to tailing dams drained by streams.[31] Studies in South Africa have shown that tailings are rich in toxic metals like Manganese, Copper, and nickel, Zinc, Cobalt and Cadmium.[39] Such metals pose a danger to aquatic ecosystem and have the potential to contaminate water sources, surface and groundwater.[32] Tailings from the beneficiation of

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Bjelkevik .Water cover closure design for tailings dams: state of the art report . (Accessed 24 August 2018) p6. [34] Fyfe 1981 *Science* 105.

[29] Bjelkevik (2005). (Accessed website 24 August 2018) p5.

[30] *Ibid.* [37] See note 22 p9.

[31] Sullivan (2017) p1. [39] Mitileni et al ''The Distribution of Toxic Metals in Sediments: case study of New Union Gold Mine Tailings ,Limpopo ,South Africa'' 2011 *IMWA* 609.

[32] *Ibid.* [41] Coil et al ''Mine tailings''p4.

uranium may contain radioactive material and, therefore, should not be used in manufacturing of construction material.[41] In some instances asbestos fibres have been found in different sources of taconite tailings which have been used in the manufacturing of roofs and other products.[33]

Acid mine drainage is considered as one of the most serious threats to rivers, streams and aquatic life. Acid mine drainage is formed when metals such as gold, copper, silver and molybdenum are found in rock with sulphide minerals. [34]When exposed to water and air, these metals oxidize and form sulfuric acid which has the potential to dissolve other toxic metals in surrounding rock. As a result, very acidic water is produced, which subsequently leaches toxic metals and chemicals into rivers, streams and the environment. [35] **Table 1** describes an overview of some harmful components that can be found in mine tailings.[36]

Waste type	**Description**
Sulphide waste	When the residue of sulphide minerals is exposed to the atmosphere and groundwater in the tailings dam, it oxidizes to form acidic sulphate-rich drainage, also known as acid mine drainage (AMD).
Heavy metal waste	Gold mines often contain tailings with concentrations of metals such as arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu) , lead (Pb), manganese (Mn), nickel (Ni), and zinc (Zn).
Cyanide waste	This waste will occur in the form of heap-leach residues, tailings and spent process water.
Radioactive waste	The tailings of uranium, some copper deposits and the processing of placer and mineral sands deposits contain radioactive elements. 87% of radioactivity can remain in the uranium tailings.

[33] *Ibid* .
[34] Coil *et al* ''Mine tailings'' (accessed website 15/08/2018) p2.
[35] John Wiley & Sons Ltd and Society for Applied Microbiology '' Shifts in microbial community composition and function in the acidification of a lead/zinc mine tailings'' 2013 *EM* 2431.
[36] Roche *et al* (Eds.) (2017) *Mine tailings storage: safety is no accident.* A UNEP Rapid Response Assessment. P20.

Phosphate waste	Phosphate waste is generated from mining potash and phosphate ores. Tailings contain salts, clay, sulphides, oxides and evaporates salts.
Bitumen waste	Can contain elevated concentrations of salts, metals, polycyclic aromatic hydrocarbons, naphthenic acids and solvents that are added during the separation process. Naphthenic acids are toxic to aquatic life.

Table 1. Examples of potentially harmful substances that can be found in tailings

2.3 TAILING DAMS

The Extractives industries handles and stores mine tailings in riverine disposals, submarine disposals, wetland retentions, backfilling, dry stacking and storage behind dammed impoundments.[37]Tailing dams are currently favoured because, amongst other things, they are normally operational and cost effect.[38] A tailing dam is a structure purposefully built for the storage of mine waste and water from the beneficiation process.[39][40]However, tailing dams can be designed to perform many other functions.

It is estimated that there are in the region of 3500 active tailings dams around the world. 49 The actual number of tailing dams could be triple as there is no detailed inventory of tailing dams around the world.

2.3.1 Tailings dam construction methods

In order to retain tailings in impoundments the extractives industry has conformed to two basic types of structures, the raised embankment and the retention dams. Either type of structure, raised embankments or retention dams, can be utilized to various forms or configurations of tailings impoundments.[41] Because the overall structural costs are of paramount importance, raised embankments are more commonly used than retention dams and therefore, raised embankments will be emphasized throughout this section.

[37] Schoenberger (2016) *Resource Policy* 119 .
[38] U.S Environmental Protection Agency (1994)'' Design and evaluation of tailings dams '' technical report'' .p3
[39] Casino mining corporation tailings dam question and answer. (accessed website 20 August 2018).
[40] Kossof *et al* 2014 *Applied Geochemistry* 229 at 232.
[41] U.S Environmental Protection Agency (1994) P5.

Unlike water supply reservoir dams, the embankment can either be built as a conventional dam or built in stages using tailings as the main construction material for the embankment.[42] The three methods of construction using tailings material are upstream, downstream and centreline. A comparison of these methods is presented in **table 2** below.

Water retention	Suitable for any type of tailings	Any discharge Procedure suitable	Good	Good	Entire embankment Constructed initially	Natural soul borrow	High	Possible
Upstream	At least 60% sand in whole tailings. Low pulp density for grain-size segregation.	Peripheral discharge well-controlled beach necessary	Not suitable for significant water storage	Poor in high seismic area	Less than 15 -30 ft/yr most desirable. Over 50 ft can be hazardous	Native soil and tailings waste rock	Low	Not possible
Downstream	Suitable for any type of tailings	Varies according to down stream	Good	Good	None	Sand tailings, waste rock, native soil	High	Possible (inclined cone)
centreline	Sands or low – plasticity slimes	Peripheral discharge of at least nominal beach necessary.	Not recommended for permanent storage. Temp flood storage can be designed	Acceptable	Height restrictions for individuals raises may apply	Sand tailings, waste rock, native soil	Moderate	possible(central cone)

Table 2: Comparison Embankment Types.

2.4.1 Upstream Method

Upstream construction is the oldest and most economical out of the three construction methods. It also appears to be the most susceptible to mining related water retaining structure accidents (**illustration 2**).[43] Because of these attributes, great care needs to be exercised in its construction and management.

Construction begins with a starter dam at the downstream toe. The starter dam must be permeable, capable of passing seepage water and the downstream portion should be resistant

[42] Rafat Abd El-Salam *Mining tailings and management* (Master's thesis 2012 Tanta University) p26.
[43] U.S Environmental Protection Agency (1994) p25.

to piping.[44] A dyke or dam is developed as a result of tailings discharged from the crest of the starter dam in order for water to separate from the tailings and beach. The beach protects the dam and becomes the foundation of the next dyke (**illustration 1**).[54] Several factors can limit the application of the upstream construction method. These factors include control of gradient, water storage capacity, susceptibility to seismic liquification, rate of raise and dust control at high winds.[45]

2.4.2 Downstream

As in upstream construction, a starter dam is constructed out of borrow material. To minimize seepage through the dam, this starter dam may be constructed of previous sand and gravel or with predominately silts and clays.[46]When the impoundment is close to being full with tailings, the next raise is placed on the downstream slope of the existing dam. Therefore, this method is called the downstream method because as the dam height rises, the crest moves downstream (**illustration 1**).[47]

2.4.3 Centreline method

The centreline construction method rises vertically at each stage of its development (**illustration 1**). It can be described as a hybrid of the downstream-type dam construction and where the risk associated with seismic stability standpoint lies between that of centreline and upstream types.[48] To prevent shear failure of the dam wall, the tailings placed on the downstream slope should be compacted. Centreline dams are more stable than either of the two construction methods mentioned above, but are also the most expensive to construct.[49]

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[44] I*bid* . [54] Wood 'Disasters and Mine water: good practice and prevention' (2012) Page 77.
[45] Bjelkevik 'water cover closure design for tailings dams: state of the report' (2005) *Forskiningsrapport* p10.
[46] U.S Environmental Protection Agency (1994) p26.
[47] European commission (2009)''management of tailings and waste-rock in mining activities'' p79.
[48] Chambers , Higman (2011) ''long term risks of tailings dam failure'' page 2.
[49] European commission (2009) ''management of tailings and waste –rock in activities'' p 78.

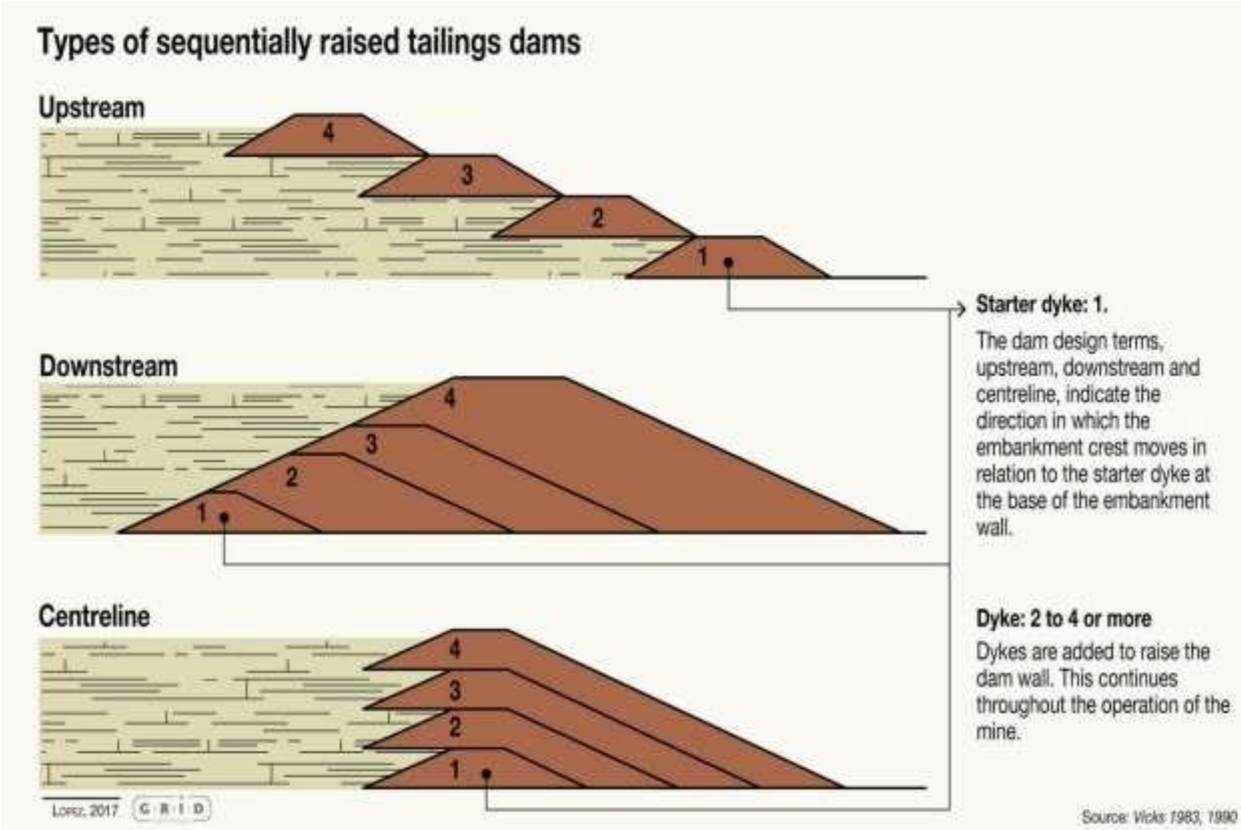


Illustration 1: Tailings dam construction methods. (Kristina Thygesen at grida.no)

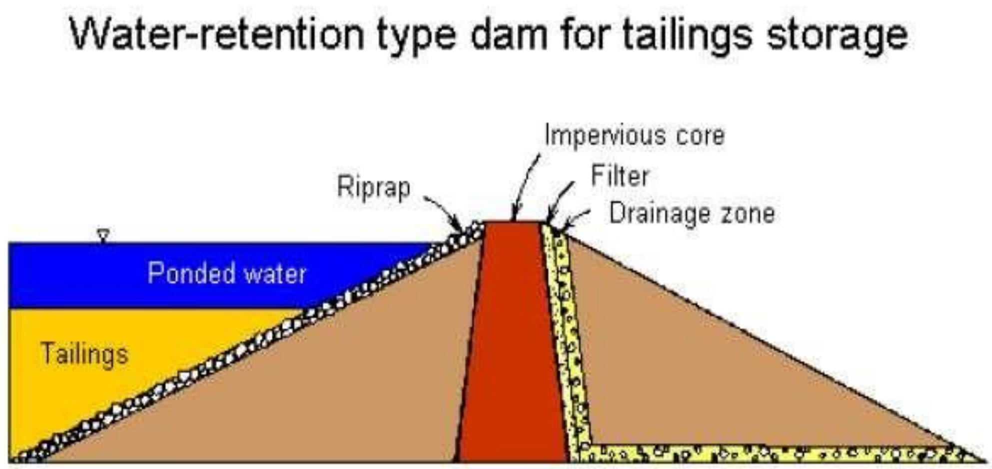
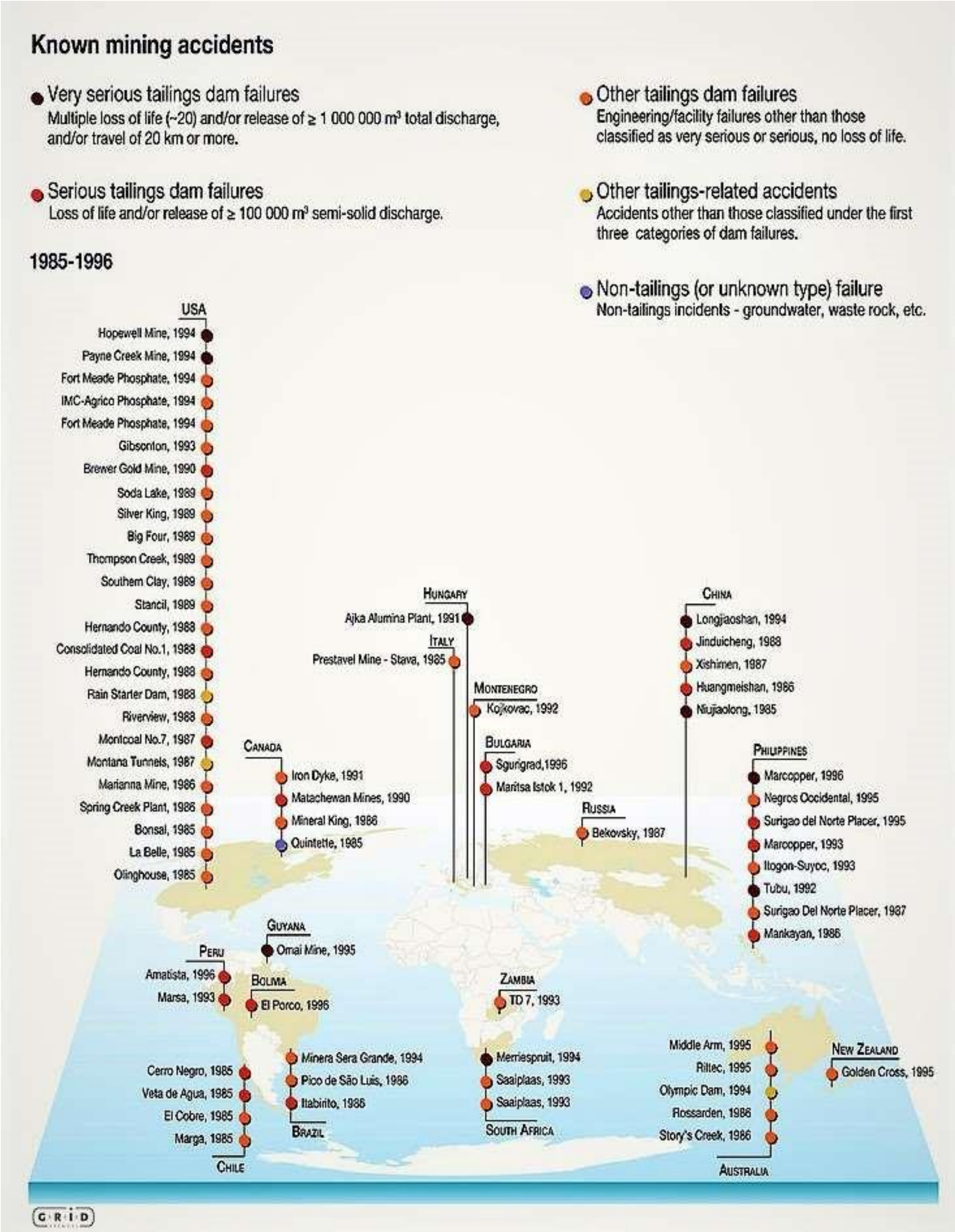


Illustration 2: Dam construction as a traditional embarkement dam. (Steven G Vick)

2.5 TAILINGS DAM FAILURES

It is widely accepted in the extractives industries that good management, coupled with an integrated approach which incorporates the facility design to closure, plays a significant role in the mitigation and reduction of tailing dam failures. Despite this, the risk of failure may be caused by some internal factors which need to be considered. **Illustration 3** shows reported tailing dam failures from 1985 to 2017.[50]

[50] Roche *et al* (Eds.) (2017) *Mine tailings storage: safety is no accident.* A UNEP Rapid Response Assessment.p 26 to 27.


Known mining accidents
Very serious tailings dam failures
Multiple loss of life (~20) and/or release of ≥ 1 000 000 m³ total discharge, and/or travel of 20 km or more.
Serious tailings dam failures
Loss of life and/or release of ≥ 100 000 m³ semi-solid discharge.
Other tailings dam failures
Engineering/facility failures other than those classified as very serious or serious, no loss of life.
Other tailings-related accidents
Accidents other than those classified under the first three categories of dam failures.
Non-tailings (or unknown type) failure
Non-tailings incidents - groundwater, waste rock, etc.
1985-1996
USA
Hopewell Mine, 1994
Payne Creek Mine, 1994
Fort Meade Phosphate, 1994
IMC-Agrico Phosphate, 1994
Fort Meade Phosphate, 1994
Gibsonton, 1993
Brewer Gold Mine, 1990
Soda Lake, 1989
Silver King, 1989
Big Four, 1989
Thompson Creek, 1989
Southern Clay, 1989
Stancil, 1989
Hernando County, 1988
Consolidated Coal No.1, 1988
Hernando County, 1988
Rain Starter Dam, 1988
Riverview, 1988
Montcoal No.7, 1987
Montana Tunnels, 1987
Marianna Mine, 1986
Spring Creek Plant, 1986
Bonsal, 1985
La Belle, 1985
Olinghouse, 1985
Canada
Iron Dyke, 1991
Matachewan Mines, 1990
Mineral King, 1986
Quintette, 1985
Hungary
Ajka Alumina Plant, 1991
Italy
Prestavel Mine - Stava, 1985
Montenegro
Kojkovac, 1992
Bulgaria
Sgurigrad,1996
Maritsa Istok 1, 1992
Russia
Bekovsky, 1987
China
Longjiaoshan, 1994
Jinduicheng, 1988
Xishimen, 1987
Huangmeishan, 1986
Niujiaolong, 1985
Philippines
Marcopper, 1996
Negros Occidental, 1995
Surigao del Norte Placer, 1995
Marcopper, 1993
Ilogon-Suyoc, 1993
Tubu, 1992
Surigao Del Norte Placer, 1987
Mankayan, 1986
Guyana
Omai Mine, 1995
Peru
Amatista, 1996
Marsa, 1993
Bolivia
El Porco, 1996
Zambia
TD 7, 1993
Minera Sera Grande, 1994
Pico de São Luis, 1986
Itabirito, 1986
Brazil
Cerro Negro, 1985
Veta de Agua, 1985
El Cobre, 1985
Marga, 1985
Chile
Merriespruit, 1994
Saaiplaas, 1993
Saaiplaas, 1993
South Africa
Middle Arm, 1995
Ritec, 1995
Olympic Dam, 1994
Rossarden, 1986
Story's Creek, 1986
Australia
New Zealand
Golden Cross, 1995
GRID

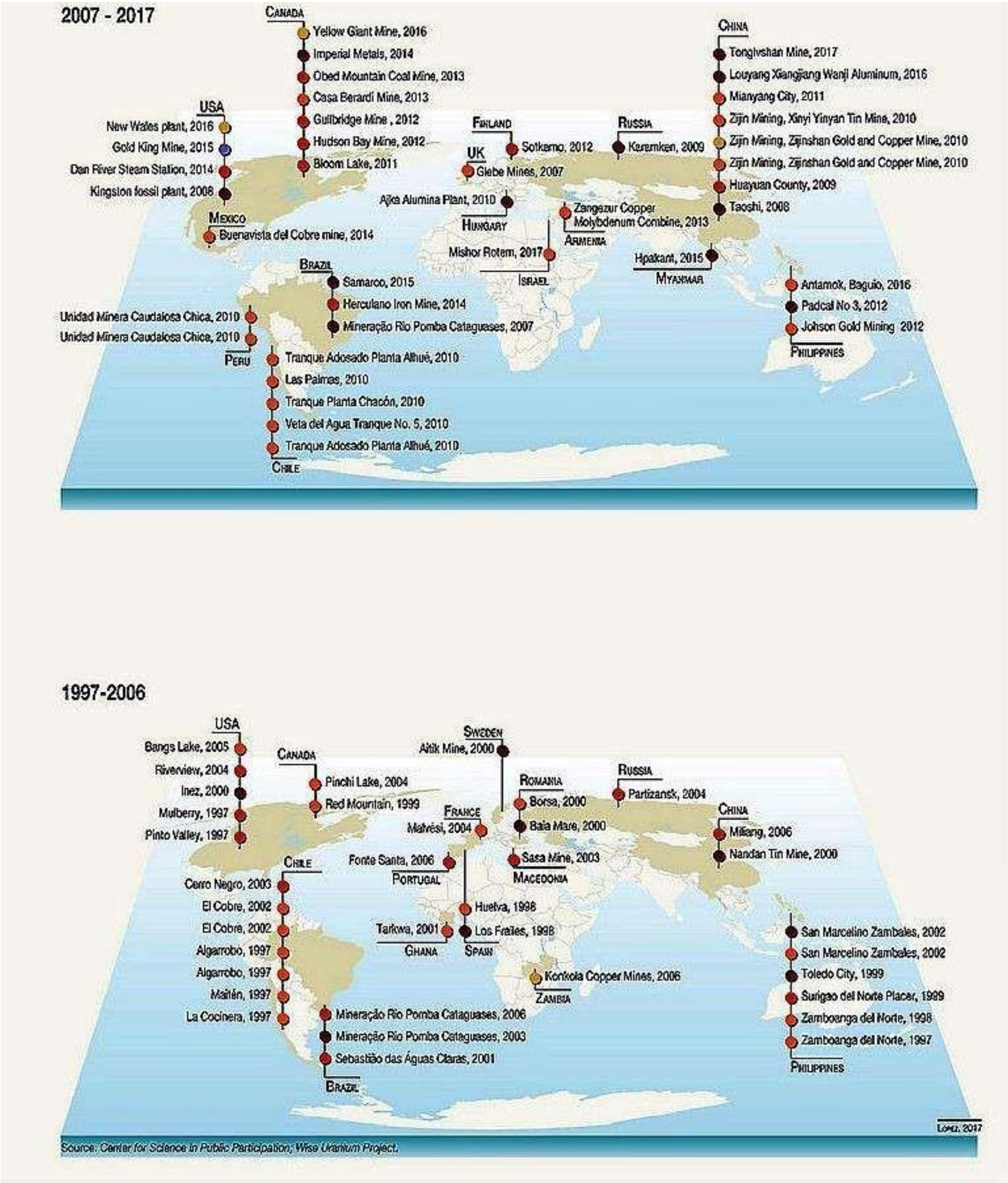


Illustration 3: An indication of the number and location of tailings dam failures since 1985. (Kristina Thygesen at grida.no)

To better illustrate the nature of tailings dam failures, and hence their impacts, a few examples are introduced. In each case, the likely cause of the failure is suggested along with the factual impact of the failure.

2.5.1 Case study 1: Mt Polley, British Columbia 2014

The Mount Polley mine is an open-pit copper mine developed by the British Columbia-based Imperial Metal Corporation in 1997.it is situated South Central British Columbia , and it was known to process around 20000 t of ore per day. [51]
On the 4th of August 2014, the Mount Polley tailings dam collapsed and released some 25 million cubic meters of mine tailings (consisting of 10.6 m^3 of supernatant water, 7, 3 m^3 of tailings solids, 6.5 m^3 of interstitial water and 0.6 m^3 of construction materials) into the picturesque Polley lake, Quesnel watershed and neighbouring rivers and streams (**Figure 4**).[52]

Cause of breach?
On the 30th of January 2015, *the report on the Mount Polley Tailings Storage Facilities Breach* (referred to hereinafter as The Report) was published. The report was commissioned by the government of British Columbia and part of its purpose was to determine the cause behind the dam breach. According to the report, the breach occurred because of the following:[63]

a) **Inadequate geotechnical analysis:**
Critical information regarding the characteristics of the soils underlying the proposed tailings dam was not detected by the design engineering firm, Knight Piesold.
b) **Inadequate design:**
Exceptionally wet years could not be accommodated for due to the water balance model being based on the average climate conditions.
c) **The built dam differed in critical respects from the design criteria that had been approved by the Ministry of Energy and Mines (MEM):**

[51] Schoenberger (2016) *RS* 119 at p124.
[52] Petticrew *et al*. The impact of a catastrophic mine tailings impoundment spill into one of North America's largest fjord lakes: Quesnel Lake, British Columbia (2015) *Canada, Geophys. Res. Lett* 3347.
[63] Schoenberger (2016) RS 119 at p125.

The construction of the second phase of the dam applied the upstream method and in doing so, deviated from the planned centreline configuration.

d) **Inadequate regulation and regulatory supervision**:
In terms of statute law, the MEM has limited influence over the designs. From 2009 to 2011, the mine was not inspected because the position of Geotechnical Engineering Manager was vacant for that period. The mine never exceeded a 1.3 factor of safety, and for some period of time ran below that figure, even when the MEM repeatedly urged the mine raise the FOS from 1.3 to 1.5.

Consequences of Mount Polley disaster.

Contaminated and toxic tailings adversely devastated the ecology in the most important fishing region, the Quesnel watershed (**Figure 5**). The indigenous communities have regarded the Frazer Rivers as an important source of salmon fishing, which is directly linked to cultural, community economy and health.[53]

There's uncertainty relating to the actual effect on the Salmon population as they only return to spawn in the watershed every four years. To determine the effects on the eggs buried in September 2014, an audit would have to be conducted through 2018.[54] As a result, some communities have opted to avoid traditional fishing areas, as mounting concern about the contamination of the Fraser River system have increased. However, some tribes have resorted to encourage its members to fish (despite concerns over the consumption of poisonous fish) following the mount Polley disaster, as the impact to the health and the economy of the community would be too great if members were unable to catch and consume fish.[55]

According to Imperial Metals, The Mount Polley clean-up is estimated to cost $ 67 Million (the equivalent of R1.028 billion).[56] In order To be cash positive, the mining company would have to cut 78 jobs by the end of 2018.[57]

[53] Shandro *et al* ''Risks and Impacts to First Nation Health and the Mount Polley Mine Tailings Dam Failure'' 2017 *inter Jou of Indig hlth* 84 at 85.
[54] Petticrew, and Owens ''protecting the pristine Quesnel watershed in Canada'' ,international innovation.
[55] Shandro *et al* 2017 *inter Jou of Indig hlth* 84 at 91.
[56] Kohls ''A Partial Timeline of the Aftermath of the Mount Polley, British Columbia Tailings Lagoon Dam Failure of August 4. 2014'' accessed on 28 August 2018.
[57] Yorski ''Staged layoffs at Mount Polley in 2018 will impact 78 jobs'' accessed on 9/7/2018.

It is currently unclear what the long-term effects to the ecology and the indigenous communities' way of life will be, but after the necessary tests have been conducted a clear picture will emerge.

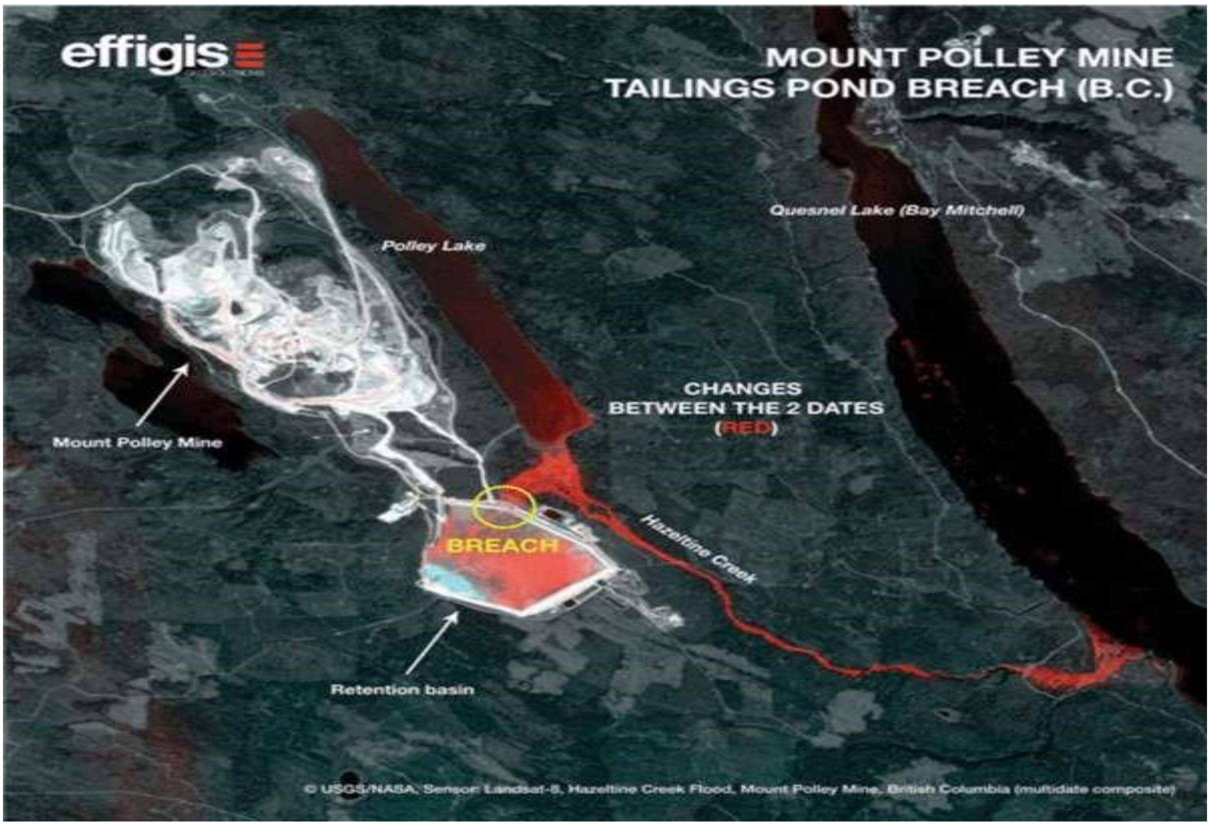


Figure 3: Satellite image of Mount Polley tailings dam breach. (Image by Effigis)

Figure 4: Tailings flowing from the dam into Polley Lake. (Image by Caiboo Reginal District)

Figure 5: Mount Polley tailings dam flows into Quesnel Lake. (Image by Vancouver Sun)

2.5.2 Case study 2 : The Samarco mining disaster, Brazil.

On the 5th November 2015, the Fundao dam wall breached and released more than 45 million cubic metres of iron ore tailings into the Rio Doce river system and travelled approximately

600 km down to the Atlantic Ocean (**illustration 4**)(**Figure 12**).[58] In the wake of the aftermath, 19 lives were reported to have been lost; the affected sustained serious damage to their property and wellbeing and the contamination and destruction of the environment along the Rio Doce resulted in the complete halt to any cultural and economic activities.[59]

Cause of breach

The Fundao dam began operating in 2008 and was designed to contain a total of 79.6 million m^3 of fine tailings and 32 million m^3 of sandy tailings during its 25-year lifespan.[60] As a result of high production levels from 2013 to 2015, in November 2015 the dam was inundated with 56.4 million cubic metres of iron ore tailings deposited in a period of seven years of operation (**Figure 6**).[72]

The Fundao dam was constructed using the upstream construction method. However, the problem associated with this method of construction is that water is the primary instability agent, and as a result, 66% of worlds reported mine tailing dam failures are associated with upstream dam designs. Technical reports have concluded that the cause of the Fundao dam disaster was due to liquefaction of the sandy tailings, a phenomenon that occurs when sandy tailings lose their mechanical resistance and exhibit fluid characteristics.[61] The Key factors contributing to the failure were:

- Structural damage to the starter dyke, resulting in increased saturation ;
- The attempt to solve structural problems with a concrete gallery that caused the axis of the dam to retract, later being raised on mud; and
- The unforeseen deposition of sludge in critical regions.[62]

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[58] Robson ''the river is dead: the impact of the catastrophic failure of the Fundao tailings dam Report'' (2017) London mining network (report) p5.

[59] Zhouri '' The Rio Doce mining disaster in Brazil: between policies of reparation and the politics of affectations'' 2017 Vibrant 1-4.

[60] Do Carmo *et al* ' 'Fundao tailings dam failures: the environment tragedy of the largest technological disaster of Brazilian mining in global context'' (2017) *Perspectives in Ecology and Conservation*145–146. [72] Robson (2017)p6.

[61] Do Carmo et al (2017) Perspectives in Ecology and Conservation 145–146.

[62] *Ibid.*

Consequences of the Samarco tailings dam disaster

The tailing was a wave of poisonous, deleterious mud/water which presented an imminent threat to health and livelihood, compromising the living ecological river as well as its hydroelectric infrastructure (**Figure 8**).[75]

The toxic tailings devastated the environment in a way never seen before. Sediment fanned [63]out into the ocean a few days after the dam breach affected the nearby coasts, including the turtle conservation area near the mouth of the river. [64] The sediment is currently most noticeable in the streams and rivers downstream from the dam, and the deposition of mine waste in certain river-bank areas.[77]Forty downstream municipalities were adversely affected and hundreds of inhabitants were left destitute and without access to clean water.

The toxic water poisoned more than 21 different types of fish species, killing tons in large numbers (**Figure 11**). Large animals such as the South American tapir, as well as turtles, birds, amphibians and invertebrates were amongst the casualties (**Figure 7**).[78]The tailings directly hit 135 identified semi deciduous seasonal forest fragments and 863, 7 ha of permanent.

Preservation Areas associated to watercourses, which were in protected areas. In addition, 294 small creeks were affected by the tailings.[65] Due to the high volume of tailings deposited in the reservoir, around 10 million m^3, the hydroelectric power plant reservoir Risoleta Neves (UHE-RN) had not resumed electrical power production. A small hydroelectric plant in Bicas was also damaged.[66]

Agricultural land near the river was also covered by the flow of mining waste. The agricultural land is unusable, and at present and for the foreseeable future- it will be impossible to farm in these agricultural communities. There is no clear vision of how the farmers will gain aces to their farming land again.[67]

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[63] Creado, & Helmreich ''A wave of mud: the travel of toxic water, from Bento Rodrigues to the Brazilian Atlantic'' (2018)*Revista do Instituto de Estudos Brasileiros, Brasil* p. 33-36.
[64] Robson 2017 the river is dead: the impact of the catastrophic failure of the Fundao dam Report p11. [77] *Ibid*. [78] Do Carmo *et al* (2017) 145 at 148.
[65] See *id* at 147.
[66] Robson (2017) p14.
[67] Robson (2017) p26.

Out of the 806 buildings directly hit buy the tailings, at least 218 were completely destroyed. These accounted for residential buildings, commercial real estate, public buildings, centennial churches and ancient farms distributed among 10 districts of five municipalities (**Figure 10**).[68] The impact of the dam collapse on the livelihood and the economy has been catastrophic. An immediate interruption of transport, electricity and water supply ,death of animals and impossibility of watering them ; the loss of agricultural machinery and equipment and the destruction of annual crops, vegetables, fruit, eucalyptus, pastures and riparian forests.

Consequently, this led to the paralysis in milk production and delivery in areas that had specialised in milk production.[69]

Illustration 4: Course of mineral tailings from Mariana to the Atlantic Ocean. (Map drawn by Max Vasconcelos 2017)

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[68] Do Carmo et al (2017) 145 at 147.
[69] Robson (2017) p25.

Figure 6: The left hand dam above is intact, whilst the one to the west appears to have failed. (Image by Reuters)

Figure 7: A fireman rescues a dog that was trapped in the mud that swept through the village of Bento Rodrigues in Brazil. (Image by Douglas Magno at abc.net.au)

Figure 8: An abandoned car caught in the mudslide amidst the ruins of Bento Rodrigues. (Rogerio Alvis/TV Senado)

Figure 9: Damage to homes after dam break in Bento Rodrigues, Mariana and Minas Gerais. (Image by Rogerio Alvis /TV Senado at unevenearth.org)

Figure 10: Destroyed buildings and homes at Bento Rodrigues as seen from the air. (Source at abc.net.au)

Figure 11 A local fisherman working for a company contracted by Samarco mine operator clears up dead fish found on the beach of Povoacao village.(Photograph: Ricardo Moraes/Reuters)

Figure 12: The mix of reddish mud, water and debris reached the Atlantic Ocean in a matter of days. (Screenshot from PigMine 7, via YouTube)

2.5.3 Case study 3: Merriespruit tailings dam failure, Virginia, South Africa

On the 22nd of February 1994, at approximately 21:00, after a brief thunderstorm and about 50mm of rain fall , the Merriespruit tailings dam wall collapsed ; sending 600 000 m^3 of liquid tailings through the suburb of Merriespruit and stopped about 3 km away from the tailings dam (**Figure 15**).[70]The dam failure occurred when many people were at their homes. As a result, 17 people died and there was widespread damage to the suburb and the environment.[71]

Causes of failure

In the conclusion of the various investigations, the stakeholders were able to demonstrate that failure was due to a number of factors, such as:

- Over a period of time, a considerable quantity of free water had gathered on the dam prior to its failure.
- The pool in compartment 4A was not located around the penstock outlet, but was lying against the north wall. As a result, the rains which fall in the impoundments of

[70] Fourie *et al* ''static liquification as a possible explanation for the Merriespruit tailings dam failure'' (2001) *Can. Geotech. J*. p 707-707.

[71] Davies ''Mine tailings dams: when things go wrong'' accessed 1 September 2018.

compartment 4A and 4B flowed towards the pool, which moved away from the penstock to the north wall.

- The pool already contained 40 000 to 50 000 m^3 of water from the plant and could not contain the additional inflow of approximately 50 000 m^3 that was the result of the rainstorm .this caused overtopping to occur at the lowest point of the north wall.
- The spill water eroded the loose tailings that had been pushed into earlier sloughs on the lower slope. The overtopping water removed the slough tailings and prevented the accumulation of the buttress at the toe of the unstable slopes.
- A series of slip failures moving up the slope occurred, culminating into a massive overall failure that released the slide (**Figure 13 and 14**).

Together with eyewitness accounts, the cause of failure can be attributed to moisture build up in the tailings along the north wall and eventual overtopping. [72]

Consequences of the failure

As a result of the breach, many people were left homeless as the 2.5 m high wave of tailings swept many houses off their foundations and others had their walls demolished.[87] The environment was left destroyed and contaminated.

The failure of the tailings dam was also responsible for the death of 17 people. The owner, the operator and six of their employees were subsequently found guilty of negligence and heavy fines were imposed. It emerged that personnel were promoted to positions that included tailings dam management, but did not receive the appropriate training or had not gained the appropriate experience in respect of tailings- dam operations.[73]

[72] Van Niekerk & Viljoen (2005) *land degradation & development* 201 at 209. [87]
Fourie et al (2001) *Can. Geotech. J.* 707 at 707.
[73] Van Niekerk & Viljoen (2005) *land degradation & development* 201 at 209.

Figure 13: Image of the Merriespruit tailings dam failure. (Image from Tailings.org)

Figure 14 Aerial view of the dam breach. (Source at tailings.info)

Figure 15: Tailings sweeping through the town of Merriespruit. (Source at tailings.info)

2.5.4 Main causes of tailings dam failures

The term failure in this dissertation refers to the various mechanisms by which tailing dams ultimately failed. Some of the long-term tailings dam failure causes include earthquakes, erosion, overtopping, seepage and piping, foundation failure, mine subsidence, slope instability and structural damages. [74] The leading causes of tailing dam failures are overtopping, slope stability and earthquakes.

To incorporate design mechanisms minimising both overtopping and earthquakes; a prediction of future seismic or hydrologic activity most likely to be experienced by the tailings dam during its lifetime is required. The basic factors that influence the constancy of a tailings dam are the conditions of the dam foundation; the properties of the embankment materials; the rate of deposition and properties of tailings; the height of the dam; the angle of outer slope; design incorporating seismic and hydrologic events and overall water management.[90]

Floods, earth quakes and operational practices activate events which lead to failure of tailing dams. **Table 3** and **Illustration 5** below show causes of failure activated by these events.

Floods	Earthquake	Operations

[74] Larrauri , Lall (2017) ''Assessing risks of mine tailing dam failures' Columbia water center''. Page 8. [90]Chambers & Higman (2011) ''long term risks of tailings dam'' p 5.

Overtopping Erosion Seepage and piping Slope instability Structural damages	Foundation failure Structural damages Slope instability	Overtopping Erosion Seepage and piping Slope instability Structural damages Foundation failure

Table 3: Common triggers and leading causes of failure.

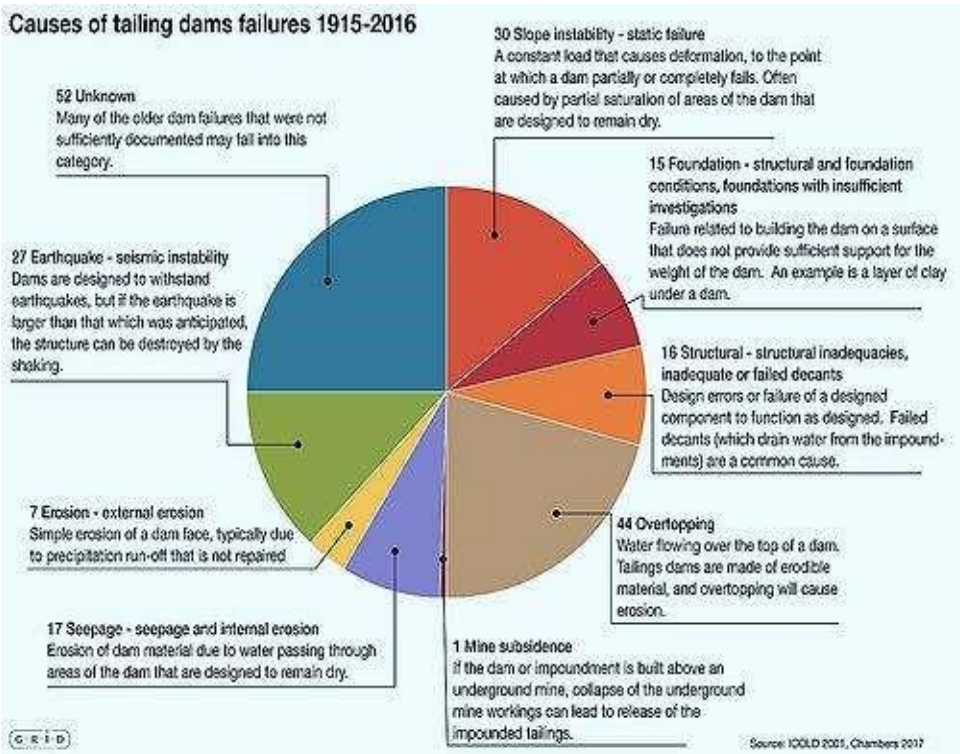

Illustration 5: Shows that the causes of tailing dam failures have not changed dramatically from 1915 to 2016. (Kristina Thygesen at grida.no)

Despite recent technological advances -designed to minimise the long-term risks associated with the design, operation and closure of tailings storage facilities- statistics relating to tailing dam failures suggests it is premature to assume these issues will be eradicated indefinitely ,as they are yet to be adequately addressed.[75] As a result, the consequences associated with

[75] *Ibid.*

the failure of tailing dams have been heavy economic loss, environmental degradation and, in certain circumstances, loss of human life.[76]

2.6 LEGISLATION AND REGULATION

Most mining jurisdictions around the world have laws applicable to the management of TSF's. However, the failure of TSF's is a common occurrence even in large reputable mining companies. A common reason for this failure is that dams are not constructed in accordance to their design criteria; the construction of the dam and the water levels are not controlled properly or there is a lack of communication between the dam operators, causing confusion and a deficiency in the knowledge pertaining to features that control safe dam operation.[77] From this perspective it is clear that a well-organized and functioning TSF's regulatory framework is of paramount importance.

In countries like Argentina, Australia (New South Wales), Canada (Alberta, British Columbia, Quebec) and France, the regulatory scheme relies on consolidated TSF legislative Framework. Other jurisdictions such as South Africa, China, Norway, Spain, Switzerland and the United Kingdom deal with tailings dam safety as one aspect in more general legislation. The applicable legislative Framework may deal generally with water, the environment, dams, energy or natural resources.[78]

The form which the legislation can take is either fragmented or consolidated. In South Africa we have fragmented legislation pertaining to TSF's. This form of legislative framework has its advantages and disadvantages .The main crux of this research is to determine in which form is tailings dam legislation most effective and why.

2.7 CONCLUSION

In this chapter the technical concept of TSF's; the composition of tailings; TSF construction methods and recent TSF's failures; and TSF's legislative framework within the extractive

[76] Chambers & Higman (2011) ''long term risks of tailings dam'' p 6.

[77] Kreft-Burman *et al* 'Tailings Management Facilities- Legislation, Authorisation, Management, Monitoring and Inspection Practices Report' 2005 tailsafe.

[78] Bradlow *et al* 'Regulatory Frameworks for Dam Safety: A Comparative Study' 2002 p58 .

industries are discussed. The key features of the TSF construction methods and causes of failure are outlined with case studies as examples.

The critical reviews give an in-depth holistic view of TSF's and the fact that the causes of failure can be attributed to two things: human error and ''acts of god''. Although the necessary technology for better construction of TSF's exists, the extractives industries have a long way to go with regards to the enforcement of TSF management regulations ;the use of appropriate TSF construction methods regardless of Costs; and constant monitoring of TSF's.

The next chapter provides an overview of South Africa's current Regulatory framework applicable to TSFs and the authorities responsible for the regulation of various aspects pertaining to TSF's. Applicable legislation and regulations will be discussed in-depth.

CHAPTER 3
CURRENT STATUS IN LAW

3.1 INTRODUCTION

The legal form of regulations relating to TSF's is of importance when considering regulatory frameworks. In South Africa, the fragmented legal form of the regulatory framework pertaining to TSF's consists of primary instruments, such legislation, and subsidiary instruments such as, regulations and guidelines.

In this part of the research, we will look at the multitude of acts and regulatory codes which have principles and requirements that that may influence TSF's .The role of Each piece of legislation will be critically analysed and dealt with separately .We will also look at the matrix of fragmented designated regulatory authorities that deal with TSF's as part of a broader regulatory responsibility. It is important to note that in South Africa, as a result of fragmented legislation, designated authorities face a duplication of administrative procedures; an overlap in jurisdiction and ubiquitous confusion in varies regulatory bodies, leading to unsustainable service delivery.

3.2 LEGISLATION APPLICABLE TO TSF's IN SOUTH AFRICA

A plethora of legislation influences the regulation of TFS's and the extent thereof varies considerably. In no particular order, the following Acts have principles or requirements applicable to TSF:

- The Constitution of the Republic of South Africa Act No. 108 of 1996 (CRSA);
- The Mineral and Petroleum resources Development Act No.28 of 2002 (MPRDA);
- The National Environmental Management Act No. 107 of 1998 (NEMA) ;
- The National Environmental Management : Waste Act No. 59 of 2008 (NEMWA); The National Environmental Management : Air Quality Act No. 39 of 2004 (NEMAQA);
- The National Water Act No.36 of 1998 (NWA);
- The Mine Health and Safety Act No.29 of 1996 (MHSA);
- The Radioactive Waste Management Policy and Strategy for the Republic of South Africa;
- National Radioactive Waste Disposal Institute Act No. 53 of 2008 (NRWDIA)
- Nuclear Energy Act(NEA);
- National Forest Act, 1998 ACT NO. 84 OF 1998 (NFA)

- SABS Code of Practice (COP) for Mine Residue Deposits (CPMRD)
- National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA)

The requirements and principles embodied by the legislation will now be critically discussed below.

3.2.1. The Constitution of the Republic of South Africa Act 108 of 1996

Section 24 of the Constitution of 1996 (including several amendments thereafter), states *inter alia*, 'that everyone has the right to an environment that is not harmful to their health or wellbeing and to have an environment protected for present and future generations.[79]The principles that are embodied within section 24 of the constitution have shaped promulgated environmental legislations in various industries.

To give legal effect to the principles embodied in the constitution, Government has been compelled to pass laws that prevent pollution and the depletion of our natural resources, promote sustainable development and conservation while promoting socio-economic development of people. Section 24 (b) of the constitution provides measures for ensuring a safe environment in mining and disposal of waste resulting from mining activities; and emphasis is placed on the prioritization of the health of communities and environment integrity during all phases of mining ,including closure, as embodied in the National Environmental Management Act .[80]

Section 195 (1) of the constitution sets out the democratic values and principles by which public servants and organs of state must be governed. Authorities regulating the mining industry are compelled by law to uphold these principles and promote the environmental rights enshrined in section 24 of the Bill of rights.[81]

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[79] The Constitution (1996) s 24.

[80] Poswa & Davies 'The Nature and Articulation of Ethical Codes on Tailings Management in South Africa' 2017 p 8.

[81] The Constitution (1996) Chapter 10 ,s 195 (1).

Despite these developments, the constitutional rights of communities affected by mine pollution are often being infringed .Abandoned and derelict mine sites cause water pollution and AMD; cattle and grazing land is affected, depriving communities of earning a living.[82]

3.2.2 The Mineral and Petroleum Resources Development Act 28 of 2002

Section 37 of the MPRDA confirms that the principles set out in NEMA apply to all prospecting and mining operations and that these operations must be conducted in accordance to sustainability principles enshrined in the act.[83]

In chapter 2 we established that residue stockpiles or tailings do not occur naturally in or on the earth. They are created during the beneficiation process in a manner that is not natural. When a residue stockpile or residue deposit is created by the holder of the mining right, or remains on the mine property on termination or expiry of a mining right, it then falls within the ambit of the MPRDA.

In the case of *Beers Consolidated Mines Limited vs Ataqua Mining Property Limited & Others,* the high court decided that the MPRDA did not apply to residues produced under old order rights or titles granted under the Minerals Act.[100]

As a result, The MPRDA Amendment Act 2013 has modified the definition of ''residue [84]deposit'' and ''residue stockpile'' to incorporate deposits or stockpiles created under an old order right.

The consequence of this amendment is that residue held in terms of an unconverted old order right, of which the conversion period has lapsed, allows the state to expropriate these deposits and stockpiles. In the event the old order right has been converted, mining companies own the old residues until the expiry of the mining right, of which the residue will vest in the state.
The MPRDA Amendment Act 2013 also deals with whether the provisions concerning stockpiles and residue have retrospective effect or not .Section 42A of the MPRDA

[82] Poswa & Davies 'The Nature and Articulation of Ethical Codes on Tailings Management in South Africa' 2017 p 7.

[83] Viljoen & associates '' BCR Minerals (PTY) LTD Spitsvale rehabilitation and closure plan: report NR P329 '' 2016 .

[84] *Beers Consolidated Mines Limited vs Ataqua Mining Property Limited & Others* (3215/06) [2007] ZAFSHC 74 (13 December 20070 PARA 23.

amendment [85] now provided that an owner of historical mines and dumps created before the act has two years, from the date the MPRDA is promulgated, to apply for a reclamation permit. In order for this permit to be granted, the Holder must intend to conduct mining operations upon the granting of such permit.[102]

Before the 2013 MPRDA amendment Bill, Section 39 of the MPRDA required companies to carry out an environmental-impact assessment (EIA) and have an approved environmental management program (EMP) and were subject to the approval of the Minister of Mineral Resources, before any mining activity could take place.

The state of the (EMP) was approved in terms of section 38A MPRDA.[86] After NEMA amendment came into force, section 38A and 38B was inserted by section 32 of NEMA 2008. Section 38B states:[8704] "An environmental management plan or environmental management programme approved in terms of this Act before and at the time of the coming into effect of the National Environmental Management Act, 1998, shall be deemed to have been approved and an environmental authorisation been issued in terms of the National Environmental Management Act 1998."

The implication of the amendment indicated that EMPs which were approved in terms of the MPRDA would be regarded as having been approved in terms of the amended NEMA.[105]

3.2.3 The National Environment Management Act 107 of 1998 (NEMA)

One of the main reasons responsible for the amendments of the MPRDA and NEMA was an agreement reached between the then Department of Minerals & Energy (now the Department of Mineral Resources) and the Department of Environmental Affairs. The agreement reached entailed that all matters pertaining to the environment would be now regulated by the One Environmental System under NEMA, which commenced on the 8th of
December 2014. [106]

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[85] MPRDA (2002) s 42A ,states that :

(1) That all historic residue stockpiles and residue deposits currently not regulated under the MPRDA belong to the owners thereof and continue in force for a period of two years from the date on which the MPRDA Bill is promulgated. [102] Feris ''mine dumps in South Africa: an ownership dilemma'' 2013 , accessed CDH website on 9/15/2018.

[86] MPRDA s 38A states:

[87]) The Minister is the responsible authority for implementing environmental provisions in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as it relates to prospecting, mining,

The one environment system was meant to rectify the issues experienced by applicants who had to apply for mining rights or permits in terms of the MPRDA, but subsequently had to obtain environmental approval from various departments, which resulted in a cumbersome application process.[107]

Exploration, production or activities incidental thereto on a prospecting, mining, exploration or production area. An environmental authorization issued by the Minister shall be a condition prior to the issuing of a permit or the granting of a right in terms of this Act.

As a result, in another attempt to achieve coherent legislation and One Environment System, the National Environmental Management Laws Amendment Bill [B14-2017] was published with provisions to facilitate this transition.

Section 24N of the NEMA regulates the environmental authorizations in relation to prospecting and mining related activities.[88] The NEMLAA Bill seeks to clarify that EMP's approved in terms of the MPRDA on or before 8th December 2014 shall be deemed to have received approval and authorization issued in terms of NEMA.[109]

But this clarification has introduced more confusion as EMP's will only be regarded as environmental authorization if the holder or applicant had also obtained, if required, environmental authorization and waste management licence for ''ancillary activities''. It is not clear as to what is meant by ancillary activities and therefore restores confusion.[89]

In 2008, the management of residue stockpiles and residue deposits was to be managed in accordance with the provisions of the Waste Act as specifically stated in NEMA .Currently this position still stands but the Bill has proposed to revert to the pre-2014 position when the Waste Act was not applicable to residue stockpiles and deposits.[90]

[88] MPRDA s 24N sets out what should be contained in an EMP'R and contains the same requirements as those under the repealed s 39. [109]

Anonymous ''the status of environmental management plans and environmental management programmes as environmental authorisations'' July 2015.Hogan Lovells website on accessed 15/9/2018 .

[89] See City of Cape Town v Macssand (Pty) Ltd and Others (4217/2009, 5932/2009) [2010] ZAWCHC 144.

[90] Vermaak '' Environmental legislation to be established in mining industry'' 2009, accessed mining weekly website on the (9/15/20182)

3.2.4 The National Environmental Management: Waste Act 59 of 2008 (NEMWA)

Stockpiles and residue deposits are currently deposited and managed in terms of the provisions of the NEMWA. Prior to its amendment on the 2nd September 2014, NEMWA did not apply to mine waste but other types of waste. This has caused problems due to the approval of waste licenses also falling under the NEMWA, causing stockpiles and residue deposits to be in line with the waste management classification regulations.[91]

The National Environmental Management Laws Amendment Act 25 of 2014 (NEMLAA), amended NEMWA to include residue stockpiles and deposits. The NEMLAA Bill 2017 seeks to reverse the current position and have residue stockpiles and deposits regulated under NEMA.[113]

3.2.5 The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA)

In order to give effect to section 24(b) of the Constitution, NEMAQA objectives are to protect the environment by providing reasonable measures for, the protection and enhancement of the quality of air in the republic; the prevention of air pollution and ecological degradation; and security ecologically sustainable development while promoting justifiable economic and social development.[114]

The main provisions that influence TSF's are Section 32 of the act (dust control) ,and section 33 (rehabilitation of disturbed area once mining operations cease).The aim of these provisions is to control the pollution of the atmosphere by dust ,both during operations and after they have seized, and to prevent nuisance by dust. Furthermore, when evaluating ambient air quality and dust fall rates, one has to look at the provisions of the South African National Ambient Air Quality Standards (NAAQS); and the National Dust Control Regulations (NDCR), which was signed into law on the 1st of November 2013, as set out in the NEMAQA.[92]

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[91] Jackson ''Amendments to mineral legislation : Curcular No 1'' 2013 *Cox Yeats* accessed on (15/9/ 2013).
[113] *Ibid.* [114] NEMAQA(2004) Chapter 1, s 2 .
[92] Airshed planning professionals''Air Quality Impact Assessment for the Proposed Spitzland Development near Roodepoort, Gauteng report'' 2018 ,p 4.

TSF's can be significant sources of dust emissions, affecting both the environment and human health. Studies have indicated that TSF's in close proximity to residents and communities pose a health risk.[93]

3.2.6 The National Water Act 36 of 1998 (NWA)

The NWA deals primarily with pollution prevention, particularly in instances where the pollution of water resource may occur as a result of activities on land.[94]Sections 24 of the constitution and the provisions of NEMA have been considered in insuring various pollutants created by mining are included. The definition of pollution according to the NWA is:
The direct or indirect alteration of the physical, chemical, or biological properties of a water resource to make it;

(a) Less fit for any beneficial purpose for which it may reasonably be expected to be used; or

(b) Harmful or potentially harmful-

(aa) To the welfare, health or safety of human beings;

(bb)To any aquatic or non-aquatic organisms;

(cc)To the resource quality; or

(dd) to property.[95]

Section 21 deals with licensing for the following water use activities. These are:

a) Disposal of effluent to facility or land (Governed by Section 21 (e), (g), (h) and (j)). These can include facilities such as TSF'S and evaporation dams.

b) Disposal of waste to facility or land (Governed by Section 21 (e) and (g)). These can include waste rock disposal and solid waste disposal.

c) Land use activities that are registered. (Governed by Section 21 (e), (g), (h) and (j)). These can include facilities such as mining operations, industrial sites and waste water treatment sites.

d) In-stream activities (Governed by Section 21 (j)). These can include activities such as channel modification.[96]

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[93] Amec Foaster Wheel Engineering and Consulting Mining ''Booysendal - Air Quality Management Plan'' 2017 (accessed 16/9/ 2018)page 22 .

[94] McCourt '' Environmental legislation and water management issues during mine closure in South Africa'' mine ,water and environment.1999 IMWA Congress .IMWA website accessed 20 September 2018

[95] NWA s 1

[96] de Waard .Waste discharge system: the practical implications from a gold mining perspective (Masters

Acid mine drainage is one of mining's most prolific water resources and environment polluter in South Africa. Section 19 of NWA imposes a wide duty of care and liability on mining companies to address this issue by means of ''reasonable measures''.[97] The NWA has introduced further regulations in terms of GN R 704 in GG 20119 4 June 1999 specifically for the use of water for mining and related activities aimed at the protection of water resources.

Schedule 7 of the GN R 704 deals with the reasonable measures which must be taken by persons in control a mine or mining activities.[98] The regulations set out comprehensive and far-reaching obligations on mining companies and also extend the liability of mines in the case of none compliance in respect to pollution, especially AMD.[99]

Dam Safety Regulations require that the classification of dams with a safety risk must be classified in accordance with regulation 2.4, taking into consideration the size and hazard potential of the dam. Authorization is required from the dam safety office before construction of a dam commences.[100]

3.2.7 The Mine Health and Safety Act 29 of 1996 (MHSA)

Health and safety in South Africa's mines is regulated by the MHSA and Mine Health and Safety Regulations.[101]

The MHSA exhibits the principles of section 24 of the constitution by providing for the protection of the health and safety of employees and non-employees. Section 102 of the MHSA defines a ''mine '' as follows:

MINE:

(i) any borehole, or excavation, in any tailings or in the earth, including the portion of the earth that is under the sea or other water, made for the purpose of searching for or winning a mineral, whether it is being worked or not...[102]

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mini-dissertation 2012) p18. Also see s 21 of NWA.

[97] NWA s 19(2).

[98] GG 20119 of 4 June 1999.

[99] Feris & Kotze '' THE REGULATION OF ACID MINE DRAINAGE IN SOUTH AFRICA: LAW AND GOVERNANCE PERSPECTIVES'' 2014 *PER/PELJ* p2135.

[100] NWA 9c.

[101] Utembe *et al* '' Hazards identified and the need for health risk assessment in the South African mining industry'' 2015 *Human and Experimental Toxicology* 1212 at 1215.

[102] MHSA s 102.

The term mineral is also defined in section 102 as follows:

MINERAL:

Any substance, excluding water, but including sand, stone, rock, gravel and clay, as well as soil other than top soil…

It is clear by the definition of a 'mine' the MHSA applies to TSF's. The MHSA further incorporates sections which apply to TSF's and mine closure employees.

Section 2 of the act states that the employer must insure the mine, including TSF's, is designed safely and is conducive for a healthy and safe environment for the employees and non-employees.[103] Section 5 on the other hand places a duty on the manager to maintain health and safe mine environment.[104]

3.2.8 The Radioactive Waste Management Policy and Strategy for the Republic of South Africa

As a member state of the International Atomic Energy Agency (IAEA), The Radio Waste Management Policy and Strategy for the Republic (RWMPS) has aligned its principles with National and International objectives in a manner which protects human health and the environment.[105] Section 24 of the constitution must also be kept in mind at all times during radioactive waste management regulations.

According to the RWMPS, radioactive waste may occur in a gaseous, liquid or a solid form that may range from low radioactivity, to highly radioactive. certain mine tailings ,medical and laboratory waste are recognized as having low radioactivity, while used fuel and certain spent radioactive sources are considered to be highly radioactive waste.[129]

Tailings from the mining and milling of ores that contain uranium, thorium, and their radioactive decay products are stored in TSF's, and as a result, the provisions of the RWMPS pertaining to the management of such waste must be adhered to.

[103] See *id* s 2 (1).
[104] See *id* s 5.
[105] IRWM Policy princ 8,par 1A & 3. [129]

See *id* IRWM Policy par 1 p 7.

3.2.9 Nuclear Energy Act 46 of 1999 (NEA)

The main aim of the NEA is to prescribe measures to be adhered to regarding the disposal of radioactive waste and the storage of irradiated nuclear fuel. In terms of the act, radioactive waste is defined as:

‘’any radioactive material destined to be disposed of as waste material.’’

It is clear from this definition that hazardous tailings producing radioactive substances such as uranium, and disposed of in TSF’s, will fall under the regulation of this act. Section 45 states that to dispose of such radioactive waste requires written permission of the Minister of Energy, in consultation with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry, may make regulations determining the manner in which the radioactive waste will be managed, stored and discarded .[106]

3.2.10 National Radioactive Waste Disposal Institute Act 53 of 2008 (NRWDIA)

The main purpose of this act is to establish a National Radioactive Waste Disposal Institute in order to manage radioactive waste disposal on a national basis; to provide for its functions and for the manner in which it is to be managed; to regulate its staff matters; and to provide for matters connected therewith.[107]

The functions of the NRWDIA applicable to TFS’s, inter alia, are:

- The design and implementation of disposal solutions for all classes of radioactive waste ,and
- The development of radioactive waste acceptance and disposal criteria in compliance with applicable regulatory health and safety environment requirements, and any other technical and operational requirements.
- Manage, operate and monitor operational radioactive waste disposal facilities, including related storage and predisposal management of radioactive waste at disposal sites.[108]

[106] NEA s 46.
[107] NRWDIA 2008.
[108] NRWDIA Chapter 2, s 5 .

3.3.1 National Forest Act 84 1998 (NFA)

In terms of NFA Regulations, chapter 4 a license must be obtained by anyone who wants to conduct mining of precious metals or base metals to carry out such activities in a State forest.[109] This is applicable to TSF as it is a result of mining activities.

3.3.2 SABS Code of Practice for Mine Residue Deposits (CPMRD)

The SABS CPMRD deals with the construction, operation and management of the disposal of mine residue. The code places emphasis on the management of water as this is a critical component of the design, operational management and closure of TFS facilities.[110]
The constitutional principle of sustainability must be adopted into the design of the TSF's, therefore, the code requires that technical studies and the design must be undertaken by suitably qualified personnel. The conservation of water and pollution prevention must be incorporated into the design to further fortify the design of the TFS.[111]

3.3.3 National Heritage Resources Act 25 of 1999 (NHRA)

If the proposed development site of a TSF has heritage resources within its footprint, the Heritage Impact Assessment (HIA) must be completed in compliance with the requirements of the NHRA to inform the South African National Resource Agency (SAHRA) and the Provincial Heritage Resource Authority of the proposed project.[112]

3.4 Regulatory bodies

The regulatory bodies are expected to work together and be responsible for enforcing compliance with legal requirements and advising government appropriately. The responsible regulators are:

- Minister of Mineral Resources in concurrence with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry (NEA)
- Department of Mineral Resources (MPRDA)
- Mine Health and Safety Inspectorate (MHSA)
- The Department of Water Affairs and Forestry (NWA)

[109] NFA regulations s 14 (1).
[110] Wimberely *Best Practice Guideline - A2: Water Management for Mine Residue* Deposits (2008) p 1.
[111] See *id* p 4.
[112] NHRA s 38 . GN R 548 chapter 3.

- The Ministry of Water and Environmental Affairs administers this legislation through the Department of Environmental Affairs and Department of Water Affairs (NEMA)
- The Ministry of Water and Environmental Affairs administers this legislation through the Department of Environmental Affairs and Department of Water Affairs (NEMAQA)
- The Ministry of Water and Environmental Affairs administers this legislation through the Department of Environmental Affairs and Department of Water Affairs (NEMWA)
- Administered by the Department of Energy (NEA)
- Minister of Water and Environmental Affairs administrates this Legislation through the department of Environmental Affairs (NFA)
- South African Heritage Resource Agency and Provincial Heritage Resource Authority (NHR)
- Administered by the Department of Energy (NRWDIA)[113]

Due to this fragmented TSF regulatory framework, the governmental departments are also fragmented, lack co-operation, coordination and often have overlapping mandates. As a result, Fragmentation ultimately results in an ineffective legislative and government framework.

3.5 Conclusion

This chapter gives a holistic view of the current fragmented Legislative Framework applicable to TSF's and the regulatory bodies responsible for the implementation of these laws and regulations. Each piece of legislation, regulation and codes are discussed and analysed in detail. It is clear that such a fragmented legislative framework structure does not always amount to good governance or the fulfilment of the constitutional mandate of environmental and economic sustainability.

Strides have been made to consolidate the environmental aspect of TSF applicable legislation with the introduction of the One Environmental System and the recent National Environmental Management Laws Amendment Bill [B14-2017], but more needs to be done to give effect to holistic TSF governance, integration and direct sustainability measures. Regulatory bodies and their overlapping mandates is another result of fragmented legislation in South Africa.
The next chapter will provide insight into the various arguments in support of and in opposition to the fragmentation and Consolidation of TSF legislation.

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[113] Department of Minerals and Energy ''Radioactive Waste Management Policy and Strategy for the Republic of South Africa'' (2005) p 12.

CHAPTER 4

AN ANALSIS OF FRAGMENTAED AND CONSOLIDATED TSF LEGISLATIVE FRAMEWORK IN THE EXTRACTIVE INDUSTRY

4.1 INTRODUCTION

The TSF legislative framework in South Africa is widely fragmented, but the environmental aspect pertaining to the TSF's legislative framework has undergone major changes with the introduction of the ''one environmental system'' in 2008.In March 2017, the National Environmental Laws Amendment Bill, 2017 (NEMLA 4) was introduced as another attempt to improve the mining regulatory regime.

Despite this development, fragmentation still presents itself in terms of structural fragmentation between the various sphere of government and the various line functionaries in each sphere. The matrix of TSF framework of fragmented legislation further gives rise to duplication of administrative procedures, jurisdictional overlap, and a time-consuming and confusing governance effort.[114]

This can hamper the endorsement of the concept of sustainability as stated in section 24 of the Constitution of the Republic of South Africa. (The main Acts controlling the design, construction and operation of tailings dam)

Consolidation (sometimes referred to as integration) of the various Acts and regulatory authorities which make up the TSF legislative framework, is the only way by which fragmentation can be addressed.in this chapter we will be looking at fragmentation and consolidation of TSF's legislative framework and determine which form is most suitable for South Africa.

4.2 FRAGMENTATION

In order for us to understand the concept of a Fragmented Legislative framework, we must have an understanding of what fragmentation is .According to kotze, Fragmentation refers to

[114] Kotze' '' IMPROVING UNSUSTAINABLE ENVIRONMENTAL GOVERNANCE IN SOUTH AFRICA: THE CASE FOR HOLISTIC GOVERNANCE'' 2006 *PER/PELJ* 261/75.

a situation where there are disconnected structures of governance along separate, autonomous line functioning organs of state that operate at national, provincial and local sphere of government fragmented governance structure result in fragmented governance processes that culminate in fragmentation. The result is disjointed legislation that emanates from separate policy process.[115]

4.3 NATURE AND EXTENT OF FRAGMENTATION IN SOUTH AFRICA

4.3.1 Legislative Fragmentation

The regulatory framework applicable to TSF's in South Africa is widely fragmented. Legislation can be fragmented in a horizontal or vertical manner. According to Kotze, horizontal fragmentation occurs when several cross sectoral Acts various Acts are applicable to a single issue or activity. Often, this causes a legislative framework to have an overlap in jurisdictions and gives rise to a multitude of confusing procedures that must be followed by applicants seeking authorization.[116]

Vertical fragmentation on the other hand refers to a situation where one has a series of national, provincial and local laws all dealing with a similar substantive issue. [141]For the purpose of this study only horizontal fragmentation will be discussed.

A range of statutes has been enacted to give effect to constitutional objectives described in chapter 3 ,*inter alia*, NEMA, which regulates the protection and preservation of all environmental resources; the NWA, which ensures the management ,protection and conservation of water resources; and NEM:WA, which provides directives for the management of waste. Collectively the TSF legislative framework includes pollution prevention, conservation and protection of natural resources. To further illustrate the nature of horizontal fragmentation. Examples are discussed below.

Chapter 5 of NEMA (as amended on the 8th of December 2014) primarily regulates the EIA aspects related to mining (including TSF's) and specifically mineral processing.[117]Apart from

[115] Kotze' *A legal framework for integrated environmental governance in South Africa and the North-West Province (*LLD dissertation 2005 doctorial NWU) p23.

[116] Kotze' 79. [141]

Kotze' 78.

[117] NEMA chapter 5.

the NEMA provisions on EIA, other acts also provide EIA procedures. The National Heritage Resources Act 25 of 2002, *inter alia*, is one of these acts. The NHRA requires all developers, including mines, to undertake Heritage Impact Assessment (HIA) for any development exceeding 0.5 ha in extent. The act further provides guidelines to be followed for impact assessment studies to be conducted where cultural resources may be disturbed by the development activities.[118]The relevant competent authorities that regulate the EIA's include, *inter alia,* the DEA and the SAHRA.

The TSF's Legislative framework also consists of various acts which regulate biodiversity resources. The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) is a complementary act to NEMA. The purpose of NEMBA is to manage and conserve South Africa's biodiversity within the framework of NEMA .To promote these objectives, protective measures are given to ,inter alia, ecosystems and protected species ,alien species, listed invasive species and genetically modified orgasm. [119] Before conducting any '' restricted activities '', such as the construction of a TSF or other mining related activities, a permit must be acquired.[120][121] The (NFA) deals with, inter alia, issues relating to the use of natural forests, establishment of plantations and authorization for various forestry activities.

146 These are just some of the acts applicable to biodiversity resources insofar as it relates to authorization of activities such as mining activities, and in particular TSF's, in nature reserves and heritage sites. The relevant competent authorities include, inter alia, DEA and the (DWAF).

TSF's often host radioactive waste and therefore become subject to the radioactive waste regulatory framework. In terms of the NEA, authorization is required to dispose of, store or reprocess any radioactive waste or irradiated fuel. [122]The Minister of Minerals and Energy, in concurrence with the Minister of environmental Affairs and Tourism and the Minister of Water Affairs and Forestry ,can impose conditions as they deem fit .The conditions imposed will be an addition to any conditions contained in a nuclear authorization as defined in the

[118] NHRA (1999).
[119] NEMBA s 51, 52, 56. see also GG 34809.
[120] s 57(1).
[121] NFA s 7(1), 10 (1) , 15 (1) , 23 (1) ,24 (9) and 28 (4).
[122] NEA s 34(1).

NNRA.[123]The NNRA requires the National Nuclear Regulator to protect persons, property and the environment against nuclear degradation through the establishment of safety standards and regulatory practices and to exercise regulatory control related to safety over the siting, design, construction, operation, decommissioning and closure of nuclear installations and to which this Act applies.

These include nuclear fuel cycle facilities and those facilities that mine and process radioactive ores and minerals. [149]The Mine Health and Safety Act 29 of 1996 makes provision for the protection of the health and safety of employees and none employees at the mines. Any hazardous material, including waste that is radioactive, also falls under the inspection and enforcement tasks of the Mine Health and Safety Inspectorate.[124]The NWA provides for measures to be taken to prevent the pollution of water resource from occurring, continuing or recurring. This includes mining activities on land, which may pollute groundwater.[125]

NWA Dam Safety Regulations published under Government Notice R139 in Government Gazette 35062 regulate the requirements for authorization, classification, safety, design, operation and decommissioning of water dams, including TSF's.[126] The SABS CPMRD also regulates the management of water, design, operation and closure of TSF's.[127]

The National Nuclear Regulator has jurisdiction over material that contains radioactive traces involving activities under the scope of regulatory control as set out in the regulations in terms of section 36, read with section 47 of the NNRA, on Safety Standards and Regulatory Practice (SSRP).the regulations provide for the storage of radioactive waste in TSF's .considerations such as: mining waste, minimizing the use of fresh water; the TSF footprint; and the potential impacts on the surrounding surface environment and groundwater resources.[128]

[123] s46. [149]
NNRA s5.
[124] MHSA. (1996).
[125] NWA s19 and 27.
[126] GN R 139 35062 s 2 to 45.
[127] SABS Code of Practice for Mine Residue Deposits.
[128] RG-0018 Interim Guide on the Management of Norm Tailings and Waste Rock p6. [155]
Kotze' 2006 *PER/PELJ* 92 .

4.4 ADVANTAGES OF FRAGMENTATION

The benefits of a Fragmented TSF legislative framework are miniscule. Firstly, a fragmented framework accommodates various needs and concerns of different sectors involved in the regulation of aspects relating to TSF's. Therefore, Different sectors perceive their individual positions better respected in a fragmented legal framework than in one piece of legislation dealing with TSF's, of which they have no authority. Secondly, the decentralization of power from one piece of legislation and authority is achieved through fragmentation.

A centralized regulatory authority is more susceptible to corrupt practices and abuses of power as there is no oversight or any involvement from other sectors in the regulation of any aspects relating to TSF's. Thirdly, fragmentation reflects the development of specialized skills and capacities which prevents a single department being the ''jack of all things'' related to TSF's, and master of none. Furthermore, fragmentation allows for a back-up system to exist, for instance, where a certain system may be able to address a problem or concern where the other system fails.[155]

4.5 DISADVANTAGES OF FRAGMENTATION

The lack of coordination and synchronization of legislation, institutions and sectors that ideally should be coordinated is the main cause of fragmentation. Fragmentation is further associated with a number of disadvantages, which may include, inter alia: the duplication of legislative provisions, causing ambiguity, and overlapping government efforts; costly delays in decision-making; organs of state that control aspects pertaining to TSF activities are not in sync; government officials behaviour is incoherent; conflicting government authorities and procedures; insufficient sustainable service-delivery results; and ineffective governance.[129]

The main purpose of TSF legislative framework is to foster environmental protection and sustainability, as stated in section 24 of the Bill of Rights. However, these objectives are seldom reached as fragmentation precludes sustainable governmental service delivery efforts; it does not enable the utilization of various governance tools; it does not provide for streamlined and aligned governance efforts. For example, Lloyd Christie ,a director in ENSafrica's natural resources and environment department , has stated that one of the remaining concerns for the implantation of the 'one environmental system' is the delay in the

[129] Kotze' 92 to 93.

issuance of water-use license by the department of Water and Sanitation, which has been chronically plagued by capacity constraints. A water-use license is a prerequisite for conducting mining operations, therefore including the operation of TSF's that use water.[130]

Moreover, fragmented governance may lead to government organs diverting responsibility and costs from themselves to another organ, conflicting programmes and policy goals, inefficient economic decision making. Ultimately, fragmentation of the TSF legislative framework, based on the disadvantages above, may play a significant role in the failure of TSF's in South Africa.

4.6 CONSOLIDATION

The concept of consolidation is a method to achieve holistic governance. It can be described as a situation where policies, regulation, service delivery and the functions of co-existing governmental organs are consolidated into a single system of government in order to achieve sustainable results.[158]

4.7 NATURE AND EXTENT OF CONSOLIDATION IN CANADA.

4.7.1 Legislative framework

Like fragmentation, Consolidation can occur vertically or horizontally. According to a study done by Aalia Ahmed, vertical consolidation refers to consolidation and coordination between the top to lower levels of management .Horizontal consolidation, on the other hand, refer to consolidation between the different departments within an organization.[131]

Consolidation has emerged as the antithesis of fragmentation as government organs seek to implement a solution to rid them of the disadvantages associated with fragmentation. Nowhere is this more evident than in the extractives industries, particularly in Canada, which epitomizes consolidation.

In Canada, the TSF legislative framework regulations are consolidated in a horizontal manner. As a result; mining activities are regulated by both the federal government and the provincial

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[130] Kerry dimmer '' Q&A with ENSafrica's Lloyd Christie'' JSE supplement mining. p 17 to 19. [158] Kotze' 95/261.

[131] Ahmed *the challenge of implementing integrated environmental management within an organizational structure: the case of the environmental sector in Drakenstein Municipality* (master's-thesis 2016 Stellenbosch University) 32. [160] Anonymous ''International Comparative Legal Guide: mining law 2019 Canada'' .accessed website on 17/10/2018.

or territorial governments. Exploration activities, development and extraction of mineral resources, and the construction, management, reclamation and closure of mine sites are all primary within the jurisdiction of the provinces of Canada (with some exception).[160] Due to the Mount Poll disaster in 2014, British Columbia updated its Health, Safety and Reclamation Code for Mines.

The Code deals with ,inter alia, the design standard, water balance and water management plan, construction of tailings and water management facilities, dam safety review and the closure of TSF's. In the event uranium tailings and environmental matters of international and inter-provincial concern or federal lands are involved, the disposal becomes the responsibility of the federal government through the Canadian Nuclear Safety Commission (CNSC).[132]

The requirements regarding the construction, operation and decommissioning of new uranium mine or mill projects and/or of new waste management facilities are set out in the Management of Uranium Mine Waste and Mill Tailings regulatory document.[133]Part 3 of the Canadian Environmental Protection Act 1999 (CEPA) requires that the Minister of Environment publish a national pollutant release inventory, including substances that ae transported to TSF's.[134]Through the Nuclear Safety and Control Act (NSCA), the CNSC is obliged to regulate, inter alia, the licensing, compliance with the NSCA, and nuclear TSF's.

Under the British Columbia Environmental Management Act 2003 (EMA), waste discharge authorization is required for effluent discharge (e.g., tailings pond supernatant, mineinfluenced run-off and sewage) and solid waste (e.g., mill tailings, water-treatment plant sludge, municipal and industrial refuse).[135] Only nuclear waste discharge will trigger federal government involvement.

In Canada, provinces have their own prescribed statutory environmental assessment requirements, which apply, to various projects in different classes. For example, the British Columbia Environmental Assessment Act 1999 requires an EA for any proposed new mine with a mineral ore production capacity equal to or greater than 75000 tonnes per annum.[136]

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132 Health, Safety and Reclamation Code for mines in British Columbia 2017 Part 10, 1-17.
133 Canada Nuclear Regulator "Management of Uranium Mine Waste Rock and Mill tailings " 2012. Canadian Nuclear Safety Commission p1.
134 CEPA (1999) part 3, s 3.5, 3.5.1 .
135 EMA sbc 2003 Part 6.1 division 2, chapter 53.
136 EAA 1999 part 2, s 5,6,and 8.

In addition, the CEAA states that if the proposed project is of a prescribed type or size, the federal government may have jurisdiction to conduct an environmental assessment.[137]
On February 8, 2018, the Minister of Environment and Climate Change tabled Bill C-69.The bill proposes to repeal the CEAA and replace it with the Impact Assessment Act.

The new impact assessment approach would consider a projects potential environmental, health, economic, and social impacts. Furthermore, if passed, it will create a single Impact Assessment Agency with the mandate to conduct and decide upon environmental assessment on behalf of the federal government. The timeline for agency led impact assessment would be reduced from 365 to a maximum of 300 days.

The Act will apply to designated projects prescribed in the Regulations Designating Physical Activities. TSF's and their potential impact to the environment form part of this impact assessment.[138] Advances have been made by the federal government of Canada by further consolidating environmental processes to strengthen its legislative framework and regulations. As a result, the various regulatory bodies in the federal government and provincial government work in a synchronized manner, thus making it easier to regulate TSF's.

4.8 ADVANTAGES OF CONSOLIDATION

Legal and regulatory Consolidation allows for a holistic approach to governance by bringing together different sectors, issues and interests. The Alignment between the three spheres of government improved communication and cooperation in conducting their affairs is achieved through legal and regulatory consolidation. The various overlapping management issues, regulatory authorities, policies, and strategies relating to TSF's are aligned.

Legal consolidation allows government to have more focused legislation, regulated by one body than to have multiple pieces of legislation dealing with the same topic and regulated by a variety of bodies in different sectors. This leads government departments to retain functional integrity and accountability in executing their specific mandates. Furthermore, Consolidation insures the implementation of all policies, and that having remote impact on TSF's are covered.

[137] CEA 2012 Par 5(1)(d), 16(1)(a) and (d), 16(2)(b) .
[138] Government of Canada " better rules for major project reviews: to protect Canadas environment and grow the economy . a handbook. 2018. Government of Canada.

4.9 DISADVANTAGES OF CONSOLIDATION

It can be argued that the centralization of power promoted by the consolidation of law and regulations is a disadvantage. For example, having one organ of state regulate all things regarding mining can also lead to corruption. Furthermore, limited synergies between the regulatory bodies can occur in the event that operations are not materially similar.[139]Sector authorities responsible for TSF activities may lose specialization and discretionary rule. Furthermore, this can lead to an increase in fragmentation as dam safety and management will not be treated consistently across sectors.

[139] Chimbombi *regional integration of the financial services regulation and supervision in the southern African development community* (Masters mini-thesis.2015 University of the Western Cape).

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

One of the challenges faced by the extractives Industries around the world is conducting mining operations in an economic and environmentally sustainable manner. Notably, South Africa is no exception to this, and as a result, has recently made the necessary changes to address environmental concerns. Despite this, it's evident that TSF's still pose the biggest environmental threat accompanying the extractives industry. The recent tailings dam's failures have exacerbate the need to strengthen legislative and regulatory measures pertaining to TSF management.

It is evident from the previous chapter that in order for the TSF regulatory framework in South Africa to effectively realise the principles of section 24 of the Constitution, and to circumvent further TSF failures ,big or small, a holistic approach to the governance of TSF's must be achieved.

It has been established that the current governance of TSF's in South Africa is fragmented. Fragmentation is the antithesis of Consolidation and therefore not conducive to sustainability. In order to achieve a holistic approach to the governance of TSF's and the consolidation method must be applied to the current regulatory framework. This will influence the government to deliver consolidated policies and insure that the various authorities deliver desirable outcomes.

It is also proposed that new TSF legislation be promulgated. The aims of the new legislation should be to improve effectiveness and efficiency of the various government organs so that the management of TSF's is achieved through sustainable governance results. The act will clearly state the various roles, mandates, jurisdictions and responsibilities of the various government organs and the respect regulatory authorities. A strong, well-conceived, consistent TSF regulatory environment would help the various regulators to work together towards a common purpose.

It is also proposed that a single agency that deals with only TSF related matters be established. However, this agency should not be fully autonomous. This is to insure that corruption and the lack of accountability is minimised. The purpose of this agency will be to create policies .TSF management guidelines, construction guidelines, safety codes and licensing.

It is time South Africa creates a consolidated TSF regulatory framework. The future of our mining industry and environment depends on it.

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