Eskom	Scope of Work	Transmission

Title: **FOUNDATIONS REHABILITATION -**

NORTH EAST GRID

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1. INTRODUCTION

Lines Engineering Services went to visit multiple lines from the North East Grid, the observations made during the site visit include soil erosion where majority of the foundations were left scouring and exposed, corrosion on the tower members and concrete spalling. There was also towers that are located next to watercourses accelerating the erosion. Figures 1- 2 show the susceptibility of soil erosion on the different lines and the proximity to watercourses. The aim of this report is to provide the scope of work for the repairs on the towers affected by erosion and corrosion as summarized in table 1. The solutions were developed from desktop studies and line walk down for each tower visited.

Table 1: Summary of the affected towers on the various lines

	Kusile - Minerva No1 400kV		
1	Kusile Minerva No1 400kV Line	Twr 105	- Buried Foundation
2	Kusile Minerva No1 400kV Line	Twr 121	- Seasonal Flooding - Concrete cracking - Backfill settlement - Concrete cracking
3	Kusile Minerva No1 400kV Line	Twr 119	- Buried Foundation - Corrosion - Water ponding
4	Kusile Minerva No1 400kV Line	Twr 117	- Buried Foundation - Wetland - Concrete cracking
5	Kusile Minerva No1 400kV Line	Twr 115	- Buried Foundation - No corrosion
6	Kusile Minerva No1 400kV Line	Twr 112	- Buried Foundation
7	Kusile Minerva No1 400kV Line	Twr 111	- Buried Foundation
8	Kusile Minerva No1 400kV Line	Twr 113	- Man-made Catchment next to the tower
9	Kendal - Apollo 400KV Line	Twr 93	- Towers close to streams
10	Kendal – Minerva 400kV	Twr 87	- Towers close to streams
	Duvha - Vulcan1 400kV		
1	Duvha Vulcan1:400kv Line	Twr101	- Soil erosion(scouring)
2	Duvha Vulcan1:400kv Line	Twr102	- Soil erosion(scouring)
3	Duvha Vulcan1:400kv Line	Twr103	- Soil erosion(scouring)
4	Duvha Vulcan1:400kv Line	Twr104	- Soil erosion(scouring)
5	Duvha Vulcan1:400kv Line	Twr105	**Complete scope**
6	Duvha Vulcan1:400kv Line	Twr106	- Soil erosion(scouring)
7	Duvha Vulcan1:400kv Line	Twr107	- Soil erosion(scouring)

			- Corrosion - Spalling
8	Duvha Vulcan1:400kv Line	Twr108	- Soil erosion(scouring)
9	Duvha Vulcan1:400kv Line	Twr109	- Soil erosion(scouring)
10	Duvha Vulcan1:400kv Line	Twr110	- Soil erosion(scouring)
11	Duvha Vulcan1:400kv Line	Twr111	- Soil erosion(scouring)
	Hendrina - Vulcan 1 400kV		
1	Hendrina Vulcan 1 400kV	Twr 196	- Soil erosion(scouring)
2	Hendrina Vulcan 1 400kV	Twr 197	- Soil erosion(scouring)
3	Hendrina Vulcan 1 400kV	Twr 198	- Soil erosion(scouring)
4	Hendrina Vulcan 1 400kV	Twr 200	- Soil erosion(scouring) - Corrosion - Concrete Spalling
5	Hendrina Vulcan 1 400kV	Twr 201	- Soil erosion(scouring)
6	Hendrina Vulcan 1 400kV	Twr 202	- Soil erosion(scouring)
7	Hendrina Vulcan 1 400kV	Twr 203	- Soil erosion(scouring)
8	Hendrina Vulcan 1 400kV	Twr 204	- Soil erosion(scouring)

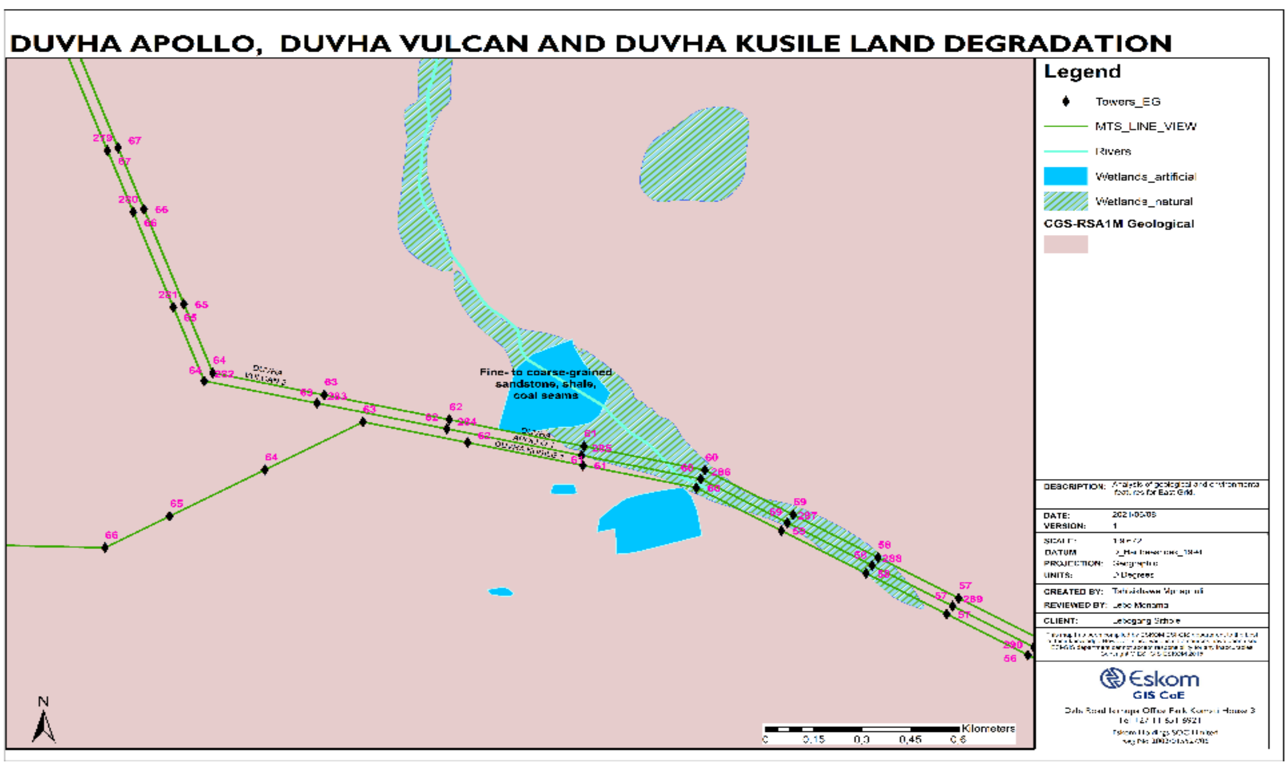


Figure 1: Watercourses next to Duvha- Apollo, Duvha – Vulcan and Duvha – Kusile Lines

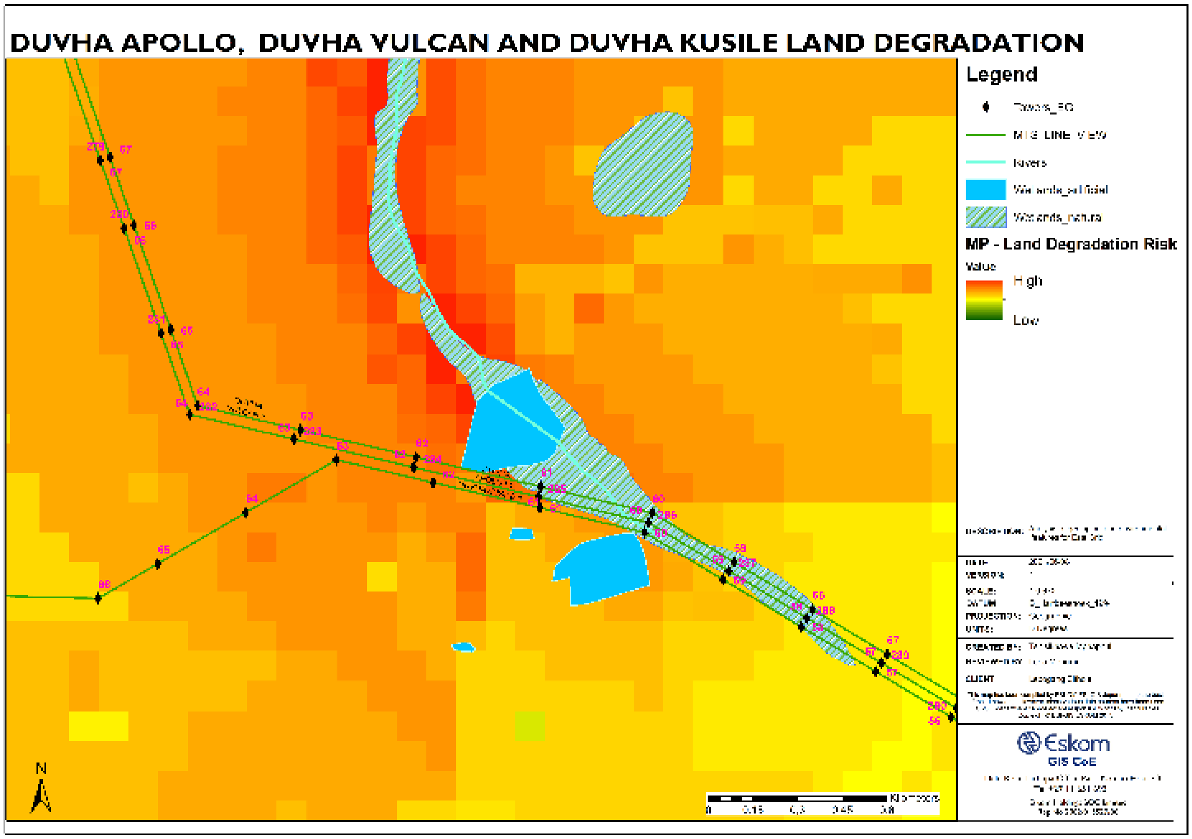


Figure 2 : Erosion Risk to Duvha- Apollo, Duvha – Vulcan and Duvha – Kusile Lines

1.1 APPLICABILITY

This document shall apply throughout Eskom Holdings Limited Divisions,

1.2 REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

- SANS 1200 AA Small works
- SANS 1200 DA Earthworks (small works)
- SANS 1200 DM - Earthworks (roads, subgrade)
- SANS 1200 DK - Gabions and Pitching
- SANS 1200 C - Site Clearance
- TRMAGABE0 Rev0 – Management of Erosion in Servitudes
- TGL41-337 Rev0 – Erosion Guidelines
- 240 - 47172520 (TRMSCAAC 6) - The Standard For The Construction Of Overhead Powerlines

1.3 DEFINITIONS

Construction work - The erection, maintenance, alteration, renovation, repair, demolition, dismantling of, or addition to a building or any similar structure.

Gabion - A cage of galvanized steel wire mesh (with or without PVC coating) that is packed with stones and is used in material retaining structures and in various situations to counter erosion.

Geotextile - A material in the form of a sheet, a blanket or a net that is permeable to water

Scouring - The particular type of localized soil erosion that happens around elements of a foundation

1.4 ABBREVIATIONS

Term	Definition
LES	Lines Engineering Services
SOW	Scope of Work
NGL	Natural Ground Level

2. MITIGATION MEASURES

2.1 KUSILE - MINERVA NO1 400KV LINE TOWER 150

The tower foundations are covered by dense vegetation as shown on figure 6. The tower legs are at a huge risk of corrosion since the stub are directly exposed to soil. The recommendation is to remove the vegetation around the tower and expose the foundation to inspect the stubs.

Figure 3: Foundations covered in vegetation

2.2 KUSILE - MINERVA 1 400KV LINE TOWER 121

The foundations are buried underground which is a violation of TRMSCAAC6 which states that foundations should protrude a minimum of 250mm above ground level. The concrete on the foundations is breaking away as shown on the figure below. The bitumen paint on the foundations stubs is also cracking which will result in the corrosion of steel members and slight corrosion was detected. Mitigation is repair the concrete, treat the corrosion and increase the encasement to 250mm above ground.

Figure 4: Cracked foundations

2.3 KUSILE - MINERVA1 400KV LINE TOWER 119

The foundation is buried, and the stub has started corroding, the corrosion around the stub is severe as shown on Figure 5. The foundations have no watershed and the water ponds around the stubs which causes the corrosion. There is also no protective coating around stubs. Mitigation is treating the corrosion and encase the legs in concrete.

Figure 5: Corrosion on the stub

2.4 KUSILE - MINERVA NO1 400KV LINE TOWER 117

The tower has cracked foundations and the one leg of the tower is buried underground as shown on figure 6. Unwanted silting refers to the build-up of sediment in structures required to channel water away from sensitive areas. When this happens, water overflows and cause erosion around and under soil erosion structures, leading to subsidence and eventual failure. Silting needs to be remedied by simply cleaning out the sediment and placing it in areas where it will not re-enter the system. The cracking to be mitigated by encasing with new concrete.

Figure 6: Concrete cracks and buried foundation

2.5 KUSILE- MINERVA NO1 400KV LINE TOWER 112

Dense vegetation around the tower, the foundations are covered with soil and cannot be inspected. Vegetation to be cleared and the tower foundations inspected for any corrosion.

Figure 7: Dense vegetation around the tower

2.5.1 KUSILE- MINERVA1 400KV LINE TOWER 111

Tower 111 of the Kusile – Minerva Line has severe corrosion, there's evidence of material loss on the stub and brace members of the tower. The foundation is buried into the ground as shown in the images below, there is no bitumen paint and the foundation cap has no watershed, which promotes corrosion.

Figure 8: Corrosion on the stub and leg

2.5.2 KUSILE - MINERVA NO1 400KV LINE TOWER 113

There is a man – made catchment next to tower used by the cattle to drink water as shown of figures below. The catchment is not a direct threat to the tower currently, however if left unattended it will expand to a point where it affects the foundations of the tower. The recommendation is for the Grid to engage the landowner to consider relocating the catchment away from Eskom's servitude.

Figure 9: Water catchment under the Eskom servitude

2.6 KUSILE - MINERVA1 400KV LINE TOWER 115

The foundations of this tower are buried but there are no signs of corrosion on the stubs, the tower must be closely monitored and the vegetation removed.

Figure 10: Buried foundations

2.7 KENDAL - APOLLO 400KV TOWER 93 & KENDAL – MINERVA 400KV TOWER 87

Tower 93 of the Kendal – Apollo Line and Kendal – Minerva Tower 87 are located next to a stream as shown on the figures below. The embankment of the stream is eroding away which directly affects the foundations of the tower. From the pictures below it is evident that the erosion path is moving towards the stay foundations for tower 87 and the foundations for the self- support tower for tower 93. The mitigation is to install gabion walls following the countering of the stream embankment as shown on figure 14 and 15. The gabion wall will act as a retaining wall to prevent further soil erosion.

Figure 11: Stream next to the towers

Figure 12: Erosion on the stream embankments towards the foundations (Google Earth imagery)

2.7.1 Gabion Wall Installation

- The specifications as referred to in **SANS 1200DK** should be taken in consideration when making gabion walls and mattresses. See Figure below for a typical schematic.

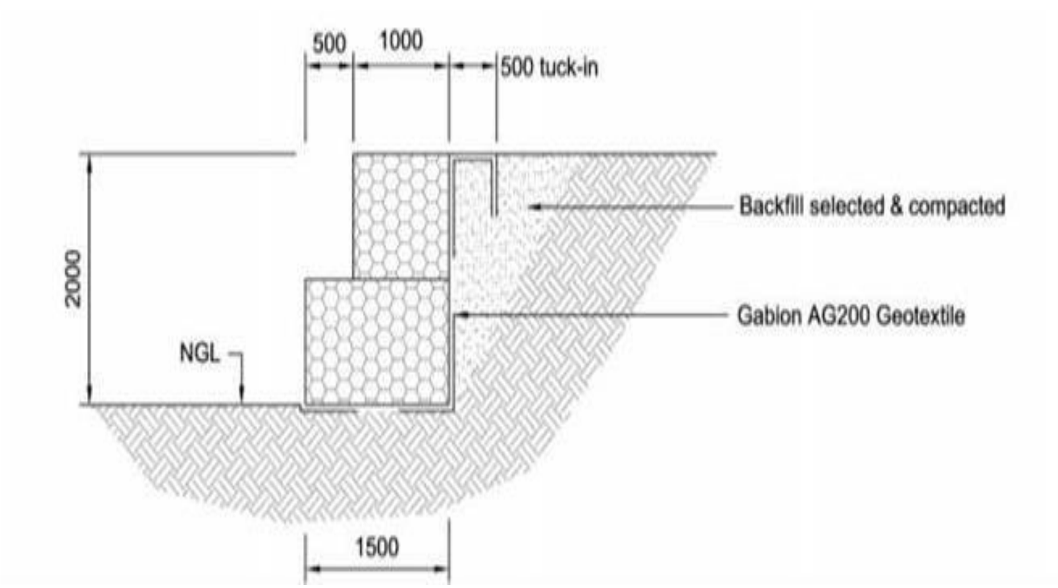


Figure 13: Gabion Wall example

- The surface on which the gabion cages are to be laid prior to their being filled with rock shall be levelled to the depth shown on the drawings to present an even surface.
- Rock used as filling for cages shall be clean, hard-unweathered boulders or rock fragments from the surrounding environment, primary crusher run, or obtained from an approved source.
- Wire mesh shall be hexagonally woven mesh in which the joints are formed by each pair of wires being twisted through three half-turns. **SANS 1580 specifies the use of galvanised mild steel wire**
- The methods of constructing, stretching, placing in position, wiring and filling the gabions with rock shall be in accordance with the manufacturer's instructions which have been approvedby the engineer, but nevertheless sufficient connecting wires shall be tensioned between the vertical sides of all the outer visible cells to prevent the deformation of boxes as they are being filled with stone.
- It is essential that the corners of gabion cages be securely wired together to provide a uniform surface and ensure that the structure does not resemble a series of blocks or panels.
- Consecutive courses of boxes should preferably be "bonded" as in brickwork to provide the staggering of the vertical joints

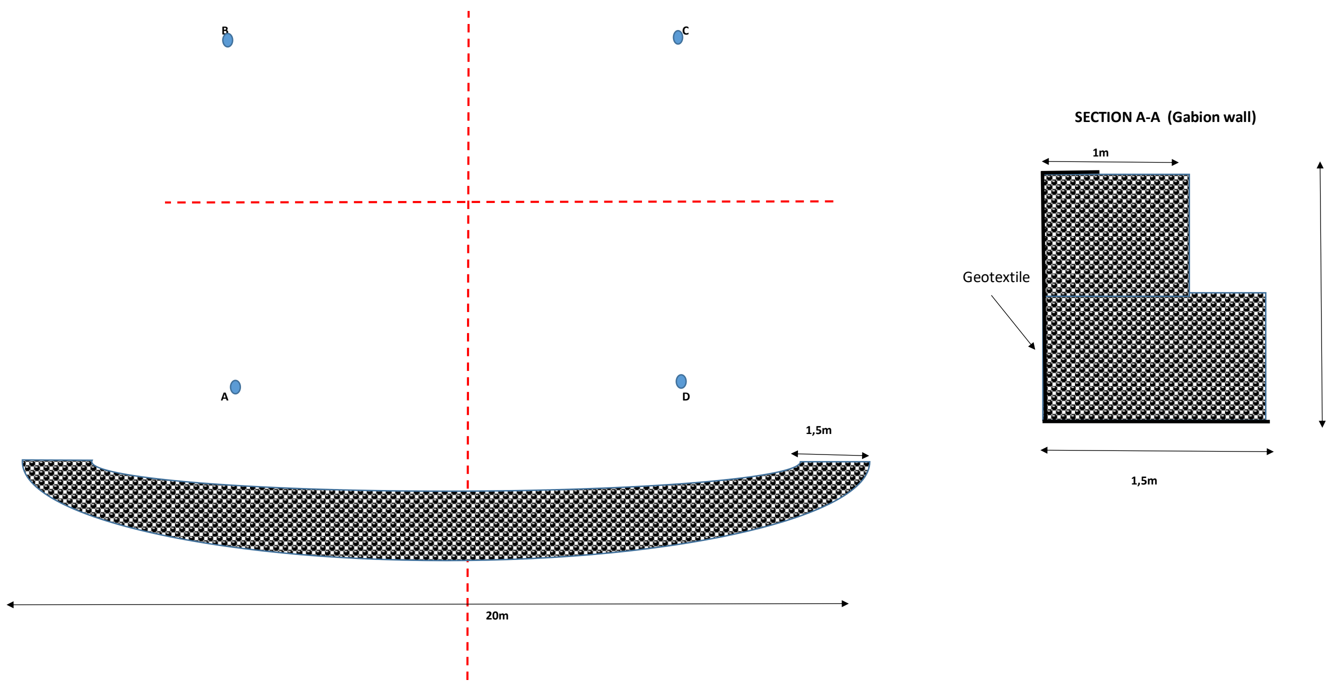


Figure 14: Kendal - Apollo 400kV Tower 93

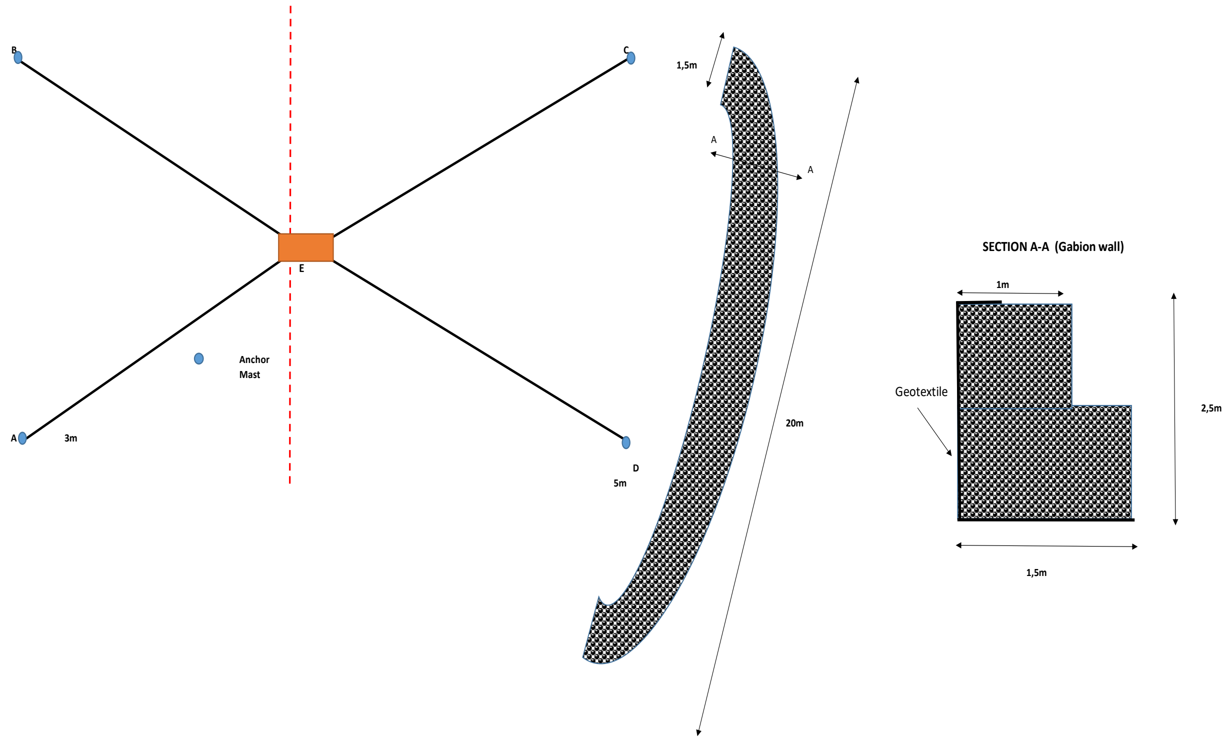


Figure 15: Kendal – Minerva 400kV Tower 87

2.8 DUVHA – VULCAN 1, HENDRINA – VULCAN 1, HENDRINA – VULCAN 2.

The figure below shows the three lines Duvha – Vulcan 1 400kV, Hendrina – Vulcan 1 400kV and Hendrina – Vulcan 2 400kV, which run parallel to each other, the towers on these lines have the same defects as determined in the site visit. These defects include soil erosion that has caused scouring as shown on the figures 14 – 25. Moreover, the foundations concrete is cracked and the corroded rebar is exposed. A few of the towers are buried into the ground, whilst the other foundations are exposed. The detailed mitigation for the towers along these spans is detailed in section 3 of this report.

Figure 16: Duvha – Vulcan 1, Hendrina – Vulcan 1, Hendrina – Vulcan

2.8.1 Duvha – Vulcan 1400kv Line Tower 101

See section 3.4 for mitigation

Figure 17: Scouring of foundations

2.8.2 Hendrina – Vulcan 1 400kV Line Twr195

See section 3.4 for mitigation

Figure 18: Scouring of foundation

2.8.3 Hendrina - VULCAN1:400kV Line Twr195

See section 3.4 for mitigation

Figure 19: Scouring of foundation

2.8.4 Duvhan- Vulcan1:400kV Line Twr104

See section 3.4 for mitigation

Figure 20: Scouring of foundation

2.8.5 Hendrina - Vulcan1:400kV Line Twr197

See section 3.4 for mitigation

Figure 21: Scouring of foundation

2.8.6 Hendrina – Vulcan 1:400kV Line Twr198

See section 3.4 for mitigation

Figure 22: Scouring of foundation

2.8.7 Duvha - Vulcan1:400kV Line Twr106

See section 3.4 for mitigation

Figure 23: Scouring of foundation

2.8.8 Hendrina – Vulcan 1:400kV Line Twr199

See section 3.2, 3.3 & 3.4 for mitigation

2.8.9 Duvha - Vulcan1:400kV LineTwr107

See section 3.4 for mitigation

Figure 24: Scouring of foundations

2.8.10 Hendrina - Vulcan 400kV Twr 200

See section 3.4 for mitigation

Figure 25: Scouring of foundations

2.8.11 Duvha Vulcan 1 400kV Twr108

See section 3.4 for Mitigation

Figure 26 : Scouring of foundation

2.8.12 Hendrina - Vulcan 1 400kV Twr 201

See section 3.4 for Mitigation

Figure 27 : Scouring of foundations

2.8.13 Duvha Vulcan1:400kV Twr 109

See section 3.4 for Mitigation

Figure 28: Existing Gabion Wall

2.8.14 Hendrina Vulcan - 400kV Twr 202

See section 3.4 for Mitigation

Figure 29: Scouring of foundations

2.8.15 Duvha Vulcan 1 400kV Twr 110

See section 3.4 for Mitigation

Figure 30: Scouring of foundations

2.8.16 Hendrina Vulcan 400kV Twr 203

See section 3.4 for Mitigation

Figure 31: Scouring of foundations

2.8.17 Duvha - Vulcan 1 400kV Twr 111

See section 3.4 for Mitigation

Figure 32: Scouring of foundations

2.8.18 Hendrina - Vulcan 400kV Twr 204

See section 3.4 for Mitigation

Figure 33: Scouring of foundation

3. EXECUTION OF WORK

3.1 CORROSION

For most of the tower the corrosion is found where the concrete and steel interface. The corrosion could be caused by the presence of the soil covering the foundation legs. Moreover, there are other factors that influence the rate of corrosion such as the properties of soil in the vicinity, presence of stray currents, PH levels, length of time the tower members are immersed in water etc. Most of the foundations have no water shed, which means that the water ponds around the leg members which promote corrosion. The corroded members will be rehabilitated by either removing the rust, reinforcement or replacement depending on the severity of the corrosion. Table 2 will be used to categorise the level of corrosion found on the foundation members as well the mitigation that matches the corrosion.

Table 2: Corrosion category

Corrosion Category:	Corrosion Condition	Restoration Category
1	No visible signs of galvanic depletion. Galvanising thickness 60 microns or more.	No Corrosion
2	No visible signs of galvanic depletion. Galvanising thickness 30 - 59 microns.	
3	Galvanising visibly depleted. Onset of steel discolouring	Light Corrosion
4	Galvanising almost depleted. Thin film of rust developing in surface.	
5	Deeper rust hardened crust / Pitting in smaller areas of 2cm	
6	Component rusted through more than 30% of cross sectional area	Severe Corrosion
7	Component rusted through more than 60% of cross sectional area and or completely disintegrated	

3.1.1 Slightly corroded tower stub/members treatment procedure (Category 1 – 2)

<u>Inadequate/No Watershed:</u>

- A mortar screed will be used to construct the watershed.
- Off the shelf screed of minimum 35 MPa strength can be sourced.
- Preparation and application should be as per manufacturer's instructions.

Flaking/Worn out bitumen painting:

- Use a Wire brush to clean and remove the flaking/worn out bitumen painting.
- Apply a primer and two coats of 99% Zinc rich paint. Ensure the painting overlaps the steel-concrete interface.

3.1.2 Slightly corroded tower stub/members treatment procedure (Category 3 – 5)

The procedure will involve the cleaning of the members using a wire steel brush and sand paper to remove the rust. The brittle and hard bitumen shall be removed to allow work to be done on the steel-concrete interface. Eskom approved coating must be applied on the freshly exposed steel. The concrete cap shall be prepared for additional concrete to create a 45 degrees slope on the top of the existing foundation cap to allow water to run off. This means scrapping of the existing surface to expose fresh concrete surface.

The bonding of the new concrete to the existing concrete is crucial to keep the water out therefore an approved bonding agent shall be used. Once the concrete cap surface is free of any loose material, it can be prepared for the application of the bonding agent. This should be done according to the manufacture's surface preparation requirements. The bonding material shall be applied as specified by the manufacturer.

3.1.3 Extensively corroded tower stubs/members (Category 6-7)

These include members with pit corrosion that compromises the strength of the members, the broken members (100% material loss) and the severely corroded members with more than 40% material thickness loss. The approach of these stubs is different from the above procedure. Stub reinforcement and the replacement of the affected cross bracings are necessary for the affected foundations. The foundation stubs in this case will be reinforced using 2 plates that will form a splicing joint between the stub and the main leg member. The bracing members will be removed and replaced with new ones of the same size. The new members will be cut and drilled on site and cold galvanising will be used to prevent corrosion. The bolts will be cold galvanised as well. The splicing will take place on one leg at a time. Two steel plates will be placed on the inside of the main leg member across the corrosion line, one on each flange. The use of plates eliminates the need to have the tower supported by a crane while carrying out work.

The rusted bolts on the joints will be replaced with new bolts. The plates will be cut and drilled on site to fit over the affected area. The additional holes will be equally spaced as the existing holes and will have the same diameter. The plates will then be cut such that it spans over the affected area and has to be cold galvanised. These plates will be drilled such that they fit on the main leg member and the holes align to the holes on the main leg member. One plate will be fitted at a time. The contractor is required to do the measurements on site before procuring the material. The cutting and the installation of the new tower members will be done on site. The Eskom construction guideline. TRMSCAAC Rev 6 will be applicable for this project. These repairs of splicing members can be carried out under live conditions; however for the replacement of the members outages will be require

3.2 CONRETE CRACKS AND SPALLING

Most of the foundations on these lines have severely cracked, there's also a presence of spalling and leaching in some isolated cases. The cracking of the concrete could be caused by many factors such as poor workmanship (handling, curing and vibration of the concrete). The strength of the concrete as well the reinforcement could also be other contributing factors.

3.2.1 Crack Mitigation

Mitigation for the repair of cracks as per TRMSCAAC:

a) All cracks less than 2mm wide and less than 30mm deep must be repaired with Eskom approved compounds.

b) For all larger cracks than specified in (a) above, the concrete will be demolished and recast.
To prevent further cracking of the foundations; the foundations will be coated with a protective coat that has the following properties:

- It will not change the appearance of the concrete structure.
- Protection against ingress: Reducing or preventing the ingress of adverse agents, e.g. Water
- Physical resistance: Increasing resistance to physical or mechanical attack.
- Resistance to chemicals: Increasing resistance of the concrete surface to deteriorations by chemical attack.

3.2.2 Concrete Spalling Mitigation

Once the water is in contact with the rebar, chlorides in the cooling water break down the iron oxide protective coating allowing localised corrosion of the steel at that point. As the rebar rusts, the corrosion by-products expand on a volumetric basis of about 7 to 1 relative to the original rebar. This causes further cement cracking and spalling, which sustains the cycle of concrete deterioration and rebar corrosion. The spalling of the concrete is a result of insufficient concrete to reinforcement cover, concretetype, carbonation and chloride attack.

Typically, concrete repair is a multi-step process. The following procedure would be followed

- Removal of all poor quality concrete and complete cleaning of the remaining concrete with a high-pressure water jet (up to 34.5000 KPa).
- Cleaning of rebar to remove rust, grease, and dirt. For rebar with excessive loss of cross- section, removal and replacement is recommended. In areas of large-scale delamination, rebar mesh can be used as replacement. Rebar and/or rebar mesh should be primed with an anti-corrosion coating protection.
- Replacement of the removed concrete with fresh mortar by hand or by machine, depending upon the area. The repair mortar should have good strength compatibility with the substrate and might include a bonding agent primer.
- After curing, application of a suitable, protective coating

3.3 CONCRETE ENCASEMENT

The concrete cap shall be prepared for additional concrete to create a 45 degrees slope on the top of the foundation cap to allow water to run off. The bonding of the new concrete to the existing concrete is crucial to keep the water out therefore and approved bonding agent shall be used. In the instance where the cracks are structural, and spalling is severe; the concrete cap should be replaced with a new one following the steps below:

(a) **Breaking of the existing tower foundation cap**

- The concrete cap will then be broken using hand tools or a hand held jack hammer. Care should be taken to make sure that the steel members are not damaged during the process.
- In a case where the concrete cap will not be totally removed it will have to be scabbled to prepare for the bonding with the new concrete cap.
- The bonding between the existing concrete and the new concrete is of vital importance to prevent water (moisture) to penetrate and reach the steel. A cement slurry should be poured on the scabbled area and immediately cast the new concrete.

(b) **Excavations**

Excavate in soft material, exceeding 500mm deep but not exceeding 1000mm deep. An excavation of about 1000mm x1000mm and 500mm around each tower leg will be required to expose the existing concrete cap.

(c) **Cleaning of the tower leg members and stub**

The tower members have to be cleaned to prepare for the application of a protective coat. A steel brush will be used to clean the rust on the members.

(d) **Painting of the tower leg members and stub**

When the tower cleaning is complete, bitumen protective coating shall be applied on the tower members.

(e) **Formwork**

Formwork should be prepared before casting of concrete for all four legs of the tower. All concrete placed against shuttering shall be free from irregularities, fins, rock pockets or other imperfections.

(f) **Casting of the concrete block**

- Before casting the new concrete block, apply the cement slurry. A minimum 25MPa concrete block (triangular prism shape) will be cast. The size of the block will be 1000mm by 1000mm with a height of 1000mm.
- The block will have a volume of (right angle triangle with 1000 mm sides and 1000 mm height.)

- For moderate to severe conditions the mix design shall comply with SANS10100-2 where the minimum cement content shall be 340 kg/m3 CEM II or CEM I cement with extenders.

(g) **Concrete curing & wood floating**

- Concrete will be cured using a curing compound or water.
- The top surface of the new concrete encasement shall have a wood float finish, and shall be contoured to allow water to shed.

(h) **Backfill**

- After completion of foundation construction, the Contractor shall backfill each excavation with suitable material
- The material to be utilised for compacted backfill shall be moistened to OMC (optimum moisture content +10%), and deposited in horizontal layers, having a thickness of not more than 300 mm before being compacted.

3.4 SOIL EROSION

There are various causes of soil erosion found on the various lines along Duvha – Vulcan 1 400kV, Hendrina – Vulcan 1 400kV and Hendrina – Vulcan 2 400kV, first being steep and long slopes where the soils are pushed downstream and cause soil erosion. The other type of erosion is the tunnelling and scouring around structures, which occurs when water erodes and undermines structures. A big contribution to the erosion is the loss of vegetation underneath the towers; the rainfall splashes harder on the soil and causes erosion. Various erosion control systems will be implemented to dissipate the flowing water energy, and these include:

- Gabion erosion control systems
- Hydro seeding

3.4.1 SCOURING MITIGATION

Tunnelling and scouring occurs where water erodes and undermines structures. It is evidenced by voids on the upstream side of retaining structures and subsidence or cracking of the soil erosion structure. This can be remedied by replacement of soil with stabilised material to prevent further scouring.

- All excavation work will be done in stages, exposing each tower leg foundation, and then backfilling prior to exposing the next.
- The material to be utilised for compacted backfill shall be moistened to optimum moisture content (OMC) ±10%, and deposited in horizontal layers, having a thickness of not more than 200 mm before being compacted.
- Use soilcrete, cement to soil ratio of 1:8 to replace backfill that has been eroded away by the stream. The Soilcrete shall be mechanically compacted to a minimum of 98% MOD AASHTO. In the instance where in-situ soil is not sufficient for backfill, then import G7 material

3.4.2 HYDROSEEDING

Hydroseeding is a fast and cost effective method of encouraging accelerated growth of natural vegetation over large areas. It entails a process of combining seed, mulch, fertilizer, pacifiers (chemicals facilitating adhesion), and optional soil amendments with water to mix in a tank to form thick slurry. This slurry is applied with pressure via hose onto the soil to create the ideal environment for seed germination and turf development. Vegetation establishes quickly providing a uniform cover for erosion control. The hydroseeding is to be done along the width the servitude around the affected towers.

4. BILL OF MATERIAL

Line	Tower	Item	Unit	Quantity
Kendal - Apollo 400KV Line	Twr 93	Gabion Wall Installation	Unit	Quantity
		Wall Length	m	20
		Wall Volume	m3	75
		Area	m2	3,75
		Gabion Stones Weight	t	112,5
		Gabion baskets (2 m x 1m x 1m)	no	10
		Gabion baskets (2m x 1,5m x 1,5m)	no	10
		Filter Fabric m wide Geo Textile	m^2	150
Kendal - Minerva 400KV Line	Twr 87	Gabion Wall Installation		
		Wall Length	m	20
		Wall Volume	m3	75
		Area	m2	3,75
		Gabion Stones Weight	t	112,5
		Gabion baskets (2 m x 1m x 1m)	no	10
		Gabion baskets (2m x 1,5m x 1,5m)	no	10
		Filter Fabric m wide Geo Textile	m^2	150
		Soil Erosion		
Duvha - Vulcan1 400kv Line	Twr101	Imported Backfill and Hydroseeding	m^3	30
	Twr102	Imported Backfill and Hydroseeding	m^3	30
	Twr103	Imported Backfill and Hydroseeding	m^3	30
	Twr104	Imported Backfill and Hydroseeding	m^3	30
	Twr106	Imported Backfill and Hydroseeding	m^3	30
	Twr107	Imported Backfill and Hydroseeding	m^3	30
		Imported Backfill and Hydroseeding	m^3	30
	Twr108	Imported Backfill and Hydroseeding	m^3	30
	Twr109	Imported Backfill and Hydroseeding	m^3	30
	Twr110	Imported Backfill and Hydroseeding	m^3	30
	Twr111	Imported Backfill and Hydroseeding	m^3	30
Hendrina - Vulcan 1 400kV	Twr 196	Imported Backfill and Hydroseeding	m^3	30
	Twr 197	Imported Backfill and Hydroseeding	m^3	30
	Twr 198	Imported Backfill and Hydroseeding	m^3	30
	Twr 200	Imported Backfill and Hydroseeding	m^3	30
		Imported Backfill and Hydroseeding	m^3	30
	Twr 201	Imported Backfill and Hydroseeding	m^3	30
	Twr 202	Imported Backfill and Hydroseeding	m^3	30
	Twr 203	Imported Backfill and Hydroseeding	m^3	30
	Twr 204	Imported Backfill and Hydroseeding	m^3	30

		Concrete Encasement		
Kusile Minerva No1 400kV Line	Tower 119	Breaking of the cracked concrete	no	4
		Steel brush the rusted members	no	4
		Splicing of tower members	no	4
		Replacement of tower members	no	4
		Casting of (1.0x1.0x1.0m) concrete cap around the tower leg	m^3	4
		Concrete cube tests	no	4
		Steel wire mesh reinforcement roll	no	1
Kusile Minerva No1 400kV Line	Tower 121	Breaking of the cracked concrete	no	4
		Steel brush the rusted members	no	4
		Splicing of tower members	no	4
		Replacement of tower members	no	4
		Casting of (1.0x1.0x1.0m) concrete cap around the tower leg	m^3	4
		Concrete cube tests	no	4
		Steel wire mesh reinforcement roll	no	1
Kusile Minerva No1 400kV Line	Tower 117	Breaking of the cracked concrete	no	4
		Steel brush the rusted members	no	4
		Splicing of tower members	no	4
		Replacement of tower members	no	4
		Casting of (1.0x1.0x1.0m) concrete cap around the tower leg	m^3	4
		Concrete cube tests	no	4
		Steel wire mesh reinforcement roll	no	1
Hendrina Vulcan 1 400kV	Tower 200	Breaking of the cracked concrete	no	4
		Steel brush the rusted members	no	4
		Splicing of tower members	no	4
		Replacement of tower members	no	4
		Casting of (1.0x1.0x1.0m) concrete cap around the tower leg	m^3	4
		Concrete cube tests	no	4
		Steel wire mesh reinforcement roll	no	1

5. CONCLUSION AND SUMMARY

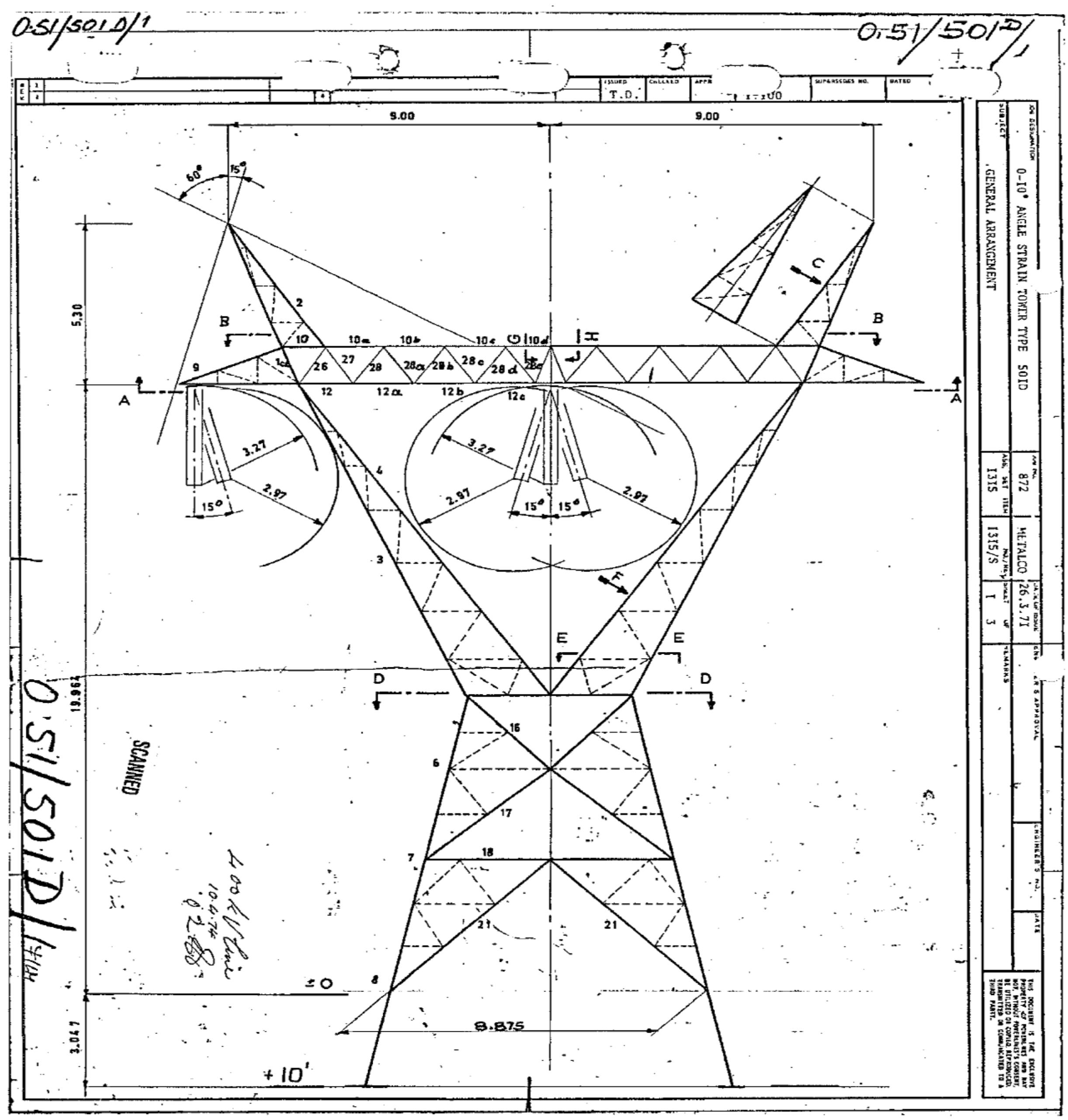
See Table 3 for a summary of the proposed mitigation for the different tower.

Table3: Summary of the Scope

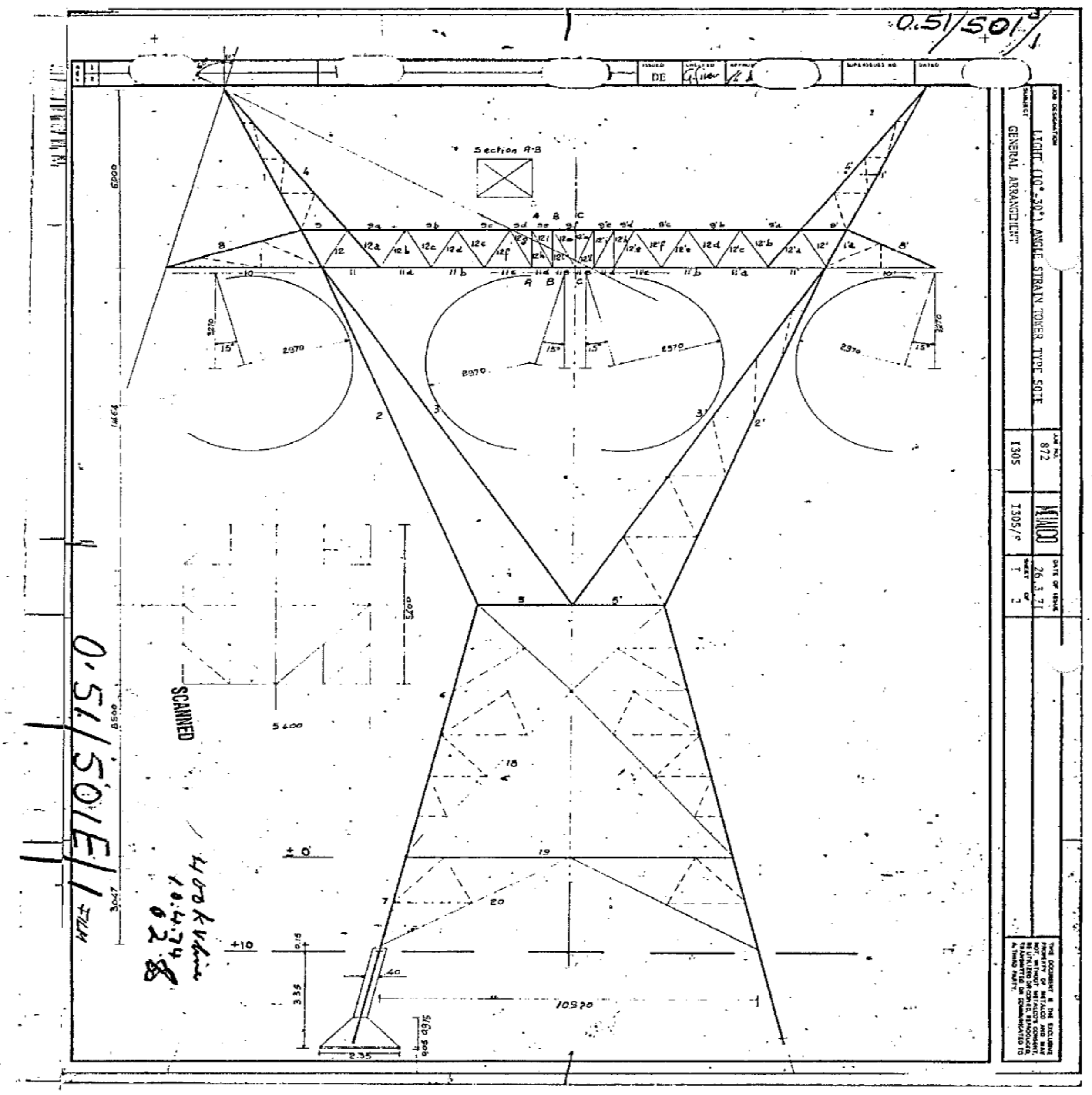
	Lucile - Minerva No1 400kV		**Mitigation**
1	Kusile Minerva No1 400kV Line	Twr 105	Maintenance
2	Kusile Minerva No1 400kV Line	Twr 121	Crack Repair
3	Kusile Minerva No1 400kV Line	Twr 119	Corrosion Assessment and Encasement
4	Kusile Minerva No1 400kV Line	Twr 117	Crack Repair and Encasement
5	Kusile Minerva No1 400kV Line	Twr 115	Maintenance
6	Kusile Minerva No1 400kV Line	Twr 112	Maintenance
7	Kusile Minerva No1 400kV Line	Twr 111	Maintenance
8	Kusile Minerva No1 400kV Line	Twr 113	Catchment to be relocated
9	Kendal - Apollo 400KV Line	Twr 93	Gabion Installation
10	KendaL – Minerva 400kV	Twr 87	Gabion Installation
	Duvha - Vulcan1 400kV		
1	Duvha Vulcan1:400kv Line	Twr101	Backfilling and Hydroseeding
2	Duvha Vulcan1:400kv Line	Twr102	Backfilling and Hydroseeding
3	Duvha Vulcan1:400kv Line	Twr103	Backfilling and Hydroseeding
4	Duvha Vulcan1:400kv Line	Twr104	Backfilling and Hydroseeding
6	Duvha Vulcan1:400kv Line	Twr106	Backfilling and Hydroseeding
7	Duvha Vulcan1:400kv Line	Twr107	Backfilling and Hydroseeding Corrosion Assessment and Encasement
8	Duvha Vulcan1:400kv Line	Twr108	Backfilling and Hydroseeding
9	Duvha Vulcan1:400kv Line	Twr109	Backfilling and Hydroseeding
10	Duvha Vulcan1:400kv Line	Twr110	Backfilling and Hydroseeding
11	Duvha Vulcan1:400kv Line	Twr111	Backfilling and Hydroseeding
	Hendrina - Vulcan 1 400kV		
1	Hendrina Vulcan 1 400kV	Twr 196	Backfilling and Hydroseeding
2	Hendrina Vulcan 1 400kV	Twr 197	Backfilling and Hydroseeding
3	Hendrina Vulcan 1 400kV	Twr 198	Backfilling and Hydroseeding
4	Hendrina Vulcan 1 400kV	Twr 200	Backfilling and Hydroseeding Corrosion Assessment and Encasement
5	Hendrina Vulcan 1 400kV	Twr 201	Backfilling and Hydroseeding
6	Hendrina Vulcan 1 400kV	Twr 202	Backfilling and Hydroseeding
7	Hendrina Vulcan 1 400kV	Twr 203	Backfilling and Hydroseeding
8	Hendrina Vulcan 1 400kV	Twr 204	Backfilling and Hydroseeding

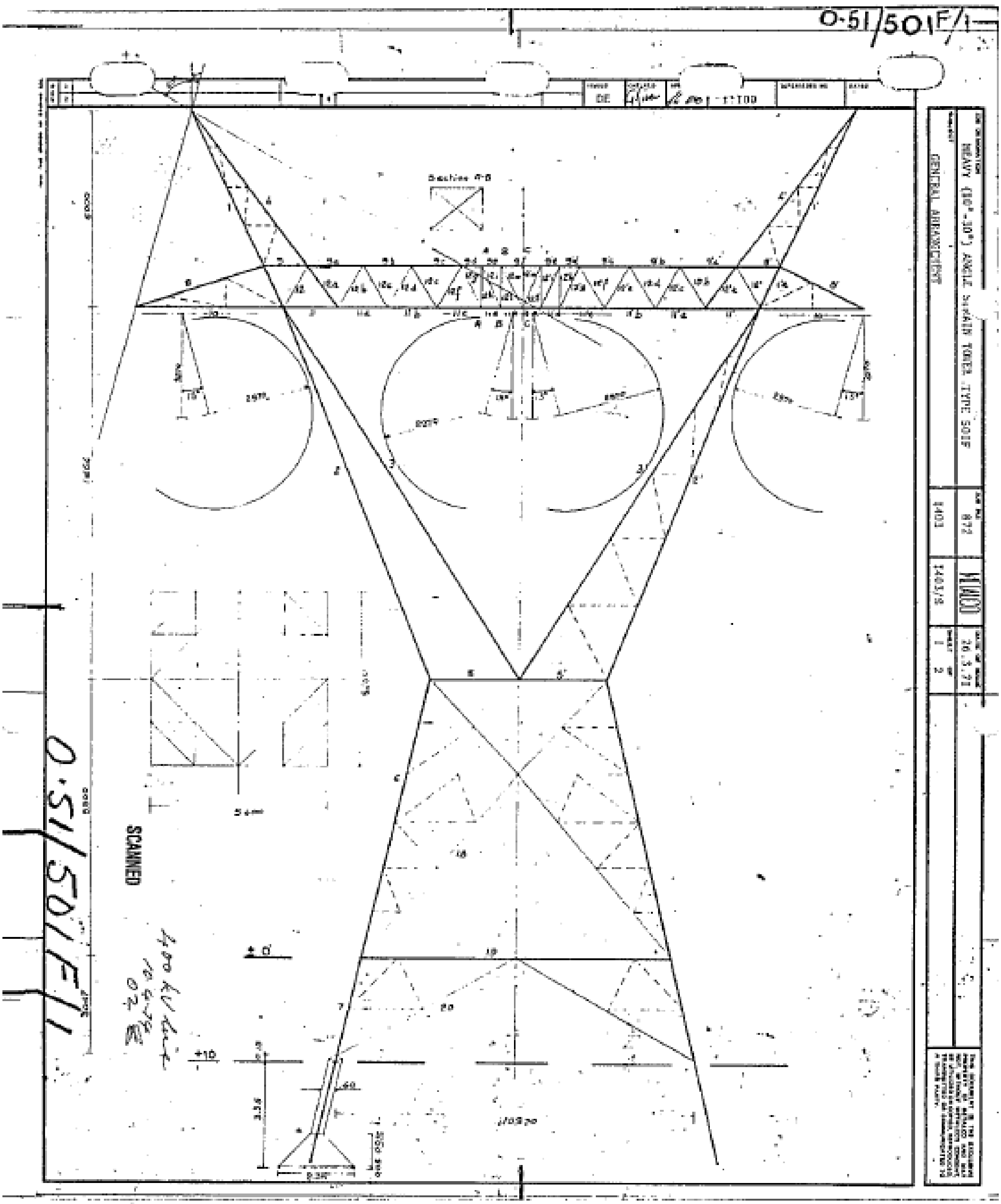
APPENDIX A - Tower outlines

Tower 501D

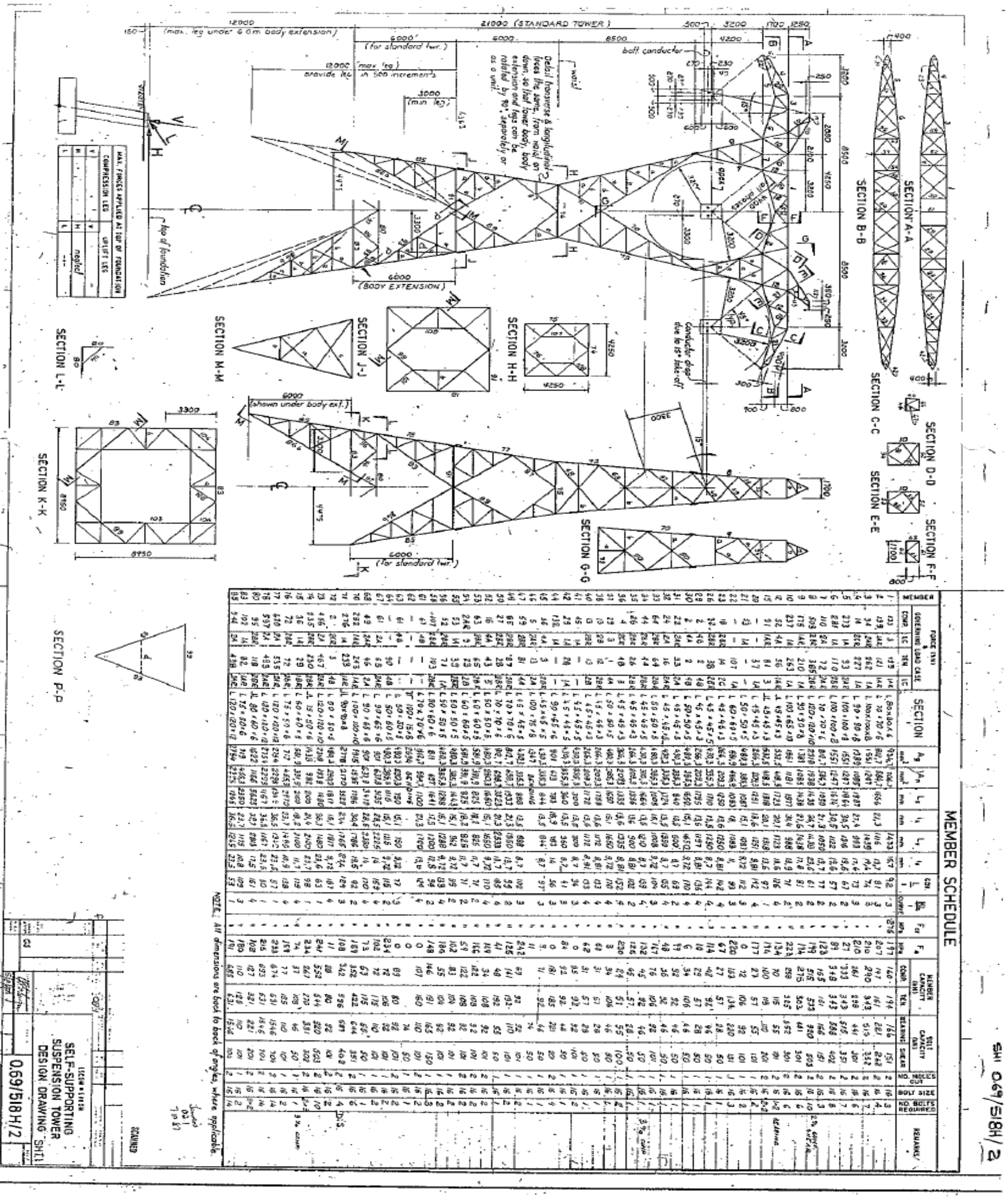


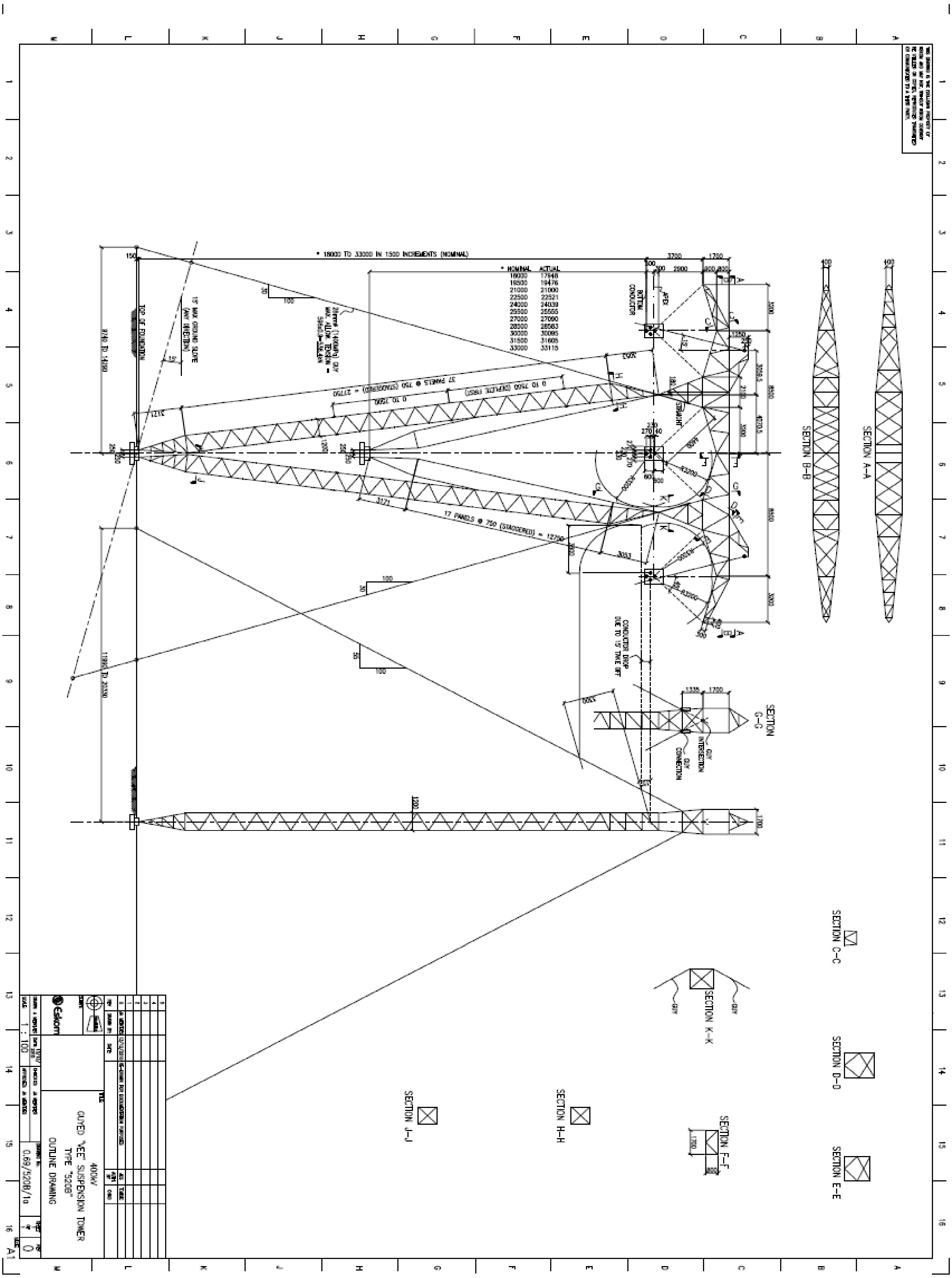
Tower 501 E




0-51/501F/1
GENERAL ARRANGEMENT
SCANNED
400 kV line

518H Tower


21000 (STANDARD TOWER)
6000 (BODY EXTENSION)
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION H-H
SECTION J-J
SECTION K-K
SECTION L-L
SECTION M-M
SECTION P-P
MEMBER SCHEDULE
SELF-SUPPORTING SUSPENSION TOWER DESIGN DRAWING
0.69/518H/2


400kV
GUYED "EE" SUSPENSION TOWER
TYPE "520B"
OUTLINE DRAWING
0.69/520B/1a
1 : 100
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION H-H
SECTION J-J
SECTION K-K
TOP OF FOUNDATION