CEOCOR

Madrid (Spain)

May 25th – May 28th, 2021

Paper 2021-11

Integrated SACP & ACIM – a case study

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INTEGRATED SACP & ACIM
- a case study.

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Abstract

Two new steel water pipelines (Majosi Pipe 23km long 800mm diameter and Mogalakwena Pipe 3.6km long 800mm diameter) in rural remote areas in South Africa were found to require both supplementary cathodic protection due to corrosive soil conditions as well as AC mitigation due to the proximity of high voltage AC powerlines. The areas were also known to be prone to theft and vandalism.

The lack of medium voltage AC power in the area together with the risk of vandalism favoured the use of sacrificial anode cathodic protection. The pipeline coating was selected in order to minimise the current demand for the cathodic protection system, but the high electrical resistance characteristic of the coating had the consequence of increasing the level of AC mitigation required to maintain safe touch potentials and minimise AC corrosion risk.

The pipeline coating integrity was analysed and ensured by means of close interval surveys.

An integrated cathodic protection and AC mitigation system utilising zinc anodes without DC de-couplers was designed and installed. Pipe potential and other key measurements after a seasonal cycle are available which prove the efficacy of the system.

This paper covers the CP design and ACM modelling process and presents the successful commissioning data for the project.

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** Daniel Hovy is an independent consulting engineer with more than 30 years experience in pipeline design and 7 years in electrical interference mitigation.

INTRODUCTION

Two 800mm ø pipelines which form parts of wider water distribution networks in the northern areas of the Limpopo Province in South Africa presented the construction engineers with some interesting challenges.

The Majosi Pipeline transfers water from a bulk infrastructure system to a regional distribution system. Owing to the high static head and surge pressures and large diameter required to facilitate optimal flow conditions, it was necessary to utilise welded steel construction.

The 23km pipeline was coated externally using sintered polyethylene with cold tape wrapped field joints.

The pipeline route traverses corrosive soils and runs parallel to a high voltage power line for much of its length.

The pipeline route and soil characteristics are shown in the following figures:

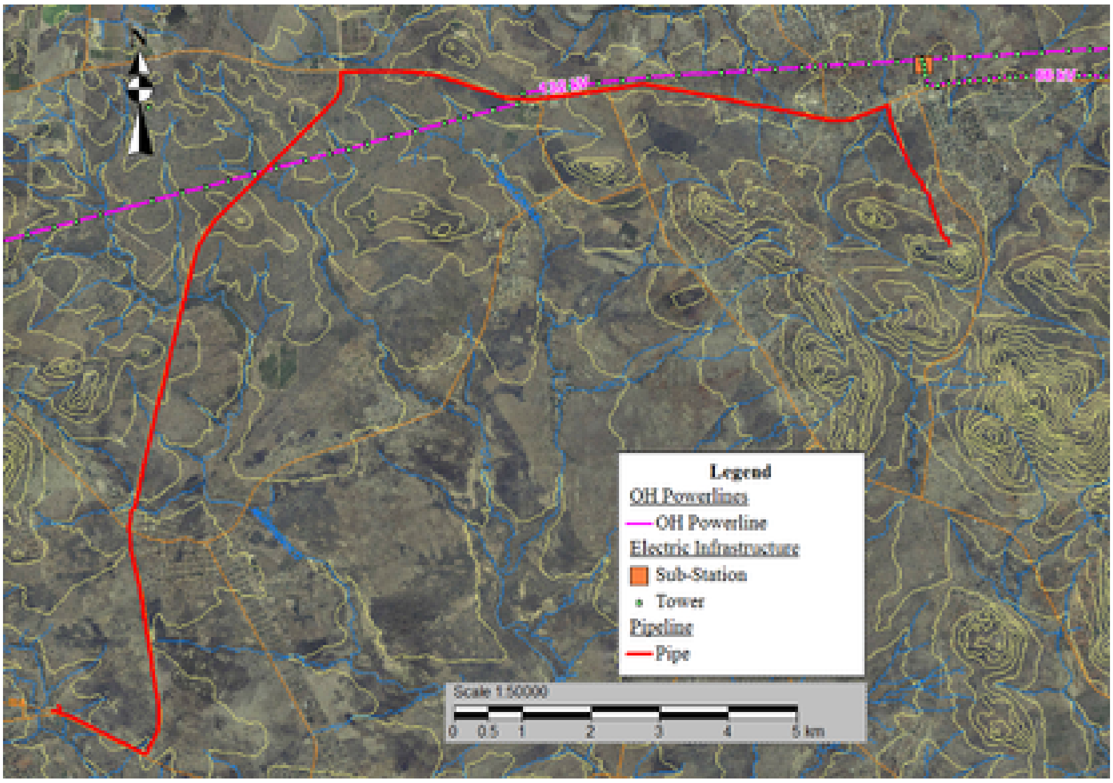

Fig 1: Majosi Pipeline route showing proximity of high voltage AC power lines

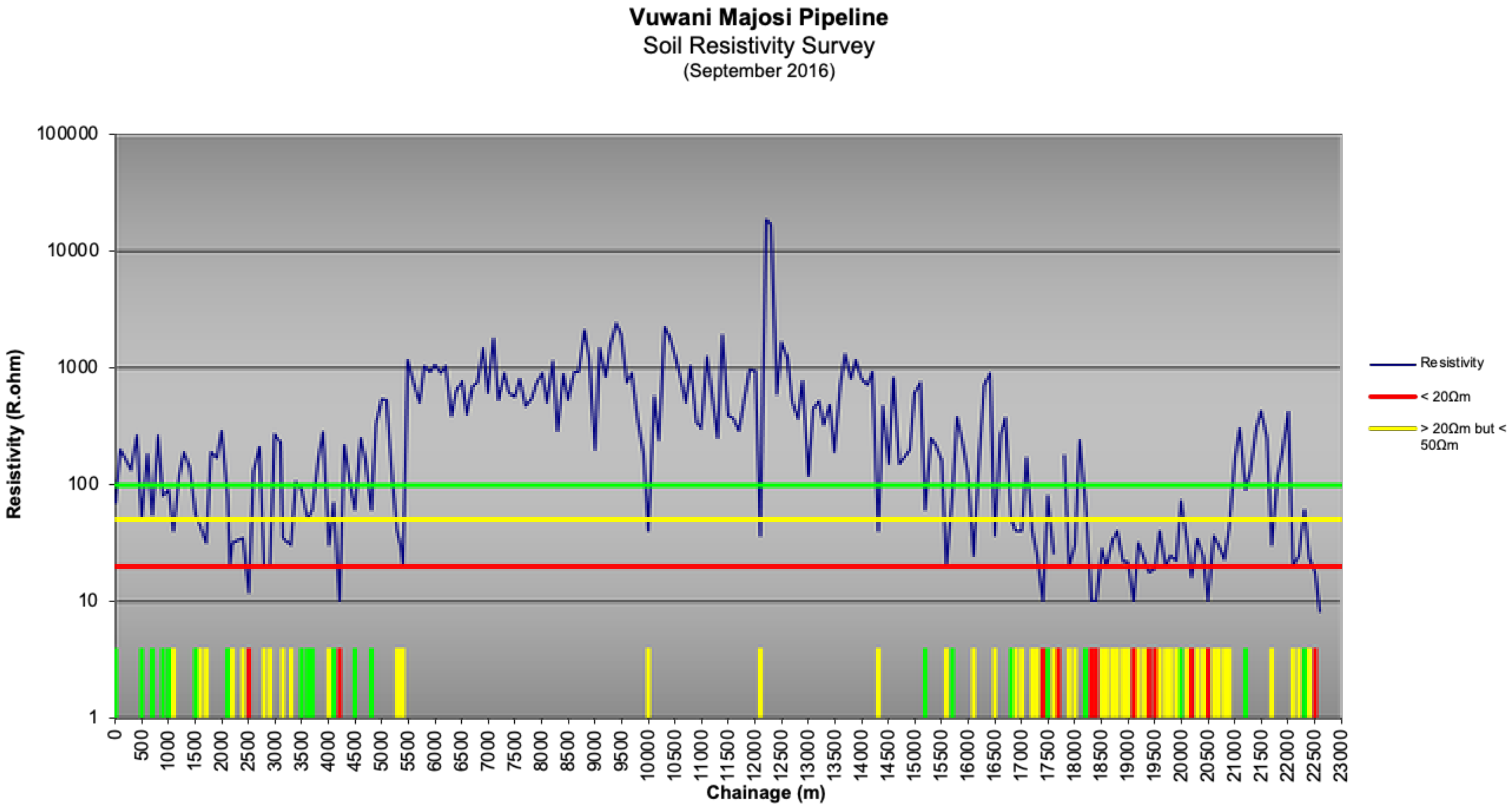

Fig 2: Majosi Pipeline soil resistivity characteristics along the pipeline route.

Similarly, a 3.6km section of the Mogalakwena pipeline system coated with rigid polyurethane is affected by corrosive soils and proximity to high voltage power lines.

Fig:3 Mogalakwena Pipeline system

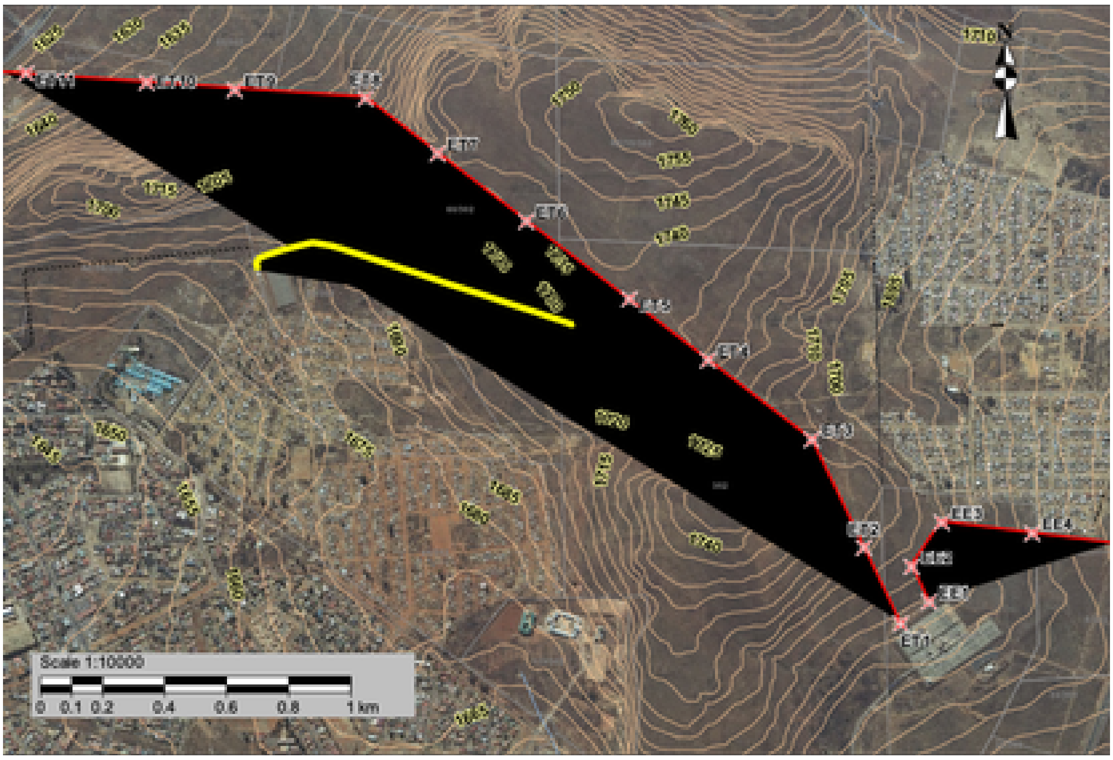

Fig 4: Mogalakwena Pipeline route showing proximity of high voltage AC power lines.

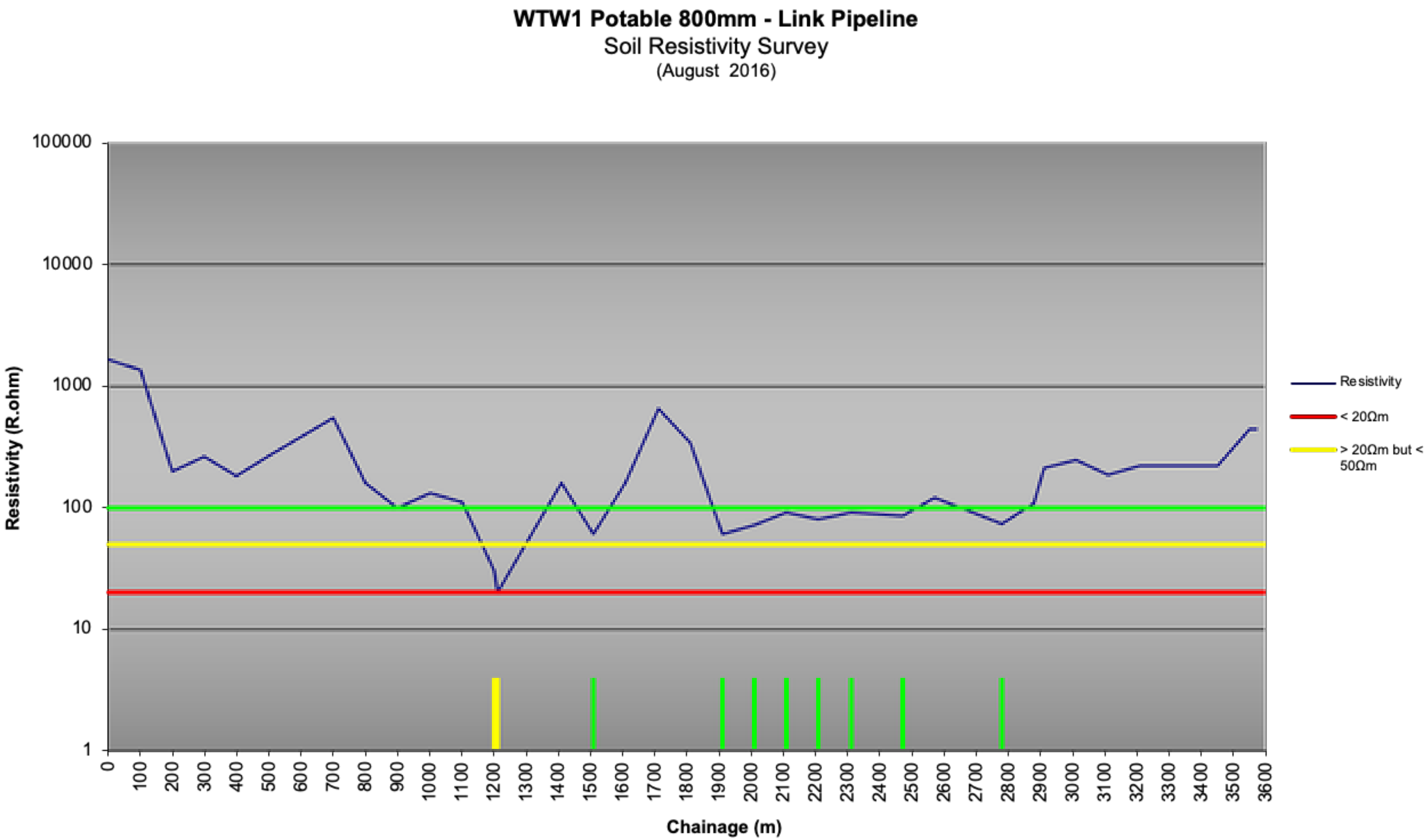

Fig 5: Mogalakwena Pipeline soil resistivity characteristics along the pipeline route.

SYSTEM DESIGN

The cathodic protection (CP) systems for both pipelines were based on a design life of 50 years with a current density of 40µA/m^2

The anticipated AC interference levels based on computer modelling are shown in the following figures for the Majosi Pipeline.

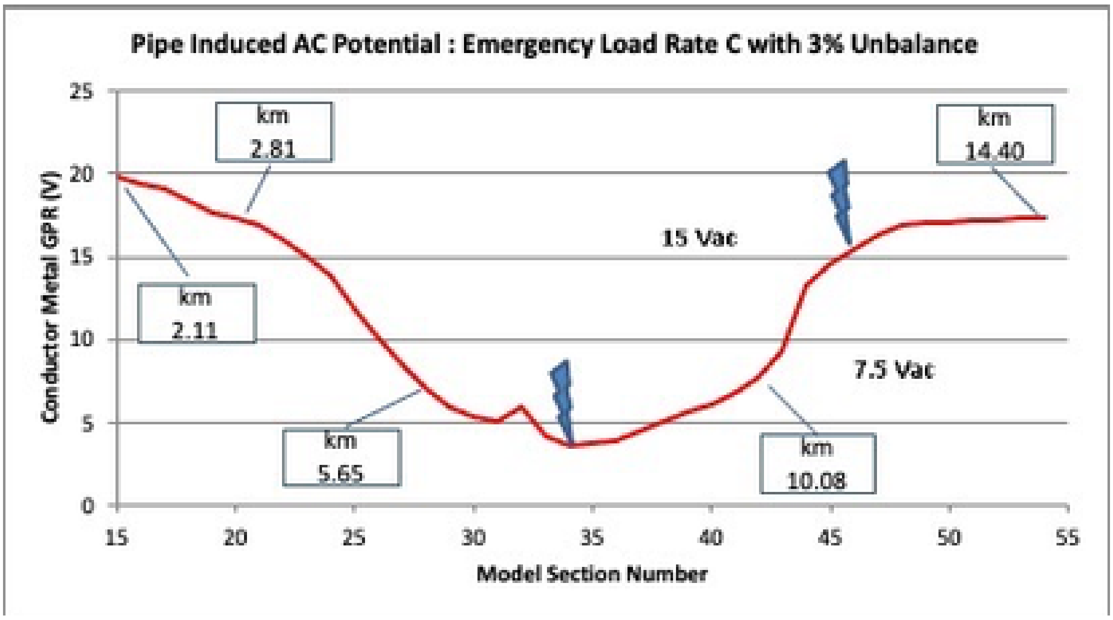

Fig 6: Majosi pipeline – anticipated maximum steady state AC potential w.r.t. ground

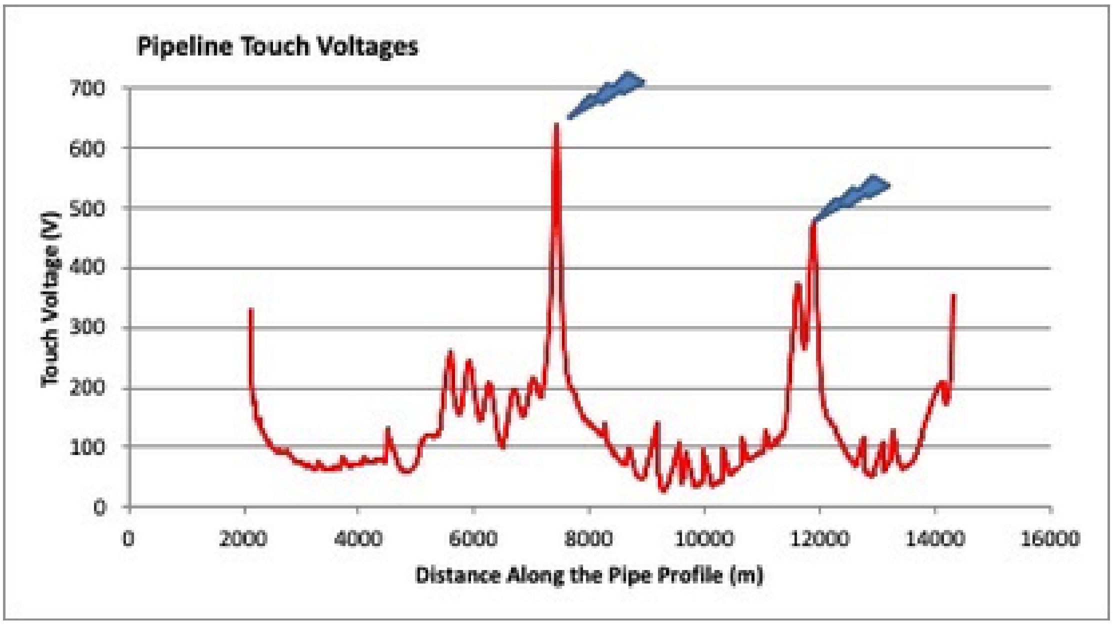

Fig 7: Majosi pipeline – anticipated maximum transient AC potential w.r.t. ground.

Both pipelines are located in areas where there is a dearth of medium voltage power supplies that could be used for ICCP systems. The areas are also subject to theft & vandalism, particularly of electrical infrastructure due to the scrap value of copper. There are no electrified rail systems in the areas.

Although magnesium anodes are generally used for soil applications due to their higher driving potential, limited design life due to self-corrosion at low current densities is a drawback. Accelerated consumption of the magnesium caused by direct connection of zinc earthing electrodes for AC mitigation is also a challenge unless decouplers are installed.

Zinc anodes were selected for cathodic protection to provide the design life required. Zinc ribbon earthing electrodes were chosen in order to do away with the need for DC decouplers and minimise electrical infrastructure associated with AC interference mitigation systems.

The two systems (CP and ACM) were designed independently. As the soil resistivity, albeit corrosive, is relatively high for the application of zinc anodes, the anodes were constructed using 3.5kg/m zinc ribbon laid in 60 – 80m lengths. The cathodic protection anodes were then located in the lower resistivity areas with sulphate rich backfill in order to keep the anodes active.

The zinc ribbons required for AC interference mitigation were located according to the AC interference modelling results and buried directly in the pipeline bedding during construction of the pipelines.

The cathodic protection results are shown in figures 8 & 9.

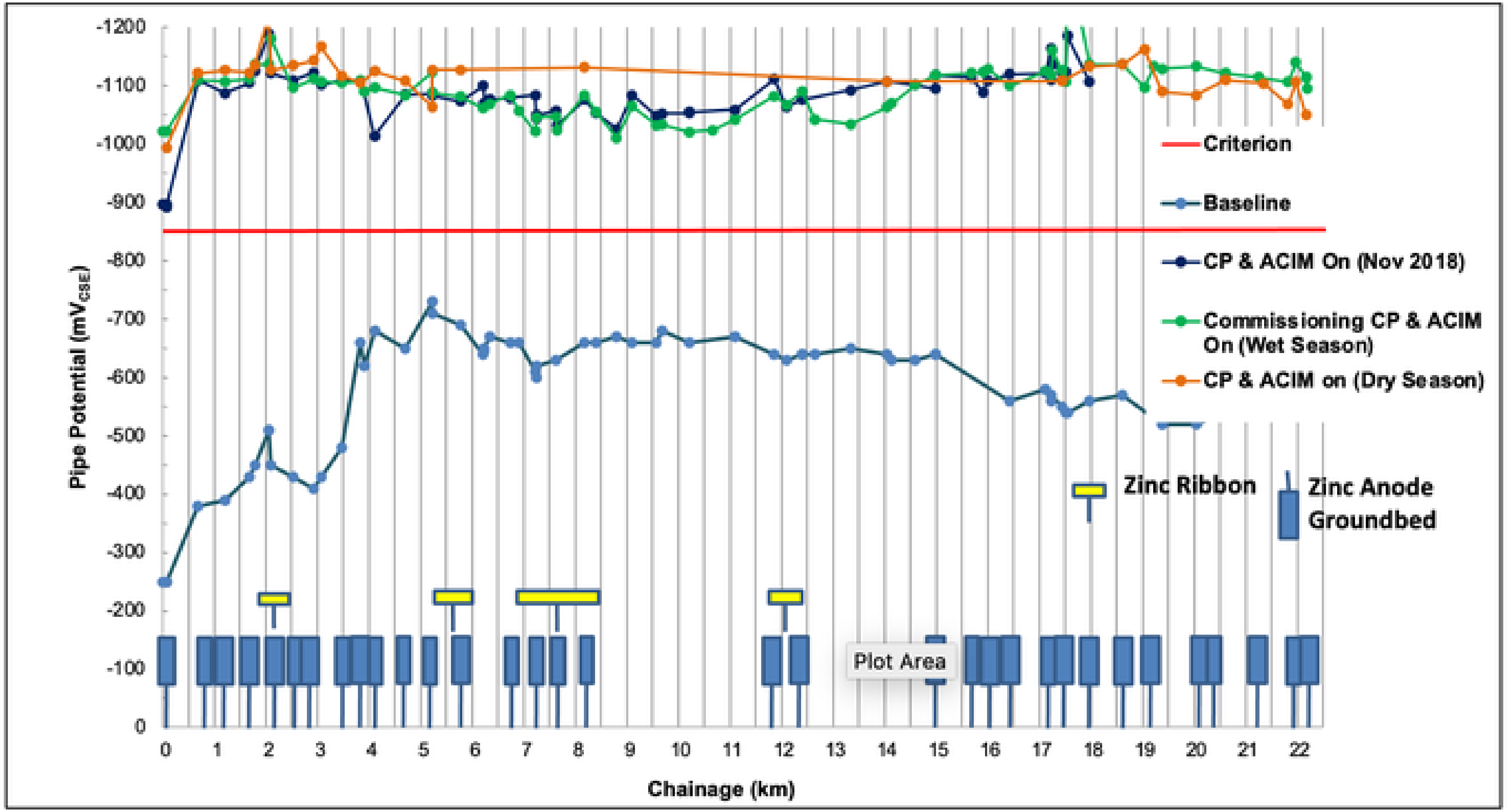

Fig 8: Majosi pipeline pipe-to-soil potentials

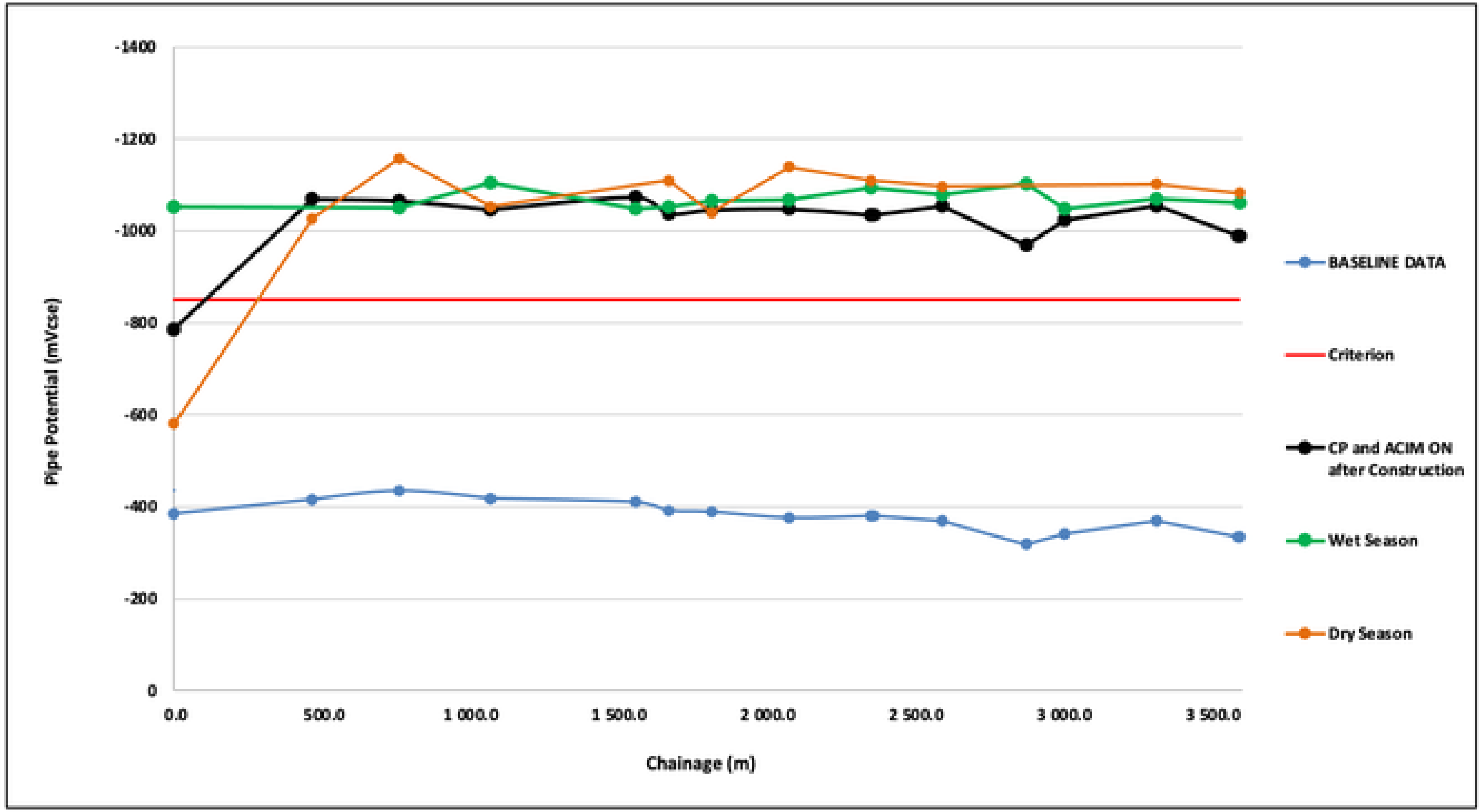

Fig 9: Mogalakwena pipeline pipe-to-soil potentials

CONSTRUCTION COMPLICATIONS

On each pipeline, a construction defect at one end of the pipeline in the form of uncoated steel encased in concrete limited the level of polarisation achieved. It can be seen that the increased output of the anodes in the wet season compensates for this, but full protection was not obtained in the dry season. The installation of additional anodes was recommended to cater for this situation.

CONCLUSION

The unanswered question is related to the effect of AC grounding on the consumption rate of the zinc anodes. No published literature appears to be available related to the consumption rate of sacrificial anodes under the combined effect of DC and AC.

As a precaution, a heavier grade than usual of AC mitigation ribbon was utilised. The theoretical capacity of the zinc anodes designated for CP was also halved.

This is a perfect subject for some university research.

Only time will tell if our gut feel was appropriate.