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Nuclear 1 Geology Peer Review

Report

Version – 1

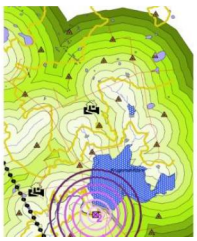
1 September 2015

Gibb (Pty) Ltd.

GCS Project Number: 13-803

Client Reference: GCS - J31314 Nuclear 1 Peer Review

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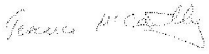
Author	Prof Terence McCarthy		September 2015
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EXECUTIVE SUMMARY

The Council for Geoscience (CGS, 2011) report is a competent compilation of data and current information from publications and other scientific reports, based on work carried out mainly by professionally capable CGS personnel. However, sources other than those originating from the CGS are not given due recognition. The Terms of Reference supplied for the geological assessment by Arcus GIBB to the CGS are in our view inconsistent with the "General Terms of Reference" for the EIA. The CGS (2011) report adheres more towards the "General Terms of Reference" and the very specific requirements of the Specialist Geology assessment do not feature in the report. This may be the cause of the lack of inventories of accumulated geological, topographic, aerial and other data, as requested in the Terms of Reference. Nevertheless, competent geological descriptions of the sites are provided and the potential risks are carefully considered, with the exception of tsunami risks.

We concur with the conclusions reached in that the substrate at each locality is suitable for the erection of a Nuclear Power Station. In the case of Thyspunt, the power plant should avoid the Goudini/Skurweberg Formation contact, because of differing physical properties of these two formations. At Bantamsklip the power plant is best placed on a base composed of quartzite of the Peninsula Formation, and at Duynefontein the Malmesbury Group bedrock is suitable for siting of a Nuclear Power Station.

There remains the important point of conducting further surveys to determine characteristics such as thickness and physical properties of the immediate substrate (sand, calcrete and related deposits) at all three sites. This information is important because these deposits will probably comprise at least part of the base on which a Nuclear Power Site is erected, once the final choice of site is made.

Importantly, the conclusions regarding the structural geology that could seriously affect choice of placement of the power plant are essentially valid. These include focusing on the position of each site relative to normal faults, especially those related to neotectonic activity (e.g. position relative to the Ceres-Kango-Baviaanskloof-Coega Fault system), but also offshore faults, where little or no geological information is available. More detailed surveys need to be carried out in these cases, because this new information could alter the conclusions reached in the report regarding choice of site.

Finally, the report does not adequately cover the possibility of a serious disaster in the form of flooding of the Nuclear Power Station by tsunamis, if the chosen position of the plant is not at an appropriate height above sea level to cope with such a disaster.

Our overall evaluations of the CGS (2011) report against the Terms of Reference for the specialist Geology Assessment are detailed in Table A. The assessment summary against the "Terms of Reference" as provided by GIBB is provided in Table B.

Table A: Terms of Reference provided to the CGS for the special Geology Assessment on geological hazards related to the construction of Nuclear Power Plants (CGS, 2011).

	Terms of Reference	Rating*	Comments
1	To provide a description of regional and site specific geology	3	
2	Data collection - existing geology coverage (digital), topographic and topocadastral information (digital, air photos (colour digital), if available), satellite imagery, hydroclimatic coverage	2	No inventory of relevant information provided
3	Geographic Information System (GIS) compilation of coverage and base plans containing above information. This is required for site reconnaissance, which is to identify land facets, site aspects, quarries and cuttings, and other relevant surface features to familiarise oneself with the expected ground conditions	2	No inventory of relevant information provided
4	Site reconnaissance: field inspection and documentation of relevant surface features, exposures (road cuttings, outcrop areas, accessibility, potential problem areas, etc.) as identified in RS and GIS-based desk-top surveys	2	No inventory of relevant information provided
5	GIS-based mapping of rock-type distributions around the (selected) sites	2	Not provided
6	Field structural mapping of outcrop-scale bed-rock fracturing	2	Not provided
7	GIS-compilation and interpretation of geological and structural data	2	Not provided
8	GIS-compilation and interpretation of geophysical data	2	No exemplar geophysical data provided
9	Identification of selected sites for pit sampling and trench-profiling	2	No inventory of relevant information provided
10	Logging of pits and trenches	2	No inventory of relevant information provided
11	GIS compilation and map integration of pit and trench data	2	No inventory of relevant information provided
*	1 = low (not or hardly addressed), 2 = medium (partially addressed or information may be present but is not provided in the document), 3 high (fullfilled)		

Table B: Assessment of "Terms of Reference" as provided by GIBB

	Criteria	Rating*	Comments
1	Fullfillment of Terms of Reference	2	A hybrid between the "General" and "Geological Specific" Terms of Reference seems to exist and resulted in some shortcomings
2	Report objectivity	3	See point 3 below
3	Technical, scientific and professional credibility	2	The report is based largely on work carried out by CGS and outside sources are not given adequate recognition
4	Defensibility of methodology and study approach	3	However, we note that outside data sources were not given adequate recognition
5	Information gaps, omissions or errors	2	Report is based largely on work carried by CGS and outside sources are not given adequate recognition. In the absence of inventories, existance of gaps cannot be fully assessed
6	Sensibility of recommendations and presentation of best options	3	
7	Alternative viewpoints, presentation and clarity of statement	3	Considertion of outside data sources and findings could have enhanced the deliverables
8	Accessibility of style of report to non-specialists	2	A geological background is required to comprehend the report
9	Meeting of normal standards of professional practice and competence	3	
*	1 = low, 2 = medium, 3 = high		

In summary: We are of the opinion that the CGS report (2011) represents a competent compilation. At the time of compilation, the product would have been improved through:

- The consideration and incorporation of relevant investigations and findings external to the CGS; and
- The incorporation of inventories of activities performed, databases compiled and the synthesis thereof, which would have also facilitated enhanced review of the report against the "Terms of Reference".

Events subsequent to the compilation of the CGS (2011) report suggest the consideration and inclusion of the likelihood of tsunamis along the southern South African coast, particularly those related to the slumping of detritus off the continental slope.

It is recommended that the above, together with the recommendations made by the CGS (2011) should be pursued to substantiate the suitability of the proposed sites for the erection of Nuclear Power Stations.

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List of Tables

1 INTRODUCTION

GCS Water and Environment (Pty) Ltd. (GCS) was appointed by Gibb (Pty) Ltd. to conduct a peer review of the geology and geotechnical report compiled by Council for Geoscience (2011) based on the EIA for a proposed Nuclear Power Station project. The project sites are located at Thyspunt in the Eastern Cape Province, and at Bantamsklip and Duynefontein in the Western Cape Province of South Africa.

The review of this particular report was sub-contracted by GCS to **Shango Solutions**, and this review report (Shango report no S0523/15) contains the findings of their expert review.

1.1 Background

During 2012 one of the authors, Prof Peter Booth (PWKB) reviewed a report on the proposed Thyspunt Nuclear Power Station site, compiled by consultants who had previously carried out fieldwork, mainly in the eastern sector of the Cape Fold Belt. The purpose of the field work and the report was to guide the Council for Geoscience (CGS) as to the suitability of erecting a Nuclear Power Station.

This author's knowledge of the proposed site was gained through a two day site visit, where the main features of the geology and structural geology were conveyed to him by Mr Marc Goedhart, the team leader for the CGS at the time. After a thorough investigation of the work carried out by geologists on the ground, supplemented by several meetings with the consultants employed to assess the Thyspunt site, PWKB concluded that all aspects of fieldwork and compilation of reports were carried out by competent and motivated personnel, whose work ethic and final product were of the highest standard.

With regard to the Bantamsklip and Dynefontein sites, PWKB participated in a geological excursion led by Dr Chris Hartnady (then at UCT) to examine the structural geology of the area between Gansbaai and Cape Agulhas. The area examined comprises predominantly quartzite of the Table Mountain Group, which have been extensively faulted (thrust fault duplexes), as well as being transected by normal faults. None of the authors have visited the Duynefontein site, and are unfamiliar with the local geology. However, PWKB was a participant on field excursions during 1998, examining rocks of the Malmesbury Group in the area north of Cape Town.

Moreover, PWKB researched the fault pattern in the Bokkeveld Group near Bredasdorp, which lies immediately north-east of the Bantamsklip site. In addition he has published extensively in the Cape Fold Belt, one publication resulted from fieldwork carried out in that area (Shone and Booth, 1993). The CV's of the authors appear in Appendix 1.

The report titled "Environmental Impact Assessment for a Proposed Nuclear Power Station (Nuclear-1) and Associated Infrastructure - Geological Hazard Environmental Impact Report" is a specialist compilation of the geology, structural geology, tectonic data, geophysical input and environmental considerations, aimed at assessing the suitability of three potential sites along the southern African coastline for the erection of Nuclear Power Stations. This compilation required a sound understanding of the geology of the entire Cape Fold Belt, as well as offshore information gained from geophysical surveys. In its broadest context the report embraces palaeo-seismic investigations especially neotectonic activity associated with the Ceres-Kango-Baviaanskloof_Coega Fault system and coastal warping. The report not only includes information related to risk factors associated with fault activity (guided by Nuclear Regulatory Code and Regulations), but also incorporates other geological risk factors pertinent to surface/near surface deformation and the effect these could have on the environment.

We note that the CGS (2011) report, based on the references cited therein, was compiled during 2009 and completed in 2010. Since then, significant developments have occurred which would have impacted on the report. For example, the Fukushima earthquake and resulting tsunami would have drawn the authors' attention to a local risk associated with the proposed Nuclear Power Station sites. Therefore, our assessment has been carried out considering only literature that was available up to the time of completion of the report. However, we draw attention to areas were further investigations are suggested in the light of more recent developments.

2 SCOPE OF WORK PROVIDED BY GIBB

The scope of work for the geology and geotechnical peer review study is as follows:

- Assess the document/ report in terms of its fulfilment of its Terms of Reference set;
- Consider whether the report is entirely objective;
- Consider whether the report is technically, scientifically and professionally credible;
- Consider whether the method and the study approach are defensible;
- Identify whether there are any information gaps, omissions or errors;
- Consider whether the recommendations presented are sensible and present the best options;
- Consider whether there are alternative viewpoints around issues presented in the report and if these are clearly stated;
- Consider whether the style of the report is written so as to make it accessible to non-specialists, technical jargon is explained and impacts are described using comparative analogies where necessary; and
- Report on whether normal standards of professional practice and competence have been met.

3 REVIEWED DOCUMENT

The reviewed document is a Geological Hazard Environment Impact Report compiled by the Council for Geoscience, March, 2011. The document is titled "Environmental Impact Assessment for the Proposed Nuclear Power Station ("Nuclear-1") and Associated Infrastructure".

3.1 Fulfilment of Terms of Reference

In the report the Terms of Reference, as set out on page 7 (CGS, 2011) include the collecting of relevant data, analysis and synthesis thereof, and the compilation of various databases, involving geology, topography, hydro-climatic and remotely sensed data. Information used in the report is reliable and documented from mostly published data, predominantly in-house reports of the CGS. In this respect, literature other than that originating from the CGS is underrepresented. A number of these are listed in the bibliography of this report (e.g. Durrheim, 1987; Malan et al., 1990; Doherty, 1992; Thomson, 1999; Paton, 2006; Parsiegla et al., 2007). Where information is lacking this has been pointed out in the report. Recommendations are made for future investigations in areas where information is lacking, or incomplete.

We perceive that a disjuncture exists between the "General Terms of Reference" as supplied by Arcus Gibb and the "Terms of Reference for the specialist Geology Assessment". The former terms are of a general nature, emphasising the environment of the site. The latter requests very specific and specialised information such as the "logging of pits and trenches", "field structural mapping of outcrop scale bed-rock fracturing", "field inspection and documentation of relevant surface features, exposures (road cuttings, outcrop areas, accessibility, potential problem areas, etc.)". The authors of the report have obviously opted for the more general approach, as detailed in the "General Terms of Reference". In the absence of an inventory of activities and data (e.g. maps, air photos, satellite images, GIS databases) we cannot ascertain with certainty whether the specific terms related to data collection have been met.

However, we note that the "Terms of Reference for the specialist Geology Assessment" request information on very specific and technical activities, such as logs on pits and trenches. This is incompatible with a report that would be accessible to non-specialists.

Our overall assessment of the report against the "Terms of Reference for the specialist Geology Assessments" is detailed in Table 1.

Table 1: Terms of Reference provided to the CGS for the special Geology Assessment on geological hazards related to the construction of Nuclear Power Plants (CGS, 2011).

	Terms of Reference	Rating*	Comments
1	To provide a description of regional and site specific geology	3	
2	Data collection - existing geology coverage (digital), topographic and topocadastral information (digital, air photos (colour digital), if available), satellite imagery, hydroclimatic coverage	2	No inventory of relevant information provided
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*	1 = low (not or hardly addressed), 2 = medium (partially addressed or information may be present but is not provided in the document), 3 high (fullfilled)		

3.2 Report Objectivity

The report stands as an objective assessment of facts, inferences and interpretations of data relating to the choice of three potential sites for the erection of one or more Nuclear Power Stations.

The systematic collection of field data using conventional methods, adequate compilation of the results, and conveyance of this information, indicates that objectivity was adhered to in this report. However, it is assumed that the majority of this compiled information is available but it has not been documented in the report.

3.3 Technical, Scientific and Professional Credibility

The report is set out in an easily readable style, with appropriate headings and sub-headings. Accompanying the report are generally well illustrated figures and tables, and an appendix. The clarity and user friendliness of the report could be improved through professional editing.

Interpretation of the regional and local geology pertinent to the three proposed areas was compiled from the work of experts, and therefore reliant on the most knowledgeable personnel in their various disciplines. These experts predominantly include geologists and geophysicists, mostly associated with the CGS, whose vast experience lends adequate scientific credibility to the report, and therefore the overall information and interpretations in the report are deemed to be reliable and trustworthy.

Each of the proposed sites (Thyspunt, Bantamsklip and Duynefontein) were evaluated, taking into account nearest ”capable” major and lesser fault systems which could cause ground movement, with consequent damaging environmental impacts at the sites. The risk of volcanic activity is discounted because current volcanism is very remote from the sites. In the initial assessment of all three areas, ground checks were carried out to verify the presence of known and inferred faults. Consequences of climate change are also taken into account drawing attention mainly to weathering rates as a result of changing precipitation patterns. However, the threat of rising sea levels on the planned structure is not considered.

3.4 Defensibility of Methodology and Study Approach

The CGS has decades of experience in regional and local mapping and geophysical investigations. It is therefore deduced that the methodologies employed by the investigating team in carrying out this study are reliable, tried and tested methods, involving relevant fieldwork techniques and appropriate interpretation of the results. The study approach, guided by the U S Regulations for Seismic Hazard Analysis and the South African National Environmental Management Act, is therefore appropriately and adequately carried out. An outline of geological inputs is set out for each site, detailing requirements for increasingly detailed surveys within a 320, 40, 8 and 1 km radius respectively, centred on each proposed site.

3.5 Information Gaps, Omissions or Errors

Data collection from extensive fieldwork and competent compilation of data has shown that gaps in information exist, notably the poor coverage of the wider literature. The authors of the report draw attention to the fact that detailed surveys need to be conducted in selected areas for reasons that preclude them from certainty in interpretations. These include areas where there is lack of outcrop, given the need to acquire physical and technical properties of the substrate. Such information for example is needed in the case of Thyspunt, where technical information and data relating to surface deposits (sand, and surficial-related deposits) are necessary and should be acquired through detailed geophysical surveys. In addition, geophysical input is required in all three proposed sites to confirm the status of major faults offshore (e.g. the Plettenberg and Cape St Francis Faults south of Thyspunt). Information in this regard could influence and alter the final recommendations in the proposed areas.

As mentioned earlier, events have occurred subsequent to the finalisation of the CGS (2011) report, which materially impact on its content, notably tsunamis. Tsunamis, such as Banda Aceh in Sumatra and Fukushima in Japan are reminder that this phenomenon should not be overlooked or treated casually. Evidence for very large tsunamis has been recognised along the Cape Coast line (Master, 2004, 2006, 2011 and 2014). During the 2004 Banda Aceh tsunami the eastern part of the southern African coastline was largely shielded from tsunami waves by Madagascar, so escaping major disaster. However, the sea level rise in the Port Elizabeth harbour, recorded over a time period of an hour or so, was some 2 metres at its height. This scenario could be repeated in the future, and can also be generated from another island arc system in the South Atlantic, viz. the Scotia Arc (off South America). In the latter case a rise in sea level (especially coincident with a high tide) would affect at least the westernmost proposed sites (Duynefontein and Bantamsklip).

An altogether different cause of a potential tsunami could originate from slumping of unconsolidated sediments off the southern African continental slope, with a resultant corresponding rise in sea level along the coastline. The largest known offshore slump on Earth (volume of 20 000 km3, 750 km long and 106 km wide) was identified on the Agulhus bank off Port Elizabeth (Dingle, 1977). Such slumps could especially be triggered by earthquakes along the Nubia/Somalia plate boundary (Hartnady, 2002). Although these scenarios appear perhaps alarmist, and may be separated by long periods of time, the potential threat exists, and should be taken into account to ensure that the location of the Nuclear Power Station is sited at an appropriate height above sea level and is constructed appropriately. Global climate change will result in a sea water level rise of at least 1 m by the year 2100 (New Scientist, 2015), and will continue to rise at an increasing rate thereafter.

The review of the CGS (2011) document is hampered by the fragmented nature and wide variety of relevant studies and information. These are, in our opinion, not seen holistically nor being included in the report. This has resulted in gaps. The CGS, for example, identified offshore slumping as a potential source of tsunamis (Roberts, 2008) and Eskom (2009) commissioned a numerical modelling study on the impact of slumps and associated tsunamis, with specific reference to the Duynefontein site. These reports are not included in the CGS (2011) report.

Errors in the report are minor, typographic and grammatical in nature. These errors, however, do not detract from the essential content of the report.

3.6 Sensibility of Recommendations and Presentation of Best Options

The overall recommendation is that all three sites are suitable for the erection of a Nuclear Power Station. This recommendation is based on a thorough understanding of the substrate geology and structural geology, which together play the major role in deciding the suitability of erecting Nuclear Power Stations. All three sites have a large number of faults transecting the local bedrock, viz. thrust faults, normal faults and strike-slip faults. Thrust faults formed predominantly in the late Palaeozoic/Mesozoic Era (just younger than 300 million years). Normal faults along coastal southern Africa developed mostly as a result of the breakup of Gondwana, and some are still active, but not markedly so (Ceres-Kango-BaviaanskIoof-Coega fault system). Some of these formed by inversion of older thrust faults (Malan et al., 1990; Bate and Malan, 1992; Doherty, 1992; Thomson, 1999; Paton et al., 2006). Neotectonic activity associated with the normal faults, however, suggests a large recurrence interval (of the order of 100,000 years) which therefore does not pose an immediate threat for the foreseeable future.

The authors of the CGS (2011) report point out the scarcity of offshore geological and geophysical data, and suggest that more detailed information is required, especially from geophysical surveys. We agree with this statement because the Agulhas-Falkland Fracture Zone, a few hundred kilometres to the south, is active at present, and can cause reactivation along all extensional related structures in the Bredasdorp Basin, and other offshore basins considered in this report, as well as trigger slumps off the continental platform.

The recommendations presented in the report are sensible and the path of options is set out in practical manner.

3.7 Alternative Viewpoints, Presentation and Clarity of Statement

Alternative viewpoints are not that many, because the geology of the three sites is relatively well understood in that the main cause of disturbance of the foundation on which a Nuclear Power Station is to be built would be ground motion, caused by earthquakes generated by severe movement along faults. The sources of movement would be located along faults in the vicinity of the proposed areas. Because thrust faults are mostly old, they are unlikely to generate movement along their fault planes, but normal and strike-slip faults do pose a threat (the latter to a lesser extent than the former). The threat can be confined largely to the Ceres-Kango- Baviaanskloof-Coega fault system, and possibly some offshore faults. These threats have been pointed out in the report, but the authors suggest that re-activation in this intra-continental fault zone is rated as a low possibility.

All aspects of viewpoints in this report are clearly set out, and ambiguous statements are absent.

3.8 Accessibility of Style of Report to Non-Specialists

There is no doubt that the style of the report is biased towards people with a geological background. Whoever reads the report should have some fundamental knowledge of how geological processes work, especially with regard to the understanding of rock types and structures that affect these rocks. This is because major decisions about suitability of Nuclear Power Station sites are decided largely on the understanding of what these two aspects of the science are about.

However, the report is written in such a style that non-professionals can understand it, albeit that they will need some assistance in getting to grips with the technical terms. Helpful to the reader, in this aspect, are the “List of Abbreviations” and "Glossary of Terms” related to technical terms used in the text (provided on page (vii) of the report). However, this list of abbreviations is incomplete, e.g. PNPS.

3.9 Meeting of Normal Standards of Professional Practice and Competence

In our judgment normal standards of professional practice have been adhered to, and competence in carrying out fieldwork, compilation and presentation of data is sound, within the context of the lack of other literature sources and inventories referred to earlier. The report has been compiled taking into account the U S Regulatory Guide, and is set out according to the norms and standards of professional best practice.

4 SUMMARY AND CONCLUSIONS

The CGS (2011) report is a competent compilation of data and current information from publications and other scientific reports, based on work carried out mainly by professionally capable personnel from the CGS. However, sources other than those originating from the CGS are not given due recognition. The Terms of Reference supplied for the Geological Assessment provided by Arcus GIBB are in our view inconsistent with the "General Terms of Reference" for the EIA. The CGS (2011) report adheres more towards the "General Terms of Reference" and the very specific requirements of the specialist Geology Assessment do not feature in the report. This may be the cause of the lack of inventories of accumulated geological, topographic, aerial and other data. Nevertheless, competent geological descriptions of the sites are provided and the potential risks are carefully considered, with the exception of tsunami risks.

We concur with the conclusions reached in that the substrate at each locality is suitable for the erection of a Nuclear Power Station. In the case of Thyspunt, the power plant should avoid the Goudini/Skurweberg Formation contact, because of differing physical properties in these two formations. At Bantamsklip the power plant is best placed on a base composed of quartzites of the Peninsula Formation, and at Duynefontein the Malmesbury Group bedrock is suitable for siting of a Nuclear Power Station.

There remains the important point of conducting further surveys to determine characteristics such as thickness and physical properties of the immediate substrate (sand, calcrete and related deposits) at all three sites. This information is important because these deposits will probably comprise at least part of the base on which a Nuclear Power Site is erected, once the final choice of site is made.

Importantly, the conclusions regarding the structural geology that could seriously affect choice of placement of the power plant are essentially valid. These include focusing on the position of each site relative to normal faults, especially those related to neotectonic activity (e.g. position relative to the Ceres-Kango-Baviaanskloof-Coega fault system), but also offshore faults, where little or no geological information is available. More detailed surveys need to be carried out in these areas, because this new information could alter the conclusions reached in the report regarding the choice of site.

Finally, the report does not adequately cover the possibility of a serious disaster in the form of flooding of the Nuclear Power Station by tsunamis, if the chosen position of the plant is not at an appropriate height above sea level to cope with such a disaster.

Our overall evaluations of the CGS (2011) report against the Terms of Reference for the specialist Geology Assessment are detailed in Table 1. The assessment summary against the "Terms of Reference" as provided by GIBB is provided in Table 2.

Table 2: Summary of peer review as provided by GIBB

	Criteria	Rating*	Comments
1	Fullfillment of Terms of Reference	2	A hybrid between the "General" and "Geological Specific" Terms of Reference seems to exist and resulted in some shortcomings
2	Report objectivity	3	See point 3 below
3	Technical, scientific and professional credibility	2	The report is based largely on work carried out by CGS and outside sources are not given adequate recognition
4	Defensibility of methodology and study approach	3	However, we note that outside data sources were not given adequate recognition
5	Information gaps, omissions or errors	2	Report is based largely on work carried by CGS and outside sources are not given adequate recognition. In the absence of inventories, existance of gaps cannot be fully assessed
6	Sensibility of recommendations and presentation of best options	3	
7	Alternative viewpoints, presentation and clarity of statement	3	Considertion of outside data sources and findings could have enhanced the deliverables
8	Accessibility of style of report to non-specialists	2	A geological background is required to comprehend the report
9	Meeting of normal standards of professional practice and competence	3	
*	1 = low, 2 = medium, 3 = high		

In summary: We are of the opinion that the CGS report (2011) represents a competent compilation. At the time of compilation, the product would have been improved through:

- The consideration and incorporation of relevant investigations and findings external to the CGS.
- The incorporation of inventories of activities performed, databases compiled and the synthesis thereof, which would have also facilitated enhanced review of the report versus the “Terms of Reference”.

Events subsequent to the compilation of the CGS (2011) report suggest the consideration and inclusion of the following:

- The likelihood of tsunamis along the southern South African coast.
  - This should incorporate the slumping of detritus off the continental slope.

It is recommended that above, and the recommendations made by the CGS (2011) should be pursued to substantiate the suitability of the proposed sites for the erection of Nuclear Power Stations.

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