3. PROJECT ALTERNATIVES

In terms of the Environmental Impact Assessment (EIA) Regulations, feasible alternatives should be considered within the Environmental Scoping Study. All identified, feasible alternatives should be evaluated in terms of social, biophysical, economic and technical factors.

A key component in the EIA process is the consideration of alternatives. Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

- incrementally different (modifications) alternatives to the project; and
- fundamentally (totally) different alternatives to the project.

Fundamentally different alternatives are assessed by Eskom at a strategic level, and these are not addressed within project-specific EIAs. Any discussions around this topic have been addressed as part of the Integrated Strategic Electricity Plan (ISEP) undertaken by Eskom, as well as the National Integrated Resource Plan (NIRP) from the National Electricity Regulator (NER) (refer to Chapter 1 of this Report). This Scoping Study therefore only considers alternatives considered in terms of the proposed pumped storage facility in the Steelpoort area, and does not evaluate any other power generation or storage options being considered by Eskom.

3.1. High-level Eskom site identification for pumped storage schemes in South Africa

The development cycle for a new pumped storage scheme started almost two decades ago when Eskom initiated an extensive programme in the search for possible pumped storage sites throughout the whole of South Africa.

In order to identify as many sites as possible, no limitations (such as potential capacity and location from demand centres) were set in this search. This process resulted in the identification of approximately 90 sites.

3.1.1 Preliminary Site Selection

A preliminary site selection process followed on the basis of the following criteria:

a) Potential capacity of scheme

The increasingly need for pumped storage schemes indicated that each scheme should have a capacity of at least 1 000 MW. Smaller capacities would therefore not be suitable.

b) Location of scheme from main demand and generating centres

In order to prevent excessive transmission integration cost and transmission losses, it is important that a scheme is located in the vicinity of the generating centers and near the main national grid.

c) Water availability

Although a pumped storage scheme does not consume water (except for a small quantity lost to evaporation), the water source must be sufficient to allow initial filling within a reasonable time.

d) Head conditions

The higher the head, the less flow is required to generate the same power and the smaller the waterways and reservoir sizes. An operating head criterion between 400 m and 700 m was decided on.

e) Accessibility

The site must be reasonably accessible from existing infrastructure as access roads could contribute a substantial impact and cost to a scheme and should therefore be kept to a minimum.

A site was deemed to be suitable if it complied with criteria a) and b) and with any two of the remaining three criteria.

In parallel with these investigations, external consultants also identified several sites and these were assessed on the same basis as the sites identified by Eskom.

Within this process, the seven most promising sites were eventually selected, namely:

- Impendle KwaZulu-Natal
- Braamhoek KwaZulu-Natal
- Mutale Limpopo
- Steelpoort Mpumalanga
- Strijdom Mpumalanga
- Waayhoek KwaZulu-Natal
- Hogsback Eastern Cape (Identified by consultants)

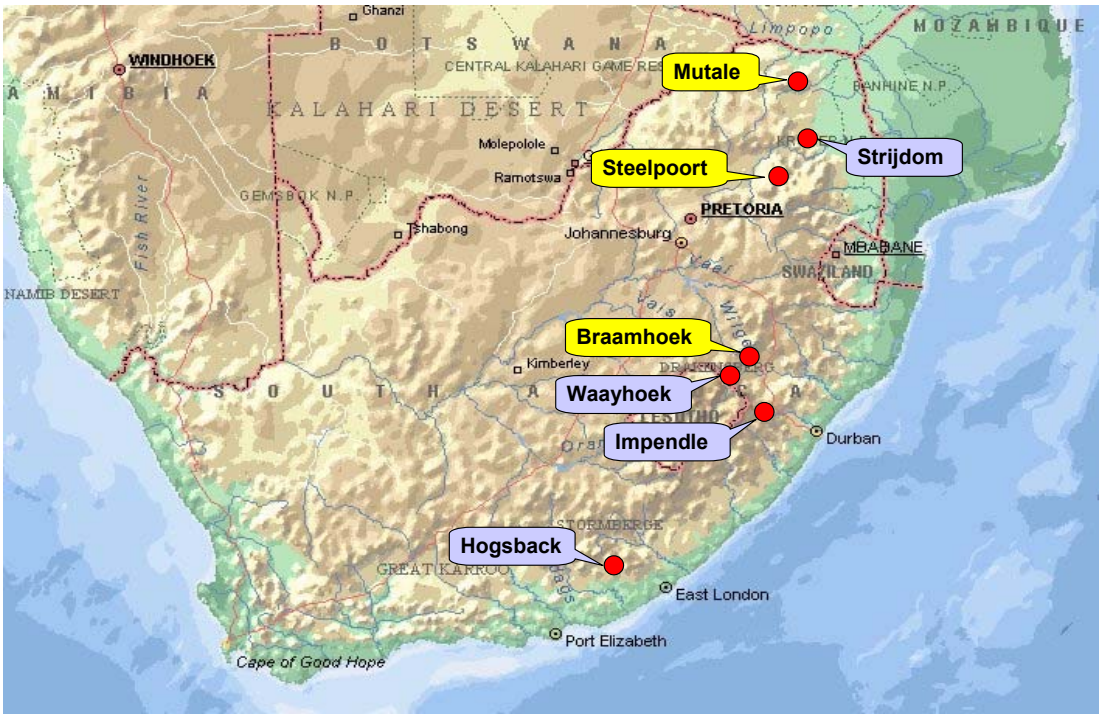

Figure 3.1: Location of the 7 most promising potential Pumped Storage Scheme sites

Pre-feasibility studies were successively conducted on these sites between 1987 and 1995 in accordance with the Level 3 requirements of the *"Framework of Investigations into Hydro-Electric Generation Projects"* formulated by the Multilateral Working Group and Water Development in Southern Africa.

These investigations included:

- Preliminary environmental assessments carried out by independent consultants.
- Preliminary design of the schemes.
- Hydrological analyses.
- Visual site inspections.
- Costing.

3.1.2. Final Site Selection

A comprehensive comparative study for the seven potential sites resulted in the following ranking:

Table 3.1: Comparative study for the seven potential sites for a Pumped Storage Scheme

Scheme	Water availability	Siltation risk	Environmental impact	Civil and geological aspects	Overall specific cost	Sum of rank	Final rank
Impendle	2,5	5	3,5	6	5	22	**5**
Braamhoek	**7**	**2,5**	**3,5**	**5**	**2**	**20**	**3**
Mutale	**6**	**2,5**	**5**	**2**	**3**	**18,5**	**2**
Steelpoort	**2,5**	**7**	**1**	**1**	**1**	**12,5**	**1**
Strijdom	2,5	6	7	3	4	22,5	**6**
Waayhoek	2,5	2,5	2	7	7	21	**4**
Hogsback	5	2,5	6	4	6	23,5	**7**

The three top ranked sites, namely Steelpoort, Mutale and Braamhoek, were identified for final feasibility studies, which commenced in 1998. These studies included the following:

- Environmental Impact Assessments (EIAs);
- Geotechnical investigations;
- Updating of scheme layouts;
- Costing; and
- Effect on electrical stability of the interconnected grid.

After extensive studies, it became apparent that the Mutale site was not suitable due to unfavourable geotechnical conditions. All further studies for that site were therefore terminated.

An environmental approval was obtained for the Steelpoort scheme in 2000 and for the Braamhoek scheme in 2002.

The Braamhoek scheme was selected to be developed first, for the following reasons:

- The extremely good dam sites allow more than double the energy storage capacity compared to the reservoirs at Steelpoort. This results in a much greater generating potential, a higher flexibility during operation and better backup to the national electricity grid during emergency conditions.
- Transmission integration is more favourable as it is located much closer to the national grid.

This EIA is being undertaken for a proposed pumped storage scheme in the Steelpoort area, Steelpoort being the second most feasible option for a pumped storage scheme from the above high-level studies.

3.2. 'Current Scheme'

A Feasibility Study of a pumped storage scheme was completed in November 2000 and a positive Record of Decision (RoD) was issued for the construction of a dam on the Steelpoort River, which would serve as the lower reservoir (in-channel). The upper reservoir would be created by damming a stream on the plateau. The machine hall and the vertical and horizontal waterways would be underground.

Subsequently, the Department of Water Affairs and Forestry (DWAF) embarked upon the Olifants River Water Resources Development Project (ORWRDP), the core element of which is a large dam to be constructed on the Steelpoort River, about 20km downstream of the site that was originally selected for the lower reservoir of the pumped storage scheme. Construction of the dam (provisionally referred to as the De Hoop Dam) was due to commence in 2006, but due to a number of appeals against the positive Record of Decision which had been issued for this project, commencement of construction has been delayed. The Minister of Environmental Affairs and Tourism, Minister Marthinus van Schalkwyk, has recently issued a final decision on the De Hoop Dam project, in which he acknowledged the validity of the appeals but stated that as there is no other feasible alternative for provision of water to the area, the dam is to go ahead. Though the dam has now been officially authorized, it is unclear when construction is to commence; however, it is expected that it will be completed before such time as water is needed for the pumped storage scheme which is planned for commissioning late 2014 (should positive authorization be issued by the relevant authorities). This offers the possibility of replacing the lower dam on the Steelpoort River with an off-channel lower reservoir, to be filled with water from the De Hoop Dam. This unlinks the location and layout of the pumped storage scheme from a lower reservoir on the river and provides greater freedom in selecting a possibly more advantageous site and layout.

The option of construction of the in-stream SPSS as per the existing RoD therefore still exists, but the option of construction an off-channel PSS is seen as more advantageous and to that end, this study explores various alternatives for construction of an off-channel PSS. **Hence the "current scheme" is no longer considered as an alternative.**

3.3. The 'Do Nothing' Alternative

The 'do-nothing' alternative is the option of not establishing a Pumped Storage Scheme in the Steelpoort area, Limpopo and Mpumalanga Provinces.

The electricity demand in South Africa is placing increasing pressure on Eskom's existing power generation capacity. South Africa is expected to require additional peaking capacity by 2007, and baseload capacity by 2010, depending on the average growth rate. This has put pressure on the existing installed capacity to be able to meet the energy demands into the future, particularly during peak electricity demand times. On the other hand, during off-peak times there is often a surplus of electricity within the grid and, as electricity cannot be stored, this surplus electricity is usually lost.

The 'do nothing' option will, therefore, result in peak-time electricity demands not being met in the short term. The 'do nothing' option would furthermore result in the continuation of surplus off-peak time electricity being lost.

The 'do-nothing' alternative is therefore not seen as a feasible alternative.

3.4. Location Alternatives for the Establishment of a Pumped Storage Facility

From the study of topographical maps and 1:10 000 orthophotos during the screening / site selection process conducted by BKS, various candidate sites were identified for the possible location of a pumped storage scheme. These were identified along the escarpment between the Steelpoort River valley and the Nebo Plateau, and through the comparison of primary variables (see below). The most promising sites were selected for more detailed investigation during the ESI, also conducted by BKS. Optional layouts at the respective sites were also investigated, though only to a pre-feasibility level of detail.

Primary variables used in the comparison of the identified candidate sites included the following:

- Upper and lower reservoir sites
- Vertical head
- Horizontal distance
- Topographic profile
- Existing developments, etc.

Based upon the screening / site selection study as described above, three alternative sites were selected as being potentially the most viable of all the candidate sites investigated at the pre-feasibility level. These three alternative sites were then investigated in more detail during the **ESI**, and a preferred alternative (site A3) was nominated from the three alternatives, based on a number of factors (see chapters 6 - 7). The three alternative sites are described in Section 3.4 below.

The **ESS** subsequently validated the ESI and additional specialist studies, which were felt by Bohlweki as EAP to be prudent, were also conducted – these studies and validation were conducted on all the alternatives that were also investigated during the ESI. The alternative sites were then evaluated by the EAP and the team of specialists in order to determine which site(s) would be most viable from an environmental (bio-physical and socio-economic) perspective.

3.5. Description of Site Alternatives Identified within the Steelpoort / Roossenekal area, Limpopo Province

The following sections (Sections 3.4.1 – 3.4.3) provide a broad overview of the various alternatives which were investigated, *viz.* Site A, Site B and Site C (Figure 2.1). Several scheme options were furthermore investigated within each of the three main alternative sites. The site alternatives are described in more detail in chapters 6 to 7, which contain the specialist findings from the ESI and weigh the site alternatives against each other in terms of a number of environmental (bio-physical and socio-economic) parameters.

3.5.1 Site A (Southern Site)

Site A includes the location of the current scheme (Alternative A1), i.e. the scheme with an existing positive RoD. This site has also been independently identified as a candidate site for a scheme with an off-channel lower reservoir. The site lends itself to in-channel and off-channel options for both the upper and lower reservoirs, with maximum heads in the range of 610 m to 660 m. The following scheme options were investigated within Site A:

- Option A1
  As primary benchmark, the current scheme was designated as Option A1. 10 hours' storage[1] (equal to 10 000 MWh storage) is possible with this option.

- Option A2
  Option A2 is similar to Option A1, but with an off-channel upper reservoir.

- Option A3
  Option A3 makes use of the same upper reservoir as Option A2, but with an off-channel lower reservoir.

- Option A4
  Option A4 is similar to Option A3, but with 20 hours' (20 000 MWh) storage.

[1] Continuous generating potential / supply of electricity (in hours) when the upper reservoir is full. In this case generation of electricity can continue for 10 hours at a time when water is released from the top reservoir (when the upper reservoir is full full and all the turbines are in use) to the bottom reservoir."

3.5.2. Site B (Middle Site, Potential High Head)

Site B has one preferred location for an upper reservoir, with different potential locations for the lower reservoir. Maximum heads are in the range of 780 m to 880 m. The following options were investigated within Site B:

- Option B1
  Option B1 is the highest head option, with 10 hours' storage.

- Option B2
  Option B2 is similar to Option B1, but makes provision for 20 hours' storage.

- Option B3 and B4
  Option B3 and B4 represent a more favourable location of the lower reservoir with relation to the Steelpoort Fault. Option B3 makes provision for 10 hours' storage, whilst Option B4 has 20 hours' storage capacity.

- Option B5 and B6
  Option B5 and B6 represent a lower pumping head, but is influenced by the Steelpoort Fault. Option B5 can provide 10 hours' storage and Option B6 20 hours.

- Option B7 and B8
  Options B7 and B8 have a lower pumping head and are clear of the Steelpoort Fault. Option B7 has 10 hours' storage capacity, with Option b8 having 20 hours' storage capacity.

3.5.3. Site C (Northern Site)

Site C is situated opposite the western shore of the reservoir to be created by the De Hoop Dam, should this Dam be constructed. The De Hoop Dam would serve the common purpose as lower reservoir for the Pumped Storage Scheme. Maximum heads are in the range of 580 m to 630 m. The following options were investigated within Site C:

- Option C1
  In terms of Option C1, the De Hoop Dam would provide the lower reservoir, with a separate off-channel upper reservoir. 10 and 20 hours' storage can be provided.

- Option C2
  Option C2 is similar to Option C1, but with an alternative upper reservoir for 20 hours' storage.

The alternative sites described above were evaluated in terms of social, biophysical, technical and economic criteria during the **ESI** in order to determine the most viable site in terms of their potential impact on the surrounding environment. Subsequent to the ESI, an **ESS** was independently conducted, in which the findings of the ESI were validated and additional studies were conducted. The nomination of a preferred site to be taken through into the EIA phase for detailed investigation will take place in this **ESS** report.

3.6. Description of Road Alternatives Identified within the Steelpoort / Roossenekal area, Limpopo Province

The selection of preferred road alternatives will be informed by the following criteria:

- Environmental acceptability (biophysical and socio-economic);
- Cost of construction; and
- Travel time (response time).

Both existing and new access roads will be used or constructed to link the proposed power station with the transport network. Details regarding the roads and route alignments or corridors are not available at this stage of the process but will be designed at a later stage and used to inform the EIA-phase studies. Hence the associated environmental impacts will be assessed in detail in the EIA Phase of this process – these impacts will be assessed in respect to aspects such as traffic, noise, air quality, impacts on fauna and flora, etc.

Apart from the access roads, there would be internal roads constructed within the power station precinct to afford access to the various buildings and structures. The impact of the proposed power station and associated infrastructure on local traffic conditions will be the subject of specialist studies in the EIA Phase.

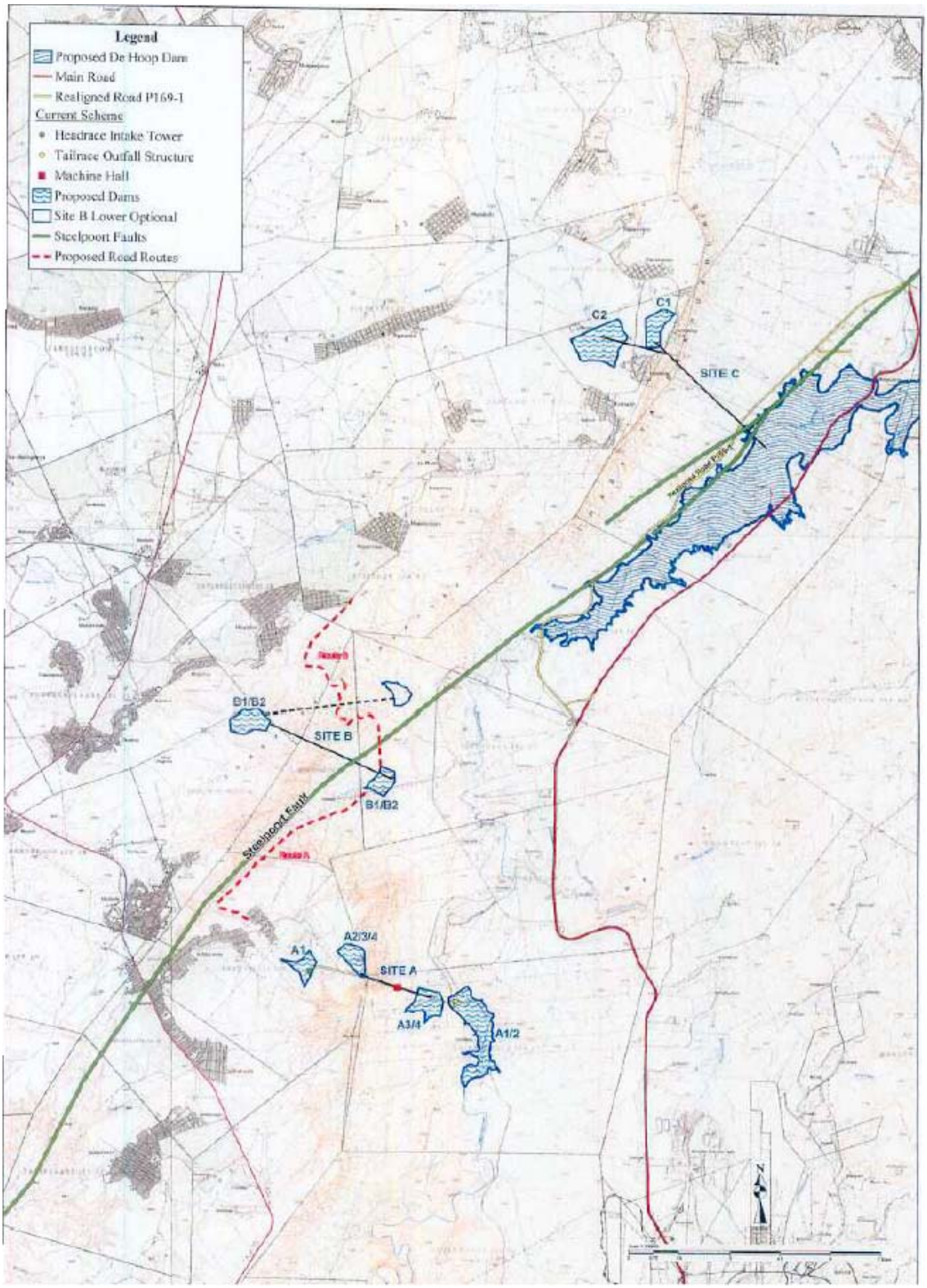

Figure 3.1: A map indicating the locality of the three alternative sites as well as the various options at each site.