

The influence of geotechnical and geohydrological studies on EIA decision making in South Africa

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ABSTRACT

The overall aim of this study was to investigate the effect of geotechnical and geohydrological reports on EIA decision making. The relation between geohydrological and geotechnical specialist recommendations and mitigation measures in the EMP was examined, followed by an investigation of the relation between the EMP and the conditions and obligations of the decision (Environmental Authorisation).

A review package that consisted of 29 criteria was generated and applied to each role player namely the specialist, environmental assessment practitioner and the authority. The list of criteria relating to geotechnical and geohydrological aspects were grouped under Review areas 1 (criteria 1 – 13) and 2 (criteria 14 – 24) respectively. There were also several additional issues (Review area 3) that did not clearly fall into the geotechnical or geohydrological fields, but rather belong to other departments, such as architecture, health, safety, etc. The trail of decision making was systematically extracted from the specialist reports, EIA reports and finally what was recommended and required in the authorization. This delivered a data set of 3 x 29 review scores (A, B, C, F and N) for every report, which were analyzed by means of basic descriptive statistics. Scores were converted to S (success) and F (fail) to reflect the effect on decision making.

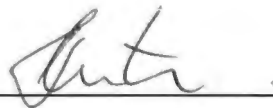
Different permutations of successes (S) and failures (F) were investigated to relate cases, performance and role players to decision making. The ideal permutation, SSS (high score for all three role players) scored 79%, which suggested that the specialist reports are adequately reflected in conditions of authorization in the majority of cases. The remaining fraction of cases is all some form of mismatch between the role players' recommendations. These are cases where good decisions followed weak specialist and/or EAP performances, and where good specialist/EAP performance was followed by poor decisions.

Both the EAP and authority comply well with the specialist reports with a relatively low failure and the EIA process could be judged as successful. Specialist reports do influence decision making and results suggest that the use of specialist reports are essential in South African EIA.

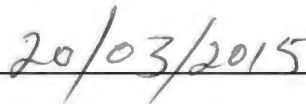
Key words: Authority, decision making, EAP, EIA report, environmental authority, geohydrological, geotechnical, specialist report.

DECLARATION

I declare that this dissertation, apart from the contributions mentioned in the acknowledgements, is my own unaided work. It is submitted for the degree of Master of Environmental Management at the North West University, Potchefstroom Campus. I also declare that it has not been submitted before to this institution for another degree or any other institution in this country or abroad.

A handwritten signature in black ink, appearing to read 'S. J. van der ...', is written above a horizontal line.

Signature of the Candidate

A handwritten date '20/03/2015' is written above a horizontal line.

Date

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LIST OF ABBREVIATIONS

BAR	– Basic assessment report
DEAT	– Department of environmental affairs and tourism
DWAF	– Department of Water Affairs and Forestry
EA	– Environmental assessment
EA	– Environmental authorisation
EAP	– Environmental assessment practitioner
ECA	– Environment Conservation Act (ECA)
EIA	– Environmental impact assessment
EIAMS	– Environmental Impact Assessment and Management Strategy
EIR	– Environmental impact report
EMP	– Environmental management plan
EMS	– Environmental management system
ES	– Environmental statement
F	– Failure
IEM	– Integrated environmental management
IUCN	– International Union of Conservation and Nature
NEMA	– South African National Environmental Management Act
NWA	– National Water Act
RA	– Review area
ROD	– Record of decision
S	– Success
SEA	– Strategic environmental assessment
UK	– United Kingdom
US	– United States

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1. INTRODUCTION AND PROBLEM STATEMENT

Environmental impact assessment (EIA) was introduced and developed in the 1960s during a time that was dominated by societal influences, such as the growth of modern environmental concern, the drive for more rational, scientific and objective environmental decision making and a desire for more public involvement in environmental decision making (Weston, 2004).

EIA is a systematic, cyclical process which examines the environmental consequences of planned developments (Glasson *et al*, 1999). It is generally seen as a tool to provide information to facilitate better decisions concerning project approval and of which conditions must be fulfilled appropriately. EIA also makes provision for specialist studies pertaining to a variety of environmental aspects, such as heritage, social, ecology, traffic, geotechnical, geohydrology, etc.

The effectiveness of EIAs is of international concern and particularly the quality of reports that emanate from the EIA process. The quality of reports is imminent regarding effectiveness, since they contain the information that provides the starting point for decision making (Sandham, *et al*, 2008b). Tinker *et al* (2005) noted that where mitigation measures are translated into practice through the use of planning conditions and obligations in England, it should be carried out with a view to improve the effectiveness of the EIA process. In essence, the EIA should therefore provide information to improve decision making.

A considerable amount of literature relevant to EIA effectiveness, EIA report quality and decision making has been published and a large and diversified number of contributions have been geared towards the assessment of the performance of national EIA systems (Pinho *et al*, 2007). No published research with regards to the relationship between recommendations and conditions and obligations in EIA practice in South Africa has been found, but it was investigated in the UK by Tinker *et al* (2005). They found in their UK study that the relationship between such recommendations and the conditions and obligations of the environmental authorisations was lacking. Some of the recommendations were not noted under conditions and obligations and some other conditions and obligations were added by the authorities which were not recommended as such in the EIA report.

The effectiveness of the EIA process could be measured according to the extent by which the integration of assessment findings are being translated into decision making in the planning and project cycles. This is often found to be low in developing countries due to a late start, resulting in poor links with project implementation (Wood, 2003). Wood (2003) also found that project decision making could be undertaken by both development assistance

agencies and governments, but it is frequently closed to external scrutiny and may be influenced by economic and social factors as well as corruption. However, the period of application for environmental authorisation of projects come with opportunities and requirements for specialists to increase the capacity of environmental managers, project managers and interested and other parties to have the required competence to make effective decisions (Münster, 2005). Decision makers often do not take cognisance of the information provided or to suggestions made in assessments, although vast amounts of money were spent on research and it is therefore suggested that the EIA should be more closely integrated into the processes that it seeks to influence (Pölonen *et al*, 2011). Concurrently, decision making is not seen as rational and EIA has considerably more roles than simply information provision (Tinker *et al*, 2005). According to Bartlett and Kurian (1999) the information processing is just one end of the decision making process and other models such as symbolic politics, political economy, organisational politics, pluralist politics and the institutionalised model form part of it, which will be discussed in the literature study (see Chapter 2).

Limited research that was carried out on the South African mining industry for both the effectiveness of the EIA system and the quality of the reports produced by the EIA system (EIR), indicate that the reports produced are generally of an acceptable standard and in line with international standards (Sandham, *et al*, 2008b). However, the quality of EIR in the South African mining industry is also seen as an area that required further research.

In South Africa the current situation is that there is neither mandatory accreditation of EAPs, nor any official criteria for qualifying as an EAP and it is therefore still a weakness within the EIA legislation (Sandham *et al*, 2013a). Although there is a strong call to reform legal arrangements for EIA in South Africa, Sandham *et al* (2013a) showed that such change would not necessarily guarantee improvements in EIR report quality.

Mankind, without science would not be able to draw relationships between the burning of fossil fuel and global climate change, between human activities and the disappearance of biological species and between the exposure of humans to some chemicals and the adverse consequences to human health. However, the relationship of science to environmental decision making is complex and a matter of considerable controversy in public guiding principles (Dimento and Ingram, 2005). Following from the above, the aim of this study is to determine to what extent specialist recommendations are reflected under conditions and obligations in the environmental authorisation, with particular focus on specialist geohydrological and geotechnical reports. The specialists' input could consist of opinions, provision of baseline information, field studies, detailed modelling and impact assessments.

However, this could be problematic when the quality and reliability of specialist inputs to EIA processes adversely affect an EIA (DEAT, 2002). This aim will be subdivided into two objectives, namely:

1. What is the relation between geohydrological and geotechnical specialist recommendations and mitigation measures in the EMP, and
2. What is the relation between EMP steps and the conditions and obligations of the decision (Environmental Authorisation)?

A literature study of EIA effectiveness with particular reference to specialist reports on decision making was conducted. The nature of relationships between geohydrological and geotechnical specialist recommendations and mitigations measures were investigated through an appropriate sample of EIA case studies.

2. LITERATURE REVIEW

This chapter reviews relevant literature on the effectiveness of the EIA system with regards to project approval. The intention to address the objectives of this study, literature on report quality, EIA necessity, mitigation, decision making and authorisation were also included.

2.1 EIA EFFECTIVENESS

Generically EIA systems should be objective, practical, appropriate, focused, adaptive, participative, interdisciplinary, credible, integrated, transparent and systematic. It is important to implement the basic steps of the EIA process to have effective systems, e.g. in a manner consistent with guiding principles, across the space they regulate and to measure their performance (IUCN. 2007). In order to evaluate the effectiveness of EIA systems, the following key questions as illustrated in Figure 2.1, should be asked:

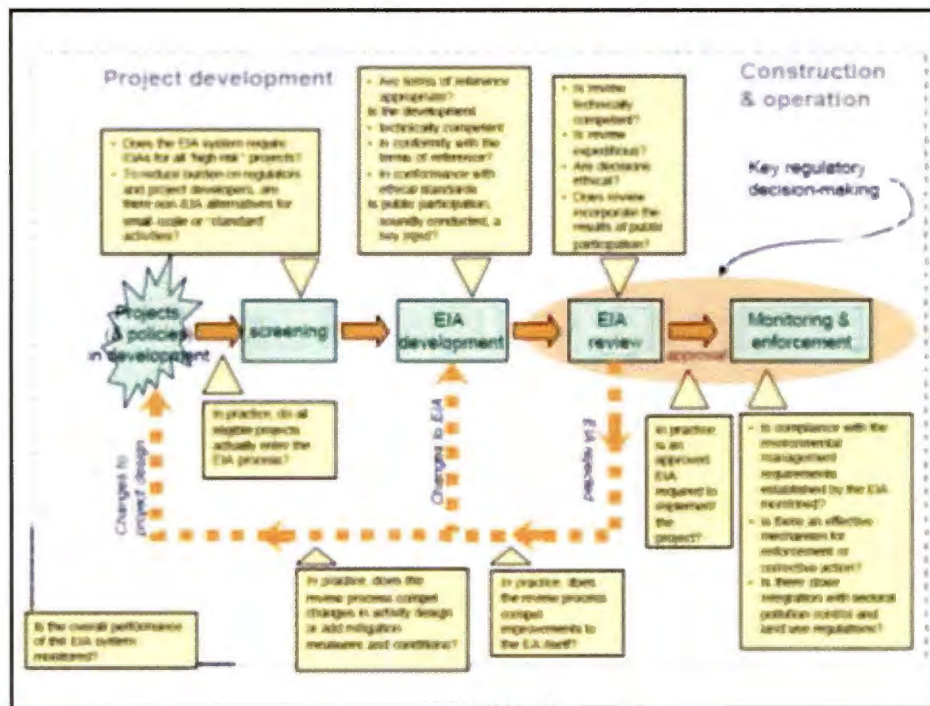


Figure 2.1: Key questions for evaluating the effectiveness of EIA systems (IUCN., 2007).

The questions relevant to the key decision making process is as follows (Figure 2.1):

EIA review:

- Does the review satisfy technical requirements?
- Is review expeditious?
- Are decisions ethical?
- Does review incorporate results of public participation?

During the approval phase it should be determined whether an approved EIA was required for implementation of a project. Upon approval, during monitoring and enforcement the following questions are then relevant (Figure 2.1):

- Is compliance with the environmental management requirements established by the EIA monitored?
- Is there an effective mechanism for enforcement or corrective action?
- Is there close integration with sectoral pollution control and land use regulations?

Following the evaluation as indicated in Figure 2.1, the effectiveness of EIA application amongst other EIA related issues remains a challenge (IUCN, 2007). Countries such as Benin, Cameroon, Ethiopia, Ghana, Kenya, Madagascar, Namibia, Tanzania, Tunisia, Senegal, South Africa and Uganda were all to a more or lesser extent involved in EIA systems and a summary of the main findings regarding the effectiveness of EIA's presented at the African Experts Workshop on Effectiveness of Environmental Impact Assessment Systems in Addis Ababa, Ethiopia, is shown below (IUCN, 2007, p.18):

- *Number of EIA applications is increasing;*
- *There's increased inter-agency collaboration;*
- *Administration/regulation is more centralized;*
- *Environmental assessment networks are increasingly being established;*
- *Quality, review systems and follow through, are constrained by inadequate human and financial resources;*
- *Public participation is increasingly integrated into the EIA process, however consultations amongst stakeholders is still inadequate;*
- *Influence on decisions, particularly projects of strategic importance is not significant;*
- *Some countries are integrating EIA systems within Environmental Management Systems (EMS); and*
- *Some countries are conducting Strategic Environmental Assessments (SEA's).*

Since 1989 the World Bank adopted environmental assessment (EA) as a standard procedure for use in the preparation and implementation of bank-financed investment projects. Between 1992 and 1995 the bank undertook two reviews on the effectiveness of EA's, where the first review focused on the EA in-house process and presented recommendations aimed at strengthening EA as a tool for project preparation (Rees, 1999). The second review found improvements in the application of EA and in efforts to link EA findings and recommendations with both project preparation and implementation. It

subsequently concludes that EA can proactively contribute to improving the selection, design, choice of site and implementation of programs and projects.

EIA is often not linked to a decision-making process and they suggest strengthening the legal provisions on decision making as a preventive and participatory environmental management tool. This would mean amendments to the provisions on permit and similar decisions. Studies by Cashmore *et al* (2004), Sadler (1996) and Ten Heuvelhof and Nauta (1997) indicated that the effectiveness of EIA's is only moderately influential in affecting project design (56% of cases), whereas Wood and Jones (1997) reported that more than one third of planning officers stated that EIA had a substantial or considerable influence on their recommendations towards decision making. It is therefore also important to mention that it does not mean that EIA is in reality ineffective, but it is suggested that passive integration with decision processes, in part a result of the obsession with the EIA report, has significantly reduced its substantive outcomes (Cashmore *et al*, 2004).

Tinker *et al* (2005) found that by analysing a different environmental component, in their case soils and geology, the number of extra conditions and obligations (far) exceeds the already covered and uncovered mitigation measures, which could be an indication that this aspect is poorly addressed. In the same study it was also found that most EIA's do not address for instance noise vibration effectively and the evidence from this study demonstrates that large numbers of additional conditions and obligations are not imposed by planners for the potential noise impacts (Tinker *et al*, 2005 and Thérivel and Breslin, 2001). Narrowing to the role of the specialist and of science in EIA, a broad debate was enacted on improving the effectiveness of EIA. It has been suggested that the EIA community remains divided on the purposes of EIA and the importance of specialists, or more objectively, the type and form of science as part of it (Cashmore, 2004).

Effectiveness of an EIA holds more credibility when it is made in the socio-economic, political and cultural context of a country. This point is illustrated by a comparison of EIA's in Kenya, Tanzania and Rwanda where shortcomings in the EIA system in Rwanda can be attributed to weaker institutional structures and a comparative lack of local capacity to work with it (Morgan, 2012). Views on effectiveness are also dependant on an individual's understanding of the nature and purpose of EIA, for example, the technical and engineering perspective of Kruopiene *et al* (2009), who expressed grief over the politicization of EIA in Lithuania and calls for much stronger recognition for the role of experts in the process.

However, the rather limited effectiveness and influence that EIA appears to have on decision making, led to a conventional response by placing emphasis on strengthening existing EIA

practice and procedures in order to enhance its effectiveness (Jay *et al*, 2007). They also noted that there has been a focus on addressing the more fundamental limitations of EIA and adapting it more closely to current understandings of decision-making processes. Concern with regards to improving the effectiveness of environmental assessment by the World Bank, is stated by Rees (1999, p.338): *“As the quality and usefulness of an EA is more dependent on the quality of the individuals who prepare it and local ownership than non adherence to a particular procedure, method, or approval, the practice of EA will only improve if greater use is made of well-qualified, local environment specialists.”* It can also be said that if there is a will by the public and politicians, EIA can provide a much more effective means of engaging with planning processes and of achieving more sustainable patterns of development (Jay *et al*, 2007). The rationale behind all this should therefore not be viewed as an academic exercise, nor expected to result in consensus. It is thus important to have an increasing recognition for the variety of ways in which purposes can be interpreted and that researchers can accurately explain and justify their perceptions of the EIA’s purposes. This should inevitably lead to more transparent debates on what clear outcomes EIA is expected to achieve and therefore, analyses of the role of specialists in achieving these aims (Cashmore, 2004).

Furthermore, in order to improve the effectiveness of an EIA, Tinker *et al* (2005) made some recommendations:

- Increase the use of environmental management plans (EMP);
- Give guidance to planning authorities;
- If imposing mandatory EMP’s are observed to be impractical, it is recommended to make use of schedules of mitigation commitments or mitigation schemes;
- The wider use of EMS’s should be encouraged as a resource for effective management of mitigation implementation and monitoring;
- Encourage improvements in environmental statement (ES) quality and
- Give attention to more research effort on EIA follow-up, in particular on cost-effectiveness.

As mentioned in the introduction, the effectiveness of EIA’s is internationally of concern and research by Tinker *et al* (2005) exposed the English EIA and planning systems to be very challenging, although it covered only one part of the English planning region. A key finding of this research is the influence on decisions, which is supported by Pölönen *et al*’s (2011) observation that one of the main shortcomings of environmental impact assessments is its rather weak linkage to decision making. They found that the relationship between EIA and decision making (especially decisions on development approvals) in Finland is a

fundamental question from an effectiveness perspective. Hence, the main constraint is not a lack of high-quality impact assessments or inadequate possibilities for public participation, but insufficient post-EIA action-forcing mechanisms (Pölönen *et al*, 2011). However, the quality of EIA as well as specialist reports is also influential to decision making which leads to the next discussion.

2.2 REPORT QUALITY

The credibility of an EIA depends upon the validity of the assessments made by experts and according to Leknes (2001), the basis thereof was widely considered to be the model by which the process should be carried out. It should be stressed at this point that report quality does not imply effectiveness of the EIA system, but whether it makes a difference towards improved decision making and ultimately sustainability (Sandham *et al*, 2008b).

Morrison-Saunders *et al* (2001) perceive the main driving forces for good EIA's as the pressure from the environmental administration, time and resources to prepare the EIA reports, pressure from the public, political expectations and financial resource availability. Concurrently, the quality of an EIA report also depends upon the size of the project, the financial investment and the size of the proponents' company (Pinho, *et al*, 2007).

The way EIA's are prepared in a country like Fiji, generally reflects a poor quality in comparison to developed countries within the South Pacific (Australia and New Zealand) and only a third of the reports were of reasonable standard. All had significant shortcomings, and many were poor compared to Australasian standards (Turnbull, 2003). Developers working in Fiji rarely acknowledge that EIA can improve project choice, formulation, and design, especially when used at the feasibility stage. Turnbull's article refers to the learning experience upon which both consultants and government staff embarked when EIA began to be used in Fiji. There has also been little public consultation beyond villagers or landowners on whose land a development is planned, which is in contrast with western countries, where EIA is seen as a means of making the premises of decisions explicit and of forcing decision-makers to publicly account for their decisions (Turnbull, 2003).

Recommendations with regards to the quality aspect of EIA's in selected African countries at the African Experts Workshop on Effectiveness of Environmental Impact Assessment Systems, were summarized as follows (IUCN, 2007, p.74):

- *Regulation of practitioners and quality,*
- *Set minimum standards and criteria for operation and*

- *Financial institutions sensitized to insist on quality.*

Despite existing (and used) guidelines and criteria, the judgement of assessments is ultimately subjective. Although the EIA professionals judged the Finnish EIS's to be generally good, they stated that by lowering the ambition level, it becomes easier to achieve good results and vice versa (Jalava, *et al*, 2010). They also emphasise that within the Finnish context the EIA process is seen as a learning process and as mentioned earlier that the relevance of EIA can be increased in particular by training its practitioners and participants. In reality it is not the accuracy of impact prediction but the prediction of potential impact(s) that matters (Beattie, 1995). In Finland the consultants seemed to consider the quality to be better than the competent authorities did. It is seen as reasonable, because ideally it is the quality controllers' task to be critical and the consultants should be able to defend their work (Jalava, *et al.*, 2010). Their findings pointed out that EIA professionals judged the Finnish EIS's to be generally good, but that earlier studies acknowledged that the descriptive parts of EIS's seem often to perform better than those areas with more analytical demand. In many different quality reviews performance on alternative considerations and mitigation have been considered as a weak area. Similar findings were made for South Africa by Sandham and Pretorius (2008).

According to DEAT (2002) typical problems regarding the quality of EIA's, are associated with:

- Poor or non-existent specialist terms of reference,
- Over-emphasis on baseline descriptions with inadequate attention given to impact assessment, analysis or evaluation,
- The use of inappropriate approaches and methods by the specialist,
- The unreliability or inadequacy of data upon which the study may be based,
- Provision of insufficient information and
- Unclear presentation of information.

The current situation in South Africa is that there is neither mandatory accreditation of EAPs, nor any official criteria for qualifying as an EAP and it is therefore still a weakness within the EIA legislation (Sandham *et al*, 2013b). Although there is a strong call to reform legal arrangements for EIA in South Africa, Sandham *et al's* (2013b) research indicates that such change would not necessarily guarantee improvements in EIR report quality that's inferred through to the EIA decision making and implementation process. The overly complex and rigid legislative regimes in South Africa clearly hinder environmental assessments to deliver more sustainable outcomes and it is therefore suggested that environmental practitioners

should explore other means in order to improve EIA effectiveness. Education and training should preferably come about through the forthcoming implementation of a wide range of programmes which is proposed under: “*Sub-theme 8, “Skills of environmental assessment practitioners and government officials” of the South African national Environmental Impact Assessment and Management Strategy (EIAMS)*”, (Sandham *et al*, 2013a, and Loubser and Freeman, 2011). This does, for example open a particular South African related avenue by improving the quality of training and professional accreditation of practitioners and then allowing flexibility in the EIA system (Sandham *et al*, 2013b).

Sandham *et al* (2013b) assumed that the environmental impact report (EIR) quality would improve under the 2006 EIA regulations in South Africa relative to those of 1997, based partly on experience in the UK and Europe which found that the overall quality of EIRs generally improves with time (Morrison-Saunders *et al.*, 2001). The conclusion by Sandham *et al* (2013b) is that the quality of EIA reports has not improved following implementation of the new regulations in 2006, but at best has reached a moderate level of stability and at worst shown some deterioration. Concurrently, the effectiveness of the EIA system and the quality of the reports produced by the EIA system (EIR) in the South African mining industry, indicate that the reports produced are generally of an acceptable standard and in line with international standards (Sandham *et al*, 2008b).

Pinho *et al* (2007) see a clear relationship between the quality of EIA reports and the extent of modifications and mitigation measures proposed to incorporate the respective projects, which forms part of the core of this study. As such, Crabbe and Leroy (2008) emphasise the importance to strive for maximum transparency and simultaneously, determining the quality of an EIA. Peterson (2010) affirmed that adequate information is also essential for decision making. Good quality and efficient EIA's require amongst other sources also financial resources which are followed by the next discussion on the necessity of EIA's.

2.3 NECESSITY OF EIA

The economics of any project, including EIA and for that matter any sustainability related issue, can never be ignored and consideration should be given of whether a project is likely to be financially viable over the long term and whether it will be ecologically sustainable (Van Zyl, *et al*, 2005). Any effort to improve the effectiveness of the EIA system must improve the funding of the EIA process and the two issues are not separable (IUCN, 2007). In 1998 Jenkins already stated that economic prosperity is almost everywhere the cornerstone of public policy. This perspective of our modern way of life is causing social and ecological disruption and that the solution is seen as the sufficient obligation of a social philosophy or

code of behavior which will lead to increased sustainability. Humankind live both by a market economy necessary for its welfare on a daily basis and by a natural economy, necessary for its welfare (existence) in the long term (Odum and Barrett, 2002). Weston (2000) also stated that artificially attributing a monetary value to environmental receptors not only ignores the subjective nature of environmental quality, but is little more than an attempt to turn essentially political decisions into mathematical ones. In Portugal for example, review practices are becoming standardised, but are hampered because of financial difficulties and staff shortages in the environmental administration. The present economic recession and uncertainty actually worsen the situation (Pinho *et al.*, 2007). Although time and resource costs may be regarded as secondary, it could as well be limiting factors. Elsewhere in Europe where more open and broad-based approaches are increasingly the norm, it is being regarded as complementing rather than replacing traditional cost-benefit analysis (Owens, *et al.*, 2004).

At the heart of the “political economy model”, it is thought that the demand for EIA might arise as a function of markets or that it might be undertaken voluntarily (Bartlett and Kurian, 1999). In this model the policy impact of EIA occurs primarily through financial opportunities, risks, and constraints and in conjunction with internationalization, ultimately anticipating and preventing environmental harm. It is however important to note that when determining planning applications, there is an apprehension that the increased weight that will be given to the financial viability of developments could reduce the influence of EIA on development decisions (Morgan, 2012). EIA in the private sector could thus be seen as part of ecological modernisation and also to have consequences and implications beyond its effects on the calculus of economic advantage (Bartlett and Kurian, 1999).

In South Africa stakeholders generally believe that an EIA undertaken under voluntary integrated environmental management (IEM) procedure has altered their behavior and that of others. They are almost unanimous that the environmental quality and acceptability of decisions are improved by EIA. Many South African developers perceive EIA as a burden, especially amongst the smaller ones who have no experience of EIA. The public and environmental groups are likely to see EIA as a means of delaying and/or improving projects. Consultants see EIA as a worthwhile process, whilst the relevant provincial authorities perceive it to be a valuable environmental management tool (Wood, 1999). It is therefore essential to take note of both negative and positive economic issues that could influence the quality, efficiency and finally authorisation of an EIA. Van Zyl, *et al* (2005, p.14) summarized it as follows:

- *Distortions that lead to financial viability, but are not to the benefit of the wider society creating a false 'viability' when seen from a broader, economic, perspective;*
- *Environmental externalities that are not accounted for in economic costs and benefits;*
- *Degree of adaptation to the economic development planning in the area (i.e. does the project compliment economic and spatial plans);*
- *Effects that allow a project to generate added benefits in the form of employment, incomes, and increased production; and*
- *Macro-economic risks (i.e. whether the project has the potential to change exchange rates, interest rates or local factor and product prices).*

2.4 MITIGATION AND ENVIRONMENTAL PLAN

Mitigation of predicted impacts with a proper description of environmental impacts is seen as a key component and could be considered as the foundation of the whole EIA process (Tinker *et al*, 2005 and Christensen *et al*, 2005).

Many companies started to use EIA as an important pre-construction planning exercise in which design attributes, site and steering strategy and mitigation concepts are closely examined prior to finalised design and project costing (Marshall, 2002). It is therefore important when moving from the planning and consenting phases into the formal construction phase that the design commitments that mitigated environmental effects in the attainment of approval are carried into practice. A responsible developer would therefore consider the follow-up of predicted mitigation requirements with the necessary commitment and managerial approach. According to Marshall (2002) environmental management plans (EMP) have an important role to play in the formalising and ensuring of mitigation follow-up and is flexible in its approach to specific forms of development (Table 2.1). It has the distinct advantage that, while it forms a component of an ISO14001 certified EMS, it is not so formalised and restricted in its approach to the site-specific issues facing a development project (Marshall, 2002). Alternatively to the use of EMP's is a schedule of mitigation commitments, whereby implementation can be progressively updated as the project develops (Tinker *et al*, 2005). The schedules should include details of implementation and enforcement for the mitigation and may be more popular with developers, because it requires less detail than an EMP.

Table 2.1: Alleged role and objective of environmental management plans (Marshall, 2002).

EIA	Environmental management plans	Construction and operation
<p>Predictive and anticipatory processes →</p>	<ul style="list-style-type: none"> • Identification of environmental responsibilities for the company and its contractor(s). • Setting of project specific objectives and targets during construction (and operation). • Setting of project specific environmental control procedures. • <i>In-situ</i> rapid reaction to site conditions or emergencies. 	<p>→ Reactive operational procedures</p>

In developing countries (e.g. Egypt, Tanzania and south-east Asia), mitigation is generally considered during the EIA process but is not always implemented. It is because there is often little opportunity for changes to be made to previously designed projects and is frequently regarded as an afterthought and found to be the weakest area in the EIS review (Wood, 2003a, and Jalava *et al*, 2010). Widespread failure to mitigate losses occurs mainly because of problematic contract design and execution (e.g. US wetlands). It may not be possible to write an efficient incentive contract if investment in restoration is too expensive, nor is it likely that a contract will be efficient and does not include penalties (over and above the cost of necessary extra investment in mitigation) for avoidance, or, if it does, it is known that they are almost never enforced (Hallwood, 2007). There is therefore an urgent need to determine and apply low-cost methods of contract enforcement whereby mitigation is a relatively easy technical and less costly exercise. Although the EIA process began with very holistic ambitions, it was found that in most cases mitigation measures and actual regulatory demands largely mirror traditional sectorised regulations, i.e. “add-on” or “end-of-pipe” technologies (Christensen *et al*, 2005). On the contrary a justifiable concern occurs because half the mitigation measures recommended in the environmental statements (ES), are not addressed in the planning decision, meaning that their implementation would be optional (Tinker *et al*, 2005).

Simultaneously, with regards to the role of specialists to the effect of mitigation, it should be noted that their impact assessments and recommendations are forwarded to the environmental assessment practitioner (EAP) for inclusion in the EIA report as well as the appropriate mitigation for the environmental management plan (EMP). These recommendations and management are forming part of information that the authorities consider for decision making and should be included under the conditions and obligations of

the environmental authorisation (EA). The extent to which specialist recommendations are reflected in the conditions and obligations of the Environmental Authorisation provides an indication of their influence on decision making. Nowadays the demands are on the specialist to not only cooperate with other disciplines, but also work trans-disciplinarily with practitioners of different disciplines to solve problems (Scholz *et al*, 2006).

Wood recognised in 1999 that mitigation is a great strength in South Africa, because of few authorisation refusals at the time. The reason was that the emphasis of the integrated environmental management (IEM) was on avoiding, reducing or treating the negative environmental impacts of development and enhancing the positive impacts at each stage in the EIA process. He also found that most relevant authorities have attempted to ensure that the mitigation measures proposed in the EIA report have been implemented by summarizing it in authorisation conditions. Although mitigation is a main focus of the South African EIA, Wood (1999) also saw that there were problem areas, i.e. that mitigation of social impacts was given far less attention than biophysical impacts. At that stage it was ECA-based¹ with no formal provision for follow-up (in ECA) and Wood evaluated only the EIA system and not the practice.

In South Africa relative weak grades are achieved in the categories relating to alternatives and mitigation that highlight a weakness in the South African EIA practice (Sandham and Pretorius, 2008, Sandham *et al*, 2008b, Sandham *et al*, 2013a and Sandham *et al*, 2013b). Mitigation measures, however in the EIR's of wetlands in South Africa were rated as satisfactory and generally well done, in contrast to other areas (Sandham *et al*, 2008a). The weaknesses regarding alternatives are actually worse because EIA is infrequently part of the life cycle of the project (Sandham and Pretorius, 2008, and Wood, 2003).

In a review of EIA report quality in the North West province, Sandham and Pretorius (2008) found that alternatives and mitigation of the reports were rated as generally satisfactory, but making this the least well-performed for the review area (the EIR quality review package developed by Lee and Colley was adapted and used by the authors to review the quality of 28 EIR's in the North West province). Mitigation measures were not always described in the reports and where they were, details provided about their implementation and effectiveness were often limited and results also indicate that it did not receive the necessary attention (Sandham and Pretorius, 2008). In the South African explosive industry the treatment of mitigation was the weakest category of the entire review (Sandham *et al*, 2013a) and it is

¹ ECA – Environmental Conservation Act, 1989. The first EIA regulations were promulgated in terms of this act.

also disturbing to note that this fundamental aspect (mitigation) of EIA is not being addressed accordingly in the spirit of the process (Sandham *et al*, 2013b).

2.5 DECISION MAKING

EIA has become an internationally accepted and established tool for environmental management over the last three decades, which led to better quality decisions. That is the result from increased use of mitigation, more stringent conditions upon permissions and occasionally, the non-implementation of potentially environmentally damaging proposals which might previously have been approved (Jay *et al*, 2007). They further see the occurrence of a growing dissatisfaction because the EIA's influence over development decisions is relatively limited and it appears to be falling short of its full potential. This inevitably led to increasing questioning about the nature of EIA and a recognition that its basic approach is out of step with the realities of decision making. The decision making process was identified as an area of concern of the EIA's influence, but must be seen in relation with a broader range of issues, such as institutional implementation, practice problems, including limited or no public participation and the limited substantive effect of EIA as a process (Morgan, 2012).

Many aspects can be used to describe the role of EIA in decision making processes. Leknes (2001) used in relation with the Norwegian petroleum industry, the following questions as a starting point for decision making as a basis for the roles that EIA may have:

- Who is participating in the decision making process?
- How can the process and relationship between the various participants be described?
- What significance do the comments from different consultative bodies carry in relation to the decisions?
- How is the EIA document used in the final decision making process?
- What degree of influence does an EIA have on the final decision?

In conjunction to the above questions, Retief (2010) asked similar questions through assessment debates and with a broader outlook the areas of concern relate to:

- Is there a clear sense of purpose for the EA process?
- Quality and
- Effectiveness – by asking the question of what is achieved through the process?

These led to various debates regarding EIA, especially the dominance of the technocratic model, but also highlight the fact of political realities in decision making (Morgan, 2012). There are many theories that deal with decision making and Leknes' (2001) point of departure is thus how the EIA process and documents are used in the decision making process concerning public approval and imposing conditions on projects (in his case the petroleum industry). Decision making in the EIA process is indeed of a very complex and diversified nature, where the same technical and scientific information included in the EIA report is able to generate different readings and understandings. This could be ascribed to contents of the report that are not precise, the language is not clear and accessible, the scope of the environmental issues dealt with is not relevant and appropriate and also the methods and techniques are not completely justified and correctly applied (Pinho, *et al*, 2007). Bartlett and Kurian (1999) composed models, explaining how EIA is expected to have an impact on policies and decisions. Although much of the literature on EIA was written by scientists, planners, engineers and lawyers with a desire to be apolitical, it is however, difficult to imagine non-political outcomes. Morgan (2012) talked about various theories and models of planning and decision-making, for example, Lawrence (2000) examined five planning theories: rationalism, pragmatism, socio-ecological idealism, political-economic mobilization, and communications and collaboration (Table 2.2), while Leknes (2001) used a simpler three-fold categorization of decision-making approach: the rational, new institutionalised and negotiation perspectives (Table 2.3). Bartlett and Kurian (1999) adopted a political science perspective and in order to create a better understanding, developed a theory of EIA decision making in six categories in terms of debates, analysing implications for a theory of EIA, both operational and normative (Table 2.4).

Table 2.2: Five theories by Lawrence (2000).

Theory	Context
Rationalism	<ul style="list-style-type: none"> • Systematic application, • Consistent public interest, • Selection of best alternative, • Predictable & controllable environment, • Independent planner whereby the planning process is separated from the political process, • Pluralistic society.
Pragmatism	<ul style="list-style-type: none"> • Each planning situation is unique, • Planning is collective and constrained, • Society is fragmented and pluralistic, • Planning environment is complex, unstable and uncertain, • Limited potential for control of the planning environment.
Socio-ecological idealism	<ul style="list-style-type: none"> • Problems complex & interrelated, • Stress on human potential, environmental sustainability and communal direction, • Planning in small & informal groups, • Integration of values and ethics, • Organizations and society without any hierarchy, • Turbulent and incoherent environments, • Planner is a social change agent, skilled in creative problem solving and interpersonal relations.
Political-economic mobilization	<ul style="list-style-type: none"> • Unity of theory and practice, • Centralisation of structural and class inequities, • State tends to support the capitalist projects and ameliorate class conflicts, • Planning is essentially political, • Planning is concerned with the historical transformation of society, • Planning should critique the historical and current organization of society and role of the state.
Communications and collaboration	<ul style="list-style-type: none"> • Communication and interactions are central to planning, • The public interest is jointly revealed and motivated, • Information is set in understandings, practices, and organizations, • Theoretical and practical together with processed knowledge are merged, • Planners are skilled in process, organizational, and communicative action, problem solving, interpersonal relations and conflict resolution.

Table 2.3: Three-fold categorization of decision making (Leknes, 2001).

Theoretical perspective	Approach
Rational	<ul style="list-style-type: none"> • Assumed public decisions influenced by a set of objectives, • Realistic analysis of alternatives in relation to established objectives, • Problem solving approach.
New institutional	<ul style="list-style-type: none"> • Directed upon organisations that participate in decision making process, • Regarded as instruments to achieve objectives, • Decisions & actions are according to rules, legal framework, established action patterns and norms and values.
Negotiation perspectives	<ul style="list-style-type: none"> • Negotiating process, resources, interests, antagonism and alliances of participants form part of decision making, • Participants have ability to influence decision, • Focus on participants, their interests, alliances and antagonism, • Who takes part, will influence decision, • Compromising.

Table 2.4: Six models by Bartlett and Kurian (1999).

Model	Salient points
Information processing	<ul style="list-style-type: none"> • Neutral with respect to political and economic goals; • Technical and scientific logic and • The power of “perfect” information.
Symbolic politics	<ul style="list-style-type: none"> • <u>Perspective:</u> EIA is a formality to generate huge volumes of information that remain inaccessible to people and are unnecessary to the decision making process. • <u>Another perspective:</u> EIA is helping to create particular kinds of meaning that shape the world; • Goal is to become a tool for moral re-affirmation of certain values with regards to environmental protection and • EIA is rather seen as helping to transform the values and world views of the larger society.
Political economy	<ul style="list-style-type: none"> • Efficiency, • Innovation, • Flexibility and • Integration.
Organisational politics	<ul style="list-style-type: none"> • Import of good value into the organization, • Getting the right people in the right place and • Also an assumption that individuals will transform environmental policy by the force of their beliefs.
Pluralist politics	<ul style="list-style-type: none"> • Seeks higher degree of public participation and • An EIA process that allows and legitimates public participation is seen as one way of ensuring that environmental issues are given more weight.
Institutionalist	<ul style="list-style-type: none"> • Integrate normative and operative aspects, • Purpose of EIA is transformation of institutional values by changing the ways of doing things in such a manner as to incorporate environmental values and • Thereby bring about changes in the mandates, rules and procedures of the agencies that in turn will influence and shape the notions of culture, values, norms and principles in the larger society.

A frequent argument from the above discussions (Tables 2.2 – 2.4) is the critique of the rationalist model of planning and decision making and thus by implication of the mainstream EIA. It resulted as far back as two decades for a need to further explore and develop models that encourage new thinking about planning and decision making processes in their wider social, cultural, political and economic views (Bartlett and Kurian 1999). This model has a

strong technical approach, with planners and other professionals acting as neutral processors of information, producing independent evaluations of the alternatives that are provided to decision makers (Lawrence, 2000). However, the rationalist imprint has attracted criticism for their failure to recognize the political and value-based nature of decision-making, with the result that consulting and collaborative approaches to planning and decision-making processes were promoted. This would mean coaxed stakeholders and communities into the processes, emphasizing the importance of communication and moving the professional technocrats from a controlling role to a facilitating role in the decision-making process. EIA practitioners should also simultaneously be sensitive to the inherent power relations found in rationalist decision-making processes that can hamper effective participation (Morgan, 2012).

In this study the influence of specialists and specifically geotechnical and geohydrological input on EIA decision making, comes under scrutiny. In relation with the previous sentence, it's been noted that EIA literature has been criticised for lack of scientific rigour in elucidating and analysing the values and judgements that underpin contested issues in environmental management (Lawrence, 2003). Cashmore's (2004) conception of the role of science in EIA provides two broad paradigms, namely EIA as an *applied science* and as a *civic science*. The first is EIA as an applied science that has the purpose of informing decision making early in the project planning (Table 2.5). This concept follows a philosophy of science with a positive epistemology (theory of knowledge) and provides for hypothesis testing of environmental impact assessments to separate fact from values in order to inform decision makers of environmental design and environmental engineering decisions. Decisions are then taken based on the rigidity of scientific methods, literature review, modelling and experimental manipulation, peer review, published evidence, etc that is characteristic of this theory of knowledge. The applied science paradigm of EIA has two models, namely an analytical scientific model with a prominent role for ecology, and an environmental design model for environmental design and engineering (Table 2.5).

Table 2.5: EIA as an applied science (Cashmore, 2004).

<u>Theme</u>	<u>Analytical scientific model</u>	<u>Environmental design model</u>
Purpose	Informs decision and enhancing scientific understanding	Informs and has influence on design decisions
Type and form of science	Applied experimental science	Applied & environmental sciences for environmental design & engineering
Role of social values	Separate facts & values	Separate facts & values
Level of stakeholder engagement	Information consultation	Stakeholder involvement viewed as part of the wider planning process
Common terminology	Systematic & comprehensive	Alternatives & design options

The second EIA paradigm is that of a civic science that accommodates varied opinions on the role of science (Table 2.6). In this concept EIA is understood as a tool for influencing decisions through the application of a practical and comprehensive form of science, known as civic science and includes a diversity of stakeholders from the scientific, administrative and social dimensions of the EIA process (Cashmore, 2004). This type of assimilation of scientific input into decision making is gradually moving away from the passive view of knowledge as described in the applied science mode and towards a more adaptive, active and inclusive mode of many stakeholders, including the public. Here, the common themes are the practical provision of responsible administrative processes, responsible analysis, and responsible consultation as guided by the Cashmore (2004) information provision model. His participation model aims to ensure a balance between scientific rationality and social rationality. Cashmore's environmental governance model calls for deliberative democracy, an extensive role of both social and natural sciences with greater emphasis on social values, a delegated power in public participation models for the purposes of enhanced plurality of expressions, social justice and equality. Here the idea is to minimise losses and empower stakeholders.

Table 2.6: EIA as a civic science (Cashmore, 2004).

<u>Theme</u>	<u>Information provision model</u>	<u>Participation model</u>	<u>Environmental governance model</u>
Purpose	Inform decision	Participatory design decisions	Deliberative democracy
Type & form of science	More of a natural than social science's role	Use both excessively: social & natural science	More of a social than natural science's role
Role of social values	Separate facts & values	Distinct, but valid role for both facts & values	Emphasis on social values
Level of stakeholder engagement	Consultation or limited participation	Early & open participation	Delegated power or citizen control
Common terminology	Systematic comprehensive	Inclusive, deliberate	Equality, justice

Studies carried out by Morrison-Saunders and Bailey (2001) indicated that practitioners have different expectations of the role of science in EIA according to the type of project and its location (i.e. Urban or remote) and the stage of the EIA process. Generally they found that good science was seen to be a trademark for effective EIA and a greater role for science in EIA was therefore advocated. Furthermore, socio-political factors also have a role on the scientific integrity of EIA's, particularly during the principal decision-making stage. Studies in South Africa (Reyers *et al*, 2010) have shown that in the case of conservation, the speed and success with which plans are converted into action remains limited and that this gap between science and action extends beyond conservation planning into many other applied sciences and has been linked to complexity of current communal problems, compartmentalization of knowledge and management sectors, and limited collaboration between scientists and decision makers.

Rational decision making was the dominant decision theory and the principles of this theory continue to influence EIA literature. There is thus a perception that provision of accurate scientific information on the environmental consequences of a wide range of alternatives will lead to better decision making. The implication, however, is that improving the scientific precision of EIA, in terms of factors such as accuracy and comprehensiveness will not necessarily result in more rational decisions (Cashmore, 2004). It is also important to note that uncertainty is inherent in environmental decisions and arises at many points along the decision making road. This is because relatively little is known about complex natural systems and how human activities affect these systems (Harding, 1998).

Although EIA's maintain their rationalist character, other actors in the process may value different aspects of the process and should therefore be encouraged and protected accordingly. There is still a significant gap between the best practice thinking (from research and practice literature) and the application of EIA on the ground and that provides for a real challenge to the EIA community. There is however a raise of concern where governments are seeking avenues to speed up the project decision making process, which subjectively will stimulate economic growth and create employment in response to the current financial crisis (Morgan, 2012). Pölönen *et al* (2010) suggested that the decision-making phase should convert the information provided by EIA into legally binding requirements that ensure, at a minimum, the prevention of significant environmental harm. The timing when decision makers are getting involved is just as important, whereby early involvement has the risk of turning processes into a political front-stage performance that reinforce existing positions and if not involved, outputs may fail to win political commitment and important opportunities might be lost (Owens *et al*, 2004). Contrarily to the previous statement is that findings of the European Conference of Ministers of Transport suggested that decision makers (particularly elected ones) should be involved at an early stage of the EIA process. It is also important to note that the impact assessment community should actually shift EIA thinking away from the licensing stage and closer to critical decisions within organizations (Morgan, 2012).

An analysis of EIA study outcomes indicates that its role in authority and design decisions is limited, primarily due to passive integration with the decision processes that it is intended to inform (Cashmore *et al*, 2004). In South Africa the information that is available to decision makers in the EIR, is of major importance to the outcome of protection and/or destruction of projects, such as wetlands (Sandham *et al*; 2008a). It is therefore of utmost importance to determine whether the report is adequate and/or whether a greater quantity of information is required before the project can be authorised. The quality of decisions involving EIA has, however improved over the last thirty-five years as a result of the increased use of modification or mitigation, the use of more stringent conditions upon permissions and also the non-implementation of potentially environmentally damaging proposals which might previously have been approved (Jay *et al*, 2007).

2.6 AUTHORISATION

Environmental authorisation may be defined as a written order, document or certificate that may be issued by a competent authority (government department, minister or authorised official) to an applicant for granting permission to perform certain acts or activities that may have an impact on the environment (Wessels, 2005). The environmental assessment procedure can be a lengthy and prolonged process invariably requiring input from the public,

a widespread body of experts and integration of the findings into an environmental impact report. After consideration of the report, the proponent of the development is then usually granted an environmental authorisation, which permits the development to proceed, subjected to the appropriate conditions (Paschke and Glazewski, 2006).

The law stands in service of the society and places a legal duty on developers to consider environmental management during their operations. These duties are scattered in the maize of environmental legislation and is also fragmented (as mentioned further in this section), (Wessels and Mkhari, 2007). It can be divided into vertical, horizontal, sectoral and inter-sectoral. In this framework of environmental legislation there are a multitude of procedures, processes and environmental management tools that cause an overlap of jurisdictions and give rise to confusing authorisation processes and procedures. There are also various relevant competent authorities' involved, conflicting mandates and jurisdictions, and other legislation that further complicates the authorisation process (Kotze, 2006).

Environmental governance faces serious challenges in terms of improving service delivery and despite the progressive domestic environmental law framework the South African situation is very fragmented. The legislation consists of a multitude of acts which are silo-based and environmental-media specific and is especially observed in terms of the various environmental authorisation procedures prescribed by the legal framework (Kotze, 2006).

Requirements in terms of environmental authorisations is actually not straight forward and might involve different departments and be influenced by different laws and regulations. The Mooirivier Mall, in Potchefstroom is an example where two separate environmental authorisations in terms of the Environment Conservation Act (ECA) and the National Water Act (NWA) had to be obtained (Wessels and Mkhari, 2007). Following onto the Record of Decision (ROD) for this project (Moorivier Mall) further authorisations amongst other, from the North-West Department of Agriculture Conservation and Environment were required.

Fragmentation in South Africa is evident in various ways and could be seen as both vertical and horizontal for environmental governance structures, which are institutional. Vertical fragmentation refers to the three separate and autonomous spheres of government, namely the national, provincial and local spheres (Kotze, 2006). Horizontally, various independent and autonomous environmental departments, or line functionaries exist in the above spheres, such as the Departments of Environmental Affairs and Tourism (DEAT), Water Affairs and Forestry (DWAF), Minerals and Energy (DME), Agriculture, and the South African Heritage Resource Agency (Kotze, 2006).

2.7 CONCLUSION

The EIA system is generally seen as an information tool concerning decisions with regards to project approval. It also makes provision for specialist studies to a variety of environmental aspects, such as heritage, ecology, geotechnical, geohydrology, etc. In the literature study EIA effectiveness with particular reference to specialist reports on decision making was conducted. It also included aspects such as the necessity for EIAs and mitigation.

Effectiveness:

The effectiveness of EIA application remains internationally very challenging amongst other EIA related issues (IUCN, 2007 and Tinker *et al*, 2005) and one of the major shortcomings is environmental impact assessments' somewhat weak link to decision making (Pölonen *et al*, 2011). The effectiveness of EIA reporting could be measured according to the extent by which the integration of assessments is being translated into decision making (Sandham *et al*, 2008b).

Report quality:

Report quality does not necessarily imply effectiveness of the EIA system, but it makes a difference towards improved decision making (Sandham *et al*, 2008b). There are clear relationships between quality of EIA reports and extent of modifications and mitigation measures proposed to incorporate the respective projects (IUCN, 2007).

Necessity of EIA:

Developers, especially the smaller ones with little experience can see EIA as a burden, whilst the public and environmental groups are more likely to perceive the EIA process as a means of delaying and, or improving projects. Consultants see it as a worthwhile process and the relevant authorities perceive the EIA process to be a valuable environmental tool (Wood, 1999).

Mitigation:

Most authorities have attempted to ensure that the mitigation measures that were proposed in the EIA report with incorporation of the specialist report; have been implemented by summarising them in authorisation conditions (Wood, 1999).

Decision making:

Decision making in the EIA process is very complex and diversified and different interpretations are possible from the same technical and scientific information (Pinho *et al*, 2007). Various decision making models exist and most of the environmental related literature was written by scientists, planners, engineers and lawyers with an apolitical aspiration. However, according to Bartlett and Kurian (1999) it is difficult to imagine non-political outcomes and they composed models explaining how EIA is expected to have an impact on policies and decisions.

Authorisation:

In South Africa various relevant competent authorities, conflicting mandates and jurisdictions and other legislation that further complicates the authorisation process (Kotze, 2006) are involved. Legislation consists of a multitude of acts which are silo based and is specially observed in terms of various environmental authorisation procedures prescribed by a legal framework (Kotze, 2006). Requirements in terms of environmental authorities is actually not straight forward and might involve different departments and be influenced by different laws and regulations (Wessels and Mkhari, 2007).

3. METHODOLOGY

In order to establish the influence of specialist recommendations on the environmental authorisation and hence the decision making process as the objective, the methodology entailed an analysis of the relation between geohydrological and geotechnical specialist recommendations and measures in the EIA report. This will be followed by an analysis of the relation between EMP steps and the conditions and obligations of the authorisation.

The selection of projects, the collection and data management will be discussed in this section. Whilst the evaluation was carried out according to a modified version of the scoring scale of the Lee and Colley review (1992), the results were compiled in tables and figures that were utilized to support the analysis.

3.1 DATA GATHERING

The selection of projects for the investigation was based on developments that were subjected to an EIA, supported by specialist reports, for which authorization had been granted. The projects were randomly selected and represent a relatively well distributed cross-section over a broad range of sectors as in Table 3.1. A sample of 15 projects with adequate geotechnical and geohydrological elements was available for perusal at various institutions, including the Northwest University, Matlosana Municipality (Parks department), Maxim Planning Solutions and AB Enviro-Consult.

Table 3.1: Activities reviewed

Activities reviewed	Total
Cemetery	1
Construction (buildings)	3
Estate development	1
Filling station	1
Solar plant	1
Township establishment	7
Waste disposal site	1
Total	15

The trail of decision making was systematically extracted from the specialist reports, EIA reports and finally what was recommended and required in the authorization. The EAP's response to the specialist recommendations in the EIA report was noted and also the recommendations forwarded to the authority. Finally, the authority's recommendations with regards to the specialist's recommendations were noted and thus following the trail from the

specialist through to authorization. In two of the projects (Case Studies 3 and 4), authorisation was based on a basic assessment report (BAR) and all the others on EIA reports and further reference in this study for all cases will be only to the EIA report.

3.1.1 DERIVATION OF CRITERIA

A list of 29 criteria (Table 3.2) relating to geotechnical and geohydrological aspects was generated by a scrutiny of the EIA reports.

Criteria 1-13 (Table 3.2) were primarily related to the geotechnical field (Review area 1), which by definition is concerned with the behavior of earth materials. These can influence matters such as foundations for structures, embankments, storage systems and soil erosion. It also takes account of issues such as seismic activities, pollution, waste sites, sewerage, hazardous material and water drainage affected by surface activities.

The geohydrological aspects (Review area 2), (criteria 14-24 in Table 3.2) deal with water below the earth's surface and therefore the occurrence, distribution and effects of groundwater. It does however also include surface objects, such as wetlands and there might be a degree of overlap with the geotechnical criteria such as drainage and ground water. The monitoring of some geohydrological criteria in certain case studies is an indication of an aquifer's² condition. Hence, it was therefore important to review the impact of the water usage, such as abstraction, production boreholes, water levels, water quality and rainfall, which all have an effect on both the human and natural environments.

There were also several additional issues (Review area 3) that did not clearly fall into the geotechnical or geohydrological fields, but rather belong to other departments, such as architecture, health, safety, etc. Some of these issues did however have a direct or indirect effect on the geotechnical or geohydrological fields and were therefore treated as additional criteria during the review of the different projects (criteria 25-29 in Table 3.2).

² Aquifer: Is an underground water-bearing permeable rock or unconsolidated materials (gravel, sand or silt) from which groundwater can be extracted.

Table 3.2: List of criteria relating to geotechnical and geohydrological aspects.

Number:	Criteria:
	<u>Geotechnical (Review area 1)</u>
1	Drainage (surface)
2	Erosion
3	Excavation assessment
4	Flood line analysis
5	Foundation recommendations
6	Ground water
7	Pollutant discharge
8	Sewerage
9	Slope stability
10	Waste management
11	Soil "stockpile" for rehab
12	Dolomitic ground (sinkholes, dolines, etc)
13	Seismic activity
<u>Geohydrological (Review area 2)</u>	
14	Evaluation of groundwater management plan
15	Geohydrological monitoring/man/appointment
16	Monitoring: Abstraction volumes
17	Monitoring: Production boreholes
18	Monitoring: Rainfall
19	Monitoring: Water quality
20	Monitoring: Water levels
21	Water abstraction/Consumption
22	Water quality – bacteriological
23	Water quality – chemical
24	Wetland(s)
<u>Additional issues (Review area 3)</u>	
25	Material assessment
26	Stockpiles
27	Designs and building plans
28	Chemical toilets during construction phase
29	Erosion "soil traps"

The specialist report was first reviewed and a score for each recommendation was plotted against a list of related criteria (discussion of criteria below). Symbols instead of numbers were used during the review of the reports to discourage broad and inadequate calculations (see explanation in Table 3.3).

3.1.2 EVALUATION SCALE

Various methods of determining the quality of Environmental Impact Reports (EIR's) have been used and developed world wide (Lee *et al*, 1999). In this study the evaluation of decisions and recommendations was scored by means of symbols adapted from Lee and Colley's (1992) quality review package, but with specific relevance to the geotechnical and geohydrological aspects (Table 3.3).

The scoring symbols A, B, and C reflected different degrees of an acceptable performance for each criterion that was addressed. In order to distinguish between these scoring symbols, a C symbol implies that a specific criterion was addressed, knowing that some additional information was required to make it meaningful with regards to decision making. B is acceptable with only minor detail outstanding, whilst an A score is regarded as complete.

According to Lee and Colley (1992), the D, E and F scoring symbols in the definition of the evaluation scale reflected unsatisfactory performance, where D is just unsatisfactory because of omissions or inadequacies. The E symbol implies an unsatisfactory performance because of significant omissions and inadequacies, whilst the F symbol is not satisfactory because of a poor performance or failure to address a criterion. The various degrees of unsatisfactory performances are not relevant in this context and were therefore combined into a single symbol, F, for “Fail” (Table 3.3).

The symbol N is used where the specific criterion is not applicable or relevant for a particular project, e.g. dolomitic ground in an area where it doesn’t occur (Table 3.3). However, a degree of geological proficiency is required for the evaluation to determine the appropriate score between A to C and also for F and N.

Table 3.3: Evaluation scale adapted from Lee and Colley (1992).

Description of score grades (partly by Lee et al., 1999):	
A	Generally well performed, no important task left incomplete
B	Generally satisfactory and complete, only minor omissions and inadequacies
C	Can be considered just satisfactory, despite omissions and/or inadequacies
F	Unsatisfactory; not addressed
N	Not applicable. The review topic is not applicable or is irrelevant in the context of the appraisal

3.2 DATA PRESENTATION

The 29 criteria were placed into an Excel spreadsheet that was used to set up a review package, which was then populated accordingly (Appendix 1 for all 15 projects). Each criterion was then individually reviewed according to the evaluation scale in Table 3.3 and was done for all 15 projects (see example of two projects in Table 3.4 and Appendix 1 for all 15 projects). A scoring symbol was allocated which reflected the comprehensiveness of recommendations and also the extent to which the criteria were addressed by the role players. The data for each project were collected into columns under the headings of specialist report, EIA/EMP and authorization. Although different sectors were covered, all 29 criteria were evaluated for each project during the review. The processing and analysis of the accumulated data will be presented and discussed in Chapter 4.

The next step was to evaluate to what extent the EAP utilized specialists into the EIA report and also what recommendations were added or not reflected based on the specialist report. In the third step, all related recommendations and obligations in the authorization were evaluated. Criteria that were not reflected in the authorization were also recorded. These are

criteria that can reasonably expect to be addressed in projects of this nature where only decisions relevant to impacts in the geotechnical and geohydrological fields were considered.

In general, there was a good distribution of the populated evaluation criteria as illustrated in Figure 3.1. Simultaneously with that distribution, a high occurrence of “N” (blue color coded) was also noticeable (Figure 3.1; Appendix 2) and will be discussed in the next chapter.

Table 3.4: Example of evaluation of scores (two of the 15 projects as an example).

No	CRITERION	Case study 1			Case study 2		
		Specialist report	EIA/EMP	Authorisation	Specialist report	EIA/EMP	Authorisation
Geotechnical (Review area 1)							
1	Drainage (surface)	A	B	A	A	F	F
2	Erosion	A	A	A	A	A	A
3	Excavation assessment	A	A	C	A	C	A
4	Flood line analysis	A	A	A	N	N	N
5	Foundation recommendations	A	A	A	N	N	N
6	Ground water	A	A	B	A	A	A
7	Pollutant discharge	A	B	A	A	A	B
8	Sewerage	A	A	A	A	A	A
9	Slope stability	A	B	B	F	F	F
10	Waste management	A	B	A	A	A	A
11	Soil "stockpile" for rehab	A	F	A	A	A	A
12	Dolomitic ground (sinkholes, dolines,etc)	N	N	N	N	N	N
13	Seismic activity	N	N	N	N	N	N
Geohydrological (Review area 2)							
14	Evaluation of ground water man plan	A	A	A	A	A	A
15	Geohydrological monitoring/man/appointment	A	A	A	A	B	A
16	Monitoring: Abstraction volumes	A	A	A	N	N	N
17	Monitoring: Production boreholes	A	B	A	A	A	A
18	Monitoring: Rainfall	A	A	A	A	A	A
19	Monitoring: Water quality	A	A	A	A	A	A
20	Monitoring: Waterlevels	A	A	A	N	N	N
21	Water abstraction/Consumption	A	A	C	N	N	N
22	Water quality - bacteriological	A	A	C	A	A	A
23	Water quality - chemical	A	A	C	A	A	A
24	Wetland(s)	N	N	N	N	N	N
Additional "issues" (Review area 3)							
25	Materials assessment	A	N	N	N	N	N
26	Stockpiles	A	F	A	N	N	N
27	Designs and building plans	A	F	A	N	N	N
28	Chemical toilets during construction phase	F	F	A	A	A	A
29	Erosion: "Soil traps"	F	F	A	N	N	N
Description of score grades (partly by Lee et al., 1999):							
A	Generally well performed, no important task left incomplete						
B	Generally satisfactory and complete, only minor omissions and inadequacies						
C	Can be considered just satisfactory, despite omissions and/or inadequacies						
F	Unsatisfactory; not addressed						
N	Not applicable. The review topic is not applicable or is irrelevant in the context of the appraisal						

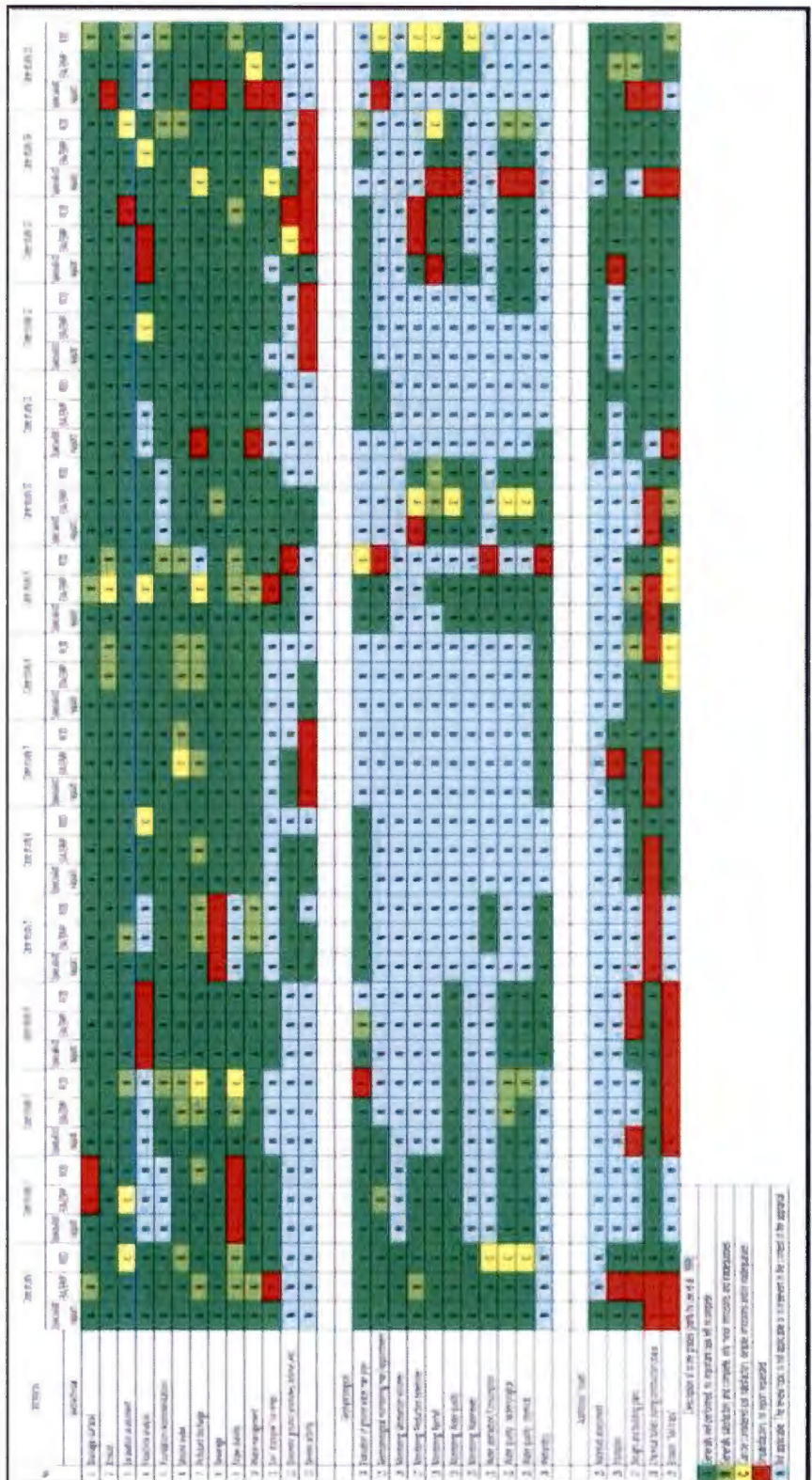


Figure 3.1: Illustration of the populated evaluation criteria.

3.3 CONCLUSION

This chapter reported on the sample selection, design of the review package and the application to the sample. The sample selection included a variety of activities that ranges from high public awareness (i.e. township establishment) to more distant activities such as the building of a solar plant. The evaluation was carried out according to scoring symbols adapted from the Lee and Colley (1992) review package. The activities were scored as satisfactory or unsatisfactory and the data placed in an Excel spreadsheet. The review package that consisted of 29 criteria was applied to each role player in the geotechnical, geohydrological and additional issues.

This delivered a data set of 3 x 29 review scores for every report. The data were obtained from the review of the reports and are analyzed by means of basic descriptive statistics, which is the focus of the next chapter.

case studies 1, 3, 9, 10, 14 and 15 (Table 4.1). On the other hand, poor performances in red (F) have a tendency to cluster by criteria, for example seismic activity (criteria 13), chemical toilets at construction sites (criteria 28) and soil traps (criteria 29).

Concerning the three groups of criteria, the geotechnical category (RA 1) reveals more even distribution of performances, whereas the geohydrological category (RA 2) has a preponderance of N scores (blue). The large number of N symbols could conceal the overall interpretation process and should therefore be removed from consideration. However these broad patterns are discussed in more detail below.

4.2 INTERACTION BETWEEN ROLE PLAYERS

A part of the study objectives was to determine the success or failure that was achieved by the role players and how it related to decision making. The interaction between role players is an indication to what extent decision making was made with regards to the criteria in the case studies. The coverage of information that was transferred from the specialist report and the managing of the recommendations showed what cognizance was given to those reports. It is therefore important what the EAP produced, for instance what information was recommended, what was omitted and what was recommended that was not in the specialist's report? The reports by the specialists were based on their knowledge which could be determinative with regards to some technical decisions by the authorities and the EAP's. Authorization by the relevant environmental authorities is subjected to the information provided through the EIA in conjunction with specialist's reports. All three role players exercised some kind of decision but the final power of decision making lies within the authority. Everyone's performance was evaluated according to their success or failure with regards to the A, B, C and F assessment symbols (Table 4.1 and Appendix 2).

The role players and individual cases were removed in the first level of processing and the data was conflated to only the assessment symbols (Table 4.2). This table which is a calculation of all the scores, also show the occurrence of "N" (N>50% is encircled). The scores for A, B and C in RA's 1 and 3 are the highest, whilst the N score is the highest at 61 % in RA 2. The F score is low for RA's 1 and 2, but 15.1% for RA 3. The N scores for RA's 1 and 3 are also notable and not omissible and will be discussed in the "Removal of N scores".

Table 4.2: Total score for each criterion, showing the occurrence of N (N>50% is encircled).

No	Criteria	Frequency											
		Total for symbols					Percentage						
		A	B	C	F	N	Σ A,B,C,F & N	A%	B%	C%	F%	N%	%
Geotechnical (Review area 1)													
1	Drainage (surface)	40	3	0	2	0	45	89%	7%	0%	4%	0%	100%
2	Erosion	40	3	1	1	0	45	89%	7%	2%	2%	0%	100%
3	Excavation assessment	38	3	3	1	0	45	84%	7%	7%	2%	0%	100%
4	Flood line analysis	23	0	4	5	13	45	51%	0%	9%	11%	29%	100%
5	Foundation recommendations	35	4	0	0	6	45	78%	9%	0%	0%	13%	100%
6	Ground water	36	6	1	0	0	43	80%	18%	2%	0%	0%	100%
7	Pollutant discharge	30	9	3	2	1	45	67%	20%	7%	4%	2%	100%
8	Sewerage	40	1	0	4	0	45	89%	2%	0%	9%	0%	100%
9	Slope stability	31	7	1	1	1	41	69%	16%	2%	7%	7%	100%
10	Waste management	38	4	1	2	0	45	84%	9%	2%	4%	0%	100%
11	Soil "stockpile" for rehab	22	0	1	3	19	45	49%	0%	2%	7%	42%	100%
12	Deionitic ground (sinkholes, dolines, etc)	13	0	1	2	29	45	29%	0%	2%	8%	63%	100%
13	Seismic activity	9	0	0	11	25	45	20%	0%	0%	24%	56%	100%
Total: Geotechnical		395	42	18	36	96	585	68%	7%	3%	6%	16%	100%
Geohydrological (Review area 2)													
14	Evaluation of ground water man plan	26	2	1	1	15	45	58%	4%	2%	2%	33%	100%
15	Geohydrological monitoring/man/appointment	11	1	1	2	30	45	24%	2%	2%	4%	67%	100%
16	Monitoring: Abstraction volumes	3	0	0	0	42	45	7%	0%	0%	0%	93%	100%
17	Monitoring: Production boreholes	8	1	2	3	31	45	18%	2%	4%	7%	69%	100%
18	Monitoring: Rainfall	12	2	2	2	27	45	27%	4%	4%	4%	60%	100%
19	Monitoring: Water quality	23	0	1	1	20	45	51%	0%	2%	2%	44%	100%
20	Monitoring: Waterlevels	10	0	1	0	34	45	22%	0%	2%	0%	76%	100%
21	Water abstraction/Consumption	6	0	1	1	37	45	13%	0%	2%	2%	82%	100%
22	Water quality - bacteriological	18	3	2	1	21	45	40%	7%	4%	2%	47%	100%
23	Water quality - chemical	19	2	2	1	21	45	42%	4%	4%	2%	47%	100%
24	Wetland(s)	18	0	0	1	26	45	40%	0%	0%	2%	58%	100%
Total: Geohydrological		154	11	13	13	304	495	31%	2%	3%	3%	61%	100%
Additional issues (Review area 3)													
25	Materials assessment	15	0	0	0	30	45	33%	0%	0%	0%	67%	100%
26	Stockpiles	12	1	0	1	29	45	27%	2%	0%	7%	64%	100%
27	Designs and building plans	25	3	0	5	12	45	56%	7%	0%	11%	27%	100%
28	Chemical toilets during construction phase	28	0	0	16	1	45	62%	0%	0%	16%	2%	100%
29	Erosion: "Soil traps"	22	2	4	10	7	45	49%	4%	9%	22%	16%	100%
Total: Additional issues		102	6	4	34	79	225	45%	3%	18%	15.1%	15.1%	100%

4.2.1 SUCCESS AND FAILURE

The assessment symbols A – C revealed different degrees of an acceptable performance for each criterion and were therefore grouped together for interpretation purposes as "successes" (S). The database was subsequently populated according to "successes" (S) and "failures" (F) with regards to decision making, where S = A+B+C. (Table 4.3 and Appendix 3). These symbols do not allow for impartiality and performances are therefore reviewed as either satisfactory (S) or unsatisfactory (F).

The success frequency for both the RA 1 and RA 2 is high, expressed as a percentage at 92.6% and 93.2% respectively and a correspondingly low "F" of below 10% (Table 4.3). Conversely, RA 3 is showing a lower "S" at 76.6% and a higher "F" at 23.3% (Table 4.3). This occurrence will be discussed in more detail in the sections addressing the individual cases.

Table 4.3: "Successes" (S) and "failures" (F).

No	Criterion	Frequency					
		Totals			Percentage		
		S	F	Σ S & F	S%	F%	%
Geotechnical (Review area 1)							
1	Drainage (surface)	43	2	45	95.6%	4.4%	100%
2	Erosion	44	1	45	97.8%	2.2%	100%
3	Excavation assessment	44	1	45	97.8%	2.2%	100%
4	Flood line analysis	27	5	32	84.4%	15.6%	100%
5	Foundation recommendations	39	0	39	100.0%	0.0%	100%
6	Ground water	45	0	45	100.0%	0.0%	100%
7	Pollutant discharge	42	2	44	95.5%	4.5%	100%
8	Sewerage	41	4	45	91.1%	8.9%	100%
9	Slope stability	39	3	42	92.9%	7.1%	100%
10	Waste management	43	2	45	95.6%	4.4%	100%
11	Soil "stockpile" for rehab	23	3	26	88.5%	11.5%	100%
12	Dolomitic ground (sinkholes, dolines,etc)	14	2	16	87.5%	12.5%	100%
13	Seismic activity	9	11	20	45.0%	55.0%	100%
	Total: Geotechnical	453	36	489	92.6%	7.4%	100.0%
Geohydrological (Review area 2)							
14	Evaluation of ground water man plan	29	1	30	96.7%	3.3%	100%
15	Geohydrological monitoring/man/appointment	13	2	15	86.7%	13.3%	100%
16	Monitoring: Abstraction volumes	3	0	3	100.0%	0.0%	100%
17	Monitoring: Production boreholes	11	3	14	78.6%	21.4%	100%
18	Monitoring: Rainfall	16	2	18	88.9%	11.1%	100%
19	Monitoring: Water quality	24	1	25	96.0%	4.0%	100%
20	Monitoring: Waterlevels	11	0	11	100.0%	0.0%	100%
21	Water abstraction/Consumption	7	1	8	87.5%	12.5%	100%
22	Water quality - bacteriological	23	1	24	95.8%	4.2%	100%
23	Water quality - chemical	23	1	24	95.8%	4.2%	100%
24	Wetland(s)	18	1	19	94.7%	5.3%	100%
	Total: Geohydrological	178	13	191	93.2%	6.8%	100%
Additional "issues" (Review area 3)							
25	Materials assessment	15	0	15	100.0%	0.0%	100%
26	Stockpiles	13	3	16	81.3%	18.8%	100%
27	Designs and building plans	28	5	33	84.8%	15.2%	100%
28	Chemical toilets during construction phase	28	16	44	63.6%	36.4%	100%
29	Erosion: "Soil traps"	28	10	38	73.7%	26.3%	100%
	Total: Additional issues	112	34	146	76.7%	23.3%	100%
	Grand total:	743	83	826	90%	10%	100%

4.2.2 CRITERION PROPORTIONS

It is also necessary in this study to give context to the proportions of the criteria which were derived from their frequencies. Table 4.3 and Figure 4.1 show the different criterion proportions, of which two, namely monitoring of abstraction volumes (16) and water abstraction levels (21) have a frequency below 10 out of a potential 45. This is a result of removing the N scores from of the data. It is important to note that each criterion was reviewed in each case study, but might not be relevant in all the cases and therefore produced different frequencies. Monitoring abstraction volumes (16) for example, appeared

at a very low frequency of 3 and therefore demonstrated that some criteria were often not relevant in a specific project. However, where a lower frequency occurred, the quality of decisions was not necessarily affected.

Out of the 29 criteria, 18 (62.1%) have a frequency above the average of 22.5 (highest frequency = 45), whilst 11 (37.9%) were below average (Table 4.3). The results for individual criteria are therefore subjective and the quality and character of the impact evaluation remains a matter of judgement (Tinker *et al*, 2005) and the differences in opinion may also play a role in how well it is done (Sandham *et al*, 2008b). In Figure 4.1 it is evident that the criteria proportions in RA 1 were the highest, but lower in RA 2. The criteria proportion in RA 3 was also high. This proportion discussion was a precursor to the analysis of how the different role players and criteria pertaining to decision making is intertwined. A twofold approach was undertaken, which firstly focussed on the criterion and role player performance and secondly dealt with the performance per case study.

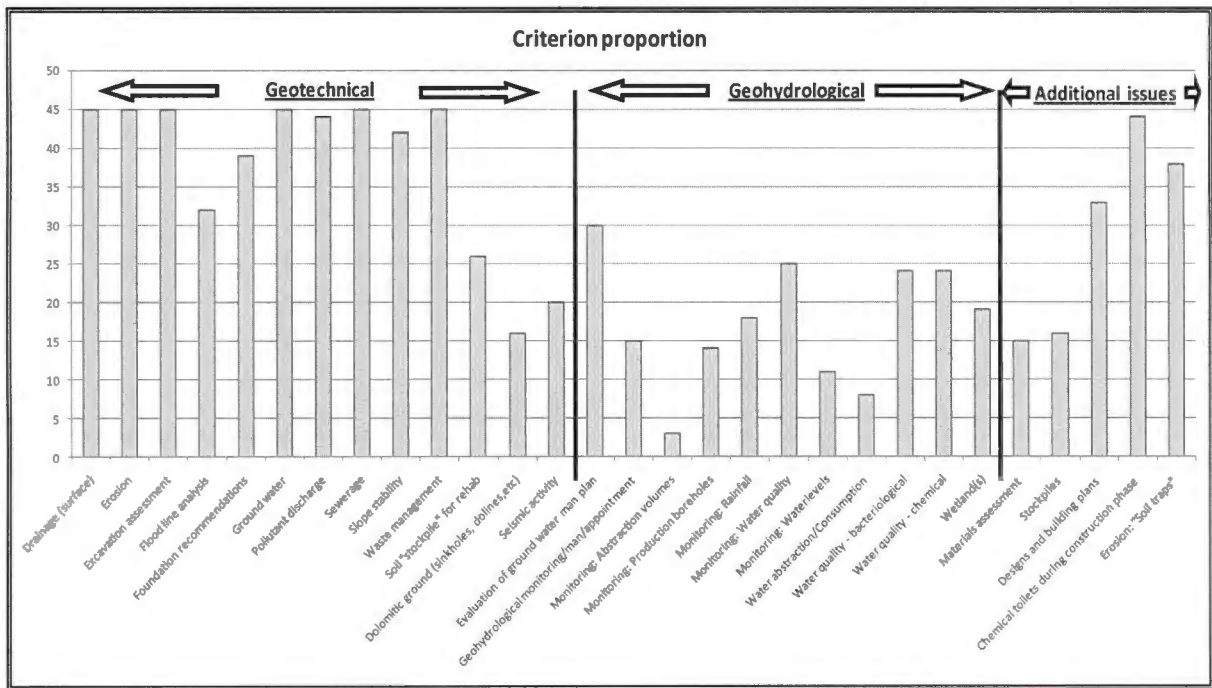


Figure 4.1: Proportions of the 29 criteria.

4.3 REMOVAL OF N-SCORES

The N-scores were allocated in case studies where a specific criterion was not relevant. Tables 4.1 and 4.2 showed the occurrence of "N" (N>50% is encircled in Table 4.2) and therefore gave an indication of the criteria that were not relevant to some projects.

The criteria dolomitic ground (12) and seismic activity (13), which falls under RA 1, scored a relatively high “N” (64 and 56% respectively). Only projects where proneness towards those conditions occurs were considered. The criterion, wetlands (24) also scored the same for that reason.

There were six criteria under RA 2 with high percentages (highest = 93%) of “N” and had to do with volumes, e.g. abstraction (16), rainfall (18), consumption (21) and production boreholes (17). These criteria were of importance to projects where it was relevant and although they were in the minority, also had to be considered in the review. The same goes for materials assessment (25) and stockpiles (26) under RA 3.

These patterns, particularly of N scores (blue), suggested that the contribution of geohydrological reports to decision making is limited in certain cases (Table 4.1). It therefore appears that the RA 2 contribution is not often as applicable compared to the RA1 contribution.

The large number of N symbols obscures the overall interpretation process and should therefore be removed from consideration. In order to eliminate the effect of high frequencies of N scores, it was necessary to remove them from the data set, delivering a reduced set of scores (Table 4.3). The relationship between “S” and “F”, with “N” being removed from the computation was applied during further analysis.

4.4 DISTRIBUTION OF SUCCESS (S) AND FAILURE (F) SCORES

Through further analysis and interpretation of the S and F scores and to have a better understanding of their nature, it was necessary to focus on the case studies and role players using more detailed tables. The scores for the “successes” (olive green) are the majority, whilst the “failures” (red) appeared to be generally in clusters amongst specific criteria, role players and case studies. The blank areas are the N scores that have been removed (Figure 4.2). Overall, the success frequency is 90% and the failure frequency is 10%, (Table 4.3). The scores were then disengaged from their individual cases to address the occurrences of the various clusters of failures. Figures 4.2, 4.3, 4.4 and 4.5 are all the same apart from lines that are left out, or placed horizontally or vertically to assist with a particular perspective and interpretation of the failures, since these are the areas where the influence of specialist reports on decision is potentially most important.

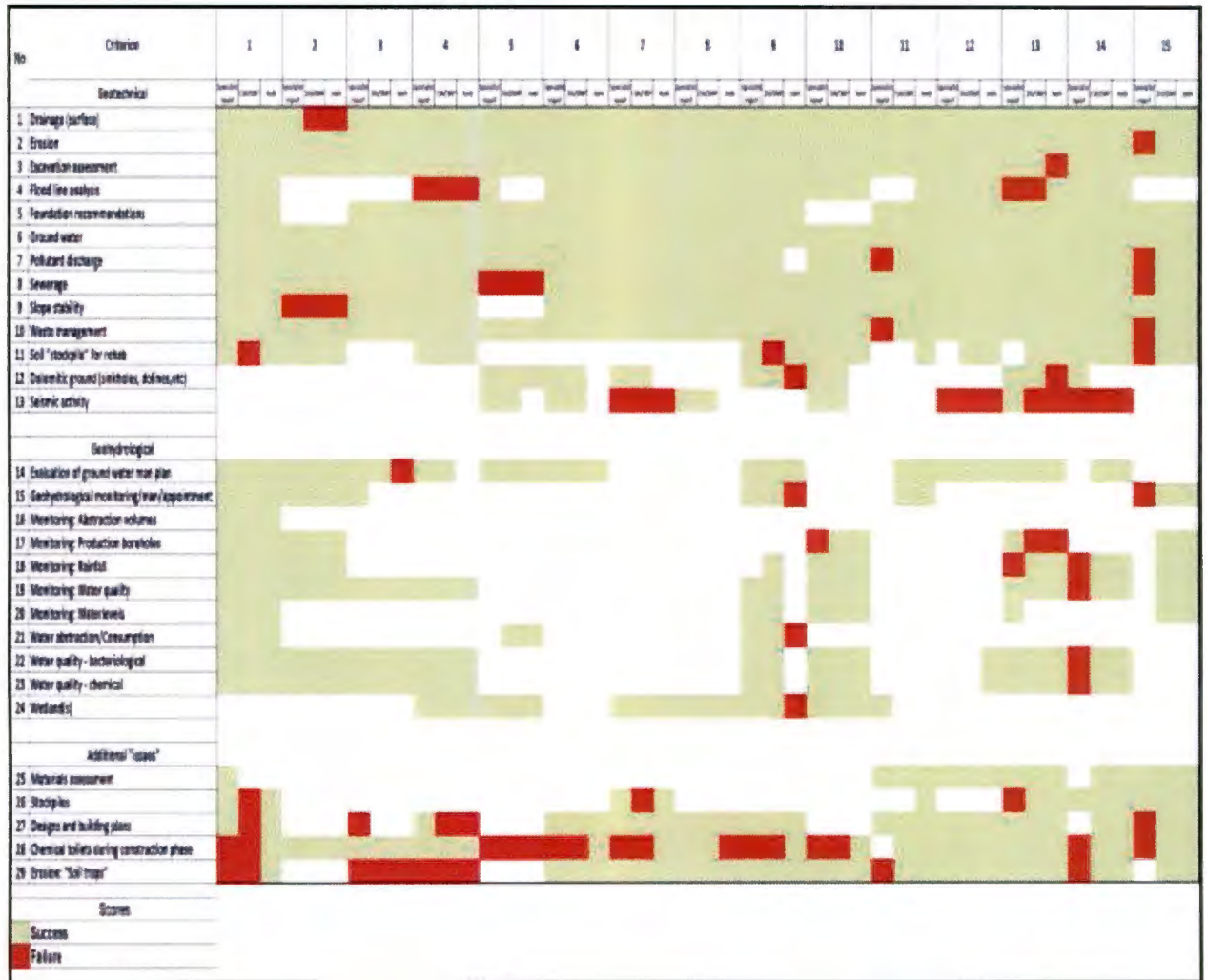


Figure 4.2: The overall distribution of "success" (olive green) and "failure" (red).

4.4.1 CRITERIA

In Figure 4.3 observations were made of the performance of each criterion and hence the horizontal lines. Analysis of the criteria, which are all equally important, was to determine what importance each criterion received from the role players. Clusters of F occurred amongst seismic activity (13), chemical toilets during construction (28) and erosional soil traps (29). These clusters are not necessarily occurring along the same criterion for all the case studies, but are scattered across the cases. This is most likely an indication that the three role players pay less attention to those specific criteria which then resulted in an unsatisfactory score (F).

The failure frequencies for all the role players reflected just the inverse of the success percentages, with S and F totalling 100% (Table 4.4). Three uncharacteristic failure percentages occurred in the different sectors, which are a low percentage of 1.5% for the EIA report in RA 2 and very high F values of 35.4% and 25% for the specialist and the EIA reports respectively in RA 3 (Table 4.4). The low percentage (1.5%) can be ascribed to a failure frequency of 1 in the “monitoring production boreholes” criterion (17). All the other criteria under RA 2 for the EIA reports scored a zero frequency for failure (Table 4.4). The total frequency of 5 (out of a possible 15) for this criterion is also relatively low.

A reason for the high failure rate for RA 3 was interpreted as a combination of the frequency scored and the total frequency for a criterion. The criterion, chemical toilets during construction phase (28) was a matter that has been overlooked by both the specialist and the EAP during their reporting, which resulted in the relative high failure of 60 and 36% respectively (Table 4.4). Three of the other criteria in RA 3 also scored failure percentages that are worth mentioning.

The criteria stockpiles (26), designs and building plans (27) and erosion (29) all have failure percentages of 20, 18 and 42 respectively in the specialist report category and 40, 18, and 23 respectively in the EIA report category (Table 4.4). The stockpiles criterion (26) has a total fail frequency of 5 (out of a possible 15), which indicated that a miss of one or two instances by a role player could result in a relatively high percentage either to success or failure. The designs and building plans (27) and erosion (29) criteria have a higher total frequency at 11 and 12 respectively, whilst a higher failure of 18% and 42% for the specialist and 18% and 23% for EIA role players were scored respectively (Table 4.4). The removal of N scores as previously discussed, resulted in a higher ratio between S and F, especially amongst criteria with a low frequency. The erosion soil trap criterion (29) has failure percentages of 42 and 23 for the specialist and the EIA respectively, but the respective failure frequencies were 5 and 3 (Table 4.4).

Although RA 1 has an overall low failure percentage of around 10%, the dolomitic ground (12) and seismic activity (13) criteria have an alarming high failure percentage for all three role players, with the authority at 100% (for seismic activity).³ Seismic activities are not an everyday event and scientific information is not as readily available to the general public as to people in the mining industry and it is therefore understandable that a certain degree of complacency amongst all role players might occur. This criterion was therefore very often regarded as a low profile environmental hazard, which could be detrimental particularly in

³The recent earthquake of 5.3 on the Richter scale in Klerksdorp area (Tuesday, 5th Aug'14) is an example of where the seismic event criterion received insufficient attention in the case studies.

“hot spot”⁴ areas. Reports by the specialist, who are supposed to be the knowledgeable incumbent about seismic activities, did not put sufficient emphasis on this criterion in order to flag it clearly with the EAP and the authority.

Table 4.4: The success and failure frequencies of the three role players.

No	Criterion	Specialist report		Specialist report		EIA		EIA		Auth		Auth		Total
		S	F	S	F	S	F	S	F	S	F			
1	Drainage (surface)	15	100	0	0	15	14	93	1	14	93	1	7	15
2	Erosion	14	93	1	7	15	100	0	0	15	100	0	0	15
3	Excavation assessment	15	100	0	0	15	100	0	0	15	100	0	0	15
4	Flood line analysis	9	82	2	18	13	8	86	2	10	10	1	9	11
5	Foundation recommendations	13	100	0	0	13	13	100	0	13	100	0	0	13
6	Ground water	15	100	0	0	15	15	100	0	15	100	0	0	15
7	Pollutant discharge	13	87	2	13	15	15	100	0	15	100	0	0	14
8	Sewerage	13	87	2	13	15	14	93	1	14	93	1	7	15
9	Slope stability	13	91	1	7	14	13	93	1	14	93	1	7	14
10	Waste management	13	87	2	13	15	15	100	0	15	100	0	0	15
11	Soil "stockpile" for rehab	6	86	1	14	7	7	78	2	22	9	10	100	0
12	Diastolic ground (sinkholes, dolines, etc)	7	100	0	0	7	6	100	0	6	1	33	2	67
13	Seismic activity	5	83	3	38	8	4	50	4	50	0	4	100	4
	Total	151	91.5%	14	8.5%	165	154	92.7%	11	11	149	91.3%	11	6.9%
14	Evaluation of ground water main plan	9	100	0	0	9	11	100	0	9	90	1	10	10
15	Geotechnical monitoring/main appointment	4	80	1	20	5	5	100	0	4	80	1	20	3
16	Monitoring Abstraction volumes	3	100	0	0	3	3	100	0	3	100	0	0	3
17	Monitoring Production boreholes	3	75	1	25	4	4	80	1	20	5	4	80	5
18	Monitoring Rainfall	3	60	2	40	5	7	100	0	6	100	0	0	6
19	Monitoring Water quality	7	88	1	11	8	9	100	0	8	100	0	0	8
20	Monitoring Waterlevels	4	100	0	0	4	4	100	0	4	100	0	0	4
21	Water abstraction/Consumption	2	100	0	0	2	3	100	0	3	2	07	1	33
22	Water quality - bacteriological	7	68	1	13	8	6	100	0	8	8	100	0	8
23	Water quality - chemical	7	86	1	13	8	8	100	0	8	8	100	0	8
24	Waterways	7	100	0	0	7	6	100	0	6	5	83	1	17
	Total	54	86.5%	7	11.5%	61	60	96.5%	1	1	58	92.3%	5	7.9%
25	Additional issues	5	100	0	0	5	5	100	0	5	5	100	0	5
26	Water's estimation	4	80	1	20	5	3	60	2	40	5	6	100	0
27	Designs and building plans	9	82	2	18	11	9	82	2	18	11	10	93	1
28	Chemical toilets during construction phase	6	40	9	60	15	9	64	5	36	14	13	87	2
29	Erosion "Soil trap"	7	58	5	42	12	10	77	3	23	13	11	85	2
	Total	21	64.6%	17	35.4%	48	36	75.0%	12	25.0%	48	90.0%	5	10.0%
	Grand total	716	89%	88	14%	714	716	91%	24	4%	710	92%	21	3%

⁴ Those areas determined by the Geological Survey of South Africa which are prone to seismic activities.

4.5 CASE STUDIES

The overall scores of the case studies presented a very favourable success frequency, which is shown by the low failure frequency in Figure 4.4 (bold vertical lines separate the 15 case studies). However the low F occurrence is used as a “reverse” indicator of success and is the vital area that influences decision making. The minority of F clusters in the different cases is discussed underneath.

4.5.1 OCCURRENCE OF CLUSTERS IN THE CASE STUDIES

The failures for each case study and also for each role player are indicated in Figure 4.4, which show that the lowest frequencies are in Cases 6 (with 2 F's), 8 (with only one F), 10, 11 and 12 with three F's each. The following cases have an overall failure frequency of more than five: Case studies 1 (7 F's), 4 (8 F's), 5 (6 F's), 7 (6 F's), 9 (7 F's), 13 (10 F's), 14 (9 F's) and 15 (8 F's).

The highest frequency of 10 failures occurred in Case 13 (Figure 4.4). Four failures were with the authority and three each with the specialist and EIA reports. In two criteria, namely seismic activity (13) and monitoring production boreholes (17), the EIA report did not convey the recommendation from the specialist report to the authority. Furthermore, the specialist also did not make recommendations with regards to the flood line analysis (4), monitoring rainfall (18) and stockpiles (26) criteria.

In Case 14, seven of the nine failures were scored in the specialist report, whilst the other two occurred in the seismic criterion under the EIA report and the authority. It is noteworthy that all the failures (8 F's) in Case 15 were from the specialist report and none from the other two role players, which were therefore all successes. Although it was overlooked by the specialist, there were recommendations made by the EIA and authority with regards to those specific criteria. In Case 4 also with eight failures, two occur in the specialist report and three each in the EIA report and the authority. In Case 9 with a failure frequency of seven, four were scored with the authority, whilst two scored with the EIA report and one with the specialist report (Figure 4.4).

The F scores in the case studies can be attributed to various reasons. In Case 14, with a high F score for the specialist, an individual's experience could be questioned rather than the consulting firm. In this case the same consultancy has carried out some other investigations as well and produced very few F scores.

In cases where there is an almost even distribution of F's amongst the role players (i.e. Cases 4 and 13), the type of project could play a role and here it was country estate and

township developments. The experience of individuals and very often the role of public participation play a role.

Case 9 which is a government institution, shows a high F for authority and the role that staff availability and competency as well as politics play, can't be ignored.

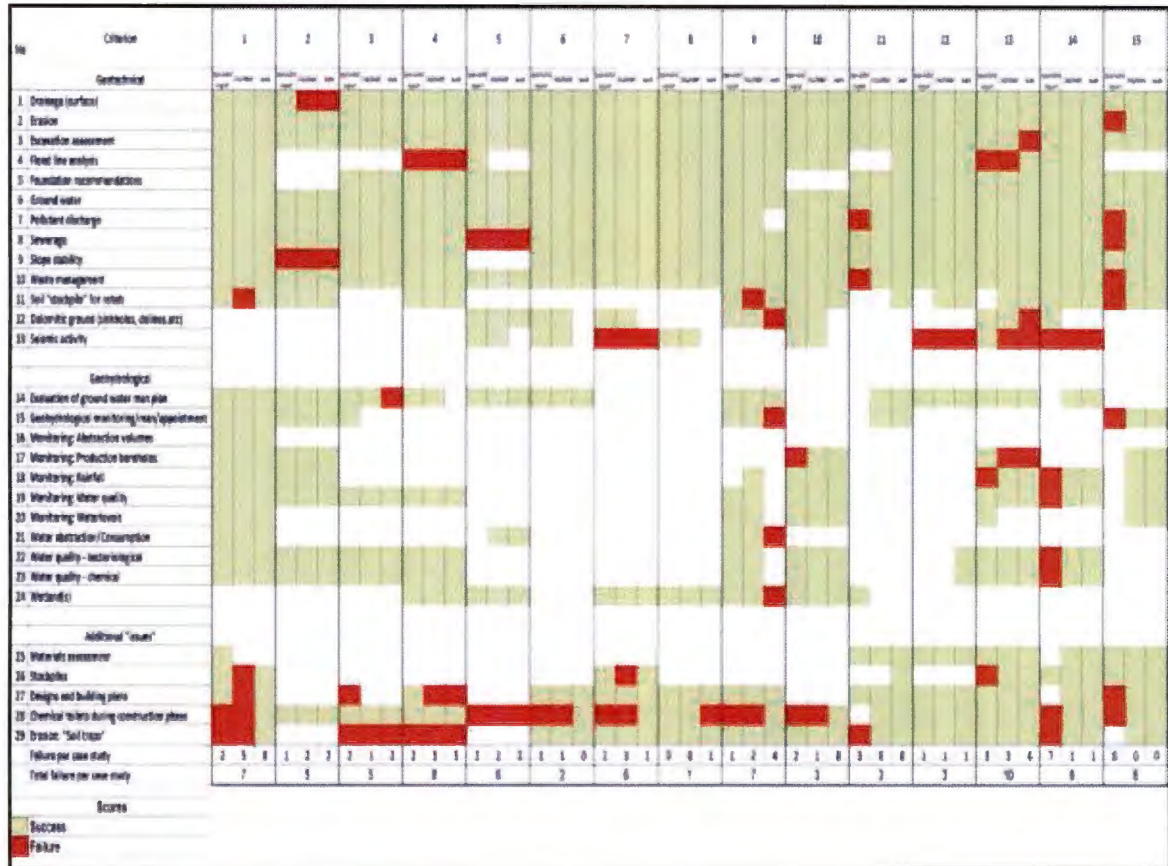


Figure 4.4: Performance per case study

4.6 SUCCESS AND FAIL PERMUTATIONS

The use of permutations gave the opportunity to relate cases, performance and role players to decision making in a holistic manner. Different permutations of the success and failure between the role players were investigated in order to test the extent of the EMP's response to the specialist report and secondly the realisation of the EMP's steps in the decision making process. The influence of specialist reports on decision making is the ultimate intent of this study, which led to two main permutation groupings, with the focus on decision making by the authority, namely:

Group A; Authority S – i.e. successful decision (SSS, FSS, SFS and FFS)

Group B; Authority F – i.e. failed decision (SSF, SFF, FSF and FFF).

Each group has four permutations, starting with SSS (optimal decision making) in Group A and ending with FFF (poorest performance) in group B (Table 4.5). Decision making was evaluated in terms of the eight permutations (Groups A and B) and therefore compared in the total picture with a frequency of 253.

The full data set with the N scores included, has a total frequency of 435 (15 cases x 29 criteria). After the N scores had been removed from the data set, a lower frequency of 253 was used for the evaluation of the eight permutations.

Table 4.5: Permutation groupings.

Specialist report	EAP/EMP	Authority	Group
S	S	S	Group A - Decision success
F	S	S	
S	F	S	
F	F	S	
S	S	F	Group B - Decision failure
F	S	F	
S	F	F	
F	F	F	

4.6.1 DISCUSSION OF SUCCESS PERMUTATIONS (GROUP A)

- SSS permutation:

The ideal permutation (SSS) is one with a high score, whilst the FFF combination is the poorest performance across the board. The SSS permutation (all three role players) obtained 79% and the total decision success for Group A is 92% (Table 4.6), which suggests an overall good performance by all the role players.

- FSS permutation:

The permutation FSS implies that recommendations and decisions were made by both the EAP and the authority without any citations from the specialist.

This permutation has the highest fail rate for specialist reports at 20 out of 253 (8%), (Table 4.6). Despite this failure, the decision is still regarded as successful and this permutation therefore reflects good performance by the EAP and the authority.

- FFS permutation:

The permutation, FFS where the authority acted in response without recommendations from the specialist and EIA reports, was at 7 (3%), (Table 4.6). Those recommendations in the decision that were not derived from the specialist and EIA reports suggested that other factors⁵ were also seen as important in formulating decisions with regards to the mitigation of environmental impacts.

It might also be that certain criteria have been poorly addressed by the specialist and to a lesser extent the EAP and that the authorities have to rely on other factors when formulating decisions. Decisions and recommendations were therefore made by the authority in any case.

- SFS permutation

The SFS permutation is an indication that the EAP failed to integrate on the specialist's recommendations and also failed to forward it to the authorities. In this permutation the EAP's communication failed on 5 (2%) occasions, though the specific recommendations were related by the specialist and the authority (Table 4.6). Although the EAP plays a key role with regards to the conveyance of recommendations and related information, a fail (F) could imply some shortcomings with regards to their effectiveness and also reluctance to use extra time and resources for the preparation of documentation to the authorities (Tinker *et al*, 2005).

The permutations of poor decision making by the authority and success by either the specialist or the EAP or both are the focus of the next discussion.

⁵ Other factors include: Nature, size, extent, duration of impact; capacity of receiving environment, etc.

Table 4.6: Permutation of decision success (a total of 253 was used in calculations).

No	Criterion	Specialist report			EIA/TEMP			Auth			Specialist report			EIA/TEMP			Auth			%	
		S	F	Freq	S	F	Freq	S	F	Freq	S	F	Freq	S	F	Freq	S	F	Freq		
1	Drainage [surface]			14																	0
2	Erosion			14																	0
3	Excavation assessment			14																	0
4	Flood line analysis			8																	0
5	Foundation recommendations			13																	0
6	Ground water			15																	0
7	Pollutant discharge			11																	0
8	Sewerage			13																	0
9	Slope stability			13																	0
10	Waste management			13																	0
11	Soil "stockpile" for rehab			4																	0
12	Dolomitic ground (sinkholes, dolines, etc)			2																	0
13	Seismic activity			0																	0
	Geohydrological (Result area 2)																				
14	Evaluation of ground water man plan			7																	0
15	Geohydrological monitoring/man/appointment			2																	0
16	Monitoring: Abstraction volumes			1																	0
17	Monitoring: Production boreholes			2																	0
18	Monitoring: Rainfall			3																	0
19	Monitoring: Water quality			6																	0
20	Monitoring: Waterlevels			2																	0
21	Water abstraction/Consumption			1																	0
22	Water quality - bacteriological			6																	0
23	Water quality - chemical			6																	0
24	Wetland(s)			5																	0
	Additional Issues (Result area 1)																				
25	Materials assessment			4																	0
26	Stockpiles			2																	0
27	Design and building plans			7																	0
28	Chemical toilets during construction phase			5																	0
29	Erosion: "Soil traps"			7																	0
	Total			200																	79
																					20
																					5
																					7
																					1

4.6.2 DISCUSSION OF FAILURE PERMUTATIONS (GROUP B)

Category B contains 8 % of the failure permutation and is the focus of the next discussion.

In contrast to group A, group B reflects decision failure because issues raised by specialists and/or EAPs were not addressed in the Authorisation (Table 4.7).

- SSF permutation:

The SSF permutation gave substantiation where the authority failed to reflect on both the specialist and EIA recommendations. The authority has failed to respond on 7 (3%) of the specialist and the EAP's communication lines. However, this failure of response by the authority may have the result that authorisation been granted and the recommendations by the other role players are seen as irrelevant. A rightful concern therefore arises because recommendations from the specialist and EIA reports were not addressed by the authority, which means that decision making became discretionary.

- SFF permutation:

The combination (SFF) where both the EIA and authority did not attend to the specialist report is 5 (2%), (Table 4.7). This demonstrates that some conditions were not imposed by the EAP and the authority for specific criteria that were addressed by the specialist, e.g. drainage (surface), (1), seismic activity (13), monitoring production boreholes (17), design and building plans (27) and chemical toilets during construction phase (28). It is therefore advisable that guidance might be necessary to deal more satisfactory with those criteria in the EIA and the decision making processes. It must also be taken into account that geotechnical and geohydrological concepts could be perceived as very complex systems and processes and are very often not easily understood by persons who are not experienced in those fields. It is therefore particularly difficult to predict impacts of this nature and to recommend suitable mitigation.

- FSF permutation:

The FSF permutation is where only the EAP recognised and recommended on environmental issues. In this permutation the specialist failed to make recommendations, whilst the EAP identified related issues that were relevant to environmental decisions. The authority on the other hand also failed to acknowledge the EAP's recommendations. There were no instances of this permutation in the sample of cases, but it remains a valid scenario for decision failure.

- FFF permutation:

The simultaneous failure permutation (FFF) on the other hand which is the invert of SSS, was 3% (Table 4.7). It would appear that there is a certain weakness with regards to the

criteria seismic activity (13) and erosional soil traps (29), because of the occurrence where all three role players have a frequency of three (1%) and two (1%) respectively (Table 4.7 and Figure 4.4).

A review of the analysis with regards to decision making will follow next in the synthesis.

Table 4.7: Permutations of decision failure (a total of 253 was used in calculations).

No	Criterion	Specialist report		EIA/EMP		Auth		Specialist report		EIA/EMP		Auth		Specialist report		EIA/EMP		Auth		%
		\$	freq	\$	freq	\$	freq	\$	freq	\$	freq	\$	freq	\$	freq	\$	freq	\$	freq	
1	Drainage (surface)		0		0		0		0		0		0		0		0		0	0
2	Erosion		0		0		0		0		0		0		0		0		0	0
3	Excavation assessment		1		0		0		0		0		0		0		0		0	0
4	Flood line analysis		0		0		0		0		0		0		0		0		0	0
5	Foundation recommendations		0		0		0		0		0		0		0		0		0	0
6	Ground water		0		0		0		0		0		0		0		0		0	0
7	Pollutant discharge		0		0		0		0		0		0		0		0		0	0
8	Sewerage		0		0		0		0		0		0		0		0		0	0
9	Slope stability		0		0		0		0		0		0		0		0		0	0
10	Waste management		0		0		0		0		0		0		0		0		0	0
11	Soil "Stoopie" for rehab		0		0		0		0		0		0		0		0		0	0
12	Dolomitic ground (junkholes, dolines, etc)		2		0		0		0		0		0		0		0		0	0
13	Seismic activity		0		0		0		0		0		0		0		0		0	1
	Geotechnical (Result area 1)																			
14	Evaluation of ground water man plan		1		0		0		0		0		0		0		0		0	0
15	Geotechnical monitoring/man/appointment		1		0		0		0		0		0		0		0		0	0
16	Monitoring: Abstraction volumes		0		0		0		0		0		0		0		0		0	0
17	Monitoring: Production boreholes		0		0		0		0		0		0		0		0		0	0
18	Monitoring: Rainfall		0		0		0		0		0		0		0		0		0	0
19	Monitoring: Water quality		0		0		0		0		0		0		0		0		0	0
20	Monitoring: Waterlevels		0		0		0		0		0		0		0		0		0	0
21	Water abstraction/Consumption		1		0		0		0		0		0		0		0		0	0
22	Water quality - bacteriological		0		0		0		0		0		0		0		0		0	0
23	Water quality - Chemical		0		0		0		0		0		0		0		0		0	0
24	Wetlands		1		0		0		0		0		0		0		0		0	0
	Additional issues (Result area 3)																			
25	Materials assessment		0		0		0		0		0		0		0		0		0	0
26	Stockpiles		0		0		0		0		0		0		0		0		0	0
27	Designs and building plans		0		0		0		0		0		0		0		0		0	0
28	Chemical toilets during construction phase		0		0		0		0		0		0		0		0		0	0
29	Erosion: "Soil traps"		0		0		0		0		0		0		0		0		0	1
	Total		7		2.8		0		0.0		5		2.0		9		3.6		1.6	

4.7 SYNTHESIS

In the analysis the relation between the geotechnical and geohydrological specialist recommendations and mitigation measures in the EMP, the EMP steps, and the conditions and obligations of the decision were investigated. It revealed to what extent the specialist recommendations were reflected in conditions and obligations of the environmental authorisation, and the success or failure of decision making.

The colour distribution in Table 4.1 shows that the majority frequency is green (A), which is a representation of satisfactory decisions with a more even distribution in the geotechnical category. There are also other trends such as light green (representing B) and yellow (representing C) that supported satisfactory conditions. However, the B (light green) and C (yellow) scoring symbols in Table 4.1 do leave room for improvement within the S score. Most likely there is the scenario where the advice of EAPs to developers and subsequent project modifications filtered the “invisible” FFF’s out and hence the high SSS percentage.

The poor performances (red) have a tendency to cluster by criteria. However there is a preponderance of N scores (blue) in the geohydrological category which is not relevant for specific case studies. The N scores were removed from the analysis in order to provide more clarity of remaining scores.

For interpretation purposes the different degrees of acceptable performances (symbols A – C) were amalgamated into one symbol, “S” (for success) and “F” was used for failure. These symbols do not allow for neutrality and performances in the overall data reviewed were therefore seen as satisfactory (S) or unsatisfactory (F), (Figure 4.2).

Clusters observed amongst the criteria show F’s are present in seismic activity (13), chemical toilets during construction (28) and erosional soil traps (29). This is probably an indication that the three role players regarded those specific criteria as subordinate to the others. The additional issues (RA 3) also had more “F” scores. That could be attributed to the role of specialists in other fields (other than geotechnical and geohydrological specialists) which dealt with those issues separately and were therefore not recognized in this study. Appropriate activities such as seismic activity (13) and erosional soil traps (29) are of a geotechnical and geohydrological nature and reflected on the thoroughness of the specialists’ investigation and reporting.

EAPs and the authorising bodies have a high success rate (S), whilst that for the specialist report is not as high as expected, but still a good performance, i.e. mostly S scores. The failure for specialists occur mainly in the additional sector (RA 3) and it could well be because those criteria fall outside the range of the geotechnical and geohydrological specialist expertise. The frequency of failure for the specialist report is the highest in the FSS permutation (8%) and a comparison between the role players indicated that there were instances where the EAP and the authority made recommendations and decisions that were not reflected in the specialist's report. Failure to recognise the specialist's recommendations will result in inadequate decisions (e.g. SFF or SSF). Conversely, those recommendations for the decision making that were not derived from the specialist and EIA reports suggested that other factors (see footnote 5) were also seen as important in formulating decisions with regards to the mitigation of environmental impacts. Notwithstanding the previous statement with regards to specialist failure, the relation between the geotechnical and geohydrological specialist recommendations and mitigation measures in the EMP is satisfactory. The S permutations for decision making also pointed to satisfactory performances. Tinker *et al* (2005) on the other hand had great concern with the EIA process in England and found that the English EIA and planning systems do not effectively ensure that mitigation measures are being implemented, while in Finland the EIA concept has proved to be functional (Jalava *et al*, 2010). This comment of Tinker *et al* (2005) relates to SSF and SFF scenarios, i.e. mitigation measures of the specialist and the EAP.

Authorisation performed well (>90%) in all three sectors, but it is notable in some cases (FFS, FSS and SFS) that decisions and recommendations were made irrespective of what the other two role players did or did not propose. In South Africa these results compared relatively better in terms of a high percentage of SSS than in the UK (Tinker *et al*, 2005). Authority failure is only a relatively small fraction of the 253. This appears to have led to the assumption that the importance of each decision is not necessary clear, which cause the authority to be overly careful. The failure permutations for decision making revealed instances where the authority failed to reflect on either or the specialist and EIA recommendations, which may have the result that the authority sees the recommendations by the other role players as irrelevant. Discretionary decision making is also a strong possibility where recommendations from the specialist and EIA reports were not addressed by the authority.

4.7.1 CONCLUSION

Sandham *et al* (2013a) revealed that South Africa is in a relative good position in terms of EIA report quality and is doing well compared to other countries. Sandham and Pretorius

(2008) also raised concern that contributions made to environmental protection and sustainable development that do not address certain important aspects, are still being approved. With this in mind, the question could be asked whether pro forma authorisations are used as a precautionary measure. Although South Africa has excellent new environmental laws there is a shortage of experienced officials in the authority due to the rapid turnover of officials and therefore relocated inexperienced officials rather follow a procedural precautionary approach. Other countries, such as Finland sees EIA as a learning process and the relevance of EIA can be increased in particular by training of practitioners and participants, including officials (Jalava *et al*, 2010).

The analysis revealed that geotechnical and geohydrological specialists do play an important role in EIAs and that cognisance is being given to their recommendations. There are however, weak areas in their roles, but overall the geotechnical and geohydrological specialist reports are indispensable in the EIA process and contribute towards a satisfactory decision making process.

The permutations in both Groups A and B show that decision making is satisfactory and that authorisation performed well (>90%) in all three result areas. The analysis revealed that some weaknesses and “overcompensation” of conditions and obligations with regards to the specialist reports were made by the authorities, but that geotechnical and geohydrological specialists is indispensable in the decision making process.

The objective(s) of this study was to evaluate the influence of the geotechnical and geohydrological specialist reports on the decision making process and authorisation of environmental management projects, which will be the discussion in the Conclusion (Chapter 5).

5. CONCLUSION

The study investigated the influence of geotechnical and geohydrological specialist reports on EIA decision making for a sample of EIA applications in South Africa. This final chapter summarises the results of the research by revisiting the guiding objectives to determine the extent to which they have been achieved:

- i) A review of the literature that is relevant to EIA effectiveness, report quality and decision making.
- ii) The methodology that was followed to gather and present the data for the research and finally
- iii) An overall conclusion and interpretation of the influence of geotechnical and geohydrological specialist reports on EIA decision making.

5.1 LITERATURE REVIEW

The literature study was done in Chapter 2 and a brief synopsis of the effectiveness and quality of reports, as well mitigation and decision making is given below. The influence of the necessity of environmental management is also briefly discussed.

Effectiveness:

The EIA reports contain the information that provides the starting point for decision making and its quality is vital with regards to effectiveness. Although the effectiveness of the EIA process is of international concern, it could be measured according to the extent by which the integration of assessment's findings is being translated into decision making (Sandham, *et al*, 2008a). The aim is therefore to determine the relation between geohydrological and geotechnical specialist recommendations and mitigation measures in the EMP and secondly, the relation between EMP steps and the conditions and obligations of the decision and therefore the environmental authorisation.

A considerable amount of literature relevant to EIA effectiveness, EIA report quality and decision making has been published (Pinho *et al*, 2007), but no published research with regard to relationship between recommendations and conditions and obligations in EIA practice in SA has been found. The effectiveness of EIA application amongst EIA related issues remains internationally very challenging (IUCN, 2007, and Tinker *et al*, 2005) and one of the main shortcomings in environmental impact assessments is its rather weak link to decision making (Pölonen *et al*, 2011).

Tinker *et al* (2005) found that by analysing a different environmental component, in their case soil and geology, it could result in extra conditions and obligations, which might be an indication that such an aspect was poorly addressed. However, it is the feeling that the EIA community remains divided on the purposes of EIA and the importance of specialists and the type and form of science as a component of it (Cashmore, 2004).

Report quality:

It must also be mentioned that report quality does not necessarily imply effectiveness of the EIA system, but that it makes a difference towards improved decision making and ultimately sustainability (Sandham *et al*, 2008b). It is also notable that the quality of an EIA report depends on the size of the project, the financial investment and the size of the proponents' company as well (Pinho, *et al*, 2007). A clear relationship exists between the quality of EIA reports and the extent of modifications and mitigation measures proposed to incorporate the respective projects which is part of this study (Pinho *et al*, 2007). Enhancement of the effectiveness of the EIA system goes hand in hand with improved funding of the EIA process and the two issues are not separable (IUCN, 2007).

Necessity of EIA:

In South Africa EIA is perceived as a burden by developers, especially amongst the smaller ones with no experience of EIA. The public and environmental groups on the other hand are likely to see EIA as a means of delaying and/or improving projects, whilst consultants see it as a worthwhile process. The relevant provincial authorities perceive the EIA process to be a valuable environmental management tool (Wood, 1999).

Mitigation:

The authorities utilise the information that they obtain from the EIA reports, with the specialist reports incorporated in their decision making process. The specialist recommendations which are reflected in conditions and obligations of environmental authorisations are therefore an indication of their influence on decision making (Scholz *et al*, 2006). Most authorities have attempted to ensure that the mitigation measures that were proposed in the EIA report have been implemented by summarising them in authorisation conditions (Wood, 1999).

Decision making:

Decision making in the EIA process is very complex and diversified and different interpretations could be made from the same technical and scientific information that is

included in the EIA report. There are different reasons for that, such as inaccurate report content, inaccessible and unclear language, the scope of the environmental issues dealt with is not relevant and appropriate and also the methods and techniques are not completely justified and correctly applied (Pinho *et al*, 2007). It is also important to note that relatively little is known about complex natural systems and how human activities affect these systems (Harding, 1998). There are various decision making models and most of the environmental related literature was written by scientists, planners, engineers and lawyers with a desire to be apolitical. It is however, difficult to imagine non-political outcomes and Bartlett and Kurian (1999) composed models, explaining how EIA is expected to have an impact on policies and decisions.

The influence of geotechnical and geohydrological specialist reports on decision making is the core of this study. However, studies noted that EIA literature has been criticised for lack of scientific rigour to clarify and analyse the values and judgements that support issues regarding environmental management (Lawrence, 2003). An analysis of EIA study outcomes also indicated that its role in decision making by the authorities is limited, primarily due to passive integration with the decision processes (Cashmore *et al*, 2004). In South Africa the information that is available to decision makers in environmental management is most important to the outcome of protection and/or destruction of projects, such as wetlands (Sandham *et al*; 2008a).

5.2 METHODOLOGY

This chapter reported on the sample selection, design of the review package and the application to the sample. The review package that consisted of 29 criteria was applied to each role player in the geotechnical, geohydrological and additional issues. This delivered a data set of 3 x 29 review scores for every report.

Data gathering:

A sample of 15 projects with adequate geotechnical and geohydrological elements was used in the investigation.

The trail of decision making was systematically extracted from the specialist reports, EIA reports and finally what was recommended and required in the authorization. The EAP's response to the specialist recommendations in the EIA report was noted and also the recommendations forwarded to the authority. Finally, the authority's commendations with regards to the specialist's recommendations were noted and thus following the trail from the specialist through to authorization.

Derivation of criteria:

A list of 29 criteria relating to geotechnical and geohydrological aspects were generated and grouped under Review areas 1 (criteria 1 – 13) and 2 (criteria 14 – 24) respectively. There were also several additional issues (Review area 3) that did not clearly fall into the geotechnical or geohydrological fields, but rather belong to other departments, such as architecture, health, safety, etc. Some of these issues did however have a direct or indirect effect on the geotechnical or geohydrological fields and were therefore treated as additional criteria during the review of the different projects (criteria 25-29).

Evaluation scale:

In this study the evaluation of decisions was scored by means of symbols adapted from Lee and Colley's (1992) quality review package, but with specific relevance to the geotechnical and geohydrological aspects. The scoring symbols A, B, and C reflected different degrees of an acceptable performance for each criterion, whilst the F symbol is not satisfactory because of a poor performance or failure to address a criterion. The symbol N is used where the specific criterion is not applicable or relevant for a particular project, e.g. dolomitic ground in an area where it doesn't occur.

5.3 ANALYSIS AND INTERPRETATION

Analysis of the dataset revealed that satisfactory decisions (A) represented in green in Table 4.1 has the largest frequency. It has a more evenly distribution in Review area 1 (Table 4.1). Trends of the B (represented by light green) and C (represented by yellow) scores also supported different degrees of satisfactory decisions. The N-scores (blue) were allocated where a specific criterion was not relevant and a large distribution occurs in Review areas 2 and 3.

The large number of N symbols was removed from the data set, which delivered a reduced set of scores. Furthermore, the different degrees of acceptable performances (symbols A – C) were amalgamated into one symbol, "S" (for success). The F symbol (represented by red) was used for failure and the overall data were therefore interpreted as satisfactory (S) or unsatisfactory (F), (Figure 4.2).

The SSS permutation is 79%, which suggested that the specialist reports are adequately reflected in conditions of authorization in a large majority of cases. The remaining fraction of cases is all some form of mismatch between the role players' recommendations, or failure by all three (FFF). Overall, approximately 13% are cases where good decisions followed weak

specialist and/or EAP performances, and approximately 5% are cases where good specialist/EAP performance was followed by poor decisions. It is also important to note that failure by the EAP and the authority to recognise the specialist's recommendations can result in inadequate decisions. However, on the contrary, other recommendations that were not from the specialist and EIA reports, suggested other factors of importance for the devise of decisions with regards to the mitigation of environmental impacts.

Although Tinker *et al* (2005) found the English EIA and planning systems do not effectively ensure the implementation of mitigation measures, Sandham and Pretorius (2008) revealed that South Africa is doing well compared to other countries. In this study the S permutations for decision making also pointed to satisfactory performances and the relation between the geotechnical and geohydrological specialist recommendations and mitigation measures in the EMP is satisfactory.

The decision making process performed very well and authorisation is >90% amongst the role players. There are however cases where decisions and recommendations from Group A (FFS, FSS and SFS) were made irrespective of what the other two role players suggested. This led to the conclusion that the importance of each decision may not be clear, which cause the authority to be overly careful. There is also the likelihood that discretionary decision making is done in cases where the specialist and EIA reports were not addressed by the authority. In reality the situation might be the use of a pro forma model as a precautionary principle. South Africa experiences a shortage of experienced officials in the authority because there is a rapid change of officials and relocated inexperienced officials rather follow a procedural precautionary approach.

5.4 SUMMARY

A synopsis of this study reveals that the relationship between the geotechnical and geohydrological proposals and the conditions and obligations of the environmental authorisations is good. Generally conditions and obligations that were not recommended in the EIA and specialist reports were added by the authorities, the recommendations that were unspecified were in the minority. Although report quality does not imply effectiveness of the EIA system, the EIA process could be judged as successful because of the extent to which the specialist assessment findings were translated into decision making.

Failure by both the EAP and authority to comply with the specialist report is relatively low. That suggested that the geotechnical and geohydrological reports were recognized as important by both the EAP and the authorities for decision making.

Key findings from the conclusion:

- Geotechnical and geohydrological reports were recognized as important by both the EAP and the authorities and are therefore influential with regards to decision making.
- The EIA process could be judged as successful because of the favourable extent to which the integration of assessment findings were translated into decision making by the role players.
- The majority of the EIA reports were regarded as effective and of good quality during the transfer of information towards the decision making process (authorisation).
- The decisions in the reviewed case studies were mainly examples of the information processing model of Bartlett and Kurian (1999), but there are also influences of the other models as well.

Specialist studies are an important part of the South African EIA landscape and the results of this study suggest that they should remain.

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