Scoping Phase – Hydrology
Combined Cycle Gas Turbine EIA

Report Prepared for

Bohlweki Environmental (Pty) Ltd

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SRK Consulting
Engineers and Scientists

Scoping Phase – Hydrology
Combined Cycle Gas Turbine EIA

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Executive Summary

Introduction

Bohlweki Environmental is undertaking an EIA for the new combined cycle gas turbine (CCGT) power plant which will be located near to the Majuba Power Station in the Mpumalanga Province. This report provides the hydrological recommendations for the pre-screening phase of that EIA. Pre-screening requires some hydrological investigation as surface water bodies form a major part of the ecosystem and also serve as transport for contaminants and sediments. Further, stormwater emanating from the site can also transport pollutants and cause erosion due to the increase in hard surfaces if not managed properly.

Nature of Impact

Flooding areas and slope were used as the basis for the hydrological sensitivity analysis.

According to best practice and regulations in most municipal areas in South Africa infrastructure must be built outside the 1 in 100 year floodline. Further, regulation 704 states that all infrastructures must be at least 100 metres from a water course and outside the 1 in 100 year floodline. The reasons for keeping infrastructure out of flooding areas is quite clearly to avoid expensive infrastructural damage, ensure safety of those using the infrastructure, protect water courses from pollution during floods and protect the riparian areas around water courses.

Areas sensitive to flooding were identified as any area within 100m of a river or water body (Table 2.1). Full floodline modeling to delineate 1 in 100 year floodlines was not feasible at this stage. Areas more than 100m from a water course but less than 200m were zoned as acceptable. These areas were not ideal as there was a possibility of occasional flooding problems but in general they had a low likelihood of being within the 1 in 100 year floodline.

The slope of an area has a large impact on hydrology. Steeper slopes produce quicker and large storm flows which are more likely to result in erosion and sediment transport. Generally, stormwater flows on steeper slopes are more difficult to control. In terms of regulation 704 stormwater from a site should be contained and treated and clean stormwater flowing onto a site should be diverted around the site. Hence the control of stormwater and consequently slope influences the degree of environmental impact and as a result the difficulty and expense of mitigating that impact.

Slopes of less than 2% provide relatively flat land for construction and stormwater control and these were designated as ideal. Slopes of greater than 5% are quite steep and demand greater measures to control stormwater and erosion and these were designated as sensitive. All other areas, between 2 and 5%, were considered acceptable. It must be noted that slopes were calculated based on 20m contours.

Extent of Impact

The extents of the impacts discussed above are tabulated with a suitability scoring approach. The possible impacts are discussed in terms of the effects that the development would have on the hydrology of the area on a short and long term basis.

Conclusions and Recommendations

It is recommended that Site 1 be explored as a potential candidate site for the construction of the CCGT Plant. A full EIA study needs to commence in order to assess the primary and secondary impacts that such construction may have on the local and regional hydrology.

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Scoping Phase – Hydrology

Combined Cycle Gas Turbine EIA

1 Introduction and Scope of Report

Bohlweki Environmental appointed SRK Consulting to undertake the necessary hydrological studies for the proposed Combined Cycle Gas Turbine (CCGT) power plant. The CCGT power plant is to be located adjacent to the existing Majuba Power Station in the Mpumalanga Province.

SRK have compiled a pre-screening report (SRK report ref. 378710, dated 24 October 2007), which provided an indication of ideal, acceptable, and sensitive areas within a ± 12 km radius of the Majuba Power Station, from a hydrology perspective.

The preliminary assessment of suitable sites was based on surface water resources (rivers, streams, dams), vulnerability to potential surface contaminant sources (surface runoff from industry and disturbed areas due to infrastructure due to the drainage density), slope (erosional problems due to steep slopes), problems associated with water supply to the power station, existing land use areas and sensitive areas (wetlands).

The resultant pre-screening data were added to the other specialist inputs (biophysical and social), which allowed for the identification of six (6) candidate sites for assessment during the scoping phase.

This report details an assessment of the candidate sites and provides recommendations regarding site suitability from a hydrological perspective.

2 Pre-screening

SRK compiled available hydrological data and assessed the regional surface water resources where flooding areas and slope were used as the basis for the hydrological sensitivity analysis.

According to best practice and regulations in most municipal areas in South Africa infrastructure must be built outside the 1 in 100 year floodline. Further, regulation 704 states that all infrastructures must be at least 100 metres from a water course and outside the 1 in 100 year floodline. The reasons for keeping infrastructure out of flooding areas is quite clearly to avoid expensive infrastructural damage, ensure safety of those using the infrastructure, protect water courses from pollution during floods and protect the riparian areas around water courses.

Areas sensitive to flooding were identified as any area within 100m of a river or water body (Table 2.1). Full floodline modeling to delineate 1 in 100 year floodlines was not feasible at this stage. Areas more than 100m from a water course but less than 200m were zoned as acceptable. These areas were not ideal as there was a possibility of occasional flooding problems but in general they had a low likelihood of being within the 1 in 100 year floodline.

Table 2-1: Hydrological sensitivity analysis criteria for water bodies

	Description
Ideal	Over 200m from water bodies on slopes of less than 2%
Acceptable	Over 100m from water bodies and on slopes of less than 5%
Sensitive	Within 100m of water bodies and on slopes steeper than 5%

Important: Slopes based on 20m contours

The slope of an area has a large impact on hydrology. Steeper slopes produce quicker and large storm flows which are more likely to result in erosion and sediment transport. Generally, stormwater flows on steeper slopes are more difficult to control. In terms of regulation 704 stormwater from a site should be contained and treated and clean stormwater flowing onto a site should be diverted around the site. Hence the control of stormwater and consequently slope influences the degree of environmental impact and as a result the difficulty and expense of mitigating that impact.

Slopes of less than 2% provide relatively flat land for construction and stormwater control and these were designated as ideal. Slopes of greater than 5% are quite steep and demand greater measures to control stormwater and erosion and these were designated as sensitive. All other areas, between 2 and 5%, were considered acceptable. It must be noted that slopes were calculated based on 20m contours.

2.1 Regional Overview

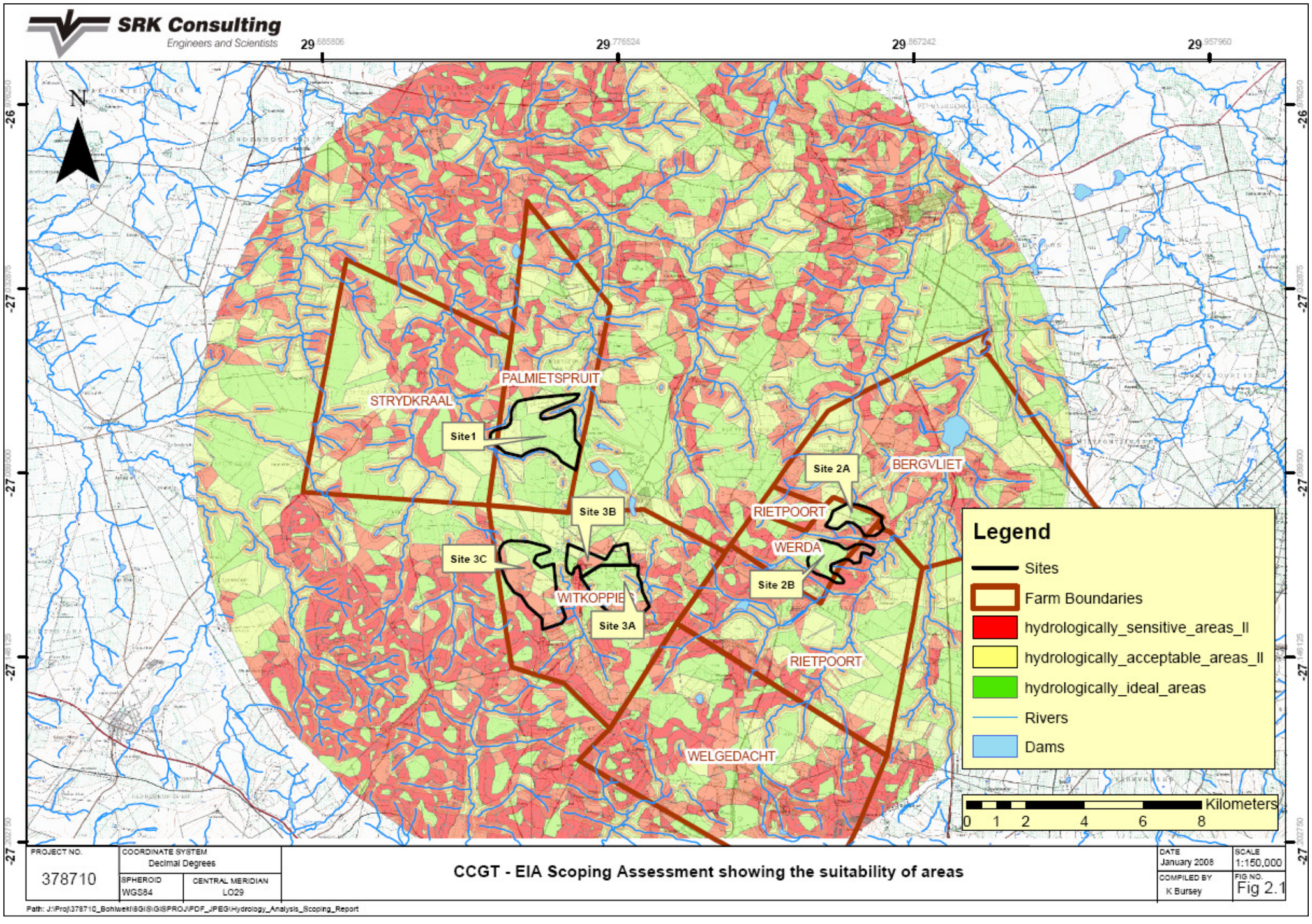
The region in which the CCGT will be situated has a slope varying between from below 1 to above 100% and contains a number of streams and rivers. Most of these are small drainage lines that flow only periodically but a few are perennial rivers with a constant flow. The steeper slopes and the areas around the rivers are the most sensitive areas from a surface water point of view and hence a large amount of area within the 12 km zone around the pilot CCGT is sensitive from a hydrological point of view.

2.2 Sensitivity Analysis

Figure 2.1 shows the areas that are ideal, acceptable and sensitive from a preliminary hydrological perspective. Areas shown as red in Figure 2.1 should be considered sensitive and of least suitability for development. In many cases these areas will require river diversions and water use license applications to DWAF as they likely to be in the floodline. Where the sensitive areas are not near a river they are due to steep slopes that will make stormwater control difficult.

Areas shown as yellow are acceptable but not ideal and from a hydrological point of view can be developed with some caution according to specific design criteria that would have to be followed exactly. Areas shown as green are the most ideal and these areas can be developed with little impact on surface water resources.

Figure 2-1: EIA Scoping Assessment showing the suitability of areas



3 Scoping approach

Further than the information that has been uncovered in the Pre-screening analysis; other elements to the sensitivity of the various sites to the development have been identified. The scoping approach will include the same concerns as the Pre-screening analysis as well as the further concerns.

Impacts envisaged are possible flooding, increased runoff from disturbed areas and infrastructure, generation and transport of domestic and industrial waste due to the proposed infrastructure, availability of water to be supplied to the CCGT Plant, water supply to the surrounding environment being affected due to the amount of water required for processing at the CCGT Plant and water users that rely on the water resources in the area not having enough water to continue their livelihoods in a productive manner. The sites must also not be in close proximity to wetlands, must not be in areas of high drainage density (exacerbates the potential problems of pollutants and increased erosion) and the sites should rather be situated on denuded or natural vegetation than on more sophisticated land uses such as irrigated or intensely agricultural land.

The availability of water to be supplied to the CCGT Plant was included in the site suitability score weighting approach but the sites were given the same weighted scores due to insufficient data being available on the water supply schemes and operations to the various sites at this stage. The issue will be more thoroughly dealt within the EIA Report. The water supply to the surrounding environment and other water users that rely on the water resources in the area not having enough water to continue their livelihoods in a productive manner due to the amount of water required for processing at the CCGT Plant was also included. The site suitability score weighting approach for this criterion were given the same weighted scores due to insufficient data being available at this stage, but will also be more thoroughly addressed in the EIA Report.

The following data was assessed to determine site suitability at each of the candidate sites:

- Hydrology – regional and site (GIS used to create suitability opinion of Kevin Bursey – SRK Consulting);
- Surface water use (GIS used to create suitability opinion of Kevin Bursey – SRK Consulting);
- Water supply to other water users and the environment (GIS used to create suitability opinion of Kevin Bursey – SRK Consulting);
- Erosion and Pollutants transport (GIS used to create suitability opinion of Kevin Bursey – SRK Consulting).

Table 3-1: Site sensitivity analysis impact criteria

Flooding
Slope (inc runoff, erosion, waste and pollutant transport)
Inc Runoff due to new disturbed areas and infrastructure
Generation and transport of industrial and domestic waste
Availability of water to the CCGT Plant
Water supply demands to environment and other water users satisfied
Drainage Density (inc erosion, waste and pollutant transport)
Wetlands or other Fatal Flaws
Denuded or Natural Land Use vs More sophisticated Land Uses

Based on available data a WASP assessment of the sites was conducted and then the preferred site identified from hydrology point of view.

4 Scoping data

4.1 Regional hydrology

The objectives of the scoping report were to conduct a site sensitivity analysis in order to give an indication to the client as to which of the proposed candidate sites would be hydrologically preferential. The criteria used to conduct this site sensitivity analysis are given in the previous chapter. The outcome of the study is to recommend one of the six sites which would be best suited for the construction of the CCGT Plant from a hydrological point of view.

4.2 Work program

The site suitability study of the six sites was completed after many revisions to the candidate sites. The task proved to be an arduous, but enjoyable experience with a lot of time and thought being devoted to the primary and secondary repercussions of the proposed CCGT Plant on the hydrology of the immediate and downstream areas.

The principal tasks in assessing the candidate site's suitability were found to be:

- Potential flooding;
- Slope (inc runoff, erosion, waste and pollutant transport);
- Generation and transport of industrial and domestic waste;
- Availability of water to the CCGT Plant (be more suitably approached in the EIA Report);
- Water supply demands to environment and other water users satisfied (be more suitably approached in the EIA Report);
- Drainage Density (inc erosion, waste and pollutant transport);

- Wetlands or other Fatal Flaws;
- Denuded or Natural Land Use vs More sophisticated Land Uses.

4.3 Project team

The project team consists of Xanthe Meyer, Kevin Bursey and Mark Stewart.

5 Program Results

The literature data review and fieldwork indicated:-

- No fatal flaws, from a hydrology perspective, were identified on any of the six sites as long as when there is a wetland located on the outskirts of the site area, the CCGT Plant is built at least 200m away from the wetland. If this is not adhered to, then the site is constituted to have a fatal flaw due to the wetland position.
- The surface water resources and vulnerability on each of the six candidate sites are similar, but some sites were found to be more suitable.

In order to determine the most suitable site, for the proposed power generation project, a surface water resource site comparison was conducted, utilising weighting factors. This comparison allows for the identification of the most suitable site (or portions of a site) from a hydrological perspective. Table 5-1 presents the site comparison.

The majority of Site 1 proved to be the highest ranking site from a hydrology perspective, the site was rated as the best suitable site due to the following factors: -

- The area where the CCGT Plant is to be built is outside of the river flooding zones, and this must be adhered to, and the marginal areas should be avoided as well.
- The slope of the proposed site is mainly quite flat, thereby not exacerbating the runoff response times, the erodibility as well as the waste and pollutant transport.
- Due to the site being disturbed from construction when the CCGT Plant is built as well as the larger impervious areas, the increased runoff from the site will have the least effect of the candidate sites because the average slope of the area is not steep.
- Again because the average slope of the area is not steep, the industrial and domestic waste created by the CCGT Plant will be able to be controlled with much more ease and it will not leave the site as rapidly.
- The drainage density of Site 1 is not too high to warrant alarm. There are small headwater streams on most sides of the proposed area. These streams are very small with small catchment areas, which will have easily controllable runoff volumes and peaks and therefore the ill-effects of the CCGT Plant will be easily managed before they enter the stream network.

- No fatal flaws are evident so long as the CCGT Plant is built at least 200m away from the wetland area to the south of Site 1.

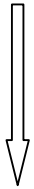
- There are areas within Site 1 where there are cultivated lands, but this is acceptable because all the sites bar one had a similar situation. The occupancy of cultivated land by the CCGT Plant, especially since it is not a massive area, is a trivial concern when compared to the effects the CCGT Plant can have on the hydrology and ecology of the region.

Site 1 was seen as the most eligible site for the CCGT Plant by some margin.

Table 5-1: Site Selection weighting factor

	Scoring in terms of suitability						Hydrological
Site selection elements	**SITE 1**	**SITE 2A**	**SITE 2B**	**SITE 3A**	**SITE 3B**	**SITE 3C**	**Weighting factor (0-1)**
Flooding	4	3	3	2	3	2	1
Slope (inc runoff, erosion, waste and pollutant transport)	4	2	3	3	3	2	1
Inc Runoff due to new disturbed areas and infrastructure	4	2	2	3	3	2	1
Generation and transport of industrial and domestic waste	3	2	2	2	3	3	1
Availability of water to the CCGT Plant (Will be inc in EIA)	3	3	3	3	3	3	0.5
Water supply demands to environment and other water users satisfied	2	2	2	2	2	2	1
Drainage Density (inc erosion, waste and pollutant transport)	3	3	2	3	4	3	0.5
Wetlands or other Fatal Flaws	4	5	5	5	4	4	1
Denuded or Natural Land Use vs More sophisticated Land Uses	3	3	4	3	3	3	0.5
Subtotal	25.5	20.5	21.5	21.5	23	19.5	
Percentage	68	55	57	57	61	52	
Ranking	**1**	**5**	**3**	**4**	**2**	**6**	

LEGEND	
fatal flaw	**1 (0-20%)**
poor	**2 (20-40%)**
average	**3 (40-60%)**
good	**4 (60-80%)**
very good (ideal)	**5 (80-100%)**



Increase in site suitability in terms of groundwater site selection elements

6 Conclusions and Recommendations

The results of the site suitability study of the candidate sites were informative as well as representative. Real issues were put forward in the screening process, with these issues having a broad range of effects on the dynamics of the water cycle. The effects on the local and regional hydrology, whether they are primary or secondary have been addressed, some in more detail than others but the scope for them to be studied has been put forward, so as that they are not ignored or brushed off.

All the candidate sites were assessed in the site suitability study by way of a weighted scoring system. This method highlighted that Site 1 was the best suited for the proposed construction of the CCGT Plant. In saying that Site 1 was found to be the most favourable, certain environmental concerns still have to be adhered to, such as building the Plant outside of the flooding zone, containing stormflows and thus controlling the erosion, pollutants as well as the industrial and domestic wastes generated from the Plant. Another concern with Site 1 is that it must be built at least 200m away from the wetland to the south.

It is recommended that a full EIA study be done with Site 1 specifically in mind. This process will entail a thorough examination of the site, and from a hydrology perspective, making informed assessments as to the repercussions of the proposed CCGT Plant on the surface water resources locally and regionally with a view of both the primary and secondary effects.

The plan for the EIA study from a hydrological viewpoint should entail the following:

- Site visit to assess local hydrology with a focus on the rest of the EIA plan;
- Review water supply details to the CCGT Plant – Inter-catchment transfer schemes taken into account and incorporating an accurate water balance for the Plant;
- Assessing the local climate;
- Pre- and Post development description of the hydrology, focussing on mean annual runoff, peak flows and volumes, drainage density and water quality studies including sampling and utilising the DWAF databases;
- Assessing the local infrastructure, including the dams in the vicinity, their size, their specific water uses and what the probability of breaking or not with the increased water supply needed in the area. The dams supplying the CCGT Plant will be included in the water balance as well. The dams will need to be assessed in terms of the long term impacts, with the dam being required to be fuller, of the increased discharge from the dam. The infrastructure will also include what stormwater management systems would have to be implemented to contain stormflows in accordance with Regulation 704 of the National Water Act;
- Controlling erosion, pollutants as well as industrial and domestic waste;
- Assess if there are any fatal flaws or environmental conflicts;

- The downstream water users would need to be considered in terms of water availability, water quality and their ability to continue with their livelihoods.

Kevin Bursey

SRK Consulting

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