DESCRIPTION OF THE PROPOSED PROJECT CHAPTER 2

Electricity cannot be stored and must therefore be generated and delivered over long distances at the very instant it is needed. In South Africa, thousands of kilometres of high voltage transmission power lines transmit power, mainly from the power stations located in the Mpumalanga coal fields to major substations, where the voltage is reduced for distribution to industry, businesses, homes and farms all over the country.

If Eskom Transmission is to honour its mandate and commitment to meet the increasing needs of end-users, it has to establish and expand its infrastructure of transmission power lines and substations on an ongoing basis. Due to substantial annual load growth, load shifts and step loads in the recent past, it has become necessary to reinforce the existing electrical infrastructure through the establishment of new electricity generation and transmission capacity.

Eskom is the primary supplier of electricity in South Africa and supplies power in bulk to most towns and cities, the municipalities of which sell it to households, industrialists and other end-users within their areas of jurisdiction. Eskom also sells bulk electricity directly to end-users in some parts of South Africa. Eskom has a mandate to satisfy potential customer needs, which implies certain responsibilities. One of the most significant of these is to find and maintain the balance between satisfying the needs of society and remaining within the capabilities of the environment. In order to achieve this Eskom must continually re-assess the projected demand for electricity[1] in relation to its present infrastructure, and take into account new developments to ensure that there is a continued supply of electricity, without significantly impacting on the environment.

As part of its capacity expansion and grid strengthening programme, Eskom Transmission is proposing the **Tshwane Strengthening Project Phase 1**. The Tshwane Strengthening Project Phase 1 is proposed to include the following:

» Extension or upgrade of the existing Verwoerdburg Substation.
» Construction of 2x 400 kV loop-in lines from Apollo – Pluto transmission lines to feed into the Verwoerdburg Substation, a distance of approximately 4 km.
» Construction of 400 kV loop-in lines to feed into the Phoebus Substation from the existing Apollo-Dinaledi transmission power line, a distance of approximately 1 km.
» Construction of a new 400kV transmission power line between the Phoebus Substation and the Kwagga Substation, a distance of ~30 km.

[1] This is undertaken through the Integrated Strategic Electricity Planning (ISEP) process

» Extension of the existing Kwagga Substation.
» Establishment of the new Phoebus substation adjacent to existing Hangklip substation

In total, approximately **36 km** of new power line is proposed as part of this project. The purpose of the proposed project is to:

» Improve the reliability of the existing Central Transmission network; and
» Improve the voltage regulation on the Central Grid Distribution and Tshwane Metropolitan Municipality network.
» Create additional Transmission network capacity which will supply the increasing electricity demand in the Central Grid.

As indicated in chapter 1 of this report, the purpose of this Draft Scoping Report is to describe and discuss impacts associated with Kwagga - Phoebus 400 kV transmission power line and establishment of Phoebus substation as well as the extension of Kwagga substation components of the Tshwane Strengthening Project Phase 1.

» The background to the selection of reasonable and feasible alternatives for the proposed **Kwagga-Phoebus 400kV transmission power line**, including a 275 kV feeder bay, and **establishment of Phoebus substation and extension of Kwagga substation** as well as potential environmental impacts associated with its construction, operation and decommissioning was **evaluated in this Draft Scoping Report** (Reference Numbers **12/12/20/1471** and **12/12/20/1524)**.

2.1. The Need and Justification for the Proposed 400 kV Transmission Power Lines

The current Eskom transmission network supplies the City of Tshwane Metropolitan Municipality (CTMM) via three substations, namely: Kwagga, Njala and Verwoerdburg. The contracted reserve capacity at each point is reviewed annually.

CTMM has applied for new supply points and a step load increase to Eskom Transmission and Distribution. The three parties (Distribution, Transmission and the City of Tshwane Metropolitan Municipality agreed on the 20-year load forecast for the CTMM and also concluded that the CTMM and the Eskom transmission networks supplying Tshwane need to be strengthened. A number of options were analysed based on technical and economical benefits to all parties involved.

The proposed solution, which is known as the **City of Tshwane Electricity Supply Plan Scheme** proposed to construct four new substations in the Tshwane area. Three are proposed to be constructed by Eskom and one is proposed to be constructed by the CTMM. These four substations are: Eskom: **Phoebus** substation; Eskom: **Verwoerdburg** substation; Eskom: **Anderson** substation and Tshwane: **Wildebeest** substation. The proposed solution will meet the CTMM's electricity requirement and is the most economical option. The solution will also de-load the heavily loaded Minerva- and Apollo substations.

Eskom Transmission has taken measures to get the most out of the existing Transmission system so that the construction of the new lines will occur only when needed. These measures included:

» Comprehensive checks on the existing lines to ensure that they are within the legal clearance for overhead lines. Lines sag when placed under heavy load conditions, due to heating of the conductors.
» Installation of new infrastructure.
» The best reinforcement options are selected to ensure that an optimised mix of cost, technical benefit and environmental impact was achieved.

As all options for optimisation of the existing infrastructure have already been studied and implemented, new transmission power lines will be required to be constructed. The new transmission lines will be brought into operation at the time when the load growth and demand exceeds the supply, i.e. by 2012. It is therefore necessary to secure the necessary servitudes timeously, to ensure this will be possible.

A definite two-fold need for new transmission power lines has therefore been identified:

» To optimise the existing system; and
» To increase line capacity in the Transmission system.

By increasing the supply into the Transmission system, the foreseen load growth can be addressed in a suitable and economical way. Optimisation of the current system is currently underway, and would alleviate some problems in the system. The medium-to long-term load requirements can be addressed by the increased supply due to the new transmission power lines.

2.2. Alternatives for Satisfying the Additional Power Need

The following alternatives for satisfying the two-fold need for additional electrical supply to the Transmission system and optimising the existing infrastructure were investigated by Eskom Transmission:

2.2.1. The Do Nothing Option (No-Go Option)

The do nothing option would be the option of not upgrading the existing substations as well as not constructing any new transmission power lines. By not taking any action, Eskom Transmission may end with a situation of not being able to ensure firm supply into some parts of the country in the very near future. This would eventually lead to load shedding which can cause major disruptions of power supply to different areas at different times. This can have a significant impact on the economy of the country, as no real economic growth would be able to take place without additional electricity supply. This option will therefore not be evaluated further in the EIA phase because it would neither supply the projected demand for electricity nor optimise the existing infrastructure.

2.2.2. Demand Side Management

Demand Side Management (DSM) can generally be defined as the activities performed by the electricity supply utility, which are designed to produce the desired changes in the load shape through influencing customer usage of electricity and to reduce overall demand by more efficient use.

2.2.3. Upgrade Existing Transmission Lines by using Bigger Conductors

The upgrade of existing transmission lines by using bigger conductors would result in the physical load on the existing towers increasing substantially. The existing towers would be inadequate to support this physical load. Furthermore, it would not be possible to remove one transmission power line from service to perform the upgrading work, as the remaining supply lines would not be able to supply the electrical loads in the Transmission system. The power transmission from the Apollo substation would not be able to be evacuated to the load centres without causing dynamic instability in the Eskom network which could result in black-outs. This option would not improve the reliability of the Transmission system nor be sustainable.

2.2.4. Construct New 400kV Transmission Power Lines between Kwagga and Phoebus Substation

The alternative is part of the new generation and transmission capacity alternatives. The need for increased capacity and the need for optimising existing infrastructure would be met through the implementation of this option. The advantages associated with this option are as follows:

» It overcomes the line overloading problems.
» It will create a more flexible network, since it forms an interconnection between the loads fed from Apollo substation and the proposed new Phoebus substation. This will improve the overall reliability of the Transmission system, which will be of benefit to both Eskom and to all electricity users within the area.
» It will improve the angular stability of the Tshwane generation pool.

Due to current land use and development in the country, very limited open corridors remain that could be utilised to install major Transmission power lines. New routes must, however be secured to ensure servitudes for the expansion of the network and to be able to meet the forecast increase in demand. Therefore, Eskom are proposing the upgrade of the Kwagga substation and the Kwagga – Phoebus 400 kV transmission power lines at Verwoerdburg substation.

The need for increased capacity and optimising existing infrastructure will be met through the implementation of this option, and is therefore thus regarded as the most feasible option by Eskom Transmission.

2.2.5. Establishment of the Phoebus substation and extension of the Kwagga substation

The alternative is part of the new generation capacity alternatives. The need for increased capacity and the need for optimising existing infrastructure would be met through the implementation of this option. The advantages associated with this option are as follows:

» It overcomes overloading problems.
» It creates a more flexible network, since it forms an interconnection between the loads fed from Apollo substation and the proposed new Phoebus substation. This will improve the overall reliability of the Transmission system, which will be of benefit to both Eskom and to all electricity users within the area.
» It will improve the angular stability of the Tshwane generation pool.

The area under investigation is already characterised by infrastructure of a similar nature, i.e. the existing Hangklip and Kwagga substations and a number of high voltage transmission power lines. It is therefore, at this stage, not foreseen that additions to the Kwagga substation or the construction and operation of the new Phoebus substation adjacent to the Hangklip substation would yield significant negative impacts to the surrounding environment.

2.3. Identification and Description of Alternative Transmission Power Line Development Corridors

From the analysis of the various alternatives to satisfy the need for additional power transmission capacity, Eskom Transmission determined that the construction of new substation and 400 kV transmission power lines as Tshwane Strengthening Project was the most feasible and cost-effective solution in order to meet the CTMM electricity requirement. This solution will also de-load the heavily loaded Minerva- and Apollo substations. The proposed project involves the following:

» Construction of a **400 kV** line from Phoebus to Kwagga Substation (a distance of approximately 30 km).
» Establishment of a **new Phoebus substation** adjacent to the existing Hangklip Substation and the **extension of Kwagga substation** including the loop-in and out to Apollo-Dinaledi from Phoebus substation.
» **Associated infrastructure works** to integrate the new transmission lines into the Transmission grid (such as access roads, bus bar, etc).

Technical Requirements for corridor selection

The width of all the three alternative corridors will be 1 km and the study area for individual corridors is 10 km wide. The following technical requirements were considered in the identification of feasible corridors for the establishment of the required transmission power lines:

» As far as possible, the servitude lengths between power supply and load points should be minimised
» As far as possible, the number and magnitude of angles along the line should be minimised in order to allow the use of less expensive and visually less-intrusive tower types
» Crossing over of existing major power lines should be avoided as far as possible, as this increases the potential for technical incidents during operation

» The alignment should cater for known topographical/terrain constraints of the tower types to be used, and soil conditions for the foundations in terms of geotechnical suitability and costs
» The proposed alignment should provide the need of appropriate access roads to the servitude and tower positions during construction and maintenance/ operation phases
» Care should be taken to avoid the following as far as tower positioning and access road construction are concerned:
  * extensive rock outcrops;
  * rugged terrain, hills and mountains;
  * active clay soil, vleis and floodplains;
  * potential unstable side-slope terrain; and
  * eroded and unstable areas.
» Other issues which technically affect the location of a transmission power line include:
  * agricultural lands, in particular those under irrigation;
  * large water bodies;
  * open-cast mining;
  * crossing points with roads, rail and telecommunication lines at off-set angles less than 60°.
» The following obvious and observable environmental issues should be taken into account:
  * human settlements and communities;
  * land use (where possible);
  * passing between water bodies (bird flight paths usually extend between water bodies);
  * ecologically sensitive areas;
  * scenic areas with high visual/aesthetic quality; and
  * un-transformed indigenous vegetation.

Technically feasible alternative transmission power line routes have been identified for investigation within the EIA process (refer to Figure 2.1 and 2.2). These alternative power line alternatives are described in further detail below.

2.3.1. Kwagga- Phoebus Transmission Line Alternatives

Alternative Route 1 (Kwagga - Phoebus) heads southwest from Hangklip Substation for approximately 6.5 km crossing the N4 highway, then heads southeast for approximately 8 km running into Kwagga Substation for 3 km in a southerly direction, while the northern section of this route passes between informal settlements. It then crosses the Magaliesburg Protected Environment 7 km north of the Kwagga Substation, which is negative from a biodiversity perspective, as it is a relatively undisturbed area with un-spoilt vegetation, and may serve as a flight path for raptors along the ridge.

Alternative Route 2 (Kwagga - Phoebus) Splits off from alternative 1 approximately 4 km southwest of the proposed Phoebus Substation. It makes an easterly loop and joins back onto alternative 1 just south of the R566 Road. This route also follows a stream for the majority of the route (wetland type area), which is negative for Fauna and Flora as certain species may occur here.

Alternative Route 3 (Kwagga - Phoebus) Splits off from alternative 1 just south of the Brits Road before making an easterly loop and joins back onto alternative 1 just southwest of the M17 Road. From here it crosses the Witwatersberg ridge and agricultural land, which is negative for avifauna as it may serve as a flight path for raptors along the Witwatersberg ridge.

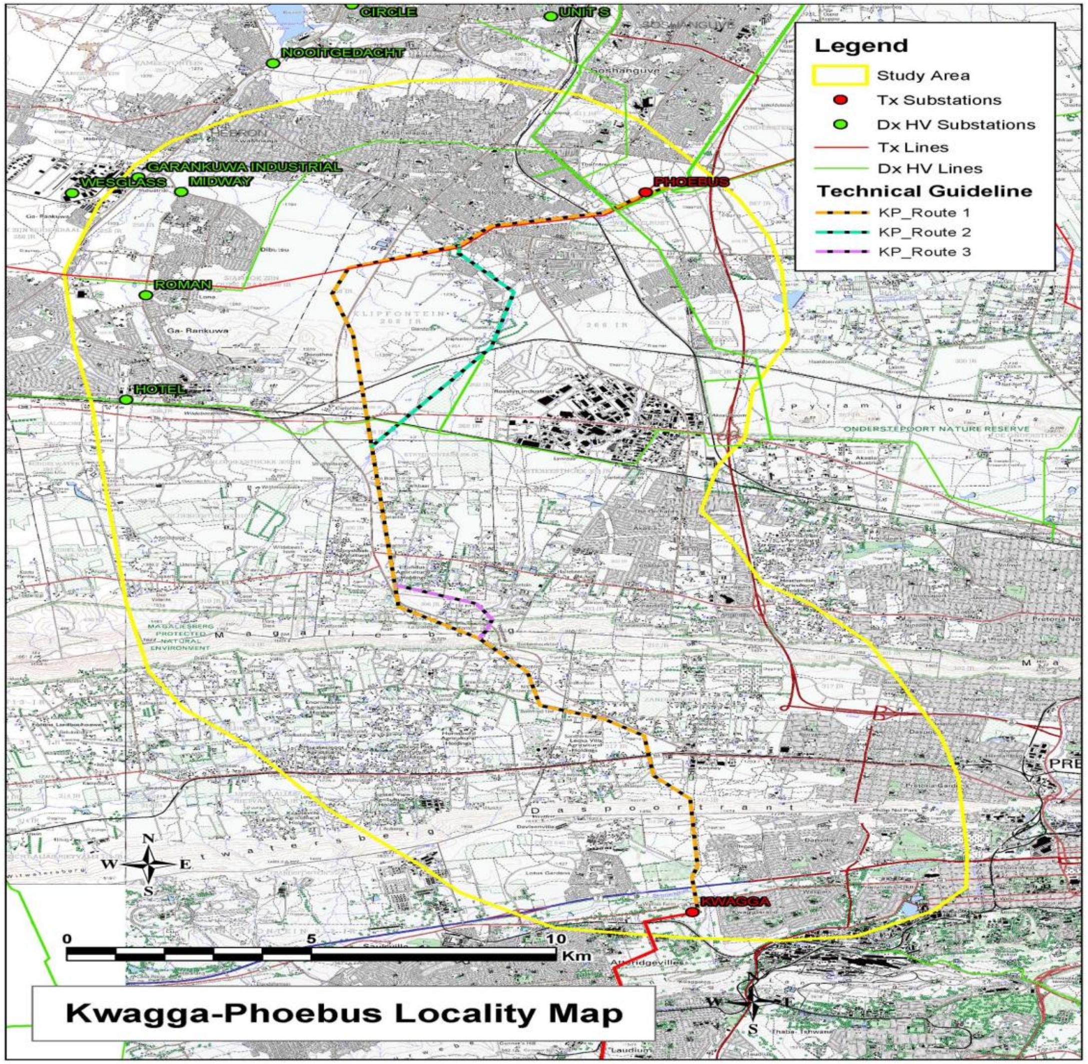

Figure 2.1: Map showing the alternative Kwagga-Phoebus transmission line routes identified for consideration in the EIA process

These alternative transmission line route alternatives are described and discussed within this Scoping Report in Chapter 5.

2.4. Construction Phase

The typical Eskom Transmission power lines are constructed in the following simplified sequence:

Step 1: Determination of technically feasible alternatives
Step 2: EIA input into route selection
Step 3: Negotiation of final route with affected landowners
Step 4: Survey of the route (by air)
Step 5: Determination of the conductor type
Step 6: Selection of best-suited conductor, towers, insulators, foundations
Step 7: Final design of line and placement of towers (including final walk-though survey by environmental specialists and compilation of site-specific Environmental Management Plan (EMP)).
Step 8: Issuing of tenders and award of contract to construction companies
Step 9: Vegetation clearance and construction of access roads (where required)
Step 10: Tower pegging
Step 11: Construction of foundations
Step 12: Assembly and erection of towers
Step 13: Stringing of conductors
Step 14: Rehabilitation of disturbed area and protection of erosion sensitive areas
Step 15: Testing and commissioning

Construction of the lines proposed as part of the Tshwane Strengthening Project will take approximately 24 months to complete. Construction of these lines is anticipated to begin in 2011. Construction crews for construction of the transmission power lines will constitute mainly skilled and semi-skilled workers. Construction camps can be located within the construction area only in consultation and agreement with the landowner. It is generally preferred that the construction camps be in close proximity to the construction site.

2.5. Servitude Negotiation and the EIA Process

Transmission power lines are constructed and operated within a servitude (55 m wide for 400 kV lines) that is established along the entire length of the power line. Within this servitude, Eskom Transmission has certain rights and controls that support the safe and effective operation of the power line. The process of achieving the servitude agreement is referred to as the Servitude Negotiation Process, or simply just the Negotiation process. The following important points relating to the negotiation process should be noted:

- » Servitude negotiation is a private matter between Eskom Transmission and the appropriate landowner
- » The negotiation process involves a number of stages (see below), and culminates in the 'signing' of a servitude. Here Eskom Transmission enters into a legal agreement with the landowner
- » The servitude is registered as a 'right of way', and Eskom do not purchase the servitude from the landowner. Compensation measures are agreed in each case
- » The agreements will detail such aspects as the exact location and extent of the servitude, and access arrangements and maintenance responsibilities, as well as any specific landowner requirements
- » The negotiation process may take place at any time in the planning of a new power line
- » This process must be completed (i.e. the agreement must be signed) with the relevant landowner before construction starts on that property
- » The negotiation process is undertaken directly by Eskom Transmission and is independent of the EIA process. It is important that the aims of the two processes are seen as separate

The EIA process has become important in the initial planning and route selection of new transmission lines. For this reason, it is usually preferable that the negotiation process begins after the EIA has been completed. At this stage there is greater confidence in the route to be adopted, and it would be supported by Environmental Authorisation. However, it may be required that the negotiation process begins earlier, and may begin before, or run in parallel with the EIA process. This may be due to urgent timeframes for the commissioning of the new power line, knowledge of local conditions and constraints, etc.

2.5.1. The Negotiation Process

Eskom Transmission is responsible for the negotiation process for all new transmission power lines. It is critical that the process is correctly programmed and incorporated into the planning of a new line.

i. the establishment, rehabilitation and maintenance of the servitude, and will be site-specific (as different landowners may have different requirements). Compensation payments would be made when the servitude is registered at the Deeds Office[2].

ii. Once the clearance certificate is signed, the responsibility for the power line and servitude is handed over to the regional Eskom Transmission office.

[2] Compensation will be based on present day property valuations for all properties obtained from registered evaluators. Eskom only pays compensation for the strip of land that is affected at 100% of present day property value. In cases where properties are significantly affected, Eskom may consider purchasing the whole property at present day market value. All improvements will be valued. Sentimental value is not considered in any valuations as it is not measurable. Valuations are done according to the Expropriation Act.

2.3.4. Technical Details of Tower and Transmission Line Designs

All components of a Transmission line are interdependent, but are distinct in the roles which they fulfil. The primary components include towers, foundations, insulators and hardware, and conductors.

» *Towers*

Transmission line conductors are strung on in-line suspension towers and bend (strain) towers. Although the power line structure typology has not yet been decided for this project, typical structures used for the majority of the proposed transmission line are the 400kV compact cross-rope suspension structures (refer to Photograph 2.1). These towers are approximately ~35 m in height and a total footprint area of 55 m is required for each tower, depending on the tower design. These towers are supported by stays or guys in order to stabilise the steel members of the towers.

Photograph 2.1: Compact Cross-rope suspension tower typically used along the existing Dinaledi-Anderson 400kV transmission power line route towards Magaliesburg Protected Area

The compact cross-rope suspension tower is typically used along the straight section of the servitude, while the self-supporting angle towers are used where there is a bend in the power line alignment. Angle towers are cumbersome and more steel-intensive than suspension towers, making them more visually intrusive and expensive to construct being more time- and labour intensive. These towers have small footprints (i.e. occupy small areas of land), and are approximately 35 m in height, on average. The average distance between towers is required to be approximately 300 m. All strain towers (used on a "bend") are generally of this type.

» *Servitude Requirements*

Where 400 kV transmission line is constructed in parallel, a minimum separation distance of 50 m is required in order to ensure the reliable operation of both lines, i.e. a total footprint of each tower will be 80 m x 50 m. The servitude width for a 400 kV transmission line is 55 m. The servitude is required to ensure the safe construction, maintenance and operation of the line, and thereby entitles Eskom Transmission Division certain rights (e.g. unrestricted access).

The minimum vertical clearance to buildings, poles and structures not forming part of the power line must be 5.6 m, while the minimum vertical clearance between the conductors and the ground is 15 m. Farming activities can be practised under the power line, providing that safe working clearances and building restrictions are adhered to under all circumstances.

The minimum distance of a 400 kV transmission line structure from a proclaimed public roads is between 30 m and 90 m from the centre line of the road (according to the road type), from the centre of the structure to the centre of the road servitude. The minimum distance between any part of a tree or shrub and any bare phase conductor of a 400 kV transmission line must be 5.6 m. However, it is important to note that Eskom does not allow trees within their servitudes.

On receipt of an Environmental Authorisation of the final power line route alternative from the environmental authorities and after negotiations with landowners, the final definition of the centre line for the transmission line and co-ordinates of each bend in the line will be determined by the surveyors.

A 4-8 m wide strip is generally required to be cleared of all trees and shrubs down the centre of transmission power line servitude for stringing purposes only. Any tree or shrub in other areas which will interfere with the operation and/or reliability of the Transmission line must be trimmed or completely cleared. The clearing of vegetation will take place, with the aid of an Environmental Control Officer (ECO) along approved profiles and in accordance with the approved EMP, and in accordance with the minimum standards to be used for vegetation clearing for the construction of the proposed new transmission line.

Once the centre line has been cleared, the contractor's surveyor will peg every tower position and marks the crossing point with existing fences for new gate installation. Where required, once the tower positions have been marked, the vegetation clearing team will return to every tower position and clear vegetation (in accordance with the specification outlined in the Environmental Management Plan (EMP) for assembling and erection purposes.

» *Foundations*

The choice of foundation is influenced by the type of terrain encountered, as well as the underlying geotechnical conditions. Geotechnical requirements for all tower types are catered for by using various foundation types, which are designed to withstand conditions varying from hard rock to waterlogged marshes. The main types of foundations include piles, pad-and-chimney, and rock anchors. The actual size and type of foundation to be installed will depend on the type of tower to be erected, and the actual sub-soil conditions. Strain towers require more extensive foundations for support than in-line suspension towers, which contribute to the construction expenses.

The construction of foundations is the slowest part of the line construction, and is typically started some time ahead of tower erection. Prior to filling of the foundations and tower erection, excavated foundations are covered or fenced in, in order to safe-guard unsuspecting animals and people from injury. The foundations also represent the biggest unknown in the cost and construction time, since access to the tower sites is required for earth-moving machinery and concrete. All foundation excavations are back-filled, stabilised through compaction, and rehabilitated at ground level.

» *Insulators and Hardware*

The insulators and hardware are used to connect the conductors to the towers. The main types are glass, porcelain, and composite insulators.

Glass and porcelain have been used for many years, and are the most common. They are, however, heavy and susceptible to breakage by vandals, as well as contamination by pollution. Composite insulators have a glass-fibre core with silicon sheds for insulation. The composite insulators are light-weight and resistant to both vandalism and pollution. They are, however, more expensive than the more common glass insulators.

» *Conductors*

The conductors are made of aluminium with a steel core for strength. Power transfer is determined by the area of aluminium in the conductors. Conductors are used singularly, in pairs, or in bundles of three, four or six. The choice is determined by factors such as audible noise, corona, and electro-magnetic field mitigation.

Many sizes of conductor are available, the choice being based on the initial and life-cycle costs of different combinations of size and bundles, as well as the required load to be transmitted.

2.4. Project Operation Phase

The expected lifespan of the proposed transmission power line is between 35 and 40 years, depending on the maintenance undertaken on the power line structures.

During the life-span of the transmission power line, on-going maintenance is performed. Power line inspections are undertaken on an average of 1 – 2 times per year, depending on the area. During this maintenance period, the power line is accessed via the access routes, as agreed with affected landowners during the negotiation phase. Maintenance of the power line is required to be undertaken in accordance with the specifications of the Environmental Management Plan (EMP) which is to form part of the EIA Report.

The creation of additional employment opportunities during the operational phase of the power line will be limited, and will be restricted to skilled maintenance personnel employed by Eskom.

2.4.1. Servitude Maintenance Responsibilities

The management of transmission power line servitude is dependent on the details and conditions of the agreement between the landowner and Eskom Transmission, and are therefore site-specific. These may, therefore, vary from one location to another. However, it is a common occurrence that there is a dual responsibility for the maintenance of the servitude:

» Eskom Transmission will be responsible for the tower structures, maintenance of access roads, watercourse crossings, and gates and fences relating to servitude access.

» The landowner will retain responsibility for the maintenance of the land and land use within the servitude (e.g. cropping activities, veld management, etc.).

Exceptions to the above may arise where, for example dual use is made of the access roads and gates or specific land use limitations are set by Eskom Transmission within the servitude which directly affects the landowner (e.g. forestry). Maintenance responsibilities are, ultimately, clearly set out in the servitude agreement.