7 PROJECT ALTERNATIVES

7.1 Introduction

In terms of the NEMA EIA Regulations published in Government Notice R543 of 2 August 2010 in terms of Section 24 of the National Environmental Management Act (Act No. 107 of 1998), feasible and reasonable alternatives have to be considered within the Environmental Scoping Study, including the 'No Go' option. All identified, feasible and reasonable alternatives are required to be identified in terms of social, biophysical, economic and technical factors.

A key challenge of the EIA process is the consideration of alternatives[1]. 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 usually assessed at a strategic level, and EIA practitioners recognise the limitations of project-specific EIAs to address fundamentally different alternatives.

7.2 The 'no go' alternative

The 'no go' alternative is the option of not proceeding with the continuous ashing project at Majuba Power Station.

Eskom's core business is the generation, transmission and distribution of electricity throughout South Africa. Electricity by its nature cannot be stored and must be used as it is generated. Therefore electricity is generated according to supply-demand requirements. The reliable provision of electricity by Eskom is critical to industrial development and poverty alleviation in the country.

Ideally, Majuba Power Station, envisages the continuation of dry ash disposal for the remainder of its life. Prior to the promulgation of Environmental laws such as the Environment Conservation Act, Eskom purchased a portion of land which they envisaged for the disposal of ash for the life of the Station (at that stage 45 years). As part of its planning processes, Eskom developed designs which were approved internally. With the promulgation of the environmental laws such as the National Environmental Management

[1] In terms of the EIA Regulations published in Government Notice R543 of 2 August 2010 in terms of Section 24 (5) of the National Environmental Management Act (Act No. 107 of 1998), the definition of "alternatives" in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity which may include alternatives to: (a) the property on which or location where it is proposed to undertake the activity; (b) the type of activity to be undertaken; (c) the design or layout of the activity; (d) the technology to be used in the activity; (e) the operational aspects of the activity and (f) the option of not implementing the activity.

Waste Act, Act 59 of 2008, in particular, Eskom would like to pro-actively align its continued ashing activities with the requirements of the waste licensing processes.

The need for this project is to allow the Majuba Power Station to continue ashing in an environmentally responsible and legally compliant manner for the duration of the remaining operating life of the power station.

In the event that the continuous ashing project does not proceed the power station will run out of land to legally dispose of its ash and the power station will ultimately be required to close down, which would contribute negatively to the provision of reliable base load power to the national grid.

Even though the 'no-go' alternative is considered to be unfeasible, it will still be investigated further in the EIA phase as an alternative as required by the EIA Regulations.

7.3 Technical Alternatives

The coal-fired power generation process results in large quantities of ash, which is disposed of at ash disposal facilities. Generally, Eskom has access to coal of a low grade (called middlings coal) which produces a larger mass of ash during combustion. Over time, the quality of the coal provided to Eskom has degraded, due to higher ash quantities in the coal. The Majuba Power Station utilises a dry ashing disposal method. This process involves ash being disposed of on an ash disposal facility by means of a stacker (**Figure 7.1**).

Figure 7.1: Stacker being used to dispose of ash at the Majuba Power Station

Due to the fact that Majuba Power Station utilises a dry ashing disposal method, it stands to reason that in order to continue ashing a dry ashing method should still be utilised.

In terms of alternative disposal options, the option of disposing of dry ash into old mine pits was identified. An old mine is located approximately 12km from the power station, however, the mine workings are underground and no open cast pit is available. Eskom has previously undertaken feasibility studies to compare the environmental risks associated with in-pit ashing and conventional ashing (i.e. dry ash disposal). Although the feasibility studies were undertaken in August 2007, specifically looking at ashing options for the Medupi Power Station in the Limpopo Province, it is felt that some of the conclusions made are still relevant to the Majuba situation. These risks are included in **Table 7.1**.

Table 7.1: Comparative Analysis on Risks (without mitigation) between in-pit and Conventional Ashing

Risk	In-Pit Option	Above-ground Ashing
Seepage	Seepage and groundwater contamination will occur	Operation is undertaken above the water table. New Legislation requires ash disposal facilities to be lined, therefore low risk of seepage and groundwater contamination
Groundwater inflow	There will be a greater groundwater in-flow into the pit area, but the water table will remain below the ash layer	No groundwater inflow would be expected into the ashing facility
Uncertainty around Life Cycle Costs	There is great uncertainty around the life cycle costing for in-pit options and in the Majuba situation; no studies have been done looking at disposal in underground workings	There is a greater degree of certainty in terms of what the life cycle costs are for conventional ashing systems – capex and opex on these systems are well know to Eskom
Level of confidence in forecasted life cycle costs	Low level of confidence due to the many uncertainties	High level of confidence due to knowledge of capex and opex
Requirement for temporary ashing solution	Temporary ashing solutions may be required during negotiations etc.	No need for a temporary solutions as the area is available immediately
Contractual complexities	Due to the nature of the operation, there would be many and significant contractual complexities	One owner-operator, hence no contractual complexities
Reliability and availability of the facility	Due to the complex nature of the operation, there is a higher degree of uncertainty around the level of plant reliability /availability	Operations and operating regimes are known and hence a high degree of certainty around plant reliability /availability
Legal Framework	Mining areas are required to adhere to additional legislation such as the Mine Health and Safety Act, making the situation legally complex	Eskom is well aware of the legal requirements and have systems in place to ensure continued compliance
Realisation of benefits for power plant water management practices	No benefits from a power plant water management perspective – the in-pit ashing option cannot assist with power plant water	Huge benefits for power plant water management – it assists Eskom in achieving its Zero Liquid Effluent Discharge (ZLED)

	management	philosophy, in that conventional ash disposal facilities act as effluent sinks
Ease of rehabilitation after closure	The costs and risks associated are unknown and there may also be uncertainties in terms of who is responsible	Rehabilitation practises for conventional ashing are well known and entrenched in Eskom and extensive research has been done on it
Clarity on liability	Low confidence in terms of clarity on liability and therefore uncertainties from a cost and legal perspective	One single party involved – hence there is absolute clarity on what the liabilities are and how to make provision therefore
Future ash utilisation	Low potential for future ash utilisation once disposed of into the mine	Potential for future ash utilisation – research is ongoing and the ash would be "readily" available for this purpose

Taking the above comparative analysis into account, the use of old mine pits / underground working is still considered unfeasible at this stage due to the numerous uncertainties and low confidence in terms of the clarity with regards to ultimate liability. This alternative is therefore not considered suitable for further investigation.

A further technical alternative to limit the need for ash disposal facilities includes the use of higher grade coal which may reduce the amount of ash produced in the power generation process. The power station was originally designed for 45 years and since, its life time has been extended to 60 years due to the increasing demand for electricity. The boilers are designed to use a specific grade of coal and the boiler plant would require a redesign for higher grade coal. In order for this alternative to be implemented would require the complete redesign and reconstruction of the power station. The combination of the costs involved in the reconstruction of the power station as well as the higher price of the higher grade coal would have a knock-on effect in terms of the country's electricity prices. In addition to this shutting down one power station is detrimental to the continued supply of electricity to the country. Therefore, this alternative is not considered feasible.

The only Ash Disposal alternative that has been identified to be feasible for the continuation of power generation at the Majuba power station is the Dry Ashing disposal process described above, following the use of middling's coal in accordance with the design of infrastructure at the Power Station.

7.4 Location Alternatives

Majuba Power Station's existing Ash Disposal Facility is almost at the 15 year boundary and urgently requires ashing infrastructure for the continuous ashing activities for the next 50 years. The particular area required for the continuous ashing facility is approximately 800 ha. The area, originally identified (in the 1980's) by Eskom for ash disposal for the life of the station comprises the existing ash facility and the area located on the southern portion of the existing Majuba Power Station ash disposal facility. .

With the promulgation of the environmental laws such as the National Environmental Management Waste Act, Act 59 of 2008, in particular, Eskom would like to pro-actively align its proposed continued ashing activities with the requirements of the waste licensing processes**.** In order to allow for a robust environmental process, all land within a radius of 12km was assessed in order to identify potential alternative sites for the proposed continuous disposal of ash. The Majuba Continuous Ashing EIA study area is therefore located within a 12 km radius around a centre point within the Majuba Power Station (**Figure 7.2**).

7.4.1 Screening Analysis and Methodology

A screening study was initiated in order to assess where potential alternative sites are located within the study area that would be suitable for use for the proposed continuous ashing project. The study area was demarcated using a 12km radius around Majuba Power Station.

In order to ensure that sites are identified in the most objective manner possible, a sensitivity mapping exercise was undertaken for the study area. The purpose of such an exercise was to identify suitable areas within the study area that could accommodate the proposed ash disposal facility and associated infrastructure and to pro-actively identify sensitive areas (i.e. fatal flaws) that should be avoided.

- ***Sensitivity Mapping***

The qualitative sensitivity mapping exercise divided the study area into three categories *viz.* lower, medium and higher sensitivity areas. A sensitivity map for the study area was requested from each of the following specialist fields:

Biophysical
- Biodiversity (Fauna and Flora)
- Surface Water
- Groundwater
- Avifauna
- Agricultural Potential

Social
- Social (including Visual)
- Air Quality
- Noise

Please refer to the detailed description in the Majuba Continues Ash Disposal facility Scoping Report (Lidwala, 2012).

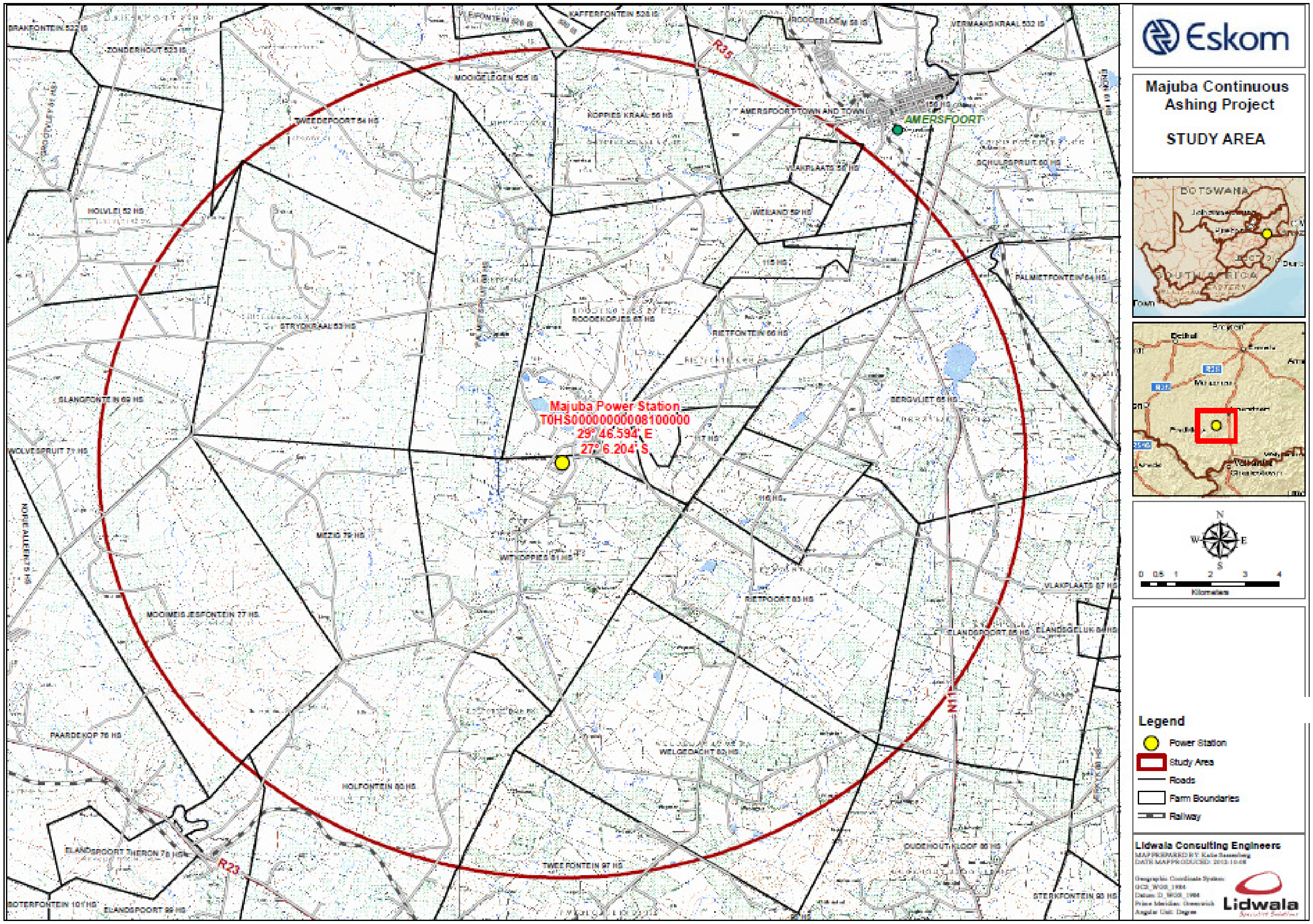


Figure 7.2: Proposed Study Area within which potential alternative sites were identified

- ***<u>GIS Layer Amalgamation and Sensitivity Indice Calculation</u>***

In order to calculate a combined sensitivity rating for the study area, all the GIS layers received from each specialist area of study (e.g. ground water, biosensitivity etc) were combined to form one integrated layer (**Figure 7.3**). During this integration, string arrays were built containing information on the layer name, the assigned sensitivity rating for each particular area and the adjustment factor for the particular layer (**Figure 7.4**).

Three results (**Figure 7.4**) were then calculated from the integrated layer (**Figure 7.3**) by unnesting and summarising the string array data using the following logics:

- **maximum sensitivity wins:**
  The maximum sensitivity rating found in the array became the sensitivity index.
- **sum of all sensitivity ratings:**
  The sensitivity index was the sum of each sensitivity rating found in the array.
- **sum of all adjusted sensitivity ratings:**
  Each sensitivity rating found in the array was adjusted by the assigned adjustment factor for each particular layer. The sensitivity index was then the sum of these.

The presented maps were then created by reclassifying each logic result into five classes, namely:

- low sensitivity (green),
- low-medium sensitivity (light-green)
- medium sensitivity (yellow)
- medium-high (orange)
- high sensitivity (red).

Finally, the reclassified layer was clipped with the pre-determined no-go areas layer (to remove them from consideration – **Figure 7.5**) and further clipped with the 8km radius study area buffer to remove any extraneous features.

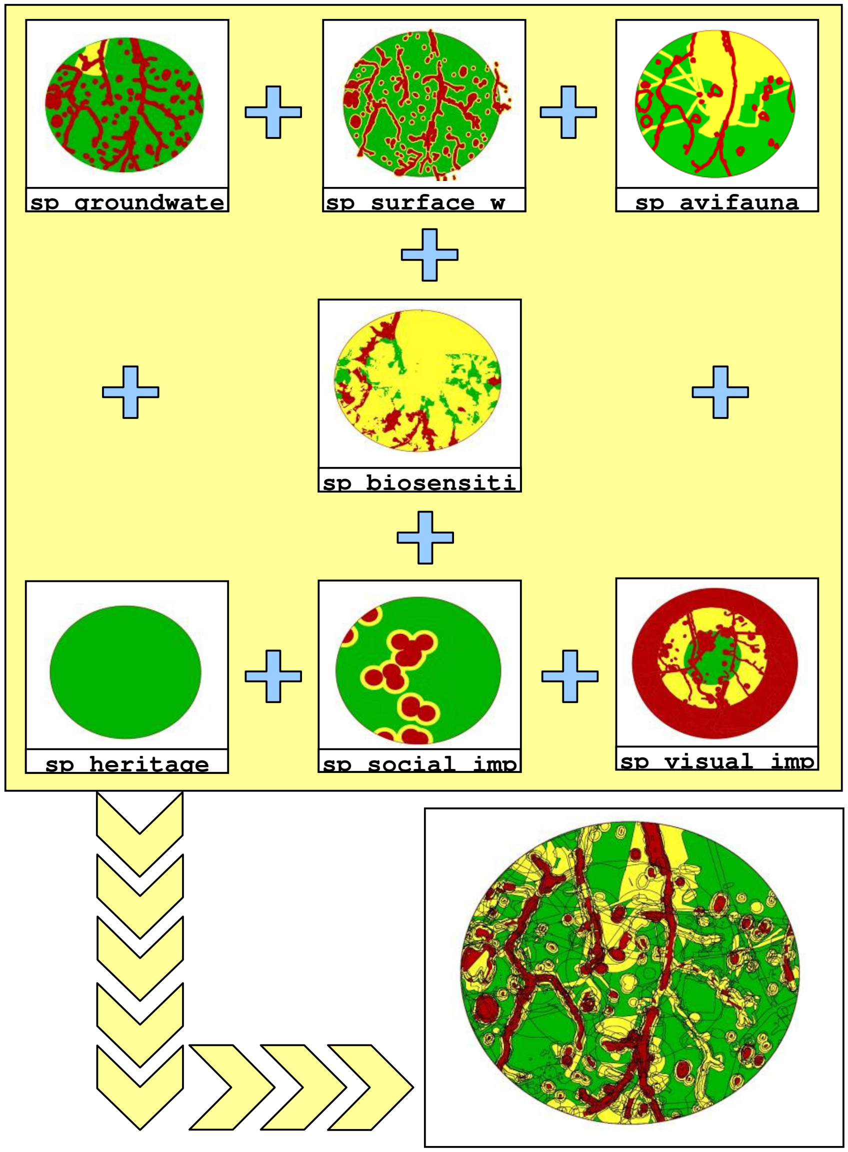
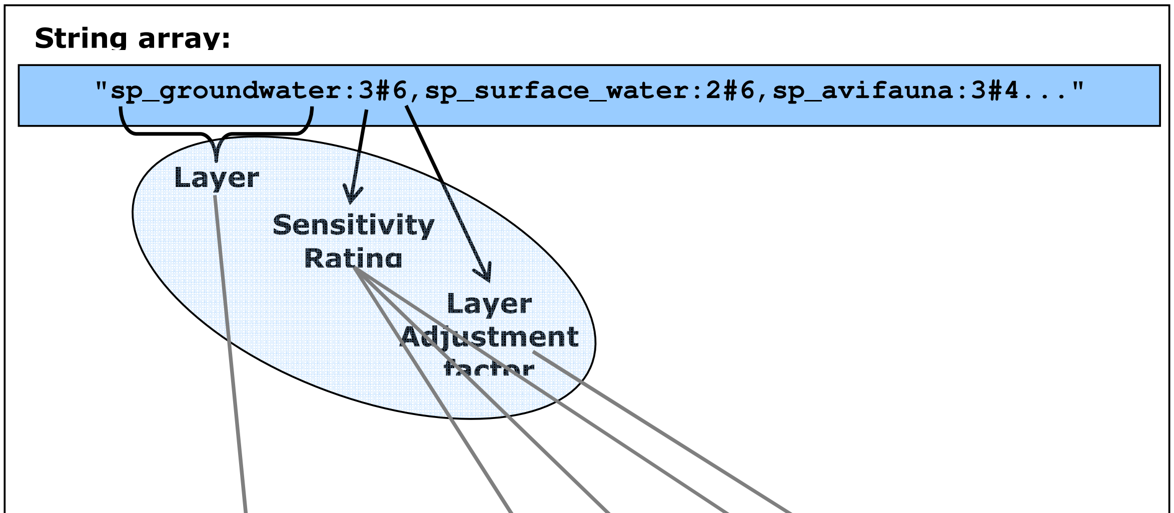


Figure 7.3: An example of typical layer integration process



Layer	Max Wins	No Factor	With Adjustment Factor
sp_g roundwater	3	3 x 1 (3)	3 x 6 (18)
sp_s urface_water	2	2 x 1 (2)	2 x 6 (12)
sp_a vifauna	3	3 x 1 (3)	3 x 4 (12)
sp_b iosensitivity	1	1 x 1 (1)	1 x 4 (4)
sp_h eritage	2	2 x 1 (2)	2 x 2 (4)
sp_v isual_impact	1	1 x 1 (1)	1 x 2 (2)
sp_s ocial_impact	1	1 x 1 (1)	1 x 2 (2)
Sensitivity Rating	**3**	**13**	**54**

Figure 7.4: String array parts and resultant indice calculations: max wins; sensitivity rating as is and sensitivity with an applied factor.

- ***Adjustment Factor / weighting factor Methodology***

In order to give each component a weighting factor with which to adjust the layers, the following methodology was utilised.

In a weighted matrix each variable / component is given a different importance weighting. In order to ensure that consensus is obtained with regards to the weighting / adjustment factors input from the project team and all specialists was obtained. Each member of the Project team was asked to rank each variable according to their own understanding of its significance, utilising the following ratings:

- 1 - low significance
- 2 - medium significance
- 3 - high significance

Once all the input was received, the rating provided for each variable was added and then divided by the number of people that took part in the exercise in order to obtain an average rating. Three sets of ratings were collected, namely:

- Specialist and Lidwala Project Team ratings (**Table 7.2**)
- Client ratings (**Table 7.3**)
- Combined ratings (**Table 7.4**)

The final decision to utilise the combined rating as the final weighting factors for the sensitivity analysis was due to the fact that the client's ratings did not dilute the weighting factors, they actually made the weighting factors stricter.

Table 7.2: Specialist and Lidwala Project Team ratings

	Specialists and Lidwala Project Team																				
Aspect	Social	Visual 1	Visual 2	Fauna	Flora	Surface Water 1	Ground water 1	Ground water 2	Design	Air	Avifauna	Project Manager	PPP1	PPP2	EIA Team	GIS	Legal	Soil	Final Total	Number participants	Average Rating
Social (including visual)	2	2	1	1	1	1	1	1	2	3	1	1	3	3	1	1	1	1	27	18	1.50
biodiversity (Fauna and flora)	2	3	3	3	3	3	2	2	1	2	2	3	2	2	3	2	3	2	43	18	2.39
surface water	2	3	3	3	3	3	2	2	2	2	2	3	3	3	2	2	2	2	44	18	2.44
groundwater	2	3	3	2	2	3	2	2	2	1	2	2	2	3	2	2	2	3	40	18	2.22
agricultural potential	1	2	2	1	1	1	2	2	1	2	1	2	2	1	1	2	2	2	28	18	1.56
air quality	2	2	3	1	1	2	2	2	3	3	2	1	3	1	2	3	3	3	39	18	2.17
Avifauna	2	2	1	3	3	3	2	2	2	2	2	3	1	2	2	2	2	2	38	18	2.11
noise	1	1	1	1	1	2	2	2	1	2	1	1	2	1	1	1	1	1	23	18	1.28

Table 7.3: Client ratings

	Eskom Team															
Aspect	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	Final Total	Number participants	Average Rating
Social (including visual)	3	3	2	2	1	1	2	1	1	1	2	1	1	21	13	1.62
biodiversity (Fauna and flora)	3	3	3	3	3	1	3	2	3	2	3	3	3	35	13	2.69
surface water	3	3	2	2	3	1	2	3	2	2	3	2	2	30	13	2.31
groundwater	3	3	3	2	2	2	2	3	3	3	3	2	3	34	13	2.62
agricultural potential	1	3	3	2	2	2	1	2	2	1	1	1	1	22	13	1.69
air quality	3	3	3	3	2	1	2	2	1	3	3	1	2	29	13	2.23
Avifauna	3	1	3	3	2	1	3	2	2	2	2	1	2	27	13	2.08
noise	3	1	1	3	1	1	1	1	1	1	2	1	1	18	13	1.38

Table 7.4: Combined ratings

	Specialists and Lidwala Project Team			Eskom Team			Final Combined Ratings		
Aspect	Final Total	Number participants	Average Rating	Final Total	Number participants	Average Rating	Final Total Combined	Number participants	Final Average Rating
Social (including visual)	27	18	**1.50**	21	13	**1.62**	48	31	**1.55**
biodiversity (Fauna and flora)	43	18	**2.39**	35	13	**2.69**	78	31	**2.52**
surface water	44	18	**2.44**	30	13	**2.31**	74	31	**2.39**
groundwater	40	18	**2.22**	34	13	**2.62**	74	31	**2.39**
agricultural potential	28	18	**1.56**	22	13	**1.69**	50	31	**1.61**
air quality	39	18	**2.17**	29	13	**2.23**	68	31	**2.19**
Avifauna	38	18	**2.11**	27	13	**2.08**	65	31	**2.10**
noise	23	18	**1.28**	18	13	**1.38**	41	31	**1.32**

The final weighting factors for each aspect are therefore as follows:

- Social = 1.55
- Fauna and Flora = 2.52
- Surface Water = 2.39
- Ground Water = 2.39
- Agricultural Potential = 1.61

- Air Quality = 2.19
- Avifauna = 2.10
- Noise = 1.32

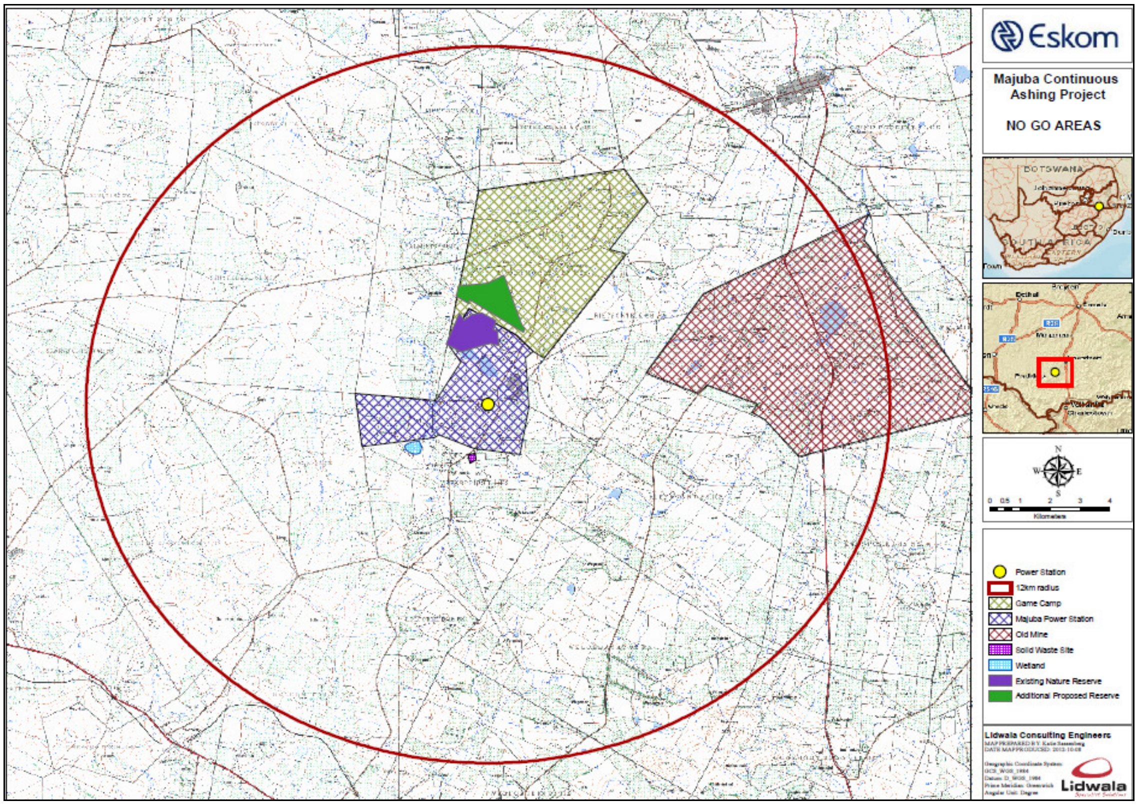


Figure 7.5: No-Go Areas Layer

7.4.2 Specialist Study Screening Results

As described above each specialist were requested to map out the identified study area according to the sensitivity of specific areas within the study area specific to the specialists field. All these sensitivity maps were then overlaid and amalgamated to identify areas with overall high sensitivity across the disciplines. For a detailed description of this entire process and the individual sensitivity maps, please refer to the Majuba Continues Ash Disposal facility Scoping Report (Lidwala, 2012)

7.4.3 Final Screening Results

Figures 7.6, 7.7 and **7.8** illustrate the results of overlaying all the specialist input maps together, thereby illustrating the overall environmental sensitivity of the area.

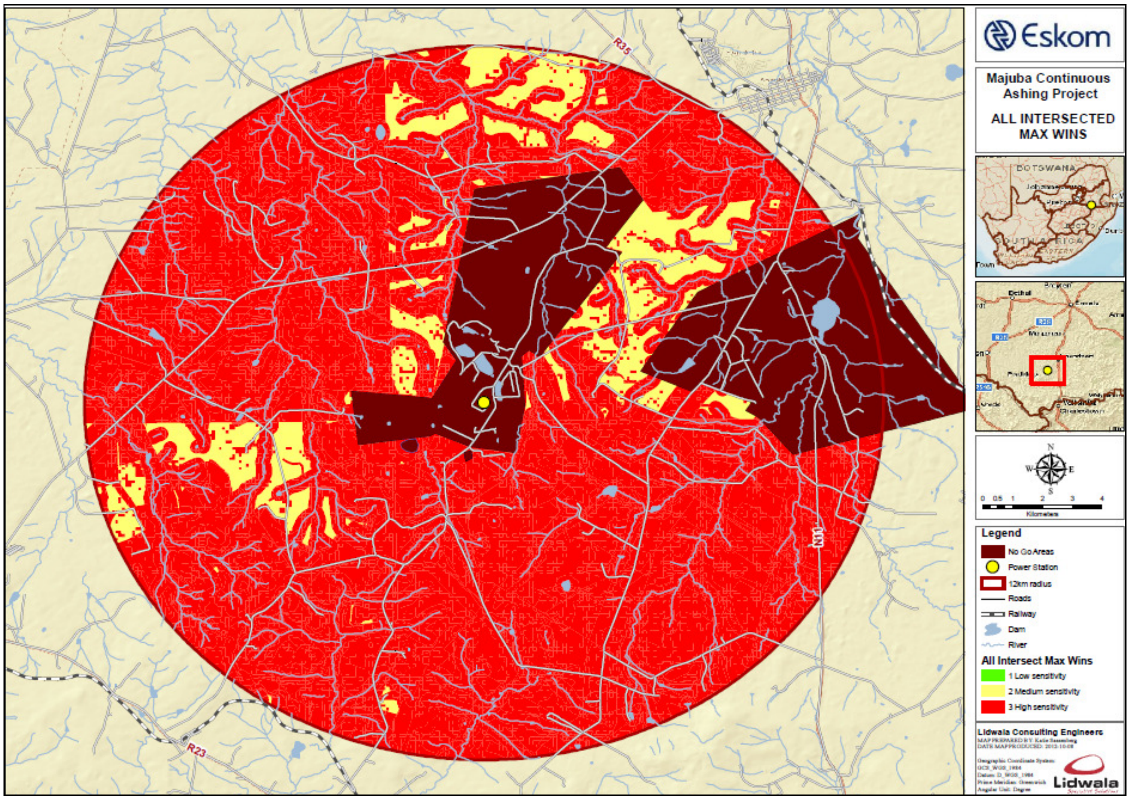


Figure 7.6: Overall Environmental Sensitivity (Max Wins)

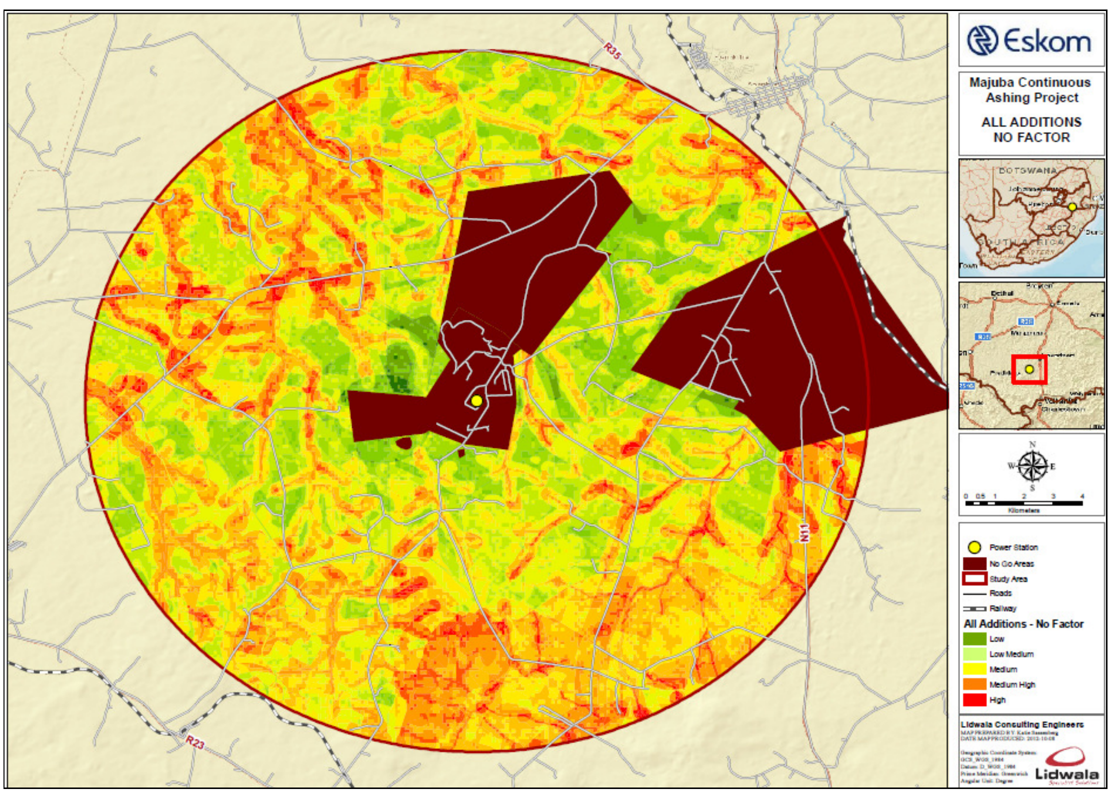


Figure 7.7: Overall Environmental Sensitivity (no factor)

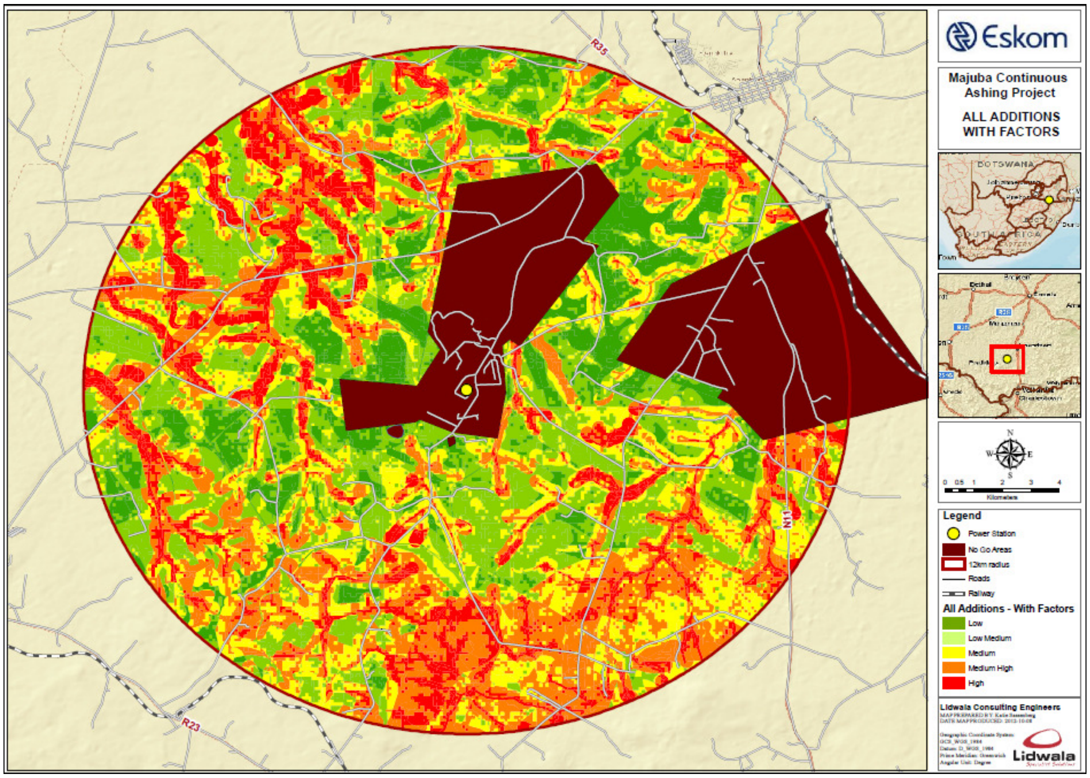


Figure 7.8: Overall Environmental Sensitivity (with adjustment factor)

Utilising the straight forward addition analysis it can be concluded that the overall sensitivity of the study area falls within the Medium to medium-high sensitivity range with only small areas being considered of low sensitivity. However, if one utilises the "max wins" (**Figure 7.8**) mapping technique, where any area marked as sensitive is kept sensitive, it is clear that the majority of the study area can be deemed to be sensitive in one way or form with only a few medium sensitivity areas scattered across the study area.

The above maps were then utilized in order to determine the least sensitive areas of sufficient size that could be considered as alternative sites for the proposed ash disposal facility at Majuba Power Station. Alternative sites are required to be at least <u>800</u> ha in size and are required to fit within the low to low - medium sensitivity areas only and preferably without disturbing any existing infrastructure. It is clear from the overall sensitivity map that there are no areas that fall only within low or low-medium sensitivity areas that are big enough to accommodate the required size for the ash disposal site. However, if one also allows the ashing area to fall over medium sensitivity areas five areas become available (**Figure 7.10**).

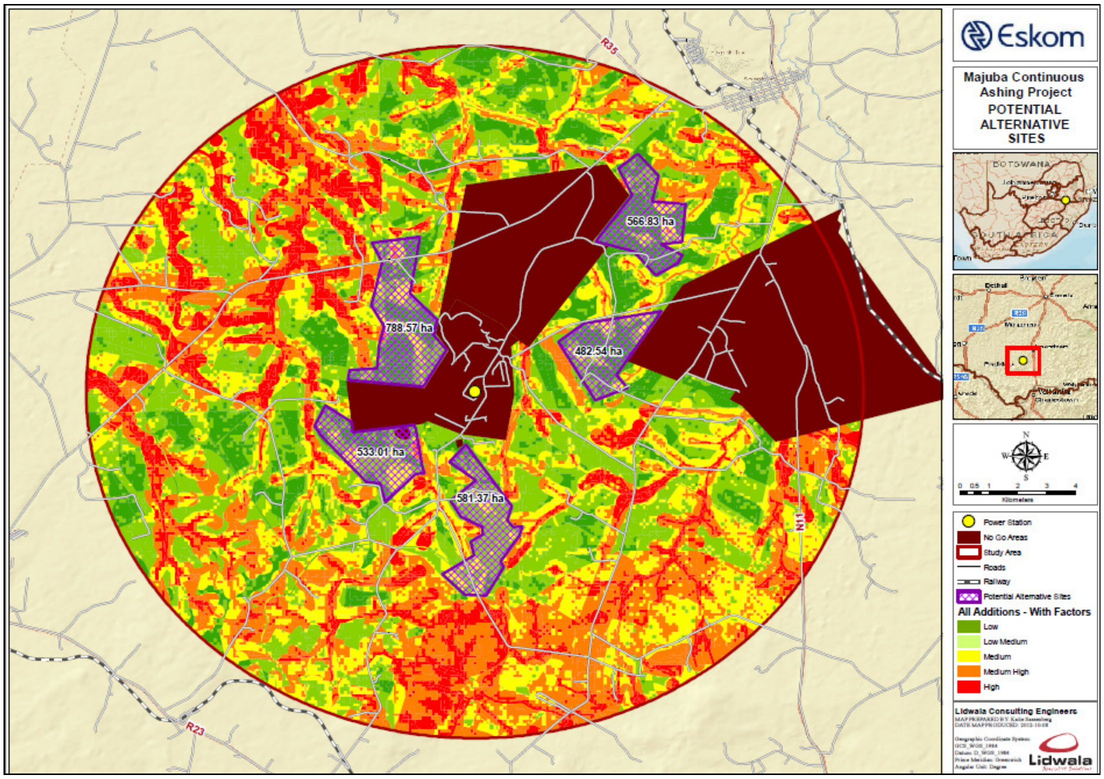


Figure 7.9: The potential alternative areas, within the study area, (overlain on sensitivity map).

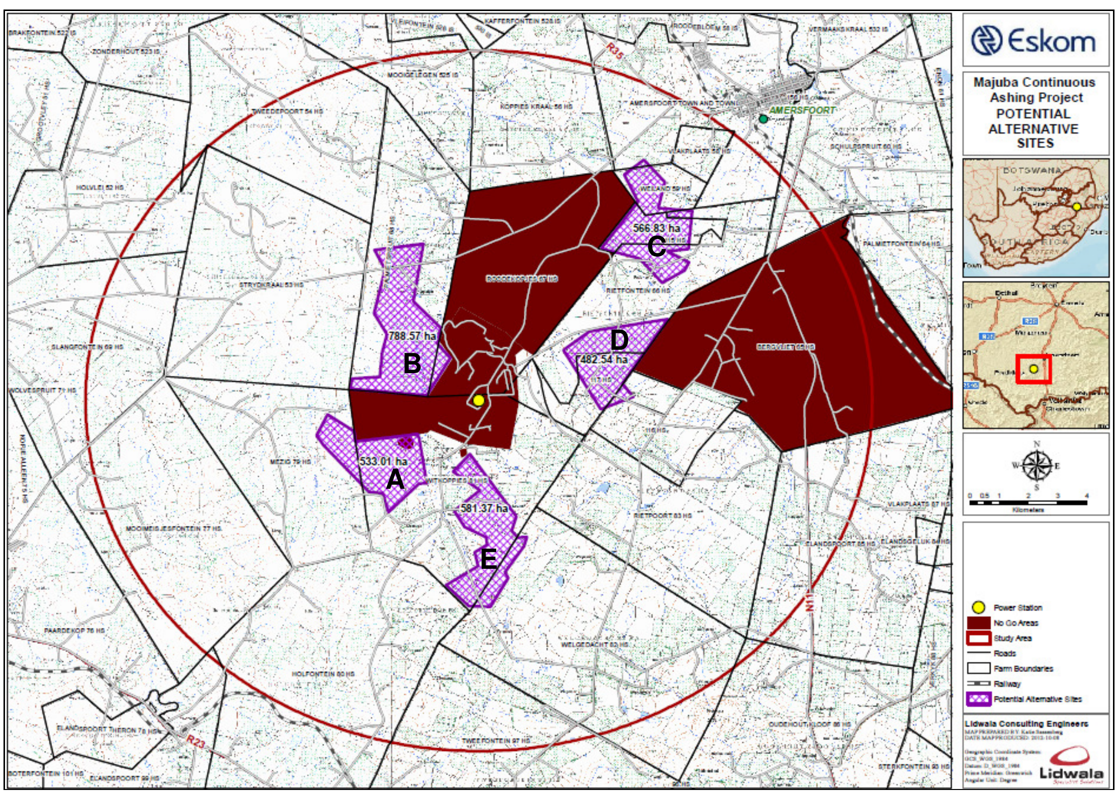


Figure 7.10: The five potentially suitable areas that was evaluated and assessed in the EIA studies (overlain on 1 in 50 000 topographic map)

From scoping, it was realised that all the individual identified alternatives areas were smaller than the 800ha footprint requirement for the proposed continuous ash disposal facility. As such, a combination of alternatives required further assessment to accommodate the required continuous ash disposal requirements. With the inception of the EIA phase it was realised that HV power lines crossed alternative B. These powerlines are currently transmitting the electricity generated from the power station out to the grid, and it was confirmed that it would not be possible/be very difficult to relocate these powerlines without shutting down the station. As such alternative B was not considered as technically feasible, and is not included in the conclusion of siting alternatives.

This lead to the three proposed siting combination alternatives that consisted of different combinations of the above site alternatives (**Figure 7.11**):

1. Alternative A+ E
2. Alternative A+ D
3. Alternative C+ D

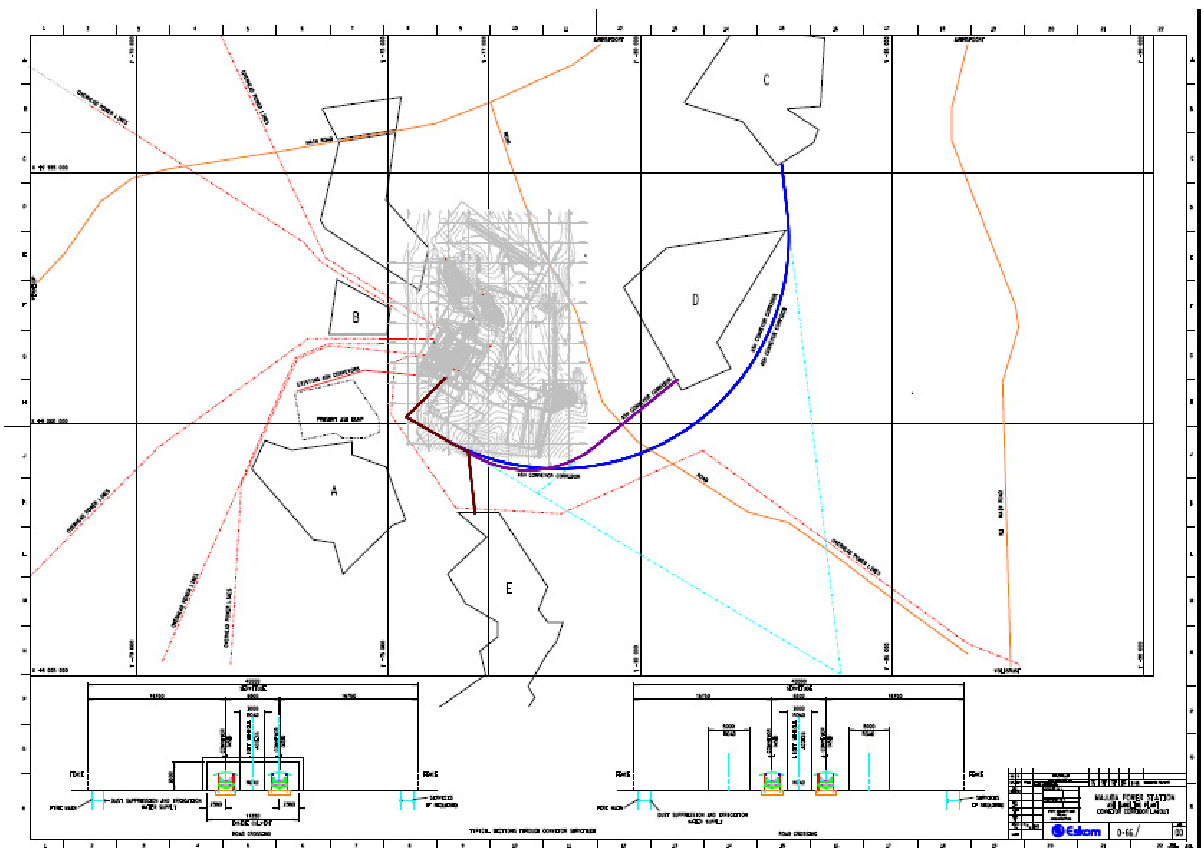


Figure 7.11: Original alternatives with proposed conveyor corridors.

Following this Scoping exercise, the EIA specialists undertook ground-truthing during the EIA phase specialist investigations at these alternatives for recommendation into the EIA. The Wetland and Ecological specialist further recommended to the EAP that the project consider the extension of the identified Alternative A to accommodate the ashing requirements of the proposed continuous ash disposal facility (i.e. 800Ha). Both specialists were of the opinion that it is not desirable to have two split facilities and the conveyor corridors traversing over large parcels of land. The specialists recommended that Site Alternative A be extended southwards to be large enough to accommodate the entire facility. Their reasoning was that this will allow for a single facility close to the station, no major conveyor corridors required, and according to both specialists, this area (to the south of Site A) appeared as not sensitive and should provide an ideal site (ecologically) for the facility. As such the extension of Alternative A (**Figure 7.12**) was included as a siting alternative, which resulted in four proposed alternatives consisting of the 3 combinations of alternatives mentioned above and the extension of Alternative A.

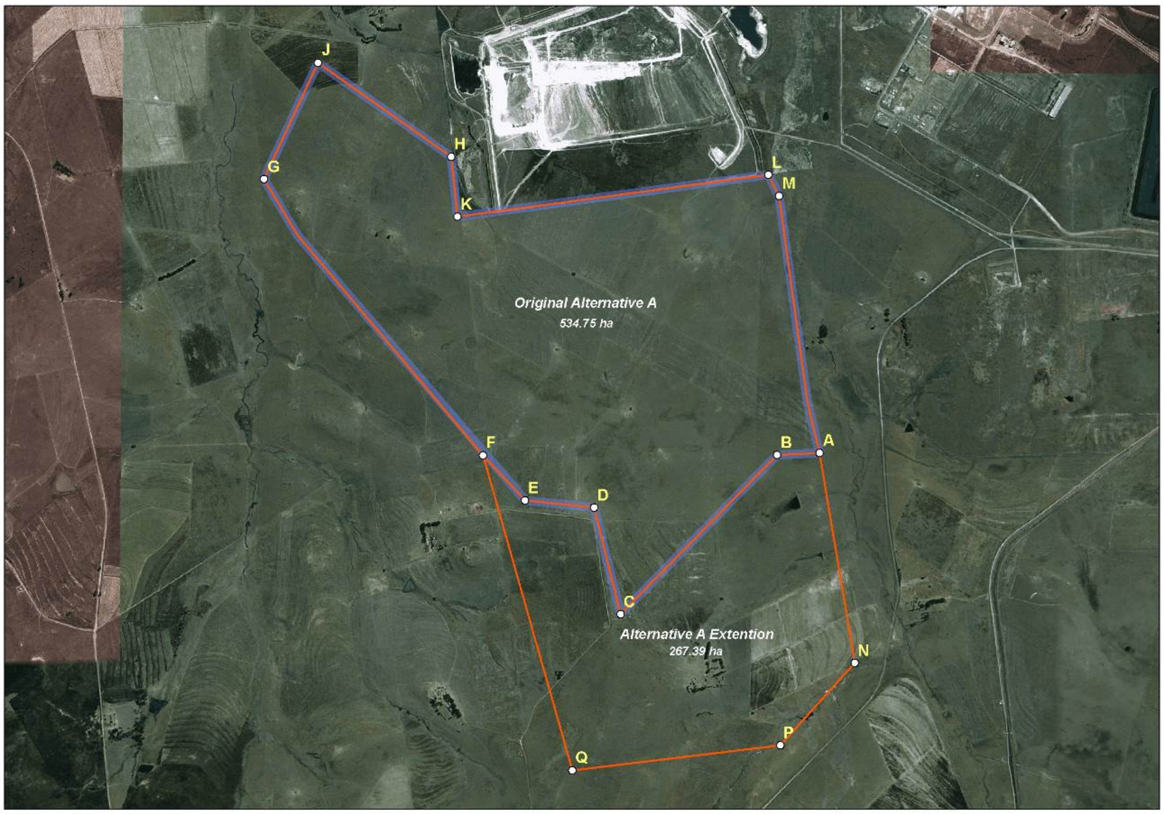


Figure 7.12: Proposed extension of Alternative A for the Majuba Ashing Disposal Facility.

These sites/siting combinations, and their infrastructure, are what was assessed and concluded in the EIA phase specialist studies. All four siting alternatives have been ranked in the same manner according to preference as the original five site alternatives by all specialists.

7.4.4 Conclusion

As explained above, although all the specialist studies focused on the original alternatives from Alternative A-E due to the fact that most Environmental Impacts cannot be meaningfully assessed in two geographically separated areas, the assessed impacts have been combined according to the four siting alternatives. These assessments have been used to determine the preference between the four siting alternatives, taking into account the combined scorings of all the specialist fields.

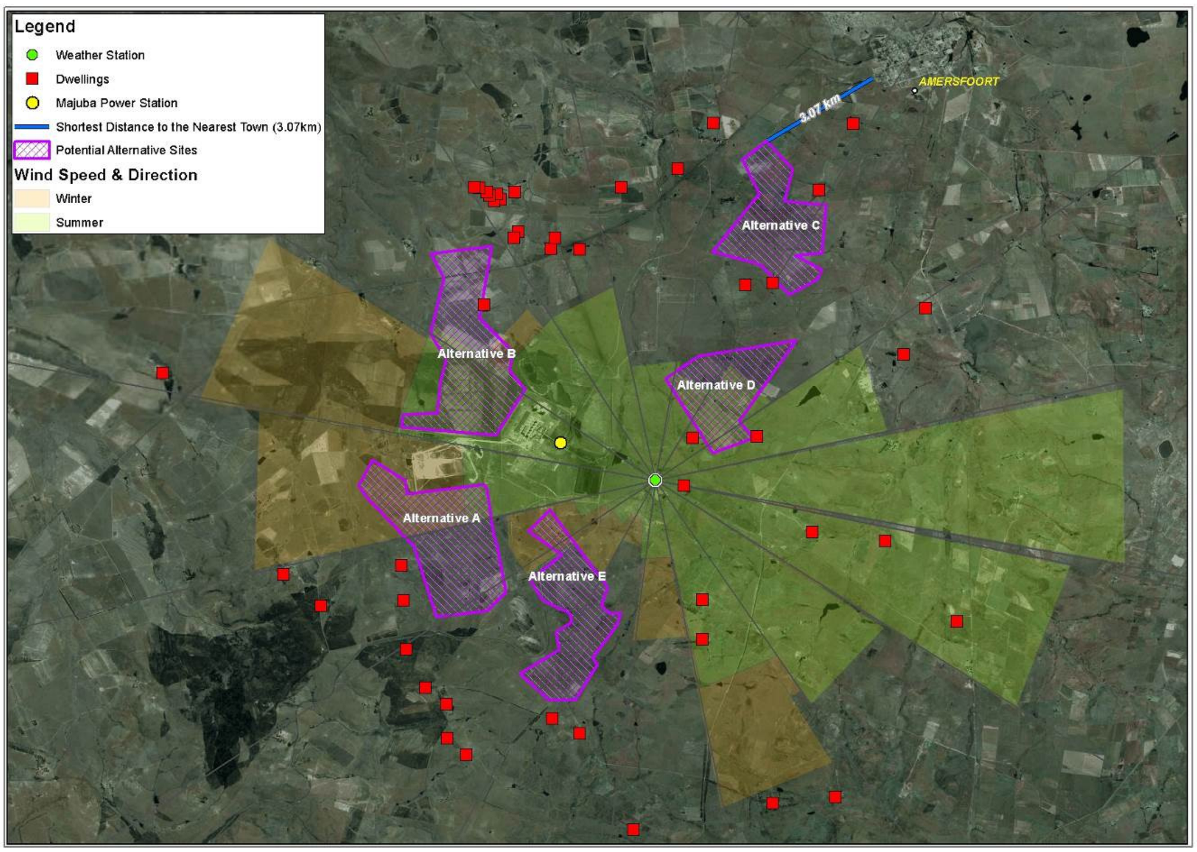


Figure 7.13: Final layout of the alternatives as assessed individually and in combination during the EIA phase.