INTEGRATED WATER AND WASTE MANAGEMENT PLAN

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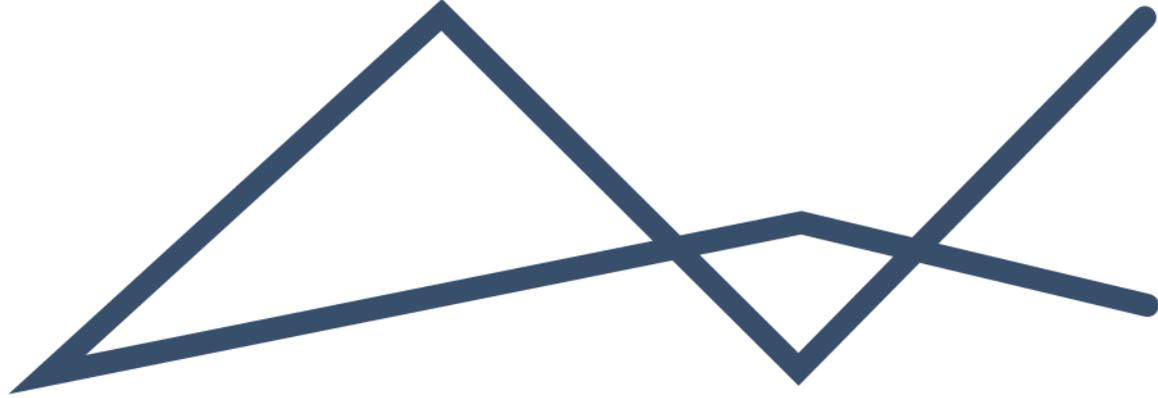
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	NAME	SIGNATURE	DATE
COMPILED:	Monica Niehof/ Andre van Rooyen	Sent Electronically	2025/10/30
CHECKED:	John von Mayer/ Monica Niehof	Sent Electronically	2025/10/30
AUTHORIZED:	Liam Whitlow	Sent Electronically	2025/10/30

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1   INTRODUCTION

Environmental Impact Management Services (Pty) Ltd, hereafter referred to as EIMS, were appointed by Kelvin Power (Pty) Ltd, hereafter referred to as the Holder or Applicant, to apply for the renewal of their existing Water Use License (WUL), Reference Number: 03/A21C/FGH/1110) issued on 24 June 2011. Section 5: License and Review Period, 5.1 of the license, indicate that the license is valid for a period of 15 years from the date of issuance. Therefore, the Holder need to apply for a renewal of the license if they want to continue with the water uses after 24 June 2026, when the license will lapse. This Integrated Water and Waste Management Plan (IWWMP) is compiled in support of the application for renewal of existing water uses and the addition of two existing water uses that have not been included in the current license.

Condition 10.2, Appendix II of the WUL states: "The IWWMP and RSIP (attached as Appendix 4) shall thereafter be updated and submitted to the Regional Head for approval, annually". This IWWMP is, therefore, also compiled to update the 2024 IWWMP and is based on the 2024 IWWMP annual update.

1.1 ACTIVITY BACKGROUND

Kelvin Power Station is a coal-fired power station, located in the Gauteng province near O.R. Tambo International Airport in South Africa. Kelvin Power is one of only a few power stations in South Africa not owned by the national energy producer, Eskom. Kelvin Power supplies between 10% and 15% of the power needs of the City of Johannesburg. Kelvin comprises of two stations; Station A and Station B. Station A is under decommissioning and a service provider duly appointed to follow the applicable closure notifications as per WUL requirements as well as the National Environmental Management Act No. 107 of 1998 prescripts. Station B is currently in operation. The power station makes use of coal and water for the generation of electricity. Station A (shut down in 2012) has six 30MW generators and 11 chain grate boilers. The newer B station has seven 60MW generators and seven PF type boilers.

Coal is combusted inside the boiler to produce super-heated steam (SHS). The SHS is transported via pipes to the turbines. Here, the SHS drives the blades of the turbine, spinning the rotor at high speed (mechanical energy). The rotor then turns the generator, which generates electricity. The slurry (containing fine and coarse ash) from the burnt coal is hydraulically routed to Ash Dam A for deposition.

For steam production in the boilers, demineralised water is added as make-up water to recycled condensate. The steam is condensed by cooling it with water circulated through the hyperbolic cooling towers. Kelvin receives approximately 3 681 m³/d of water from Rand Water and about 13 955 m3/d of treated effluent.

Station A, which utilised a larger coal fraction for heat generation, produced coarse ash, most of which was previously discarded on an open dumping area to the west of the power station. Station A is in care and maintenance and is not operational.

Station B uses a pulverised fine-coal fraction for heat generation, which results in a fine ash by-product. Previously, all the ash was pumped in slurry form to Ash Dam A. Presently, approximately 10% of the ash is being collected by a cement manufacturer as raw material, thereby facilitating waste minimisation (both in terms of ash and water use) at the power station. In addition, this practice is increasing the life of the Ash Dam's operational phase. The remainder of the ash is still slurried and disposed of on Ash Dam A.

The final waste product from Kelvin is in the form of a wastewater effluent, consisting of cooling tower blow-down, effluent from miscellaneous cooling water uses, ash-quenching effluent and washings. These effluents are discharged to the Modderfonteinspruit after de-siltation.

1.2 CONTACT DETAILS

The addresses of the related sections, as well as contact information of the responsible persons in terms of water management are listed in Table 1 below:

Table 1: Kelvin Power contact details.

Business Unit	Address	Responsible Person	Contact Details	
Management				
General Manager	3 Zuurfontein Road Kempton Park 1619	Segotsane Hendrick (Oupa) Seota	Email	oupa.seota@kelvinpower.com
Environmental Department				
Environmental Manager	3 Zuurfontein Road Kempton Park 1619	Lavhelesani Nelwamondo	Email	lavhelesani.nelwamondo@kelvinpower.com

1.3 REGIONAL SETTING AND LOCATION OF ACTIVITY

Kelvin Power Station falls within the Ekurhuleni Metropolitan Municipality, Gauteng Province, South Africa. The existing development is situated approximately 4.0 km southwest of Kempton Park and approximately 8.0 km northwest of Benoni covering a total footprint of ~149.0 ha . Kelvin Power is bordered by a residential area, Croyden to the south, Sebenza industrial area to the west and Spartan industrial area to the east. Kelvin Power is situated within the Modderfonteinspruit catchment, which forms part of the greater Jukskei and subsequently the Crocodile catchment. Kelvin Power Station is active on the farm Zuurbekom 33 IR. See Figure 1 for the location and Figure 5 for the layout and maps respectively, of Kelvin Power Station.

1.4 PROPERTY DESCRIPTION

The properties in respect of the WUL (03/A21C/FGH/1110) activities are associated with the farm Zuurfontein 33 IR. Table 2 tabulates the facility, property descriptions, municipalities, and associated owner details as applicable to Section 21 water use activities in terms of the NWA.

Table 2: Property details.

Project Area	Portions 87, 88 89, 90, 91, 96, 97, 98, 99, 100, 391 of the farm Zuurfontein 33 IR
Magisterial District	Gauteng Province
Local Municipalities	Ekurhuleni Metropolitan Council
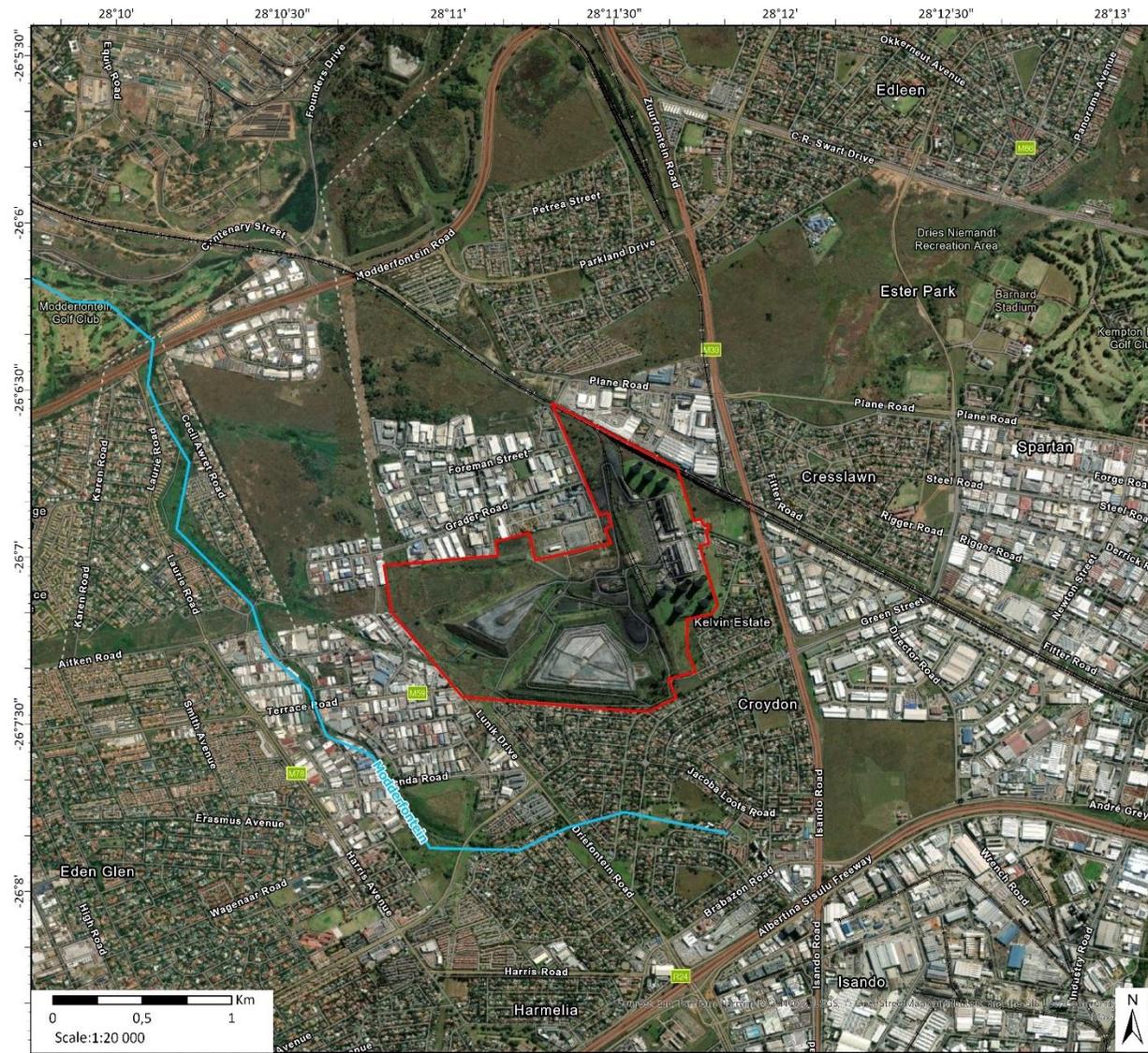
Figure 1: Locality map Kelvin Power Station

1.5   PURPOSE OF THE IWWMP

The objective of this IWWMP is not to merely compile all existing site knowledge from prior Environmental Authorisation (EA) processes or Environmental Management Programmes (EMPr) into a single manageable document. It also applies the principles of the hierarchy for Water Quality Management (WQM) and Resource Water Quality Objectives (RWQOs) to focus on management measures that impact either directly, or indirectly, on water resources. Objectives and action plans are set for the control of water (containing waste) and waste as sources of pollution which include, but not limited to, Stormwater Management Plans (SWMPs); Waste Management Plans (WMPs), audit schedules and monitoring programmes (Figure 2).
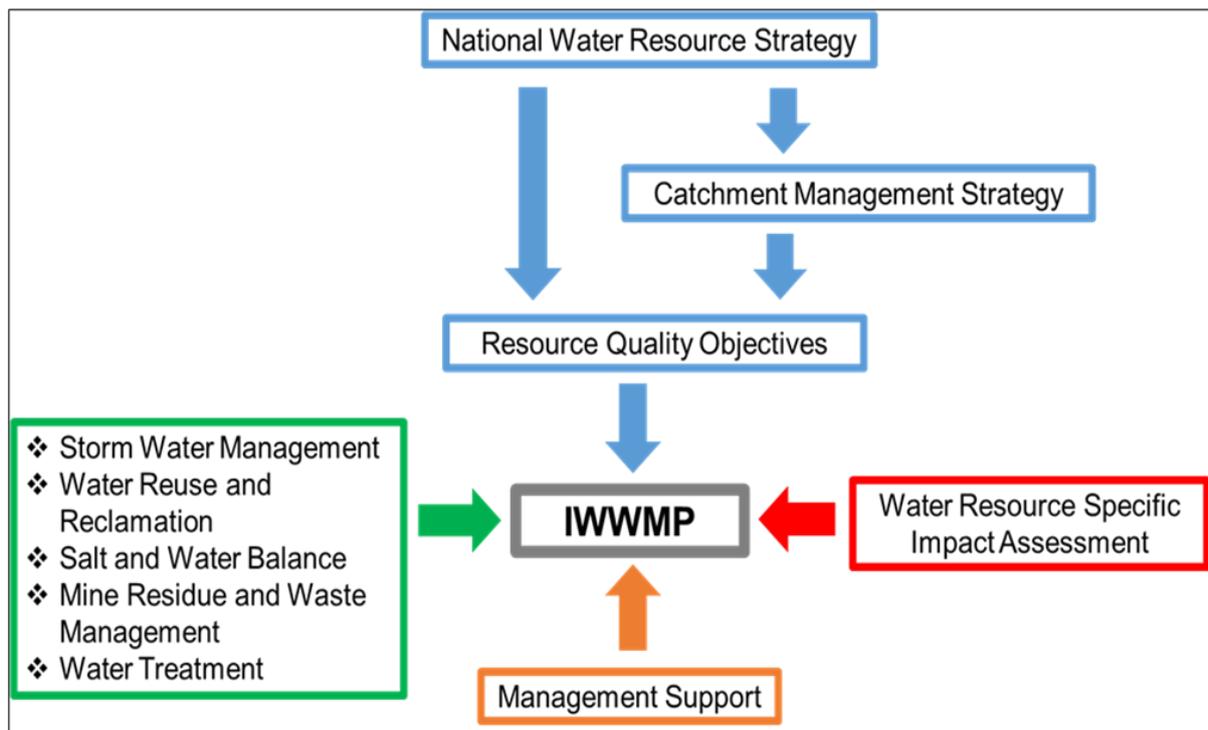
Figure 2: IWWMP Flow Diagram (ENVASS, 2024).

The hierarchy (Figure 3), makes use of precautionary principles and sets an order of priority for water and waste management decisions and actions. The summarised specific objectives of Kelvin Power with reference to the IWWMP would therefore be to ensure the:

- Implementation of appropriate pollution and stormwater control;

- Prevention measures; and

- The efficient re-use and recapture of 'dirty' water on the site.
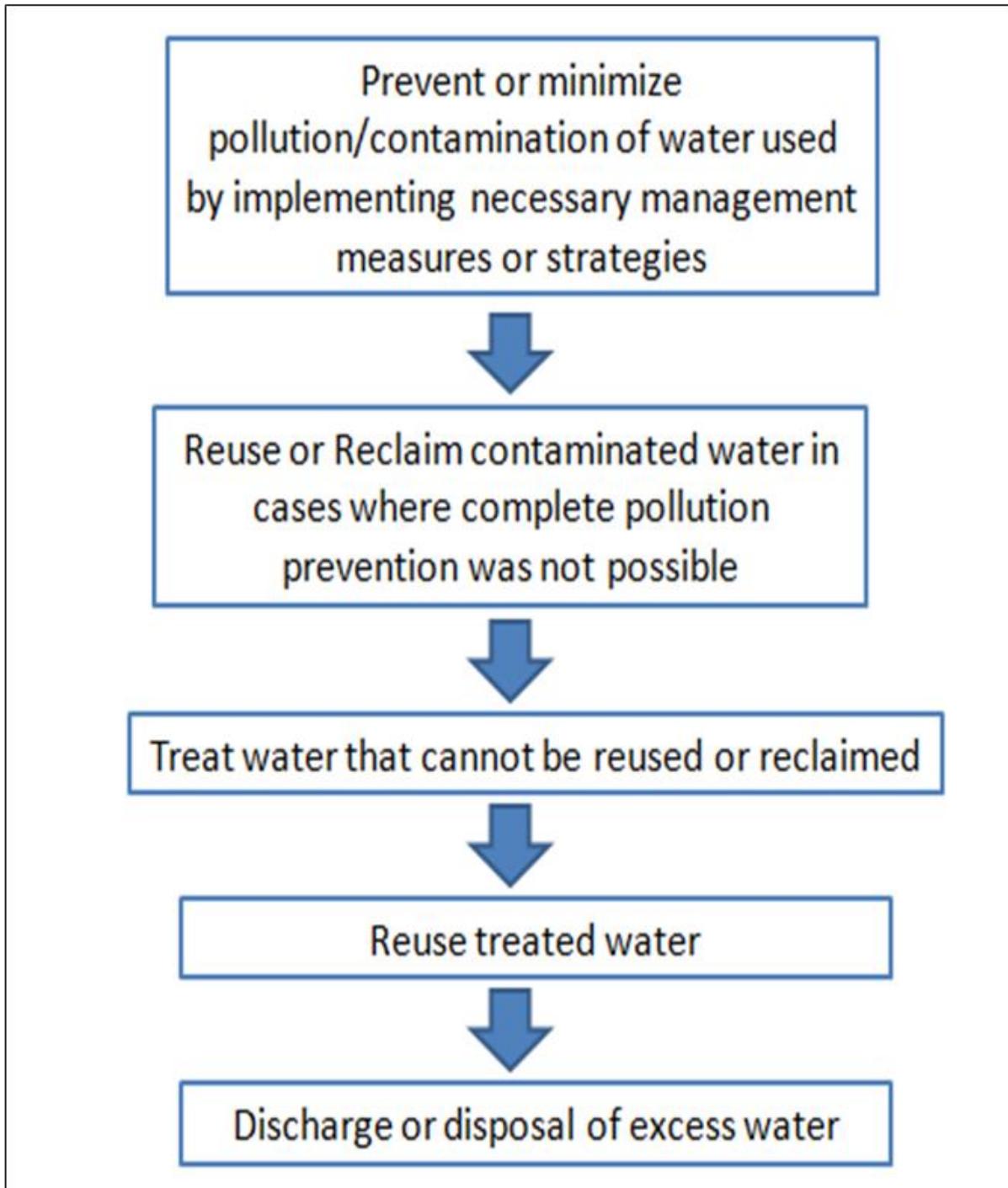
Figure 3: Hierarchy of Water Quality Management (ENVASS, 2024).

The plan also considers the water and waste management actions required through the entire Life of Activity (LoA) (incl. the post-closure and rehabilitation phase), whilst being dynamic enough to respond to changes in the receiving environment and available Best Practise Environmental Technology alternatives. This document is intended to be read in conjunction with the WUL and any new WUL applications as a legal requirement of the Department of Water and Sanitation (DWS) and binding document to which the licensee must comply, especially since the IWWMP forms part of the conditions specified in a WUL.

As part of the IWWMP phase, a detailed analysis is conducted of water use and waste management on-site, construction and operational management, as well as monitoring and controls to be or already implemented. It also includes an assessment of the implementation of best practices on site. The most important component of

the IWWMP development process is the formulation of goals, objectives and strategies for water use and waste management. The IWWMP addresses key areas related to development namely process water, stormwater, groundwater, surface water and waste. The implementation of the IWWMP is an interactive process whereas its performance is to be monitored on an annual basis to ensure that the concept of continual improvement is applied throughout the lifecycle of Kelvin Power.

The assessment of the IWWMP thus includes:

- The assessment of the document itself, as well as the submission of information relating to monitoring and auditing conducted in terms of the IWWMP which could lead to the identification of shortcomings and must be addressed as part of the IWWMP and action plan.

As part of the IWWMP process, the various roles and responsibilities of the different role players need to be identified, understood, and respected. The role of DWS is not to identify and select the water and waste management measures for implementation by a water user, however, is the responsibility of the water user to demonstrate that the selected management measures in the IWWMP action plan adhere to the "SMART" concept i.e.:

S = Sustainable;

M = Measurable;

A = Achievable;

R = Resource allocated; and

T = Timeframe specific.

The overall objective of the IWWMP is thus summarised as:

- Compilation of an annual IWWMP update based on the performance of Kelvin Powers' production processes against the WUL conditions;

- Provision of a management plan to guide a water user regarding the water and waste related measures which must be implemented on site in a progressive, structured manner in the short, medium and long term; and

- To formulate measures, compile strategies and an action plan to address the identified matters of concern.

2   CONTEXTUALISATION OF THE ACTIVITY

This chapter provides a detailed description of Kelvin Power Stations' operation, processes and products. The purpose of this section is to provide an understanding of the activities that may have an impact on the surrounding environment and the mitigation measures, monitoring and action plans proposed to be implemented to mitigate potential negative impacts. Kelvin Power consists of two (2) individual power stations, Station A and Station B:

- Station A – currently being demolished; and

- Station B – currently operating below its installed capacity.

2.1   DESCRIPTION OF ACTIVITY

2.1.1   STATION A

Station A operations ceased, and this station is currently being demolished. Station A used to have an installed capacity of 180 megawatts comprising six (6) turbo-alternators of 30 megawatts each and 11 boilers which consume approximately 85 tonnes of coal per hour. The furnaces at this station were chain grate types as opposed to the pulverised fuel type in Station B.

Station A, which utilised a larger coal fraction for heat generation, produced coarse ash, most of which was previously discarded on an open dumping area to the west of the power station (Golder, 2021).

2.1.2   STATION B

The power station makes use of coal and water for the generation of electricity. Relatively small quantities of chemicals are also utilised for the treatment of water for the boilers in the demineralisation plant.

Kelvin consumes approximately 1.5 million tonnes of coal per annum, which is transported by road to Kelvin from various mines in the Mpumalanga Province. Station B uses 0.85 to 1.0 million tonnes per annum. These quantities will increase in proportion to production rate.

Kelvin receives water from the Rand Water Board (RWB) and treated effluent from the Northern Wastewater Treatment Works (NWTW) which is situated in Diepsloot. Roughly 15 000 m^3/d of water from NWTW is utilised at the Kelvin Power Station.

Station B has an installed capacity of 420 megawatts comprising seven (7) turbo-alternators of 60 megawatts each, and seven (7) boilers, which consume 250 tonnes of coal per hour. The steam is delivered at 62 bar and 482°C. The station turbo-alternators are not operated at full capacity to safeguard against failure (Golder, 2021).

The turbine shaft is coupled to the alternator rotor, rotating at 3 000 revolutions per minute. This large electro-magnet produces electricity by inducing voltage, which causes current to flow in the alternator stator. The electricity is transformed up to the grid voltage by the generator transformer and supplied to the grid via the switch yard.

For steam production in the boilers, demineralised water is added as make-up water to recycled condensate. The steam is condensed by cooling it with water circulated through the hyperbolic cooling towers to the south (five towers for Station B) of the power station buildings.

Station B uses a pulverised fine-coal fraction for heat generation, which results in a fine ash by-product. Previously, all the ash was pumped in slurry form to Ash Dam A. Presently, approximately 10% of the ash is being collected by a cement manufacturer as raw material, thereby facilitating waste minimisation (both in terms of ash and water use) at the power station. In addition, this practice is increasing the life of the Ash Dam's operational phase. The remainder of the ash is still slurried and disposed of on Ash Dam A.

The final waste product from Kelvin is in the form of a wastewater effluent, consisting of cooling tower blow-down, effluent from miscellaneous cooling water uses, ash-quenching effluent and washings. These effluents

are discharged to the Modderfonteinspruit after de-siltation. Figure 4 provides a simplified, visual schematic of the above-mentioned processes.
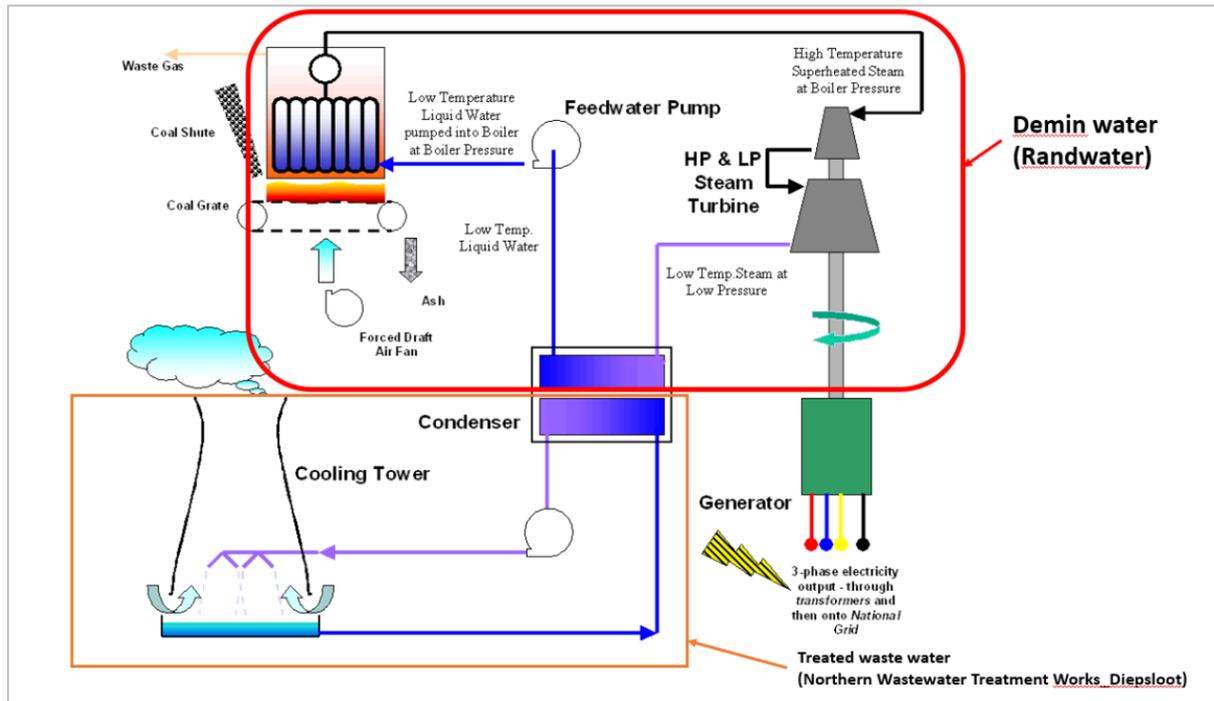
Figure 4: Simplified process schematic (Golder, 2021).

2.2 EXTENT OF ACTIVITY

The Kelvin Power Station comprises of an area with an extent of roughly 160 ha.

2.3 KEY ACTIVITY RELATED PRODUCTS AND PROCESSES

The key water and waste processes are the use of coal and water to generate electricity which is sold to City Power for use in the National Grid (Eskom). Coal is hauled in by road and stored in stockpiles. This coal is then burned to generate steam which is used to turn the turbines that generate electricity.

Ash is produced as a by-product or waste, some of which is sold to companies that are able to utilise it as a raw material. The coarse ash is best equipped for the use in brick manufacturing while cement manufacturing companies prefer the fine ash.

2.4 ACTIVITY LIFE DESCRIPTION

Kelvin Power's power generation license will expire in 2026 and will be renewed for another three (3) years thereafter. It is after this that Kelvin Powers' Station B will demolished, and the area rehabilitated.

2.5 ACTIVITY INFRASTRUCTURE DESCRIPTION

The infrastructure associated with Kelvin Power are depicted in Figure 5. Station A and associated 3 cooling towers are currently under extended care and maintenance (to be demolished in the near future). The infrastructure associated with station B of Kelvin Power includes the following:

- Station B with 5 cooling towers;

- High Voltage (HV) Yard (88 kV switchyard) – which belongs to City Power who also operates the HV Yard;

- Offices, mill store, change house, administration buildings and workshop which draws water from the RWB line;

- Dry coal stores A and B. These coal stores are covered;

- Coal stockpiles which are open to the environment;

- Railway and siding for coal transport (no longer in use);

- Weighbridge for trucks;

- Haul roads and access roads;

- De-silting Dam;

- Two Ash Dams, Ash Dam A and Ash Dam B;

- An Ash Return Water Dam (ARWD) near Ash Dam B;

- Pump station near the ARWD;

- Reservoir which is supplied by RWB;

- Pump station for the RWB reservoir; and

- Overhead tank (providing pressure) from RWB water line.
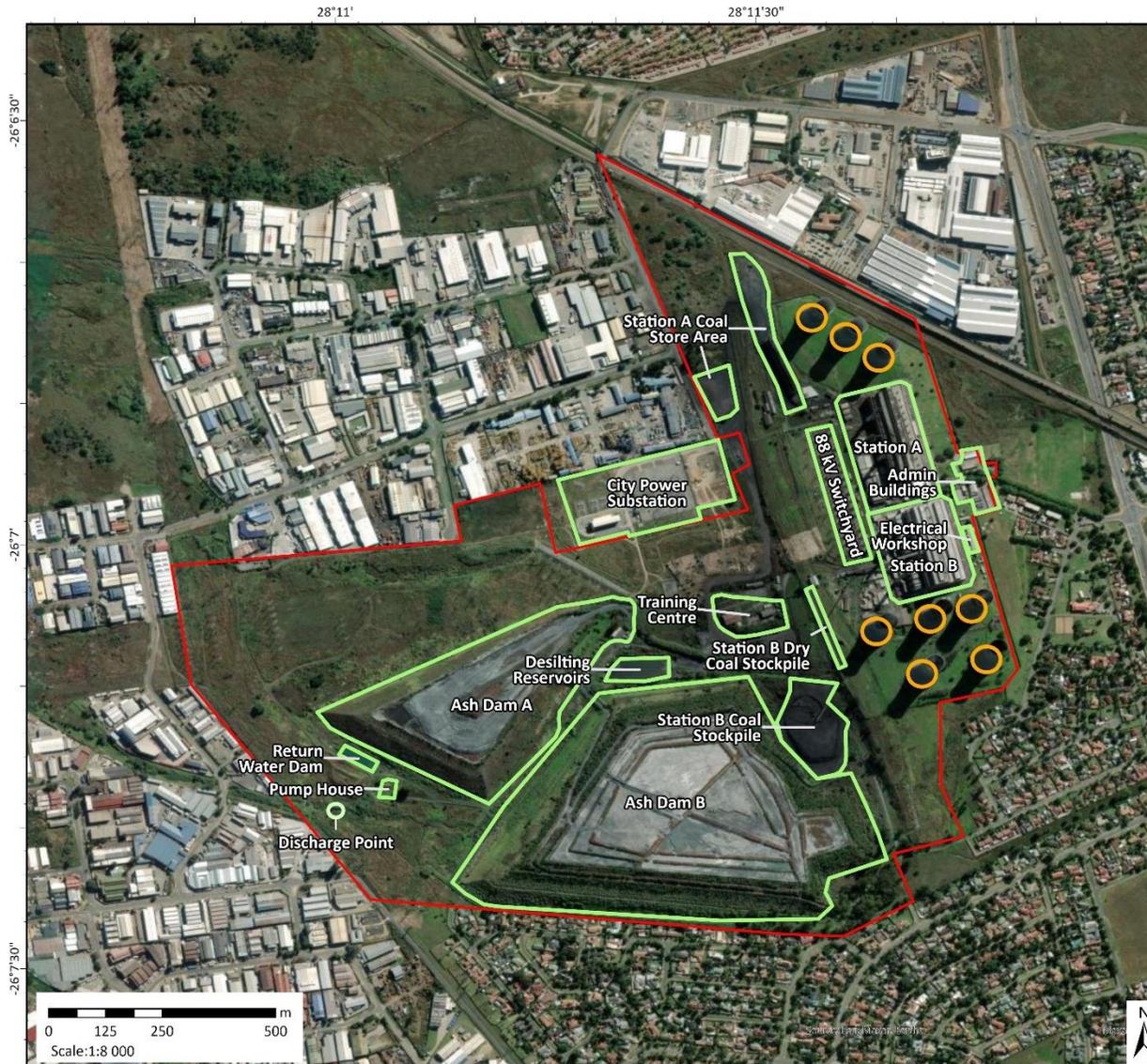
Figure 5: Kelvin Power infrastructure map.

2.6   KEY WATER USES AND WASTE STREAMS

2.6.1   AUTHORISED WATER USES TO BE RENEWED AND NEW WATER USES

As per the WUL (03/A21C/FGH/1110) issued on 24 June 2021, the authorised water uses (to be renewed) are

listed in Table 3 and illustrated in Figure 6 below. Waste stream activities are summarised in Table 4 below.

Table 3: Water Uses

Section 21 Water Use	Description of Water Use	Volume (m³) per annum	Capacity (m³)	Coordinates	Included in Current License	Property
Water uses to be renewed						
21 (f)	Discharge from Return Water Dam and secondary channel to the Modderfonteinspruit.	2 599 380 m³/a	-	26° 07' 18.167" S 28° 10' 59.491" E	Yes	Portions 89 and 90 of the Farm Zuurfontein 33 IR
21 (g)	Desilting reservoirs 1 and 2.	4 891 000 m³/a	12 794 m³	26° 07' 08.724" S 28° 11' 21.708" E	Yes	Portions 98 and 99 of the Farm Zuurfontein 33 IR
	Return water dam.	7 426 800 m³/a	7 200 m³	26° 07' 15.001" S 28° 11' 01.568" E	Yes	Portion 89 of the Farm Zuurfontein 33 IR
	Ash Dam A.	207 377 m³/a	2 065 851 m³	26° 07' 19.119" S 28° 11' 25.084" E	Yes	Portions 97, 98, 99, 89 and 90 of the Farm Zuurfontein 33 IR
	Ash Dam B.		7 454 241 m³	26° 07' 10.886" S 28° 11' 10.653" E	Yes	Portions 90, 91, 99 and 100 of the Farm Zuurfontein 33 IR
21 (h)	Discharge to the Modderfonteinspruit.	2 599 380 m³/a	-	26° 07' 18.167" S 28° 10' 59.491" E	Yes	Portions 89 and 90 of the Farm Zuurfontein 33 IR
Existing water uses to be licensed						
21 (g)	Coal stockpile A (covered).	1 300 000 t/a	42 000 tonnes	26° 07' 05.896" S 28° 11' 35.032" E	No	Remainder of Portion 391 of the Farm Zuurfontein 33 IR
	Coal stockpile B (open).	2 100 000 t/a	100 000 tonnes	26° 07' 12.997" S 28° 11' 34.222" E	No	Portions 99, 100 and the Remainder of Portion 391 of the Farm Zuurfontein 33 IR

2.6.2   WASTE STREAMS

The hazardous waste streams generated at Kelvin Power include the following:

Table 4: Hazardous waste types generated at Kelvin Power.

Waste Type	Description	Management and/ or Disposal
Oil and grease waste.	Waste generated from the servicing of vehicles, empty oil drums.	Recycled.
Fluorescent tubes/ globes.	Used fluorescent tubes/ globes.	Disposal at a licensed hazardous waste facility.
Asbestos	Waste generated from old building materials.	Disposal of at a hazardous landfill site.
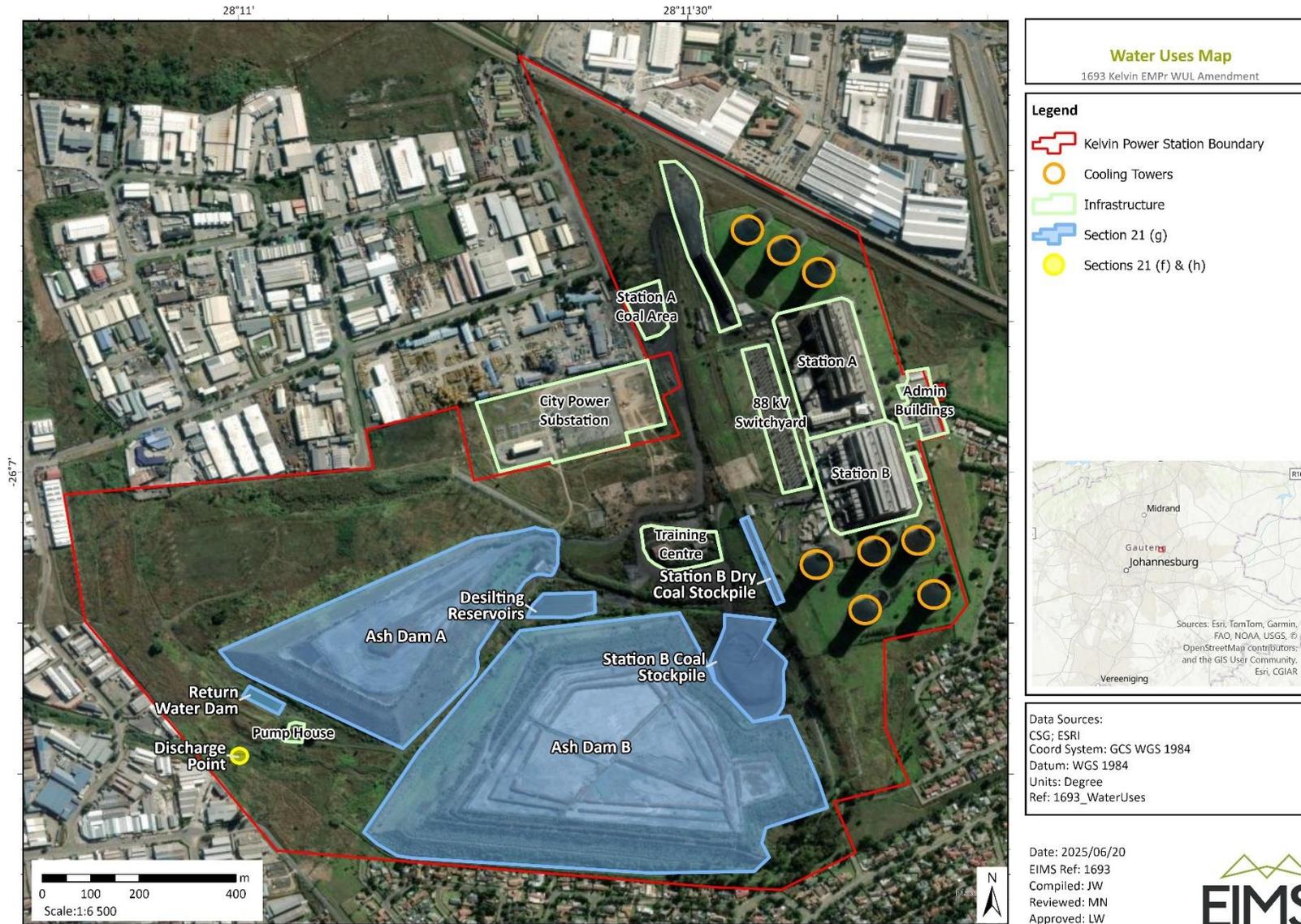
Figure 6: Water uses

2.7 ORGANISATIONAL STRUCTURE OF ACTIVITY

In accordance with Regulation GN 704(13) of 1999, the following statement persists: "the person in control of a mine or activity must provide the manager with the means and afford him or her every facility required to enable the manager to comply with the provisions of these regulations".

By formally documenting environmental management measures and commitments, the IWWMP serves a vital role in ensuring that potential negative impacts of the proposed activities are reduced, or minimised and positive impacts maximised. The IWWMP, therefore, is a tool that guides the management and monitoring of impacts. If impacts are found to be higher than initially predicted, additional mitigation measures will need to be implemented to control, reduce, or prevent an impact from occurring. This IWWMP is intended to provide an overview of the on-site environmental management philosophy and organisational structure at the operation. In addition, it specifies common environmental management and monitoring principles that are applied and recommends additional management and monitoring where necessary. The roles, responsibilities and authorities of personnel at Kelvin Power are assigned to facilitate effective environmental management. provides as overview of the organisational structure of Kelvin Power.

2.8 BUSINESS AND CORPORATE POLICIES

Kelvin Power has developed environmental and social policy (E&S) policy and procedures which outlines Kelvin's vision and policy with regards to E&S. At Kelvin Power, environment and social issues are implemented in accordance with E&S principles in order to minimise impacts on the surrounding environment. Kelvin Power E&S principles include the following:

- Provide sustainable energy and integrated environmental and social factors;

- Identify all environmental and social issues associated with our activities and manage them in a sustainable manner;

- Ensure compliance with applicable legal and other requirements;

- Implementation and maintenance of an environmental and social management system based on ISO 14001, OHSAS 18001 and SA8000;

- Providing sustainable energy and the integration of environmental and social factors into business decisions;

- Pursuing efficient use of energy, material, and natural resources to prevent pollution, minimise waste and encourage recycling where appropriate;

- Providing sustainable energy and integrating environmental and social factors into business decisions; and

- Increase the level of environmental competency, awareness and culture in our employees and contractors through communication, training, and promotion of best practice.
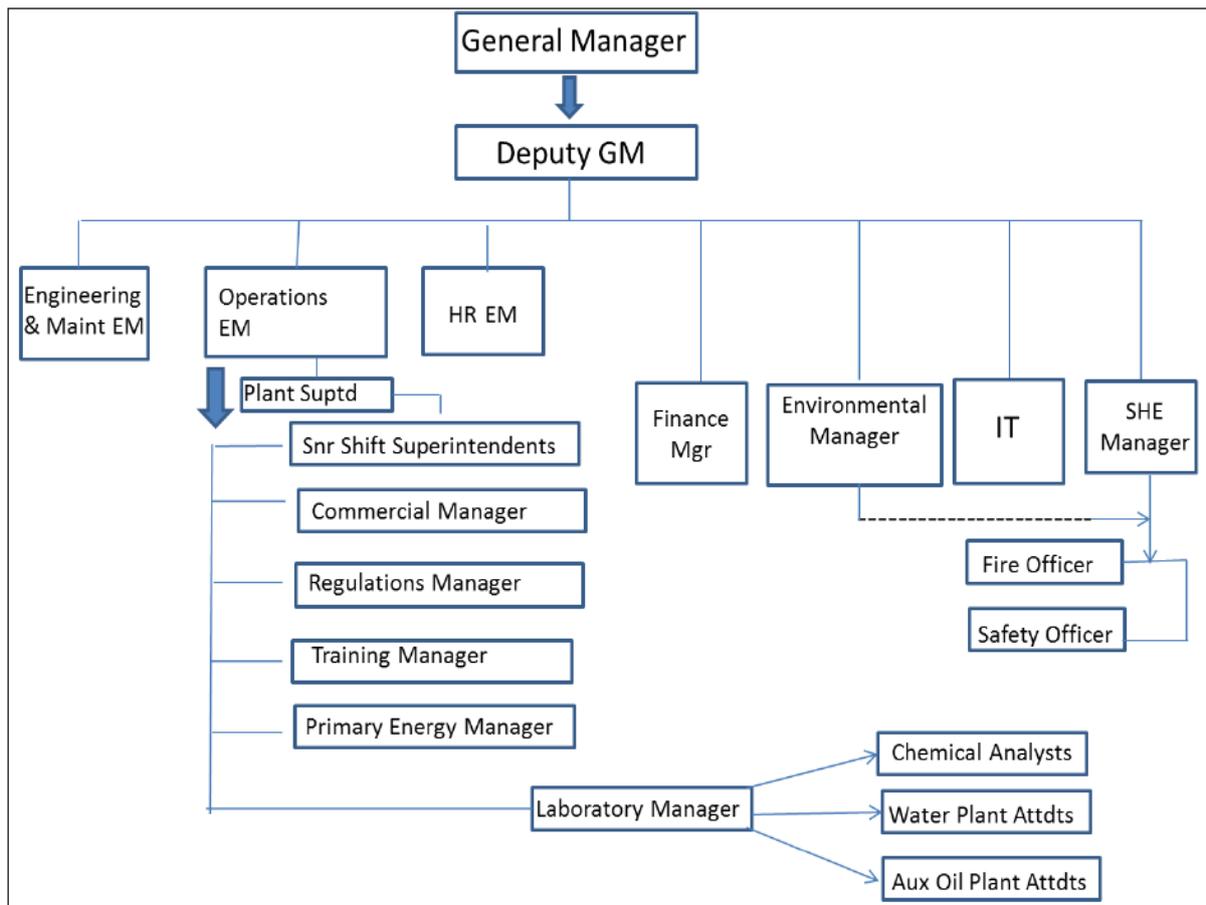
Figure 7: Organisational structure of Kelvin Power (ENVASS, 2024).

2.8.1   KELVIN POWER ENVIRONMENTAL AND SOCIAL POLICY

The Kelvin Power Environmental and Social Policy states the Kelvin Power Station is committed to:

- Provide sustainable energy and integrate environmental and social factors into our business decisions.

- Identify all environmental and social issues associated with our activities and mange them in a sustainable manner.

- Ensure compliance with applicable legals and other requirements and where appropriate perform better than required.

- Implement and maintain an environmental and social management system based on ISO 14001, OHSA 18001 and SA 8000.

- Continuously improve our performance through regular review of the objectives and targets.

- Pursue efficient use of energy, material and natural resources, to prevent pollution, minimise waste an encourage recycling where appropriate.

- Respect and protect the values of our culturally diverse society by interacting with stakeholders.

- Increase the level of environmental competency, awareness and culture in our employees and contractors through communication, training and promotion of best practice.

3 REGULATORY WATER AND WASTE MANAGEMENT FRAMEWORK

The regulatory framework pertaining to the water use activities and waste management activities associated with Kelvin Power is described and discussed in the succeeding sections.

3.1 SUMMARY OF ALL WATER USES

The purpose of the NWA, is to provide for fundamental reform of the law, relating to water resources, to repeal certain laws as well as to provide for matters connected therewith. The purpose of the NWA is to ensure that the nation's water resources are protected, developed, conserved, managed, and controlled. Sections 40 and 42 of the NWA provide for the responsible authority to request Public Participation (PP) and an assessment of the likely effect of the activities in terms of the protection, use, development, conservation, management, and control of the water resource. The NWA defines eleven (11) consumptive and non-consumptive water uses, namely:

- 21(a): Taking water from a water resource;

- 21(b): Storing water;

- 21(c): Impeding or diverting the flow of water in a watercourse;

- 21(d): Engaging in a stream flow reduction activity;

- 21(e): Engaging in a controlled activity;

- 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit;

- 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource;

- 21(h): Disposing in any manner of water which contains waste from, or which has been heated in any industrial or power generation process;

- 21(i): Altering the bed, banks, course or characteristics of a watercourse;

- 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

- 21(k): Using water for recreational purposes.

The water uses relevant to Kelvin Power include the following (Refer to Table 3 and Figure 6):

- 21(a): Taking water from a water resource;

- 21 (f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit;

- 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource; and

- 21(h): Disposing in any manner of water which contains waste from, or which has been heated in any industrial or power generation process.

3.2 EXISTING LAWFUL WATER USES

In terms of Section 32 of the NWA, an Existing Lawful Water Use (ELWU) is defined as follows:

"Water use which has taken place at any time during a period of two years immediately before the date of commencement of the Act (1 October 1996 to 30 September 1998) and which was authorised by or under any law which was in force immediately before the date of commencement of this Act, or which has been declared an existing lawful water use in terms of Section 33 of the Act".

It can therefore be summarised that a person may apply to the DWS to have a water use declared as an ELWU or the DWS on its own initiative make such a declaration. This declaration is only possible if DWS is satisfied that the water use:

- Took place more than two years before the date of commencement of the NWA and was discontinued for good reason; or

- Had not yet taken place at any time before the date of commencement of the NWA but:

  o Would have been lawful had it so taken place; and

  o Steps towards effecting the use had been taken in good faith before the date of commencement of the NWA.

There is no ELWU declared for Kelvin Power and all the water uses on site are authorised in terms of a water use licence, WUL 03/A21C/FGH/1110 of 24 June 2011.

3.3   RELEVANT EXEMPTIONS

The Minister of DWS is responsible for the protection, use, development, conservation, management and control of the water resources of South Africa on a sustainable basis. Regulation 704 (Government Gazette 20119, 4 June 1999), under the NWA, stipulates conditions for managing water. Section 26 (1) of the NWA provides for the development of regulations of the following:

- Require that the use of incoming and discharging water from a water resource be monitored, measured and recorded;

- Regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat; and

- Prescribe the outcome or effect that must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource.

Kelvin Power was granted an Exemption Permit (No. 1979 B) by the then Department of Water Affairs and Forestry (now DWS) in terms of Section 21(4) of the Water Act (Act 54 of 1956) for the use and disposal of purified or treated water on 14 August 2001. This however expired in December 2010.

3.4   GENERALLY AUTHORISED WATER USES

In terms of Section 22(1) of the NWA a person may use water without a licence if that water use is permissible in terms of a General Authorisation (GA) issued under Section 39 of the Act. A GA does not apply to Kelvin Power, as Kelvin Power is in possession of a WUL issued on 24 June 2011 (WUL: 03/A21C/FGH/1110).

3.5   NEW WATER USES TO BE LICENSED

All the authorised water uses will need to be renewed and there are three new water uses applied for (refer to Table 5 and Figure 6).

Table 5: New water uses to be applied for.

NWA S21	Activity	Annual volume	Capacity (m³)	Location	Portion
21 (g)	Coal stockpile A (covered).	1 300 000 t/a	-	26° 07' 05.896" S 28° 11' 35.032" E	Remainder of Portion 391 of the Farm Zuurfontein 33 IR
	Coal stockpile B (open).	2 100 000 t/a	-	26° 07' 12.997" S 28° 11' 34.222" E	Portions 99, 100 and the Remainder of Portion 391 of the Farm Zuurfontein 33 IR

3.6 WASTE MANAGEMENT ACTIVITY (NEM:WA)

3.6.1 NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT (NEM:WA), 2008 (ACT NO. 59 OF 2008, AS AMENDED)

Waste is regulated under the National Environmental Management Waste Act (NEM:WA), 2008 (Act No. 59 of 2008, as amended). Any hazardous waste generated requires regulation under NEM:WA. This means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical, or toxicological characteristics of that waste have a detrimental impact on health and the environment. The NEM:WA follows the principle that waste generation be avoided, or if it cannot be avoided, that it is reduced, reused, recycled, or recovered, and as a last resort treated and/ or safely disposed of. NEM:WA previously excluded mine residues controlled under the MPRDA but the NEM:WA Amendment Act (NEM: WAA) came into effect on 2 June 2014 (Act No 26 of 2014, Government Gazette 37714) and makes provision for inclusion of mine residue deposits and stockpiles under Schedule 3 (defined wastes) of NEM:WA. Although the Minister of the DMR is the licensing authority for residue stockpiles and residue deposits, their management must be in accordance with the NEM: WA Regulations as prescribed by the Minister of the Department of Forestry, Fisheries and Environment (DFFE).

Residue deposits and residue stockpiles include:

- Wastes resulting from physical and chemical treatment of minerals;

- Wastes from mineral excavation;

- Wastes from physical and chemical processing of metalliferous minerals;

- Wastes from physical and chemical processing of non-metalliferous minerals; and

- Wastes from drilling muds and other drilling operations.

Government Gazette No. 39020, GN: R632, 24 July 2015 deals with characterisation and classification of the residue; investigation and the selection of sites; design; assessment/ prediction of impacts; analysis of risk relating to the management of residue stockpiles and deposits; duties of permit holders; monitoring and reporting; dust management; and decommissioning, closure, and post-closure management.

Government Notice 921, which was published in Government Gazette No. 37083, on 29 November 2013, listed the waste management activities that required licensing (Table 6). A distinction is made between Category A waste management activities, which require a Basic Assessment, and Category B activities, which require a full EIA.

Category C waste management activities must comply with the relevant requirements and standards:

- Norms and Standards for storage of waste (GN 926 of 2013);

- Standards for extraction, flaring or recovery of landfill gas (GN 924 of 2013); or

- Standards for scraping or recovery of motor vehicles (GN 925 of 2013).

Table 6: Waste Management Activities (GN 921 of 2013).

Waste Management Activity	Category A	Category B
Storage of waste in lagoons.	1) General waste.	1) Hazardous waste (excluding effluent, wastewater, or sewage).
Recycling or recovery of waste.	2) Sorting, shredding, crushing, screening or bailing of general waste >1 000 m^2.	2) Reuse and recycling of hazardous waste >1 t/day.

Waste Management Activity	Category A	Category B
	3) Recycling at facility >500 m^2 (n/a when part of internal manufacturing process on same premises).	
	4) Recycling of hazardous waste 0.5 – 1 t/day (n/a when part of internal manufacturing process on same premises).	3) Recovery (refining, utilisation or co- processing) of general waste >100 t/day or hazardous waste >1 t/day.
	(5) Recovery (refining, utilisation or co-processing) of general waste 10 – 100 t/day or hazardous waste 0.5 – 1 t/day (n/a when part of internal manufacturing process on same premises).	
Treatment of waste.	6) General waste 10 – 100 t.	4) Hazardous waste >1 t/day.
	7) Hazardous waste 0.5 – 1 t.	5) Treatment of hazardous waste in lagoons (excluding effluent, wastewater and sewage).
		6) General waste >100 t/day.
Disposal of waste.	9) Inert waste 25 – 25 000 t.	7) Hazardous waste on land (any quantity).
	10) General waste on footprint of 50 – 200 m^2, not exceeding 25 000 t.	8) General waste >200 m^2 and >25 000 t capacity.
	11) Domestic waste of areas not serviced, >500 kg/month.	9) Inert waste >25 000 t.
Construction, expansion or decommissioning of facilities.	12) Construction of a Category A waste management facility.	10) Construction of a Category B waste management facility.
	13) Expansion of a Category A or B facility without additional waste management activity.	
	14) Decommissioning of a Category A or B facility.	
Category C		
Storage of waste.	(1) General waste at facility with capacity >100 m^3, excluding waste lagoons.	
	2) Hazardous waste at facility with capacity >80 m3, excluding waste lagoons.	
	3) Waste tyres >500 m^3.	
Recycling and recovery.	4) Scrapping or recovery of motor vehicles with operational area >500 m^2.	
	5) Extraction, recovery or flaring of landfill gas.	

3.6.2   WASTE CLASSIFICATION

The Waste Classification and Management Regulations (WCMR) (GN R.634 of 2013) were promulgated in terms of the NEM:WA with the following associated Norms and Standards:

- National Norms and Standards for the assessment of waste for landfill disposal (GN R.635 of 2013); and

- National Norms and Standards for disposal of waste to landfill (GN R.636 of 2013) including detail on the barrier design based on the classification of the material.

3.6.3 SANS 10234 CLASSIFICATION

According to Section 4(2) of GN R. 634 of 2013, all waste generators must ensure that their waste is classified in accordance with SANS 10234 within 180 days of generation, except if it is listed in Annexure 1 of the GN R.634. Furthermore, waste must be re-classified every 5 years.

Waste classification according to SANS 10234 (based on the Global Harmonised System) indicates physical, health and environmental hazards. The SANS 10234 covers the harmonised criteria for classification of potentially hazardous substances and mixtures, including wastes, in terms of its intrinsic properties/ hazards.

Table 7 indicates the different hazard classes for waste according to SANS 10234. The classification of the waste is based on background information on the characteristics as well as analytical results.

Table 7: Hazard classes according to SANS 10234.

Class	Description
Class 1	Explosive.
Class 2A	Highly flammable.
Class 2B	Flammable.
Class 3	Oxidising.
Class 4	Substances that release toxic gases in contact with water or acid.
Class 5	Irritant.
Cass 6	Corrosive.
Class 7	Harmful.
Class 8	Toxic.
Class 9	Mutagenic.
Class 10	Carcinogen.
Class 11	Toxic for reproduction.
Class 12	Ecotoxic.

3.6.4 CLASSIFICATION OF WASTE TYPE IN TERMS OF GN R. 635

In terms of these Norms and Standards, the potential level of risk associated with disposal of materials/ wastes can be determined by following the prescribed and appropriate leach test protocols. The results must be assessed against the four levels of thresholds for leachable and total concentrations, which in combination, determines the waste type and associated barrier design/ liner requirements. The terminology is as follows:

- LC = means the leachable concentration of a particular contaminant in a waste, expressed as mg/l;

- TC = means the total concentration of a particular contaminant in a waste, expressed as mg/kg;

- LCT = means the leachable concentration thresholds for particular contaminants in a waste (LCT0, LCT1, LCT2, LCT3); and

- TCT = means the total concentration thresholds for particular contaminants in a waste (TCT0, TCT1, TCT2).

Figure 8 shows the flow diagram of the process to be followed to determine the waste type for disposal. According to this process, the waste needs to be analysed to determine total and leachable concentrations of potential constituents of concern (CoCs). The results are then compared to the threshold values to determine the waste type.
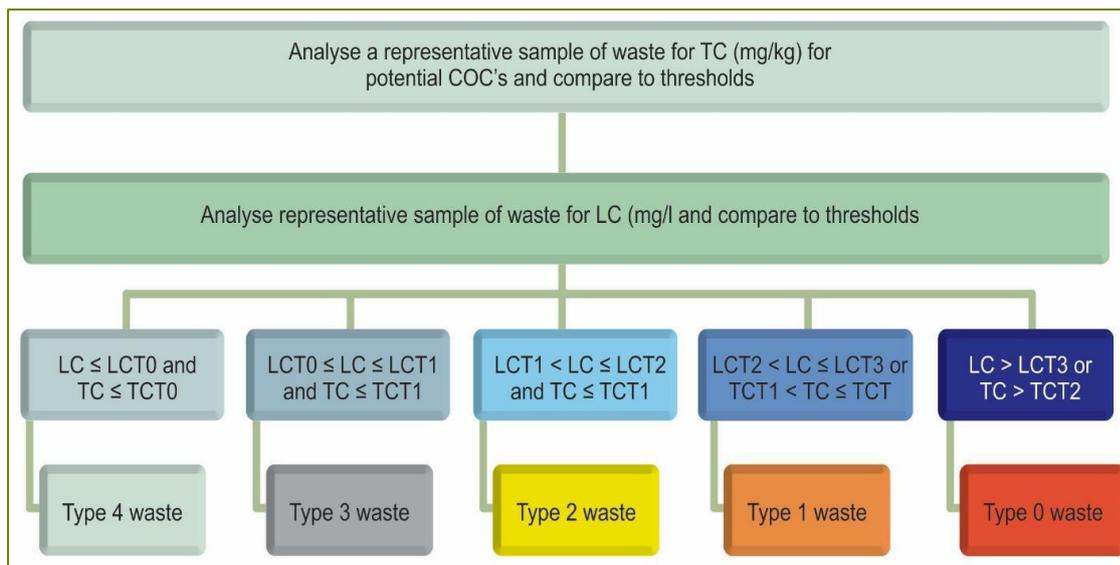
Figure 8: Flow diagram for waste classification according to the WCMR (ENVASS, 2024).

In the Government Gazette, 24 August 1990, the definition of waste specifically excluded: "ash produced by or resulting from activities at an undertaking from the generation of electricity under the provisions of the Electricity Act, 1987 (Act No. 41 of 1987)". Power station ash was thus excluded from the definition of waste, however the new waste amendment act, Act No. 26 of 2014, National Environmental Management Act: Waste Amendment Act, 2014, no longer excludes power station ash. As the activity commenced prior to the promulgation of this Act and no expansion of the footprint is planned it is assumed that no waste management license is required.

3.7   WASTE RELATED AUTHORISATIONS

Kelvin Power applied for registration as a hazardous waste generator: Waste Information Systems (WIS) Regulations. The certificate was issued on the 24th of April 2013.

3.8   OTHER AUTHORISATIONS (EIAS, EMPS, RODS, REGULATIONS)

Kelvin Power has an Air Emissions Licence (AEL) in terms of section 41(1) (a) of the National Environmental Management: Air Quality Act (NEM:AQA), 2004 (Act No.39 of 2004), in respect of Listed Activity 1.1 Combustion Installation (Solid Fuel Combustion Installation) and 5.1 Storage and Handling of Ore and Coal, as published in terms of Section 21 of the Act. The AEL was issued on the 14th of August 2023 (AEL number: 14/1/1/7/1/66/Kelvin/Kemp) and is valid until 31 August 2028.

4   PRESENT ENVIRONMENTAL STATUS

4.1   CLIMATE

This section describes the areas environmental conditions at the present state.

4.1.1   REGIONAL CLIMATE

Kempton Park falls within the cold interior climatic zone of South Africa (SANS 204:2011) which consists of warm summers from December to February and cold, dry winters between June to August. The cold interior climate zone is known for moderately high summer and winter daytime temperatures which vary from about 14 ºC to 26 ºC during the summer and on average from 4 ºC to 22 ºC in winter (Table 10). The area experiences summer rainfall, wintertime frost, fog, and varying wind speeds (Figure 9, Figure 10 and Figure 11).
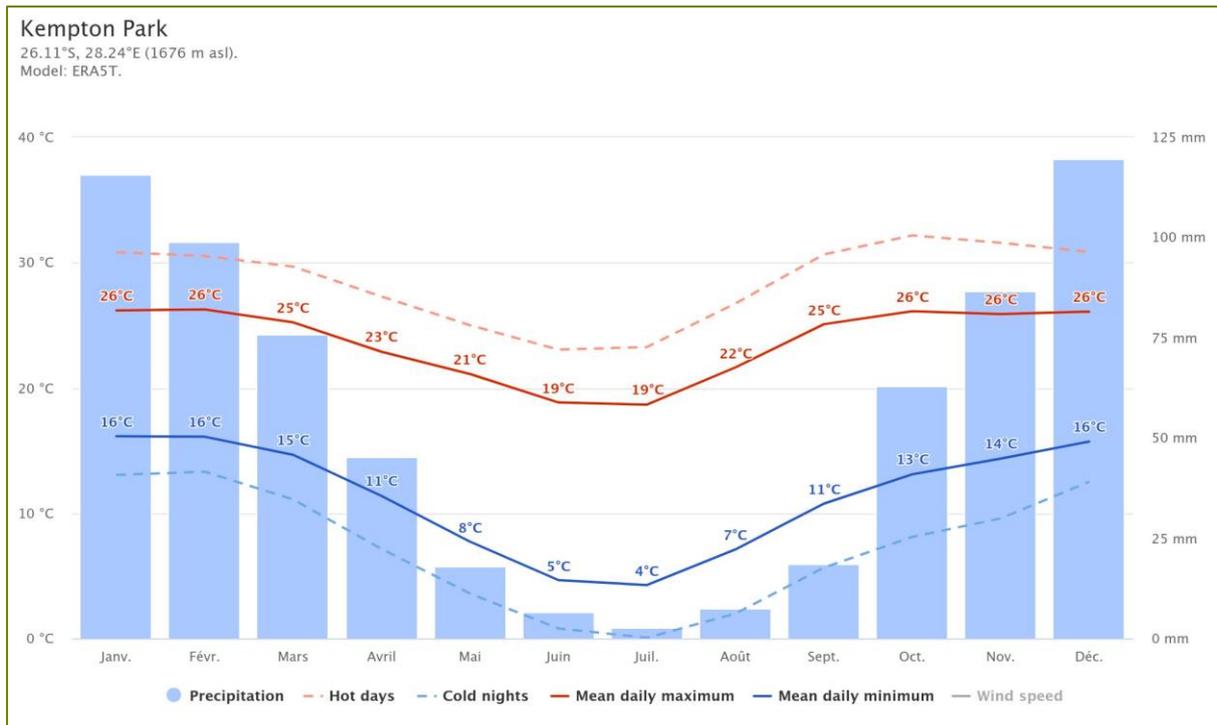
Figure 9: Average temperatures and precipitation of Kempton Park (Meteoblue, 2025).
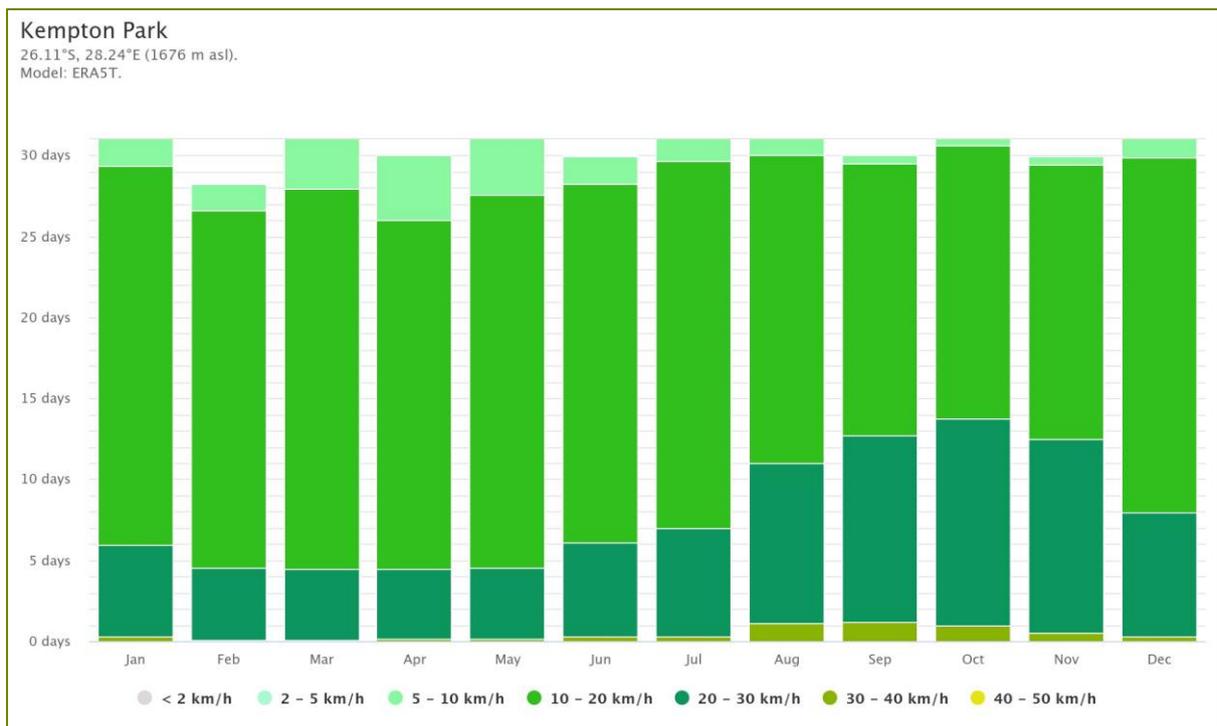
Figure 10: Average wind speed of Kempton Park (Meteoblue, 2025).

4.1.2   RAINFALL

The region experiences unpredictable rainfall that ranges from 715 mm to 735 mm annually, as averaged at 620 mm. Winter months are typically dry, while precipitation is mainly associated with thunderstorms during the summer (October to March). Figure 11 illustrates the mean monthly rainfall values for the study area (Meteoblue, 2025).
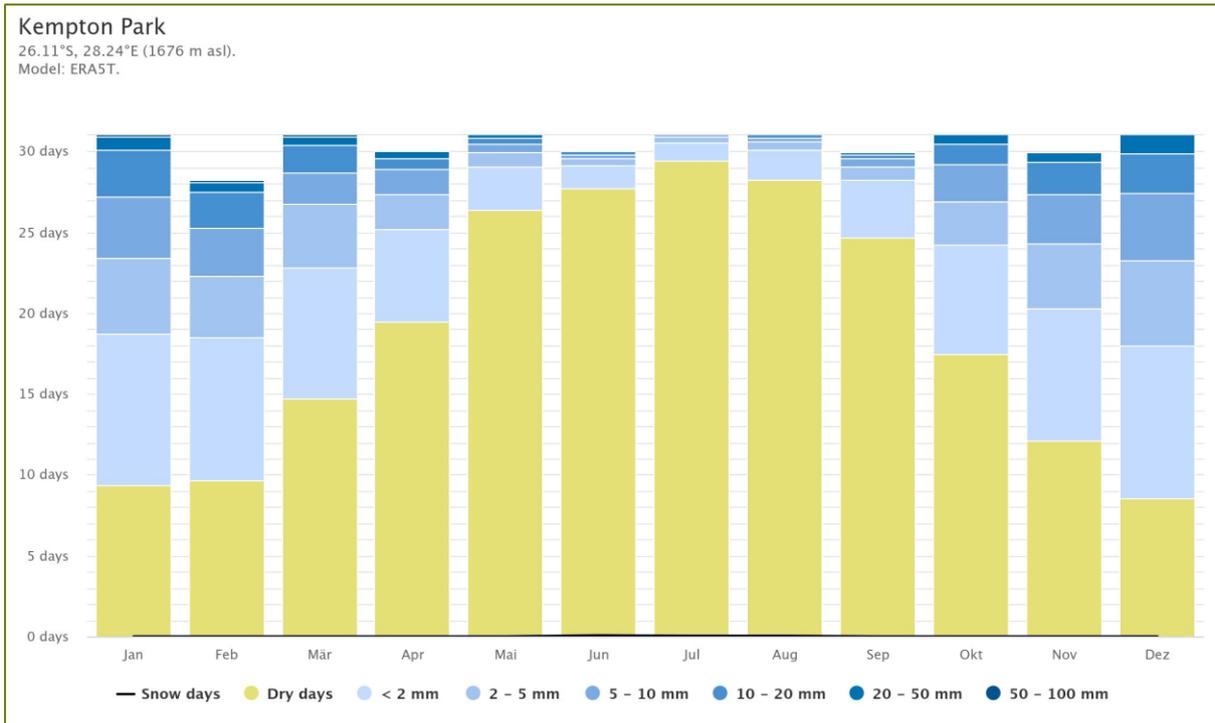
Figure 11: Average precipitation for Kempton Park (Meteoblue, 2025).

4.1.3   EVAPORATION

Monthly evaporation data was available from the DWS station A2E009, located approximately 5km south-east of the project site (DWS, 2025). This station has an approximate Mean Annual Evaporation (MAE) of 2207.6 mm (S-Pan) over the period of available data (1957-1984). The highest evaporation occurs in the spring/ summer months of September to March. The average monthly evaporation values are shown in Table 8**.**

Table 8: Average month evaporation values for station A2E009.

Month	Average Monthly Evaporation (mm)
October	249.3 mm
November	228.6 mm
December	235.4 mm
January	223.1 mm
February	182.9 mm
March	170.5 mm
April	134.9 mm
May	124.1 mm
June	111.2 mm
July	128.2 mm
August	177.3 mm
September	230.5 mm

4.2 SURFACE WATER

4.2.1 WATER MANAGEMENT AREA

Kelvin Power is situated in the Modderfonteinspruit catchment, which forms part of the greater Jukskei catchment (Golder, 2021), which forms part of the Limpopo Water Management Area (WMA).

4.2.2 SURFACE WATER HYDROLOGY

The Kelvin site is situated on the boundary of two quaternary catchments, A21C and A21A, however 97% of the site falls in catchment A21C (the Jukskei River catchment) (refer to Figure 12).

Catchment A21C drains in a Northwesterly direction where the Jukskei River eventually confluences with the Crocodile River. Catchment A21C is 75 961 ha in extent and the part of the Kelvin site contributing to this catchment is 154.7 ha (or 0.2%).

The 3% of the site that falls within catchment A21A is part of the "Remainder" facility and drains Northeast into Sesmylspruit. Catchment A21A is 48 189 ha and the part of the Kelvin site contributing to this catchment is 5.4 ha (or 0.01%). The site is at an elevation of between 1620 and 1680 mamsl with a gentle slope of approximately 0.03 (Golder, 2021).

4.2.3 SURFACE WATER QUALITY

4.2.3.1 SURFACE WATER MONITORING OBJECTIVES

The objective of surface water monitoring is to assess the impact that the operations have or may have on the surface water resources and to implement mitigation measures, as necessary. The objectives of water quality monitoring are as follows:

- To monitor water quality at the monitoring positions identified in the Kelvin Power WUL (03/A21C/FGH/1110 of 24 June 2011;

- To demonstrate that the potential impact associated with Kelvin Power are proactively monitored;

- Develop environmental and water management programmes based on incident and impact monitoring to facilitate decision making;

- To investigate possible surface water contamination which serves as an early warning system to allow remedial measures and subsequent actions to be taken for the mine and region;

- Compare water quality in terms of the physical and chemical characteristics with baseline values and WUL standards to identify possible trends and/ or changes with regard to surface water quality by tracking contaminants of concern as indicators of pollution;

- Monitoring of water usage (including downstream and upstream) by various users;

- Verification and calibration of various prediction and assessment models, which includes planning for decommissioning and closure; and

- Assessment of compliance with set standards and legislation, such as WULs, EMPr, etc.
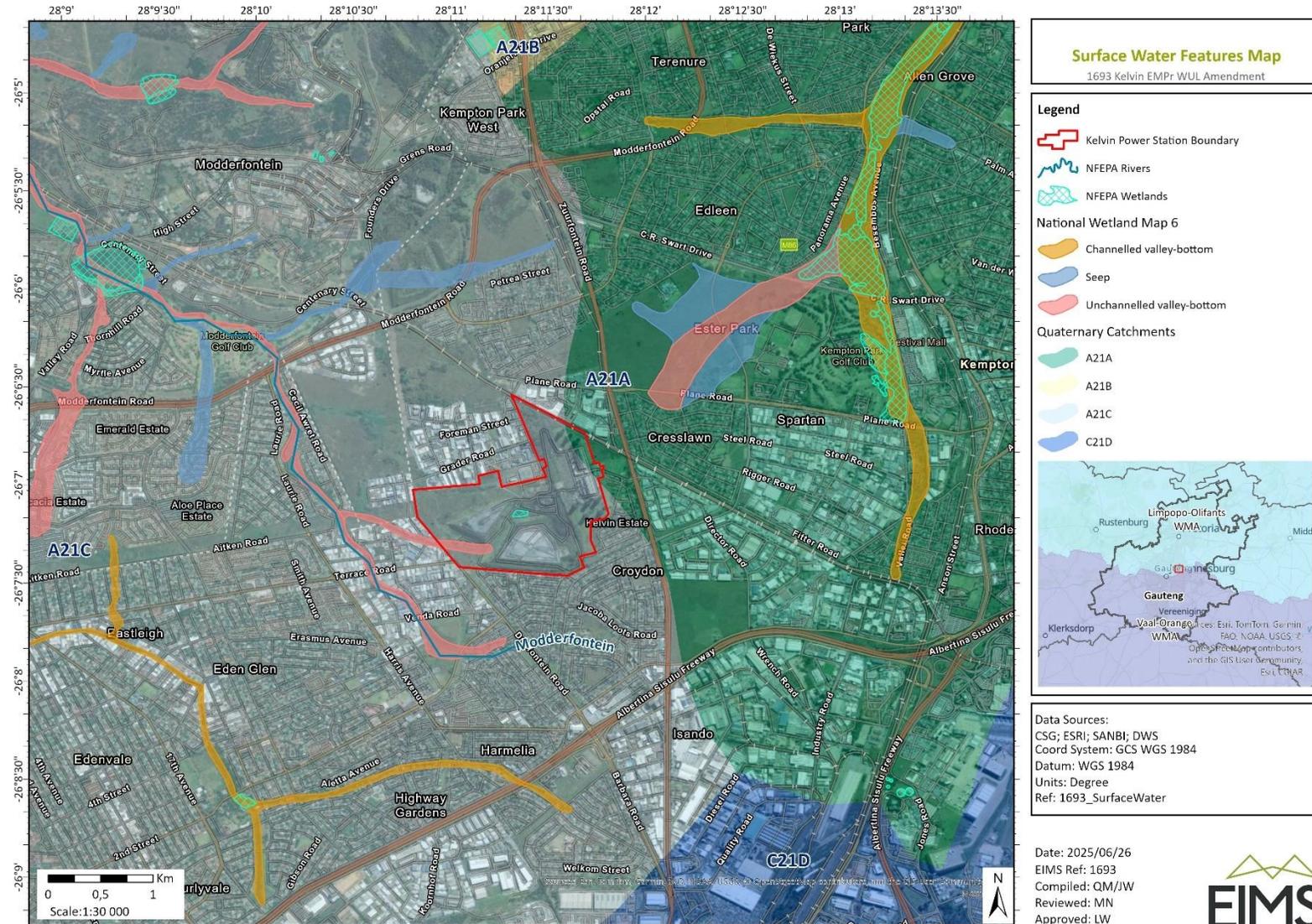
Figure 12: Location and quaternary catchments for Kelvin Power.

4.2.3.2 TOXICITY AND BIOMONITORING POINTS AND FREQUENCY

The surface monitoring points listed in Table 9 are sampled as specified below at Kelvin Power. The monitoring points (Clean Stream, 2024) (report attached as) were adapted from the monitoring plan as approved by the Regional Head as stipulated in the Kelvin Power WUL (03/A21C/FGH/1110) of 24 June 2011.

Table 9: Sampling register for surface water monitoring and Biomonitoring (Clean Stream, 2024).

Monitoring Site ID	Description	Biomonitoring Protocols		GPS Coordinates	
		Protocol	Frequency per annum	Latitude (South)	Longitude (East)
K1	Upstream (from Kelvin Power Station effluent) site in the Modderfonteinspruit.	SASS5 and in-situ water quality.	Six-monthly	S 26.119475°	E 28.173828°
		Toxicity (acute screening water).	Quarterly		
		Toxicity (direct sediment contact).	Annual		
K2	Downstream (from Kelvin Power Station effluent) site in the Modderfonteinspruit.	SASS5 and in-situ water quality.	Six-monthly	S 26.109192°	E 28.168992°
		Toxicity (acute screening water).	Quarterly		
		Toxicity (direct sediment contact).	Annual		
K3	Approximately 1 km downstream from K2, on the Modderfontein golf course in the Modderfonteinspruit.	SASS5 and in-situ water quality.	Six-monthly	S 26.103308°	E 28.1658°
		Toxicity (acute screening water).			
		Toxicity (direct sediment contact).			
K4	Approximately 2 km downstream from K3, directly downstream from an instream pollution control dam in the Modderfonteinspruit.	SASS5 and in-situ water quality.	Six-monthly	S 26.095919°	E 28.151933°
		Toxicity (acute screening water).			
		Toxicity (direct sediment contact).			
Eff	Effluent stream within the power station boundary.	SASS5 and in-situ water quality.		S 26.121806°	E28.183108°
		Toxicity (definitive testing water).	Quarterly		
		Toxicity (direct sediment contact).			
Eff-plus	Effluent stream, downstream from the power station, just upstream from confluence with Modderfonteinspruit.	SASS5 and in-situ water quality.		S 26.118978°	E 28.174103°
		Toxicity (acute screening water).	Quarterly		
		Toxicity (direct sediment contact).	Annual		

| Monitoring Site ID | Description | Biomonitoring Protocols | | GPS Coordinates | |
		Protocol	Frequency per annum	Latitude (South)	Longitude (East)
RWD	Pollution control facility return water dam.	–Toxicity (definitive testing water).	Quarterly	S 26.120857°	E 28.183835°
Ash Dam	Pollution control facility.	Toxicity (definitive testing water).	Quarterly	S 26.119063°	E 28.189330°
Desilting Dam	Pollution control facility.	Toxicity (definitive testing water).	Quarterly	S 26.121652°	E 28.189947°

4.2.3.3 TOXICITY METHODS FOR KELVIN POWER

4.2.3.3.1 BIO-TOXICITY ASSESSMENTS

Acute toxicity testing is performed by exposing testing organisms to water sources in order to determine the potential risk of such waters to the biota or biological integrity of the receiving water bodies. A risk category is determined based on the percentage of mortalities or inhibition-stimulation of the exposed biota. It is important to note that the hazard classification is based on the standardised battery of selected test biota and therefore represents the risk/hazard towards similar biota in the receiving aquatic environment. The toxicity hazard is therefore in terms of the aquatic biotic integrity and does in no way represent toxicology towards humans or other mammals (Clean Stream, 2024). Standard, internationally accepted methods, and materials were applied in order to conduct acute and short-chronic toxicity testing and hazard classification based on three (3) trophic levels or taxonomic groups, namely *Vibrio fischeri* (bacteria), *Daphnia magna* (crustaceans) and *Selenastrum capricornutum* (micro-algae). All tests were conducted in environmentally controlled rooms using the *Allivibrio fischeri* bioluminescent, *Selenastrum capricornutum*, *Daphnia magna* acute toxicity.

4.2.3.3.2 TOXICITY TEST RESULTS CLASSIFICATION

A risk/ hazard category was determined by the Department of Water and Sanitation. The Direct Estimation of Ecological Effect Potential (DEEEP) is a recommended protocol and is broadly based on the hazard classification by DWS. This risk category equates to the level of acute/ chronic risk posed by the selected potential pollution source (water sample). After the determination of the percentage effect, obtained with each of the battery of toxicity tests performed, the sample is ranked into one of the following five classes, based on either screening or definitive testing protocols.
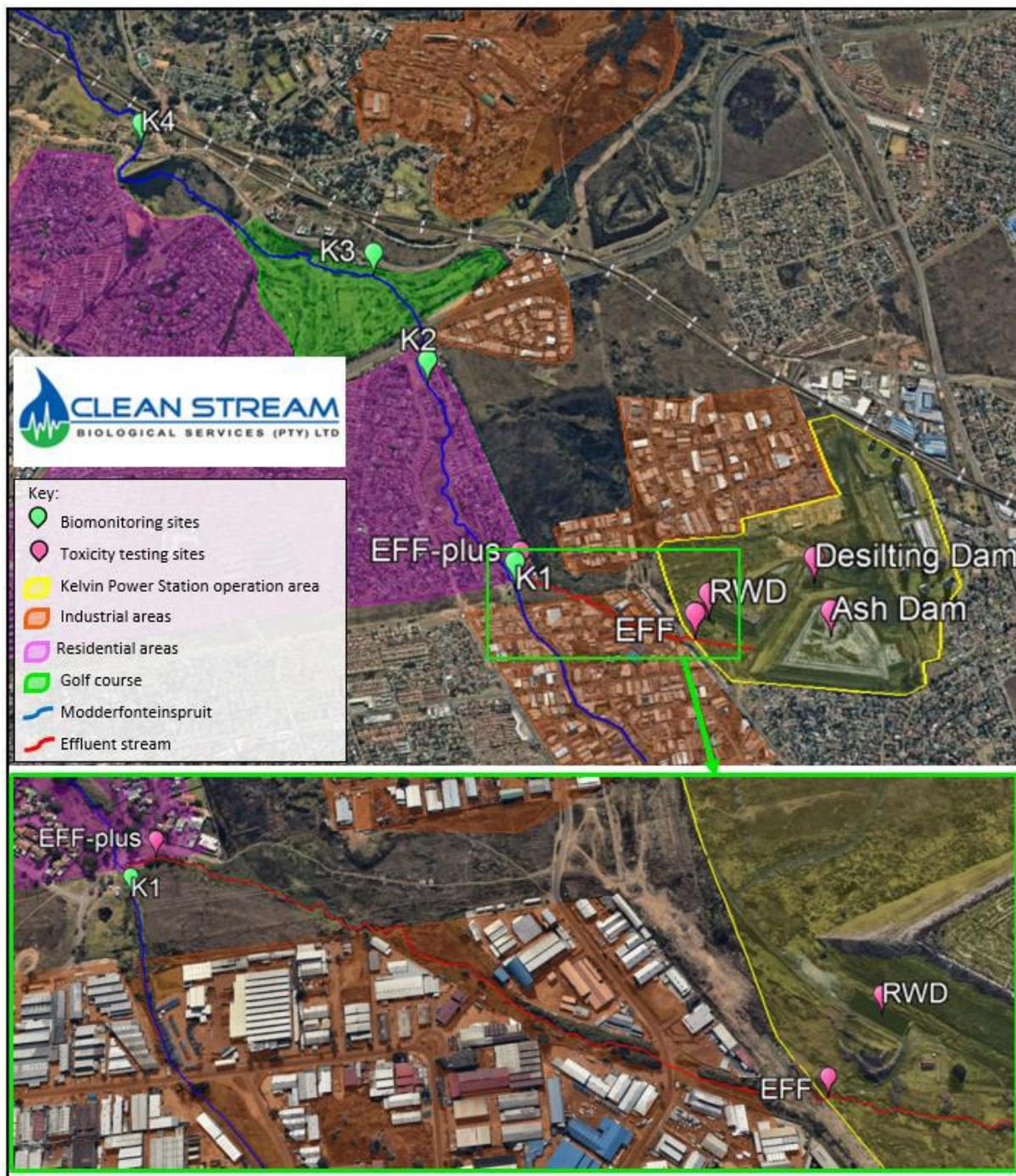
Figure 13: Location of surface water and biomonitoring points (Clean Stream, 2024).

4.2.3.4 IN-SITU WATER QUALITY

The downstream and upstream water monitoring results for November/December 2024 are discussed below (Table 10) as part of the most recent biomonitoring and toxicity report results Clean Stream, (2024) (Appendix 4). All monitoring results are obtained from the monitoring points as per Table 9 above.

Table 10: In-situ surface water quality (Clean Stream, 2024).

Monitoring Site	EC (mS/m)	pH	Oxygen Saturation (%)	Dissolved Oxygen (mg/l)	Water Temp (°C)
K1	56.6	6.7	157.0	10.0	22.5
K2	109.8	6.6	176.0	10.0	21.3

Monitoring Site	EC (mS/m)	pH	Oxygen Saturation (%)	Dissolved Oxygen (mg/l)	Water Temp (°C)
K3	96.4	6.7	103.4	6.6	23.8
K4	104.0	7.0	170.0	8.7	25.5

Electrical conductivity (EC) values were sourced from the toxicity testing laboratory results and the in-situ records, where relevant. In November 2024, a notable increase (deterioration) in EC levels was recorded from site K1 (56.6 mS/m) to site K2 (109.8 mS/m) (Table 10). Temporal data clearly show that salinity consistently increases between these sites, and while a stable trend is reflected for site K1, an increasing (deteriorating) trend is shown for site K2. The EC levels recorded for the Effluent Stream sites Eff (149.3 mS/m) and Eff-plus (143.6 mS/m) were substantially higher than in the receiving Modderfonteinspruit (as represented by site K1), confirming the Effluent Stream (carrying potential KPS impacts) as a source contributing to the salt load of the Modderfonteinspruit. Industrial activities did not lead to an increase in salinity of this stream (Eff to Eff-plus) during most preceding surveys; however, it is again noted that the June 2021 survey reflected likely impacts from industrial development as the EC levels increased towards the more downstream site, Eff-plus. Temporal data are reflecting trends of increasing salinity at both site Eff and Eff-plus, with the increasing trend at site Eff-plus likely a response to the upstream increase as seen at site Eff. Bank erosion remains a notable impact at site K2, and the regularly observed sedimentation of the stream may have contributed in part to the increase in EC between sites K1 and K2 during some recent surveys. It is reiterated that Kelvin Power Station's environmental staff should take steps to mitigate any potential contributions to the increased salinity of the Modderfonteinspruit, especially given the higher salinity consistently recorded in the Effluent Stream during recent surveys.

The dissolved oxygen (DO) concentration measured above the median guideline (> 5 mg/l) at all four Modderfonteinspruit sites during the November 2024 survey (Table 10), and would not have limited aquatic biota at these sites. This reflects improvement at site K1 compared to the May 2024 survey when the DO concentration at this site measured below the median guideline level. Low DO concentrations have been observed at several Modderfonteinspruit monitoring sites over recent surveys, but the scenario is generally already present at site K1 (upstream of potential KPS impacts) and appears unrelated to KPS activities. Sewage contamination is believed to be underlying the low DO concentrations, with other signs of sewage pollution, such as algal proliferation, supporting this notion.

The toxicity test results for December 2024 / January 2025 are tabulated in Table 11 and briefly interpreted thereafter.

Table 11: Toxicity test results (Clean Stream, 2024).

	Results	K1	K2	EFF Plus	EFF	Ash Dam	Desilting Dam	RWD
Water quality	Test date yy/mm/dd	2025.01.06	2025.01.06	2025.01.06	2025.01.10	2025.01.10	2025.01.10	2025.01.10
	pH @ 25°C (NA)	8.1	8.3	7.9	8.8	9.9	9.1	10.1
	EC (Electrical conductivity) (mS/m) @ 25°C (NA)	42.9	151.2	143.6	149.3	204.2	139.7	176.7
	Dissolved oxygen (mg/l) (NA)	8.5	8.7	9.2	7.3	7.3	7.0	7.5
A. fischeri bacteria) (A	Test started on yy/mm/dd	2025.01.13	2025.01.13	2025.01.13	2025.01.21	2025.01.21	2025.01.22	2025.01.22
	% 30min inhibition (-) / stimulation (+) (%)	**39**	**19**	**11**	**34**	**14**	**22**	**-69**
	EC/LC20 (30 mins)	*	*	*	n.r	n.r	n.c	62
	EC/LC50 (30 mins)	*	*	*	n.r	n.r	n.r	85
	Toxicity unit (TU) / Description	no sub-lethal hazard	no sub-lethal hazard	no sub-lethal hazard	<1	<1	<1	1.2
D. magna waterflea) (A	Test started on yy/mm/dd	2025.01.06	2025.01.06	2025.01.06	2025.01.13	2025.01.13	2025.01.13	2025.01.13
	% 48hour mortality rate (-%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	EC/LC10 (48hours)	*	*	*	n.r	n.r	n.r	n.r
	EC/LC50 (48hours)	*	*	*	n.r	n.r	n.r	n.r

Results		K1	K2	EFF Plus	EFF	Ash Dam	Desilting Dam	RWD
P. reticulata guppy) (A	Toxicity unit (TU) / Description	no lethal hazard	no lethal hazard	no lethal hazard	<1	<1	<1	<1
	Test started on yy/mm/dd	2025.01.09	2025.01.09	2025.01.09	2025.01.20	2025.01.20	2025.01.20	2025.01.20
	% 96hour mortality rate (-%)	**-33**	**-8**	**0**	**0**	**-8**	**0**	**0**
	EC/LC10 (96hours)	*	*	*	**13**	**6**	**n.r**	**n.r**
	EC/LC50 (96hours)	*	*	*	**n.r**	**n.r**	**n.r**	**n.r**
	Toxicity unit (TU) / Description	S.D.O.T.H	no lethal hazard	no lethal hazard	<1	<1	<1	<1
Minimum acceptable effect level/ Estimated safe dilution factor (%) [for definitive testing only]		**N/A**	**N/A**	**N/A**	**13**	**6**	**<1**	**62**
Overall classification - Hazard class***		Class II - Slight lethal hazard	Class I - No lethal/sub-lethal hazard	Class I - No lethal/sub-lethal hazard	Class II - Slight lethal hazard	Class II - Slight lethal hazard	Class II - Slight sub-lethal hazard	Class III - Sub-lethal hazard
Weight (%)		33	0	0	33	33	33	33
Key:								

% = for definitive testing, only the 100% concentration (undiluted) sample mortality/inhibition/stimulation is reflected by this summary table. The dilution series results are considered for EC/LC values and Toxicity unit determinations n.r. = not relevant, i.e. the 100% concentration caused less than 10/20/50% (effective concentration) mortalities or inhibition

n.c. = not calculable, although the 100% concentration showed no significant light emission inhibition effect such slight effects were observed on other dilutions of the sample, and could not be diluted out up to a 0.78% dilution of the sample * = EC/LC values not determined, definitive testing required if a hazard was observed and persists over subsequent sampling runs

Results	K1	K2	EFF Plus	EFF	Ash Dam	Desilting Dam	RWD

S.D.O.T.H = Some degree of lethal/sub-lethal toxic hazard based on this single test organism, refer to overall hazard classification, which takes into account the full battery of test organisms.

*** = The overall hazard classification takes into account the full battery of tests and is not based on a single test result. Note that the overall hazard classification is expressed as both lethal (*Daphnia* & *Poecilia*) and sub-lethal (*Aliivibrio*) levels of toxicity

Weight (%) = relative toxicity levels (out of 100%), higher values indicate that more of the individual tests indicated toxicity within a specific class site/sample name shaded in purple = screening test

site/sample name shaded in orange = definitive test

The December 2024 water sample from the upstream Modderfonteinspruit site, K1, reflected a slight lethal environmental toxicity hazard (Class II) based on a 33% vertebrate mortality effect. This represents an increase in toxicity hazard compared to the September 2024 survey, which showed no lethal/sub-lethal environmental toxicity hazard (Class I). As site K1 is the upstream (control) site, the slight toxicity hazard recorded in December 2024 is considered unrelated to KPS.

No lethal/sub-lethal toxicity hazard (Class I) was detected for the December 2024 sample from site K2, located downstream of potential KPS impacts. This indicates that, based on the December 2024 samples, there was no increase in the toxicity hazard class of the Modderfonteinspruit following the inclusion of potential KPS impacts via the Effluent Stream. The September 2024 survey also reflected spatial stability between sites K1 and K2, with both samples showing Class I hazard ratings.

A slight lethal environmental toxicity hazard (Class II) was assigned to the January 2025 sample from site Eff, which represents the Effluent Stream inclusive of potential power station impacts but excluding industrial impacts. The hazard was based on toxicity effects observed in the dilution series, and a safe dilution factor of 13% was calculated (i.e. 13 parts Eff water diluted with 87 parts clean water). This continues the trend of improvement in toxicity hazard for site Eff compared to the November 2023 survey, which recorded a very high lethal toxicity hazard (Class V). Despite the improvement, the presence of a slight toxicity hazard remains a concern, and KPS's environmental staff should continue monitoring and mitigation efforts.

The water toxicity hazard decreased towards the downstream Effluent Stream site, Eff-plus, which includes both potential power station and industrial impacts. The January 2025 sample from this site showed no lethal/sub-lethal environmental toxicity hazard (Class I), indicating that industrial and/or other impacts along the Effluent Stream did not increase the toxicity hazard. This finding also reflects a decrease in toxicity hazard compared to the September 2024 survey, when a Class II hazard was recorded at Eff-plus.

Based on definitive testing, the January 2025 sample from the Ash Dam reflected a slight lethal environmental toxicity hazard (Class II), with a safe dilution factor of 6% (i.e. 6 parts Ash Dam water diluted with 94 parts clean water). This marks an improvement from the September 2024 survey, which recorded a Class III hazard.

The Desilting Dam sample from January 2025 showed a slight sub-lethal environmental toxicity hazard (Class II) based on bacterial light emission inhibition effects. However, no safe dilution factor could be established, as the slight effects persisted even at a 0.78% dilution. This is a decrease in hazard compared to the September 2024 survey, which recorded a Class III hazard.

The Return Water Dam (RWD) sample from January 2025 was assigned a sub-lethal environmental toxicity hazard (Class III), based on a 69% bacterial light emission inhibition effect and a toxicity unit (TU) of 1.2. A safe dilution factor of 62% was calculated (i.e. 62 parts RWD water diluted with 38 parts clean water). This is consistent with the September 2024 survey, which also recorded a Class III hazard, although no safe dilution factor could be determined at that time.

These findings underscore the importance of continued and definitive toxicity testing for the Pollution Control Dams (PCDs), which remain critical for environmental risk management and mitigation planning.

4.2.4   RESOURCE CLASS AND RIVER HEALTH

The biomonitoring (SASS5) results for November/December 2024 are tabulated in Biotic integrity remains poor throughout the study area, consistent with previous surveys. In contrast to the May 2024 findings, biotic integrity decreased from K1 to K2, remained fairly stable from K2 to K3, and showed a slight improvement from K3 to K4. Habitat differences, as assessed via IHAS and biotope suitability scores, may have influenced biotic responses, but SASS5 scores are considered more reliable due to low taxa diversity.

Table 12 and briefly interpreted thereafter.

Biotic integrity remains poor throughout the study area, consistent with previous surveys. In contrast to the May 2024 findings, biotic integrity decreased from K1 to K2, remained fairly stable from K2 to K3, and showed a slight improvement from K3 to K4. Habitat differences, as assessed via IHAS and biotope suitability scores, may have influenced biotic responses, but SASS5 scores are considered more reliable due to low taxa diversity.

Table 12: Biomonitoring results (Clean Stream, 2024).

SASS5 and Associated Habitat			Sampling Sites					
	Measuring Unit	Guideline/ Target	K1	Eff	Eff-Plus	K2	K3	K4
Total SASS5 score.	Score	n.r.	36	N/A	0	22	24	32
ASPT.	Average score per taxon	n.r.	3.6	N/A	0	3.1	2.7	2.9
IHAS.	Habitat score	n.r.	66	N/A	0	55	66	57
Biotype suitability.	Habitat score	n.r.	7	N/A	0	5	9	8

The November 2024 SASS5 findings differ from those of the May 2024 and November 2023 surveys (report KEL-D-23), which did not detect further deterioration in biotic conditions along the reach from K1 to K2, but are consistent with the June 2023 findings (report KEL-B-23), which showed further deterioration in biotic integrity from site K1 to site K2, with water quality deterioration identified as a contributing factor. Comparison of the November 2023, May 2024, and November 2024 findings shows that the total SASS5 score at site K1 increased from 21 (Nov 2023) to 24 (May 2024) and further to 36 (Nov 2024), despite fluctuating water toxicity hazard levels (Class II to Class I to Class II). The persistent sewage contamination and low dissolved oxygen (DO) concentrations at this site, observed in multiple surveys, likely continue to contribute to the poor biotic integrity.

At site K2, the total SASS5 score decreased from 34 (Nov 2023) to 29 (May 2024) and further to 22 (Nov 2024), despite water toxicity hazard decreasing from Class II to Class I. This decline in biotic integrity highlights the need for close monitoring. Biotic conditions remain very poor at both sites, and the spatial deterioration from K1 to K2 observed in November 2024 is concerning.In November 2024, the total SASS5 score and ASPT remained fairly stable from site K2 (22 and 3.1) to site K3 (24 and 2.7), despite better habitat conditions at K3 (as indicated by IHAS and biotope suitability scores). The absence of a corresponding improvement in biotic integrity may point to water quality deterioration. The GSM biotope was the most comparable between these sites, with SASS5 scores of 10 (K2) and 9 (K3), which does not provide definitive evidence of water quality differences. In-situ measurements showed improvement in salinity towards site K3, but other water quality variables not included in the in-situ range may have influenced the results.

The November 2024 SASS5 findings suggest possible water quality-related impacts to the biotic integrity of the reach from K2 to K3, likely stemming from industrial and residential activities. It is reiterated that no known further KPS impacts occur downstream of site K2.

4.2.5   RECEIVING WATER QUALITY OBJECTIVES AND RESERVE

The Receiving Water Quality Objectives (RWQO) for the Modderfonteinspruit catchment are being developed by the DWS. DWS is responsible for providing the Reserve.

The licence issued to Kelvin Power has the compliance qualities (Appendix II, Condition 2.5) for water as indicated in Table 13.

Table 13: Quality of wastewater to be disposed.

Variable	Limit	RQO
pH	6.5 – 8.5	5 – 9.5
Electrical Conductivity (EC)	80 mS/m	115 mS/m
Total Suspended Solids (TSS)	40 mg/l	-

Variable	Limit	RQO
Chemical Oxygen Demand (COD)	50 mg/l	-
Sulphate (SO_4)	200 mg/l	200 mg/l
Sodium (Na)	25 mg/l	49.5 mg/l
Calcium (Ca)	25 mg/l	100 mg/l
Magnesium (Mg)	15 mg/l	61.6 mg/l
Free Residual Chlorine (Cl)	0.2 µg/l	-
E. coli/ Faecal Coliforms	0 cfu/100ml	-
Ammonia (ionised and un-ionised) as Nitrogen (NH_3 as N)	2 mg/l	-
Nitrate/ Nitrite as Nitrogen (NO_3/ NO_2 as N)	6 mg/l	6 mg/l
Ortho-Phosphate as Phosphorous (PO_4 as P)	0.1 mg/l	-

4.2.6   SURFACE WATER USER SURVEY

Kelvin Power Station is situated very close to a number of residential areas. The informal settlement of Alexandria is suggestive of downstream, informal use of water from the Modderfonteinspruit. A hydrocensus was also conducted for the updated groundwater model as indicated in section 4.3.5.

4.2.7   SENSITIVE AREAS SURVEY

There are no known wetlands near or within Kelvin Power. The area is predominantly residential and industrial; however, no baseline studies have been conducted to verify that the site is not within the area of a delineated wetland to date (Divhani, 2024).

4.3   GROUNDWATER

Groundwater baseline information have been derived from the 2024 IWWMP and a study that was conducted by Gradient, 2025 (Appendix 1). The following sections summarises the regional and site-specific hydrogeology.

4.3.1   REGIONAL HYDROGEOLOGY

The Department have characterised South African aquifers based on host-rock formations in which it occurs together with its capacity to transmit water to boreholes drilled into relative formations. The water bearing properties of respective formations can be classified into four aquifer classes defined below. Each of these classes is further subdivided into groups relating to the capacity of an aquifer to transmit water to boreholes, typically measured in l/s. The groups therefore represent various ranges of borehole yields:

a.   **Class A:** Intergranular Aquifers associated either with loose and unconsolidated formations such as sands and gravels or with rock that has weathered to only partially consolidated material.

b.   **Class B:** Fractured Aquifers associated with hard and compact rock formations in which fractures, fissures and/or joints occur that are capable of both storing and transmitting water in useful quantities.

c.   **Class C:** Karst Aquifers associated with carbonate rocks such as limestone and dolomite in which groundwater is predominantly stored in and transmitted through cavities that can develop in these rocks.

d.   **Class D:** Intergranular and fractured Aquifers that represent a combination of Class A and B aquifer types. This is a common characteristic of South African aquifers. Substantial quantities of water are stored in the intergranular voids of weathered rock but can only be tapped via fractures penetrated by boreholes drilled into it.

According to the DWS Hydrogeological map (DWS Hydrogeological map series 2526 (Johannesburg) the study area is predominantly underlain by a Class d3 intergranular and fractured aquifer (typically associated with

median borehole yields ranging between 0.5 and 2.0L/s), it should however be noted that higher yielding boreholes (>5.0l/s) may occur along intruding dyke contact zones and other structural features i.e., fault zones etc. (Barnard, 2000). The host aquifers consist of primarily intermediate or alkaline intrusive. Most hard-rock aquifers are secondary in nature with groundwater associated with fracturing, fault zones as well as contact zones.

According to Vegter's groundwater regions delineated (2000) the study area can be classified as falling under the Central Highveld Region (Region 17). The maximum aquifer thickness i.e., shallow, intergranular aquifer system is <20m with water stored mainly in fractures principally restricted to a shallow zone below groundwater level.

Figure 14 depicts a conceptualised cross section of the greater study area. Refer to Figure 15 for a map illustrating the typical groundwater occurrence for the greater study area while Figure 16 depicts the hydrogeological map of the greater study area.

4.3.2   LOCAL HYDROSTRATIGRAPHIC UNITS

For the purposes of this investigation, three main hydrostratigraphic units/aquifer systems can be inferred in the saturated zone[1]:

i.   A shallow Quaternary (perched and unconfined) aquifer: These aquifers consist of recent types of sediments and are characteristically primary porosity aquifers, such that groundwater flow occurs in the pore spaces between soil and sediment particles. These aquifers are formed by alluvial material along the riparian zone of local drainages and are limited to a zone of variable width and depth. Clay lenses in the soil and unsaturated zones may cause local, perched water tables which occur above the regional water table.

ii.   A shallow, intergranular aquifer within the Halfway House Granites: These aquifers occur in the transitional soil and weathered bedrock formations underlain by more consolidated bedrock. Groundwater flow patterns usually follow the topography, discharging as natural springs at topographic low-lying areas. Usually, these aquifers can be classified as a secondary porosity aquifer and is generally unconfined with phreatic water levels. In secondary porosity aquifers, groundwater flow occurs along fractures, while water is stored within the rock matrix. Due to higher effective porosity (n) this aquifer is more susceptible to impacts from contaminant sources compared to confined aquifers.

iii. A deeper, fractured aquifer within the Halfway House Granites: In fractured aquifers, pores are well-cemented and do not allow any significant flow of water. Groundwater flow is dictated by transmissive secondary porosity structures such as bedding planes fractures, faults and contact zones fracture zones that occur in the relatively competent host rock. Fractured granite as well as dolerite dykes and sills are considered as fractured rock aquifers holding water in storage in both pore spaces and fractures. Groundwater yields, although more heterogeneous, can be expected to be higher than the weathered zone (shallow) aquifer. This aquifer system usually displays semi-confined or confined characteristics with potentiometric heads often significantly higher than the water-bearing fracture position.

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[1] Refer to project assumptions and limitations, it should be noted that no site characterisation boreholes have been drilled to confirm this statement.

Figure 14: Schematic cross section to illustrate typical groundwater occurrence in the Johannesburg area (Barnard, 1999).
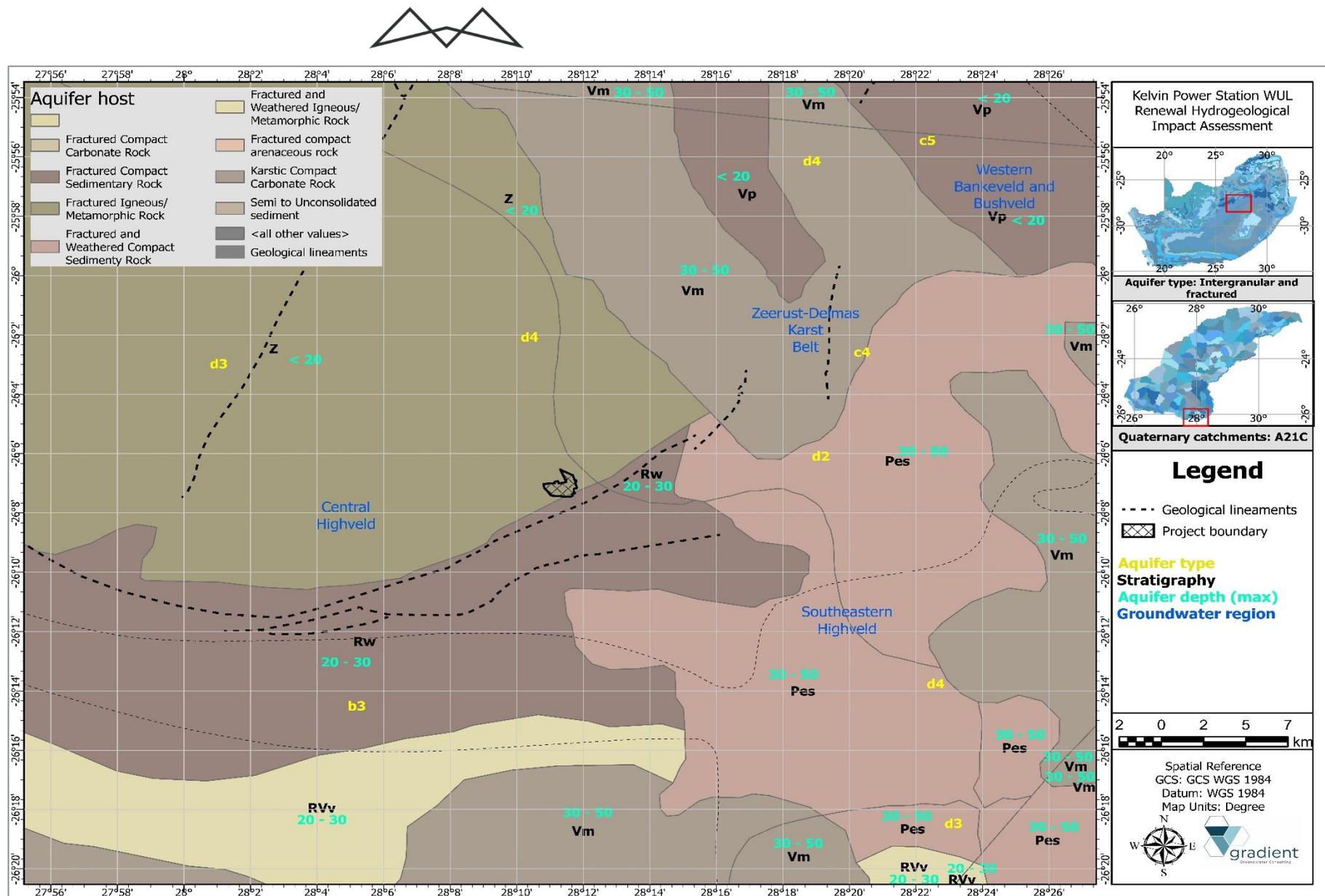
Figure 15: Typical aquifer hosts and groundwater occurrence for the study region (2526 Johannesburg).
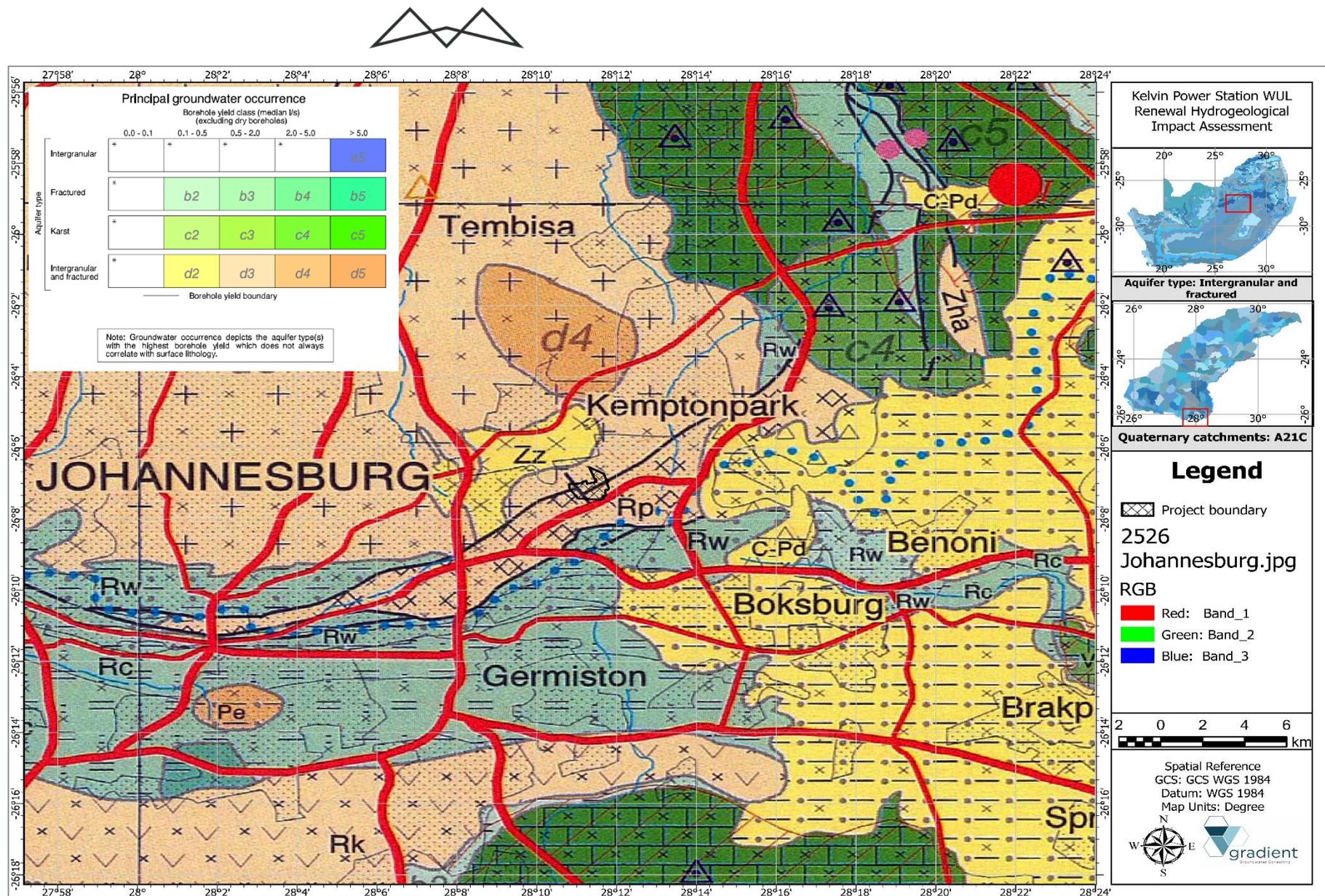
Figure 16: Hydrogeological map of the greater study region (2526 Johannesburg).

4.3.3   GROUNDWATER-SURFACE WATER INTERACTION

Groundwater and surface water interaction is an essential component of the hydrological cycle. The hyporheic zone (stream bed) is the zone of most interaction (Adams et. al.,2012) as shown in Figure 17. According to records documented by Van Tonder and Dennis (2003), under natural conditions this area exhibits certain regions where there is pronounced interaction between surface and groundwater. The two regimes are therefore well-linked and should be integrated to manage any water-related issues in these catchments. Regional drainages can be generally classified as influent or gaining stream systems. Groundwater head elevation compared to topographical elevation confirms that there exists groundwater discharge as baseflow to local drainages.
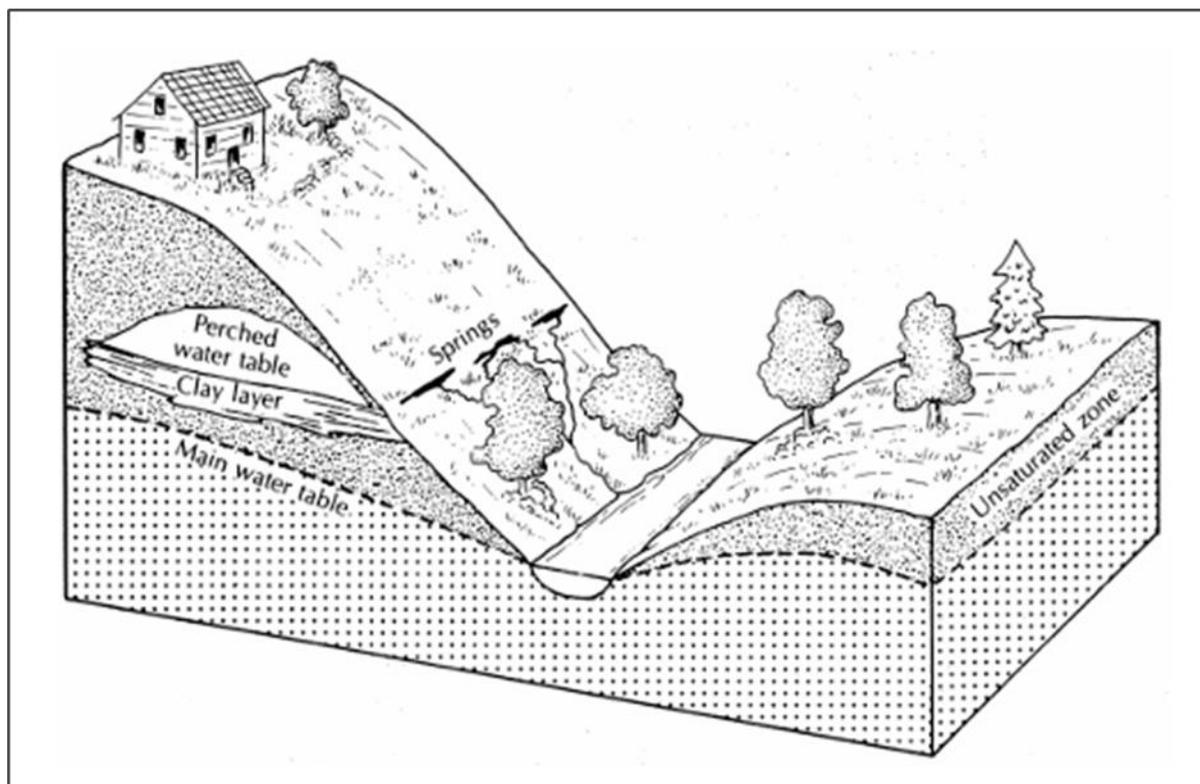
Figure 17: Illustration of the Unsaturated Zone (Fetter and Kreamer, 2023).

4.3.4   HYDRAULIC PARAMETERS

To follow is a brief overview of aquifer hydraulic parameters based on published literature for similar hydrogeological conditions as well as historical reports.

4.3.4.1   HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY

Hydraulic conductivity is the constant of proportionality in Darcy's Law which states that the rate of flow through a porous medium is proportional to the loss of head, and inversely proportional to the length of the flow path as indicated in the following equation:

Equation 1: **Hydraulic Conductivity (Darcy's Law).**

$$K = \frac{Q}{A\left(\frac{dh}{dl}\right)}$$

where:

K   = Hydraulic Conductivity (m/d).

Q   = Flow of water per unit of time (m^3/d).

dh/dl = Hydraulic gradient.

A = is the cross-sectional area, at a right angle to the flow direction, through which the flow occurs (m^2)

The hydraulic conductivity of igneous formations such as evident on site can range from 10E^{-05} – 10E^{-02} m/d. The hydraulic conductivity of fractured igneous rocks (i.e. dolerite) varies between 10E^{-06} – 10E^{-01}m/d, while conductivity values for un-fractured igneous rocks (i.e. fresh dolerite sill) ranges between 10E^{-09} – 10E^{-06} m/d.

It should be noted that the hydraulic conductivity of fault zones traversing the greater study area may be orders of magnitude higher than the matrix formations and will act as preferred pathways for groundwater flow and contaminant transport. The hydraulic conductivity of quaternary deposits and alluvial pockets associated with the drainage system i.e., riverbed aquifers can be orders higher and can vary between 10E^{-02} – 10E^{+01} m/d as depicted in Figure 18 (Freeze and Cherry, 1979).

Transmissivity can be expressed as the product of the average hydraulic conductivity (K) and thickness (b) of the saturated portion of an aquifer and expressed by:

Equation 2: **Transmissivity.**

$$T = Kb$$

where:

T = Transmissivity (m^2/d).

K = Hydraulic Conductivity (m/d).

b = Saturated aquifer thickness.

Data interpretation from recent constant discharge pump tests conducted indicate average transmissivity values ranging between 0.50 to 1.50m^2/d (Groundwater Complete, 2025).
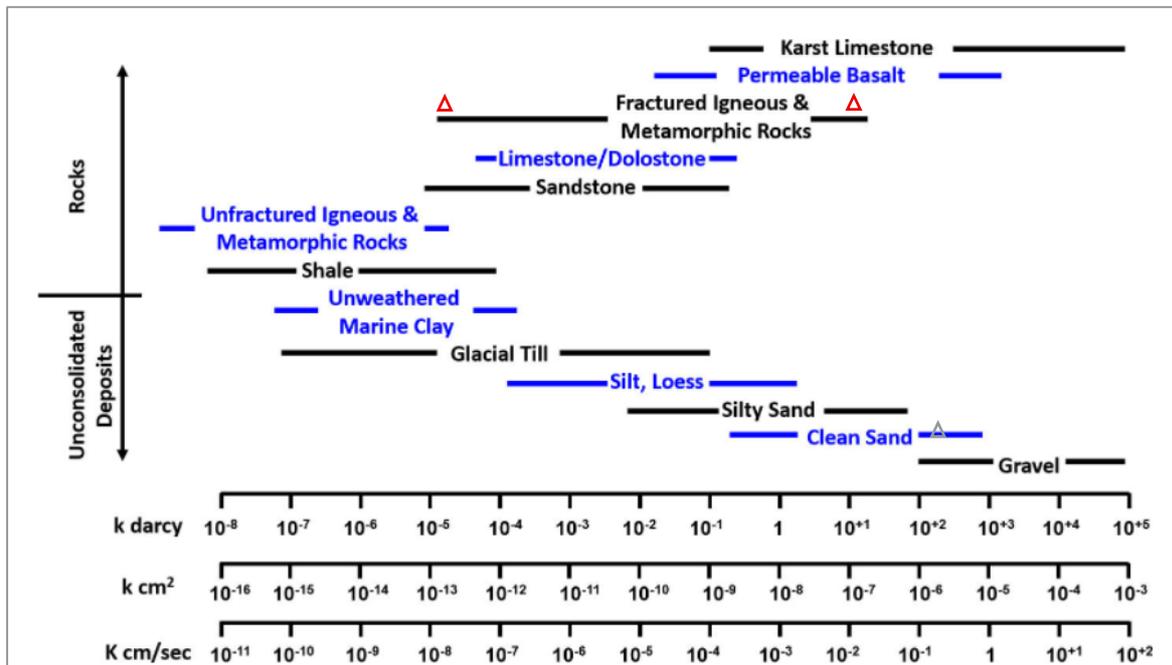
Figure 18: Typical hydraulic conductivity values for on-site hydrostratigraphical units.

4.3.4.2 STORATIVITY

Storativity refers to the volume of water per volume of aquifer released as a result of a change in head. For a confined aquifer, the storage coefficient is equal to the product of the specific storage and aquifer thickness.

Typical storativity values for fractured rock systems is in the order of $10E^{-05} - 10E^{-03}$ (Freeze and Cherry, 1979). Storativity values of the shallow, weathered aquifer will be slightly higher i.e., $10E^{-02}$.

4.3.4.3 POROSITY

Porosity is an intrinsic value of seepage velocity and hence contamination migration. Porosity is an intrinsic value of seepage velocity and hence contamination migration. The porosity of fractured igneous formations ranges between 0.1% – 1%, while porosity of weathered formations can range between 3% to 10% depending on the nature and state of weathering. The intrinsic porosity of primary aquifers i.e., alluvial deposits can be as high as 15% depending on the nature of sorting (Freeze and Cherry, 1979).

4.3.4.4 RECHARGE

An approximation of recharge for the study area is estimated at ~4.23% of MAP i.e. ~28.82 mm/a as summarised in Table 14. Groundwater recharge was calculated using the RECHARGE Program1 (van Tonder and Xu, 2000), which includes using qualified guesses as guided by various schematic maps. The following methods/sources were used to estimate the recharge: (i) Chloride Mass Balance (CMB) methodology (refer to Figure 19, Figure 20 and Figure 21)

Table 14: Recharge estimation (after van Tonder and Xu, 2000).

Recharge method/ Reference	Recharge (mm/a)	Recharge (% of MAP)	Weighted Average (High = 5; Low = 1)
Chloride	25.58	3.75	4.00
Geology	34.10	5.00	1.00
Vegter	45.00	6.60	2.00
ACRU	30.00	4.40	3.00
Baseflow	25.00	3.67	4.00
Published literature	24.50	3.59	3.00
Weighted average	**28.82**	**4.23**	**17.00**

Notes: Recharge per annum were calculated using a MAP of 682.0mm/a.
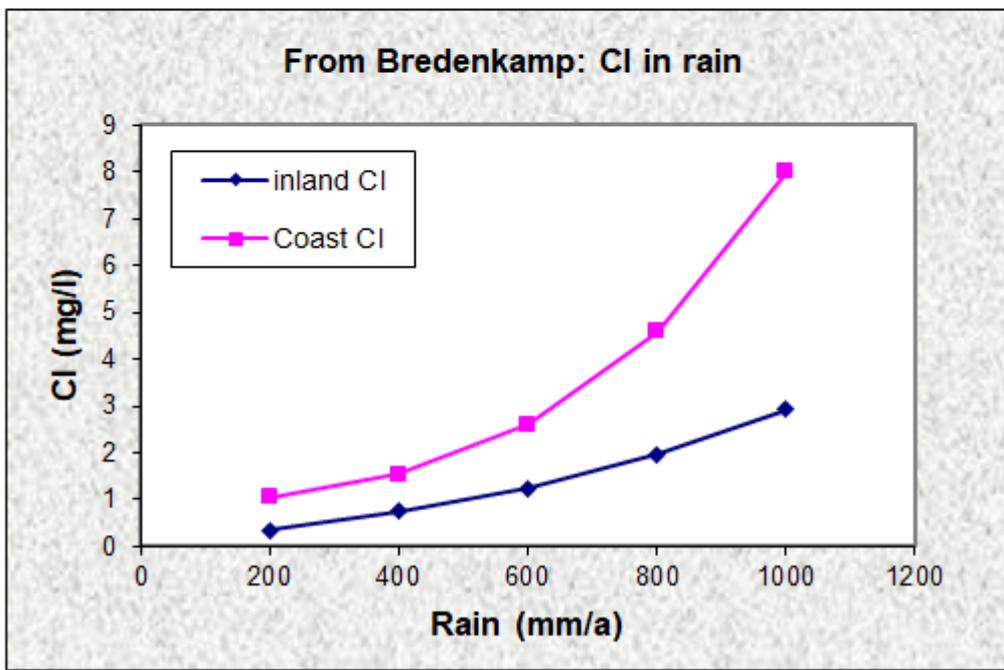
Figure 19: Chloride Mass Balance (CMB) method summary.
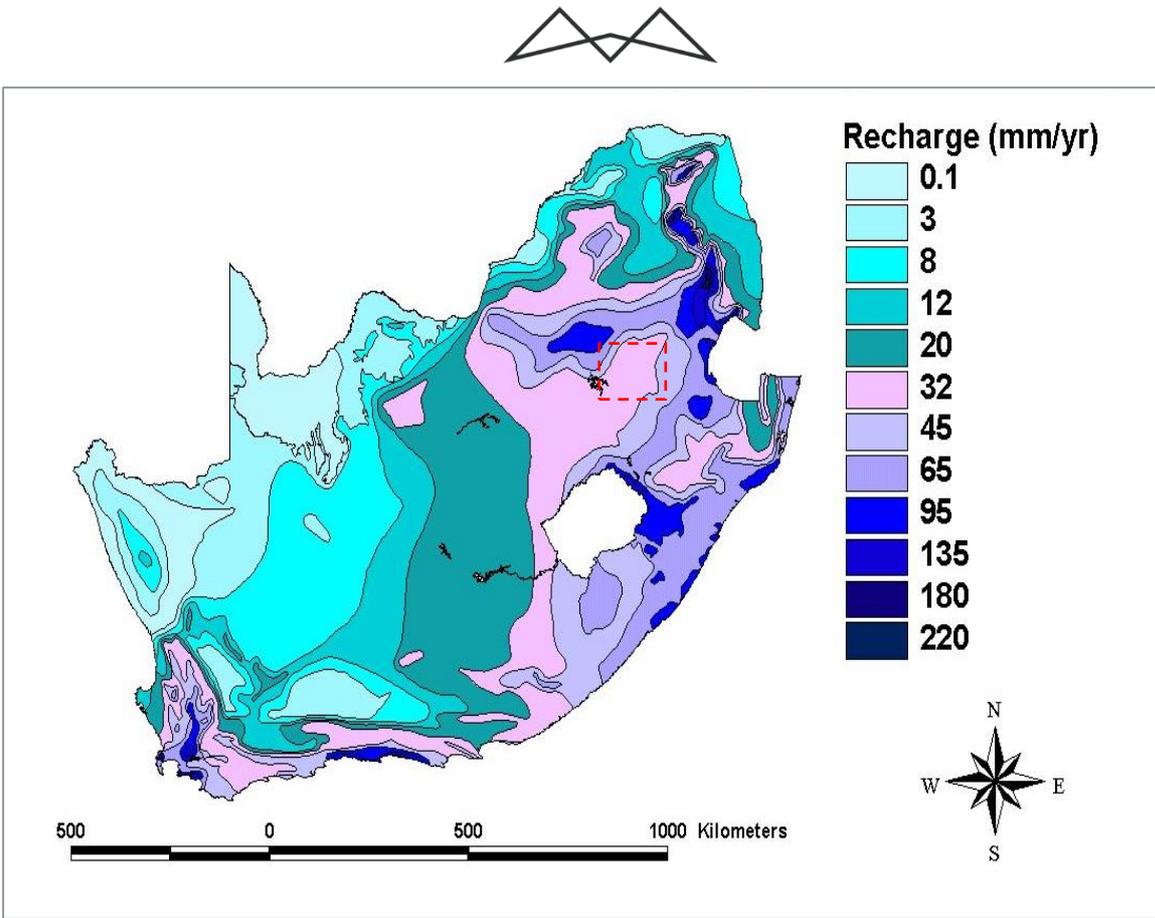
Figure 20: Groundwater recharge distribution in South Africa (After Vegter, 1995).
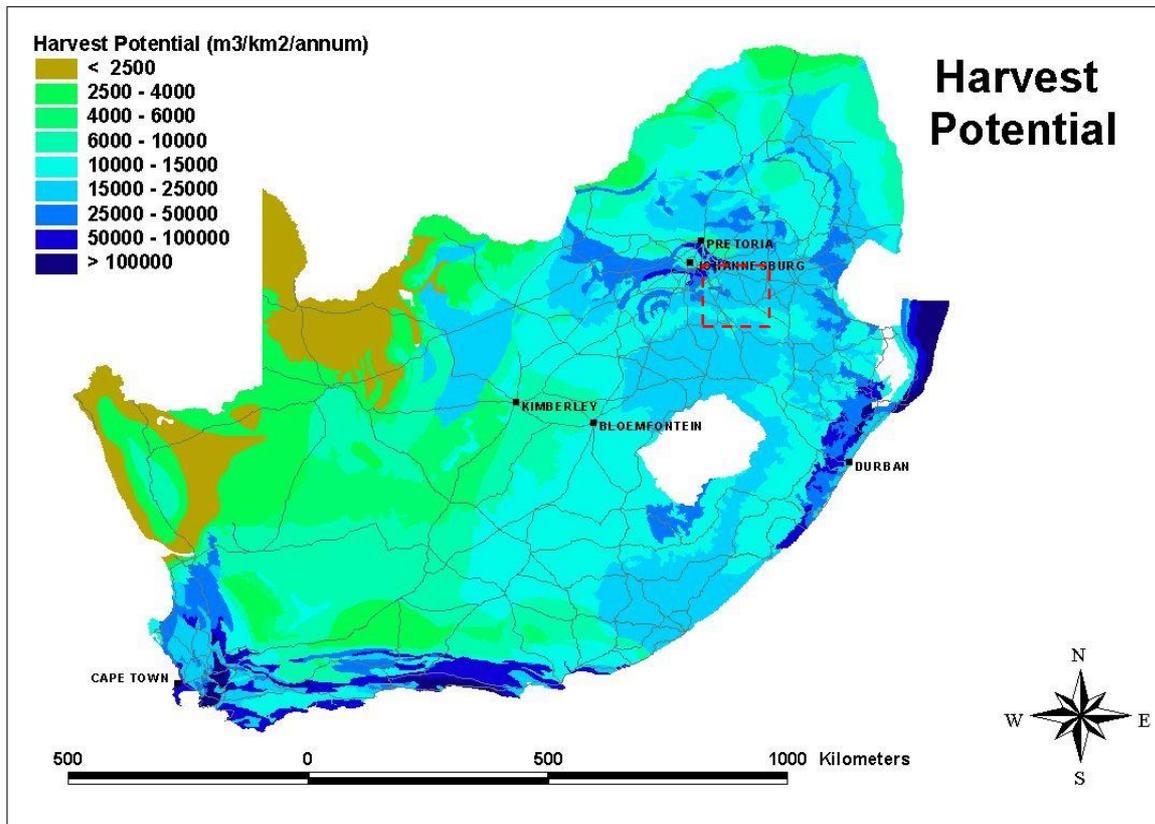
Figure 21: Harvest potential distribution in South Africa (DWS, 2013).

4.3.5 HYDROCENSUS USER SURVEY

A hydrocensus user survey within the greater study area was conducted during July 2025[2] where relevant hydrogeological baseline information was gathered. The aim of the hydrocensus survey is to determine the ambient and background groundwater and surface water conditions including applications and to identify potential sensitive environmental receptors i.e., groundwater and surface water users including wetlands or spring localities in close vicinity to the existing power generation operations. A total of 25 geosites were visited as part of the hydrocensus user survey. Relevant information is summarised in Table 16 with a spatial distribution map of geosites shown in Figure 22. Table 15 tabulates local landowners visited, however no boreholes or other receptors could be identified.

4.3.5.1 GEOSITE TYPE

A total of 25 geosites or potential receptors were visited and recorded consisting of 22 boreholes (~88.0%) and 5 surface water features (12.0%).

4.3.5.2 GROUNDWATER STATUS

All the boreholes recorded are in use and being applied for monitoring purposes.

4.3.5.3 BOREHOLE EQUIPMENT

None of the boreholes visited are equipped as they are being applied for monitoring purposes.

Table 15: Hydrocensus user survey: relevant visited outside of the project boundary.

Site ID	Latitude	Longitude	Owner	Field notes
n/a	-26.11603	28.19807	Kelvin Estate	No boreholes, appointment only, spoke with security
n/a	-26.12456	28.19072	Host Hub Guest House	No borehole, spoke with owner
n/a	-26.12748	28.18546	Rolop CC	No borehole, spoke with owner
n/a	-26.12308	28.18255	Trouw Nutrition	No borehole, spoke with facilities manager
n/a	-26.12720	28.18536	Sondor Performance Foams	No borehole, spoke with facilities manager
n/a	-26.12504	28.18381	Coprechem	No boreholes, appointment only, spoke with security
n/a	-26.12156	28.20029	Eco Motel	No borehole, spoke with receptionist
n/a	-26.11960	28.20166	GlenChem	No borehole, spoke with receptionist
n/a	-26.11677	28.20056	Berry & Donaldson	No borehole, spoke with receptionist
n/a	-26.11828	28.20008	Sasol Fill station	No borehole, spoke with manager
n/a	-26.11222	28.19755	Engen Fill station	No borehole, spoke with manager
n/a	-26.10827	28.19580	Steel Mate	No borehole, spoke with owner

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[2] Relevant site information gathered will thus be representative of dry-season contribution.

Site ID	Latitude	Longitude	Owner	Field notes
n/a	-26.10941	28.19257	Air Liquide	No borehole, spoke with security
n/a	-26.11149	28.18766	Value Chemical Logistics	No borehole, spoke with receptionist

Notes: N/A: Not applicable

Notes: Due to the POPIA act (Act 4 of 2013) no personal contact details were reflected in this table

Table 16: Hydrocensus user survey: relevant geosite information.

Site ID	Latitude	Longitude	Geosite type	Site status	Water level status	Depth (mbgl)**	Water level (mbgl)	Equipment type	Water application	Owner	Field notes
KPS-BH01	-26.12013	28.18283	Borehole	In use	Static	6.50	3.00	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-BH02	-26.12184	28.18618	Borehole	In use	Static	11.81	1.27	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-BH04	-26.12237	28.18397	Borehole	In use	Static	12.00	1.62	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-BH05	-26.12414	28.19104	Borehole	In use	Static	17.00	2.84	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-BH07	-26.12285	28.18427	Borehole	In use	Static	15.00	3.47	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON01	-26.11181	28.19264	Borehole	In use	Static	35.00	8.77	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON02	-26.11296	28.19177	Borehole	In use	Static	30.00	5.98	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON03	-26.11576	28.18842	Borehole	In use	Static	30.00	5.70	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON04	-26.11849	28.18463	Borehole	In use	Static	30.00	2.39	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON05	-26.12339	28.18576	Borehole	In use	Static	30.00	2.43	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON06	-26.11965	28.19179	Borehole	In use	Static	30.00	2.04	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON07	-26.12163	28.19426	Borehole	In use	Static	20.00	1.90	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON09	-26.11730	28.19633	Borehole	In use	Static	35.00	4.99	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON10	-26.11724	28.19632	Borehole	In use	Static	15.00	4.95	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON11	-26.11528	28.19416	Borehole	In use	Static	25.00	4.79	Not Equipped	Monitoring	Kelvin Power Station	Sample taken

Site ID	Latitude	Longitude	Geosite type	Site status	Water level status	Depth (mbgl)**	Water level (mbgl)	Equipment type	Water application	Owner	Field notes
KPS-MON12	-26.11740	28.19366	Borehole	In use	Static	25.00	6.17	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON13	-26.11819	28.18978	Borehole	In use	Static	16.00	4.78	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON14	-26.11473	28.19191	Borehole	In use	Static	20.00	5.46	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-MON16	-26.11738	28.18219	Borehole	In use	Static	20.00	3.97	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-NBH01	-26.12166	28.18339	Borehole	In use	Static	47.00	1.68	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-NBH02	-26.11940	28.18218	Borehole	In use	Static	50.00	1.78	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
KPS-NBH03	-26.12418	28.19327	Borehole	In use	Static	27.00	3.41	Not Equipped	Monitoring	Kelvin Power Station	Sample taken
DC	-26.12157	28.18394	Decant	In use	Flowing	n/a	n/a	n/a	Water management	Kelvin Power Station	Decant only if dams are full.
RD1	-26.12109	28.18415	Return Water Dam	In use	Flowing	n/a	n/a	n/a	Water management	Kelvin Power Station	Process water, reused.
RD2	-26.11901	28.18887	Return Water Dam	In use	Flowing	n/a	n/a	n/a	Water management	Kelvin Power Station	Process water, reused.

Notes: N/A: Not applicable

**Borehole depth reflected is approximate depths and should be confirmed
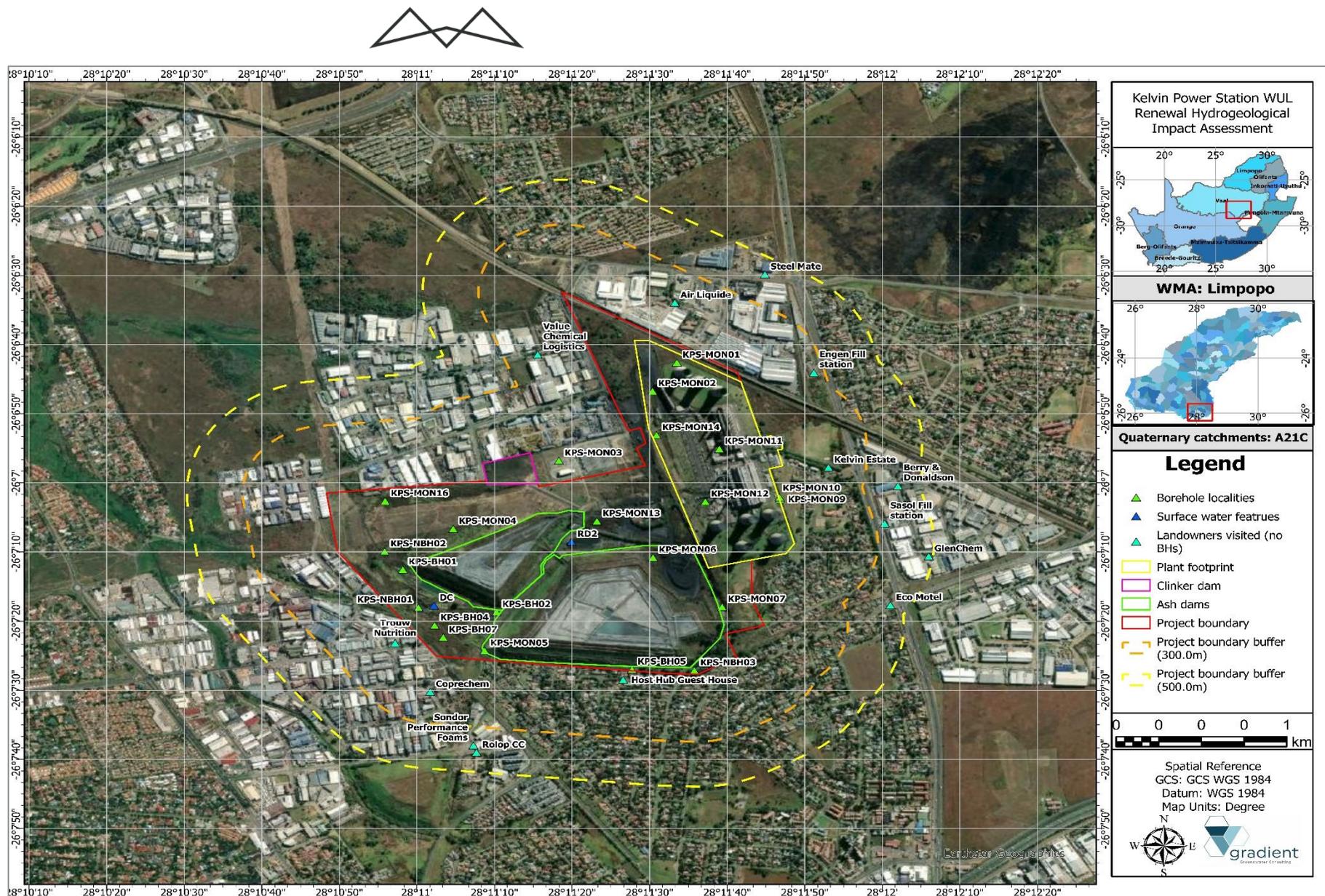
Figure 22: Spatial distribution of hydrocensus user survey geosites.

4.3.6 SOURCE-PATHWAY-RECEPTOR EVALUATION

In order to evaluate the risk of groundwater contamination, potential sources of contamination should be identified, as well as potential pathways and receptors. The pollution linkage concept relies on the identification of a potential pollutant (i.e. source) on-site which is likely to have the potential to cause harm to a receptor by means of a pathway by which the receptor may be exposed to the contaminant (Figure 23).
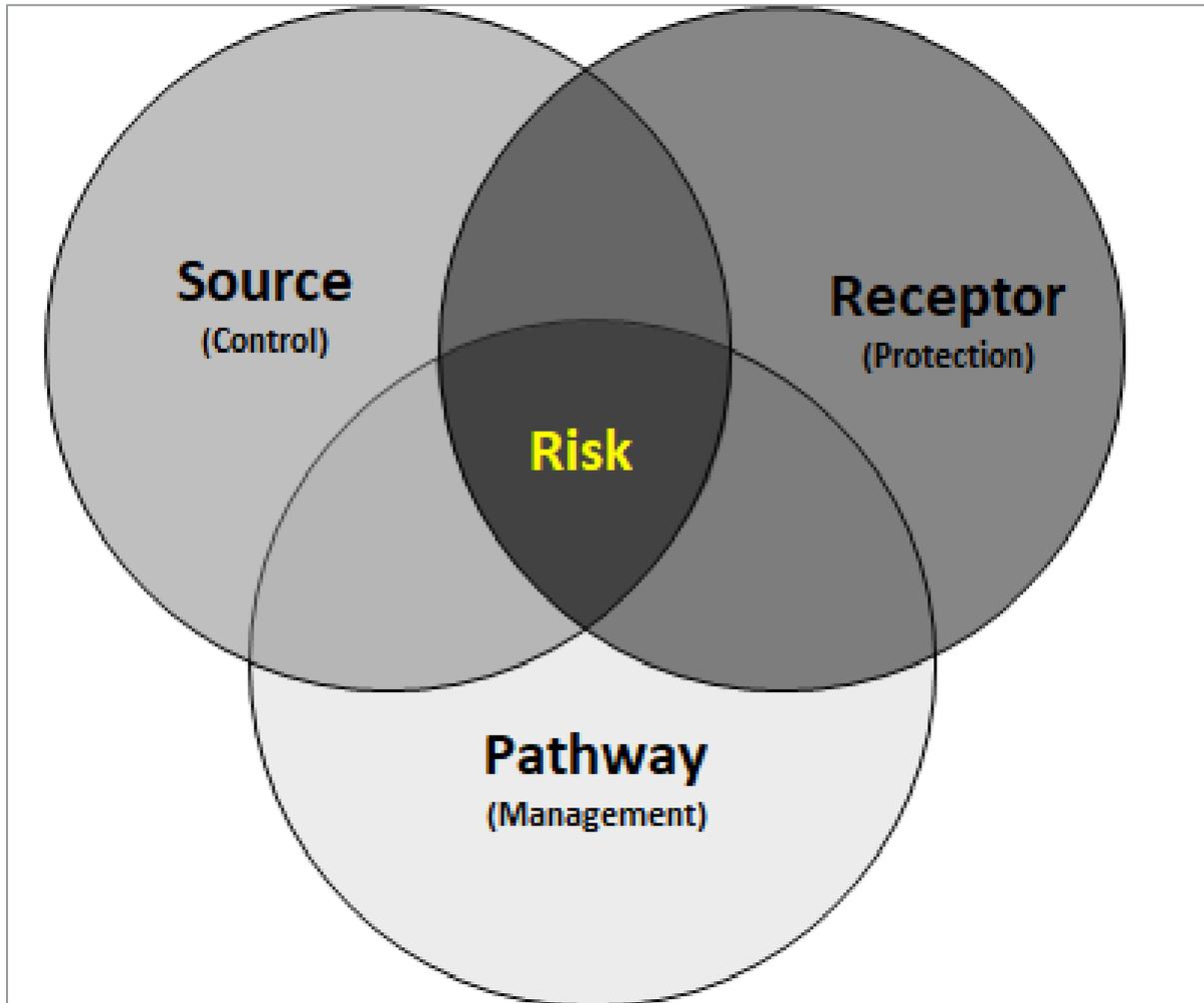
Figure 23: Source pathway receptor principle.

4.3.6.1 POTENTIAL SOURCES

The following potential sources have been identified:

i.   Seepage of poor-quality water originating from wastewater management infrastructure.

ii.   Leachate of elements from ash dumps and coal stockpiles causing poor-quality water entering local resources and host aquifers.:

iii. Mobilisation and maintenance of heavy vehicles and machinery on-site may cause hydrocarbon contamination of groundwater resources.

4.3.6.2 POTENTIAL PATHWAYS

The following aquifer pathways have been identified:

i.   Vertical flow through the unsaturated/vadose zone as well as saturated zone to the underlying intergranular and fractured rock aquifers. The rate at which seepage will take place is governed by the permeability of sub-surface soil layers and host-rock formations.

ii. Preferential flow-paths include the contact between the depth of weathering and fresh un-weathered rock, fractures, faults, joints and bedding planes. Secondary fractures may also potentially act as transport mechanisms.

4.3.6.3 POTENTIAL RECEPTORS

The following receptors were identified:

i. Shallow, inter-granular as well as the intermediate, fractured aquifer units situated within the plume migration footprint(s). The riparian zone aquifer associated with drainage patterns throughout the greater study area can also be viewed as a sensitive groundwater receptor.

ii. Down-gradient drainages and streams including associated riparian zone aquifer system(s) and baseflow contribution.

iii. Private or neighbouring boreholes associated with relevant fracture zones and/or structures(s)if intercepted by the pollution plume migration footprint

4.3.7 HYDROGEOLOGICAL CONCEPTUAL MODEL

The hydrogeological conceptual model consists of a set of assumptions, which will aid in reducing the problem statement to a simplified and acceptable version. Data gathered during the desk study and site investigation has been incorporated to develop a conceptual understanding of the regional hydrogeological system. Figure 24 depicts a generalised hydrogeological conceptual model for similar environments and illustrates the concept of primary porous media aquifers and secondary fractured rock media aquifers. In porous aquifers, flow occurs through voids between unconsolidated rock particles whereas in double porosity aquifers, the host rock is partially consolidated, and flow occurs through the pores as well as fractures in the rock. In secondary aquifers the host rock is consolidated, and porosity is generally restricted to fractures that have formed after consolidation of the rock.

Figure 25 depicts the formulated hydrogeological conceptual model for the pre-mitigation scenarios while Figure 26 show the hydrogeological conceptual model for the mitigated scenario with relevant data and information included (refer to Figure 28 for spatial reference).

A: Primary porosity aquifer   **B: Double porosity aquifer**   **C: Secondary porosity aquifer**
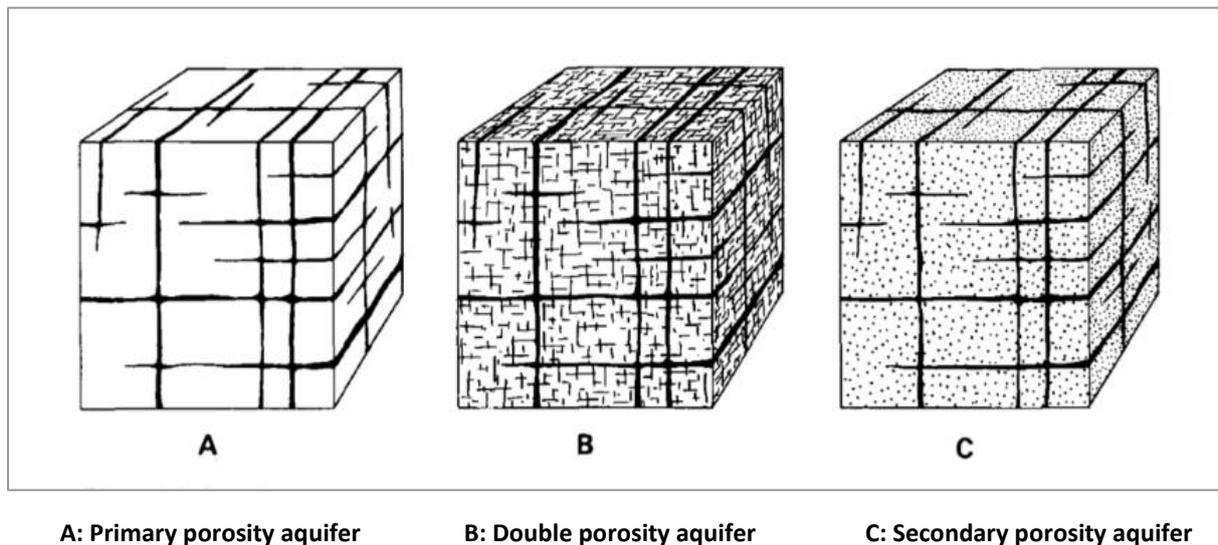
Figure 24: Generalised conceptual hydrogeological model (after Kruseman and de Ridder, 1994).
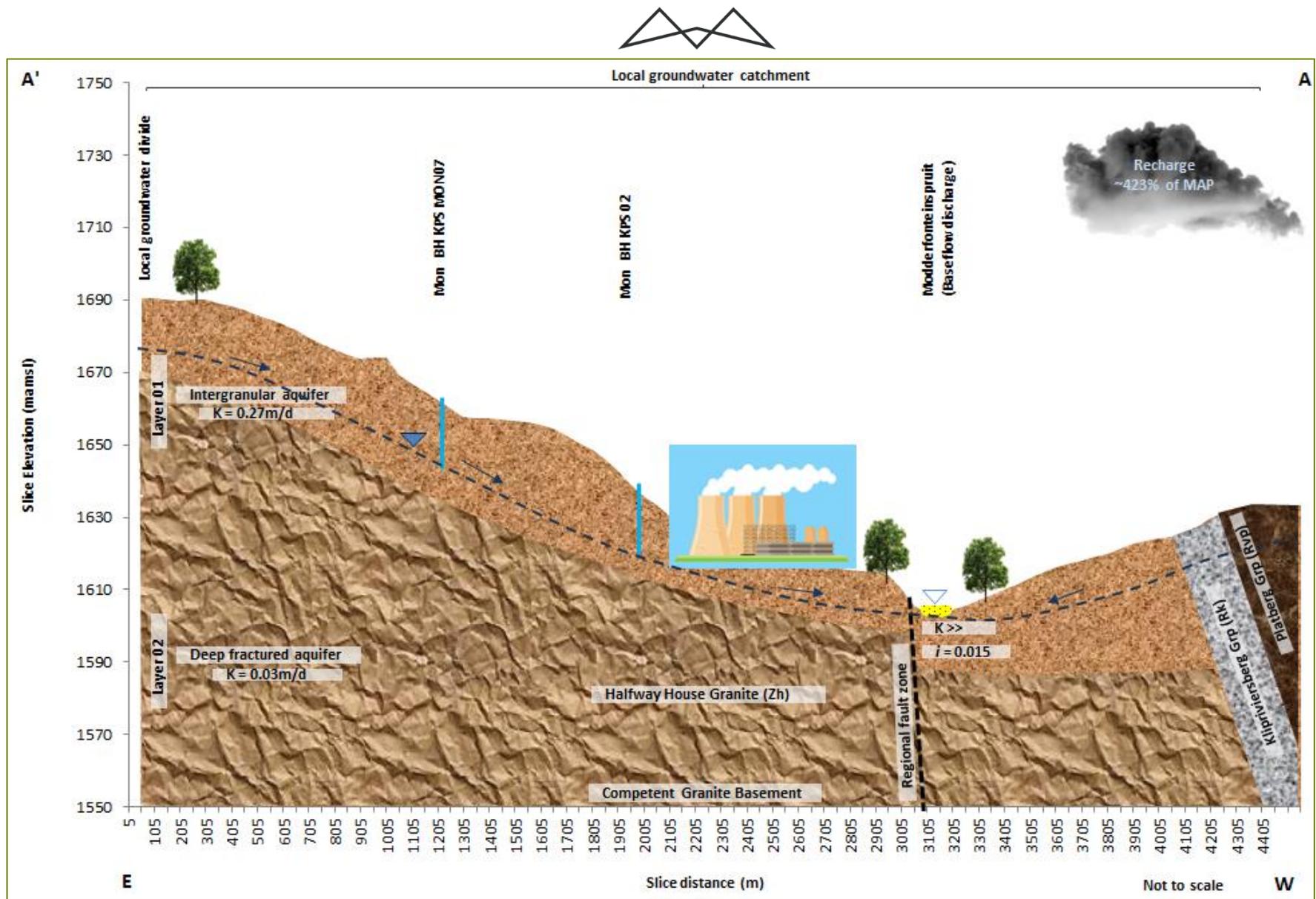
Figure 25: Hydrogeological conceptual model (Pre-mitigation): East-West cross section (A'-A).
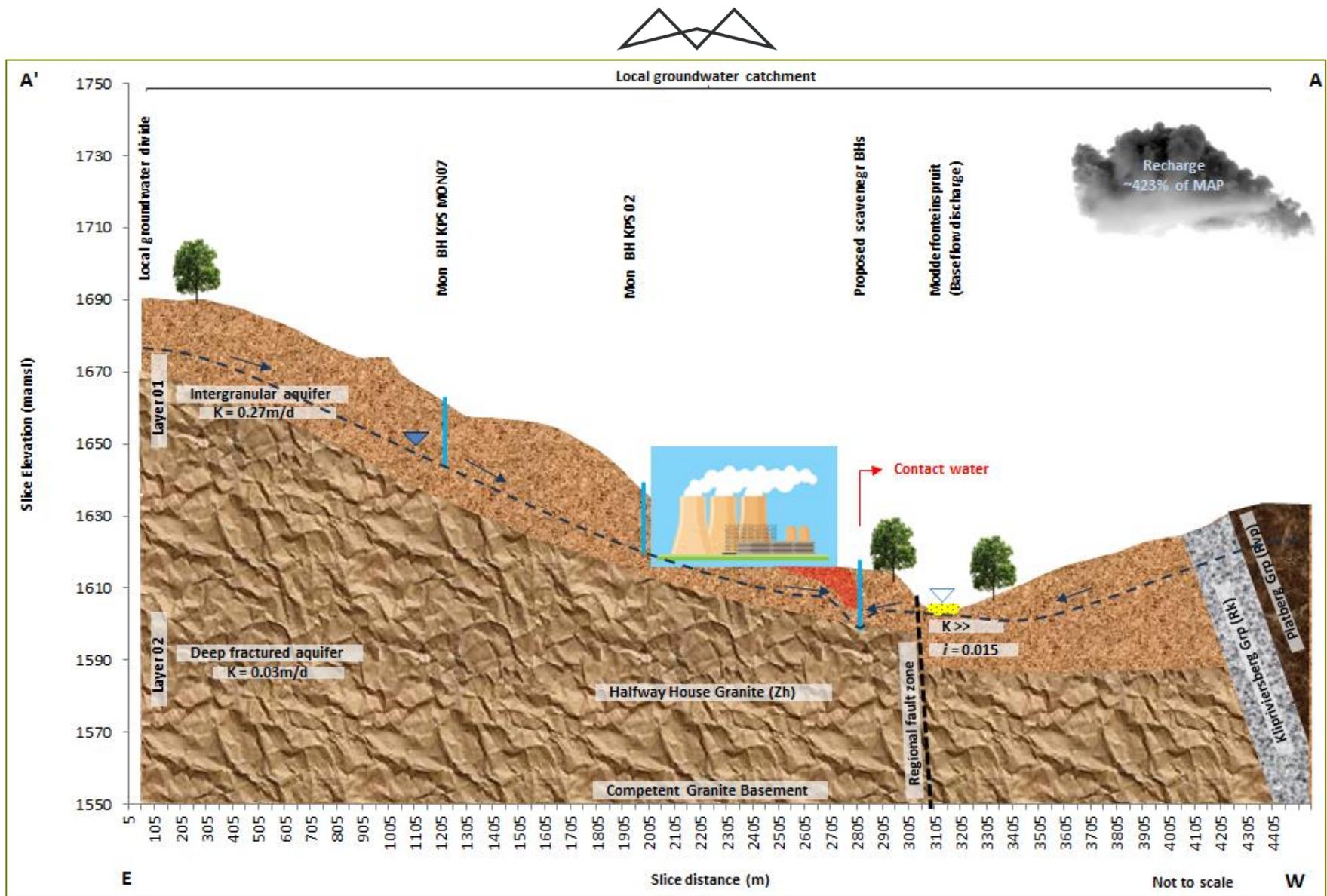
Figure 26: Hydrogeological conceptual model (Post-mitigation): East-West cross section (A'-A).

4.3.7.1 NUMERICAL GROUNDWATER FLOW AND CONTAMINANT TRANSPORT MODEL

The purpose of a groundwater model is to serve as a tool to evaluate various water management options and scenarios.

4.3.7.1.1 APPROACH TO MODELING

The typical workflow and modelling approach employed is summarised in Figure 27 below and encompass a conceptualisation phase, calibration phase as well as a prediction phase.
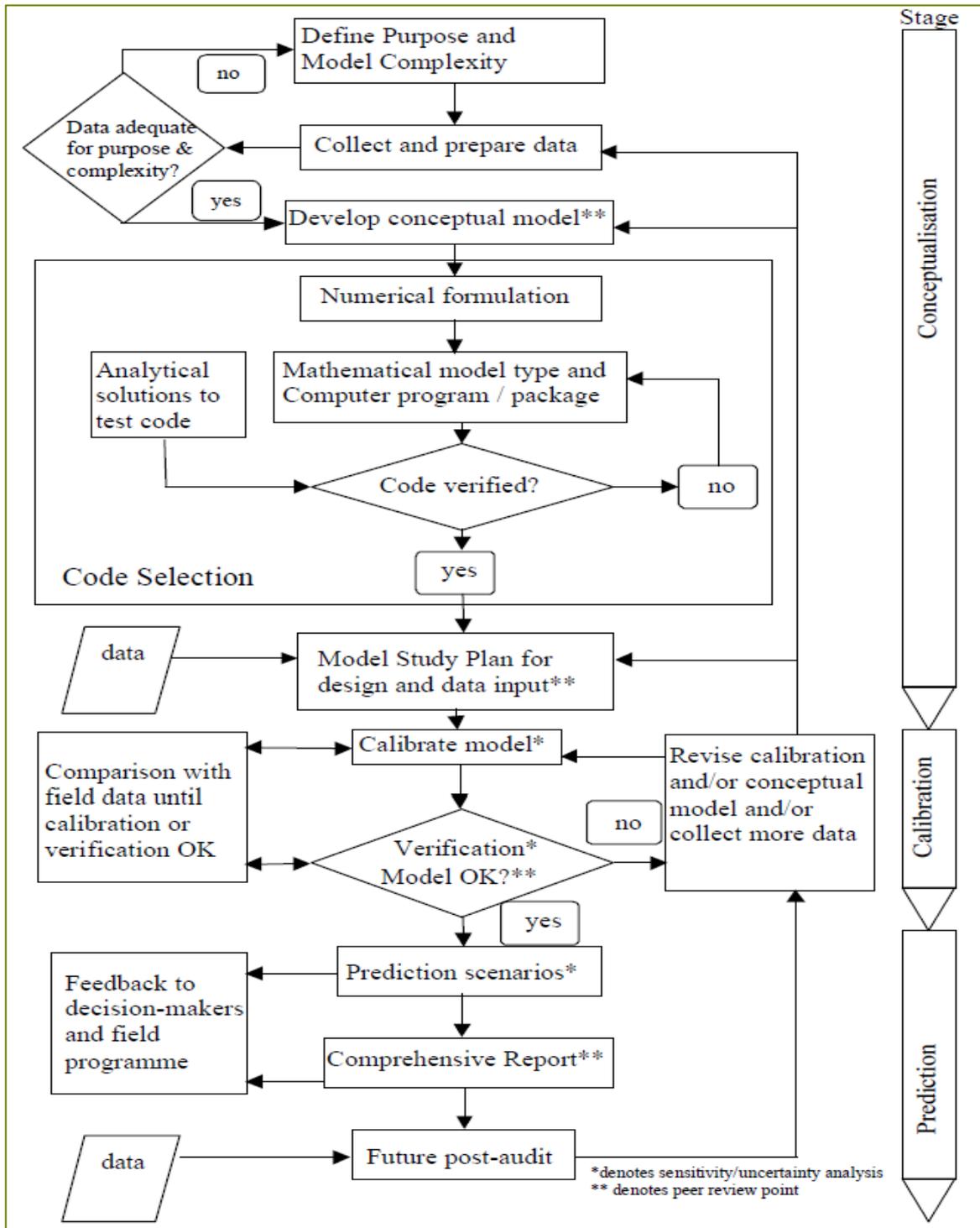
Figure 27: Workflow numerical groundwater flow model development.

In natural steady-state conditions, the net groundwater inflow from recharge is balanced by base flow and losses. The groundwater balance is given by:

Equation 3   Simplified groundwater balance.

$$Q_{Recharge} - Q_{Baseflow} + Q_{Losses} = 0$$

where:

$Q_{Recharge}$ = Groundwater inflow from rainfall recharge (m³/d).

$Q_{Baseflow}$ = Groundwater outflow as baseflow (m³/d).

Q_{Losses} = Groundwater outflow from other losses (m³/d).

The piezometric gradient, which can be measured from site characterization and monitoring boreholes are known and the boreholes can be pump tested to determine the transmissivity and hydraulic conductivity. The outflow per unit length (L) of aquifer are given by Darcy's law as, q=K dh/dL where q is the Darcy flux in m/d (or m³/m²/d) and K is the hydraulic conductivity, D the aquifer thickness and dh/dl the piezometric gradient. Since K, D and the head gradient can be measured, a steady-state model can be calibrated by changing the recharge value until the measured and simulated head gradients have a small error (usually <10.0 % of the aquifer thickness).

4.3.7.2   SOFTWARE APPLICATION

A dynamic flow model was developed by applying the modelling package FEFLOW (Finite Element Flow) and interface (Diersch, 1979). This modelling software has been developed by WASY and is based on the partial differential equation principle. The finite element method is a numerical technique for finding approximate solutions to boundary value problems for partial differential equations.

4.3.7.3   MODEL DEVELOPMENT

4.3.7.3.1   MODEL DOMAIN

A model grid was created with global origin X: 81178.98[m] and Y: -2890528.51[m] using triangular prism type of elements. The model has a width of 28 645.6[m], height of 19 788.0[m], depth of 565.48[m] and spans an area of 4.30e⁺⁰⁸m² with a volume of ~7.31e⁺¹⁰m³. The model domain was delineated based on regional drainages as well as topographical highs i.e., discharge zones and no-flow zones (Figure 28). Figure 29 indicates the model supermesh view from which the finite element mesh was generated while Figure 30 and Figure 31 shows the model finite element mesh (FEM) construction.

4.3.7.3.2   MODEL CONSTRUCTION

The model was constructed from FEM and consist of two layers i.e., three slices, 474 232 triangular prism elements per layer, a total of 948 464 elements for the model domain, with 237 340 nodes per slice a total of 712 020 nodes for the model domain. The mesh quality is acceptable and summarised below:

- Delaunay violating triangle: 0.40%.

- Interior holes: 0.

- Obtuse angled triangles: 0.10% > 120°, 3.70% > 90°.
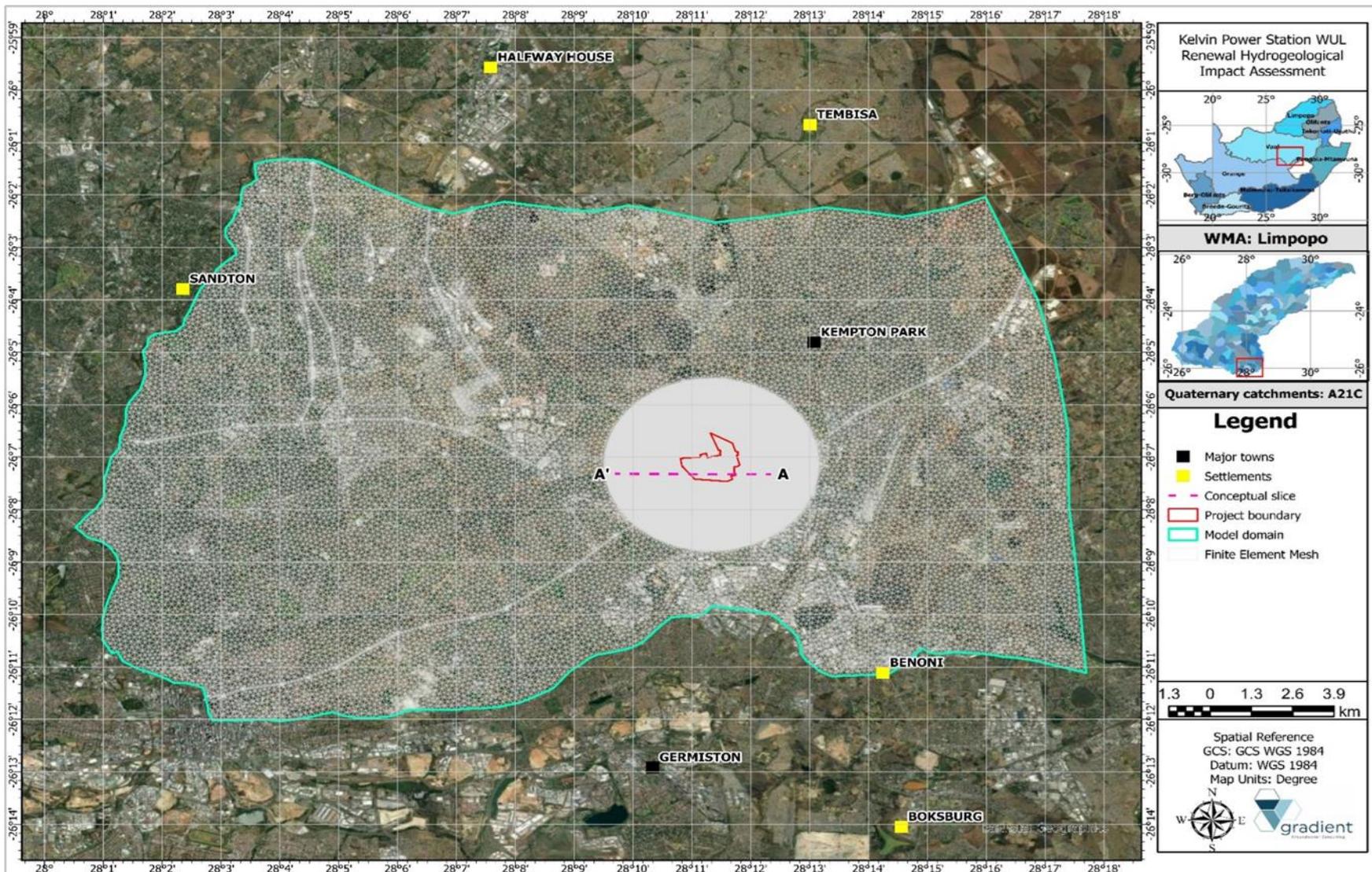
Figure 28: Model domain: Aerial extent.
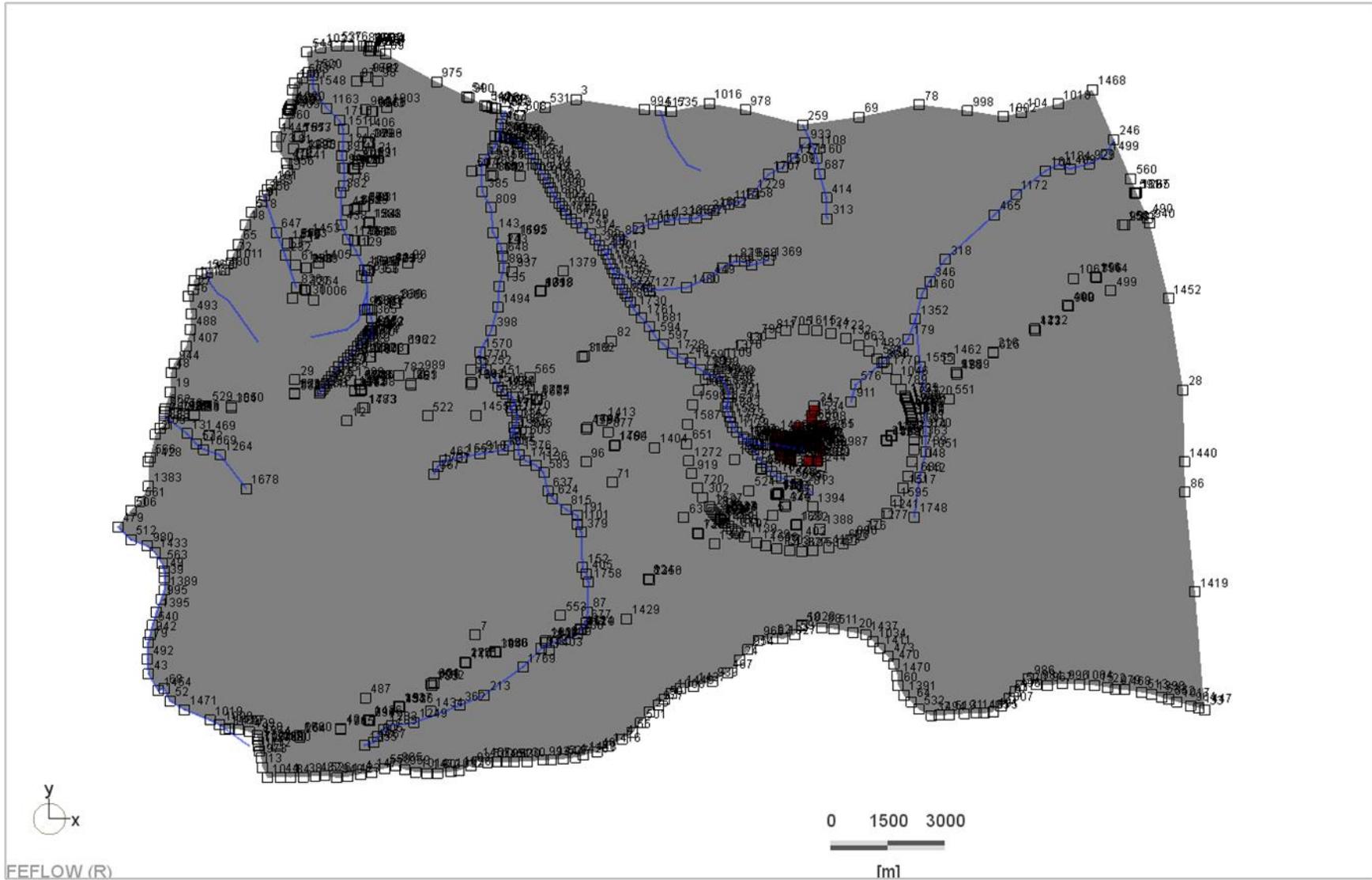
Figure 29: Model domain: Supermesh view.
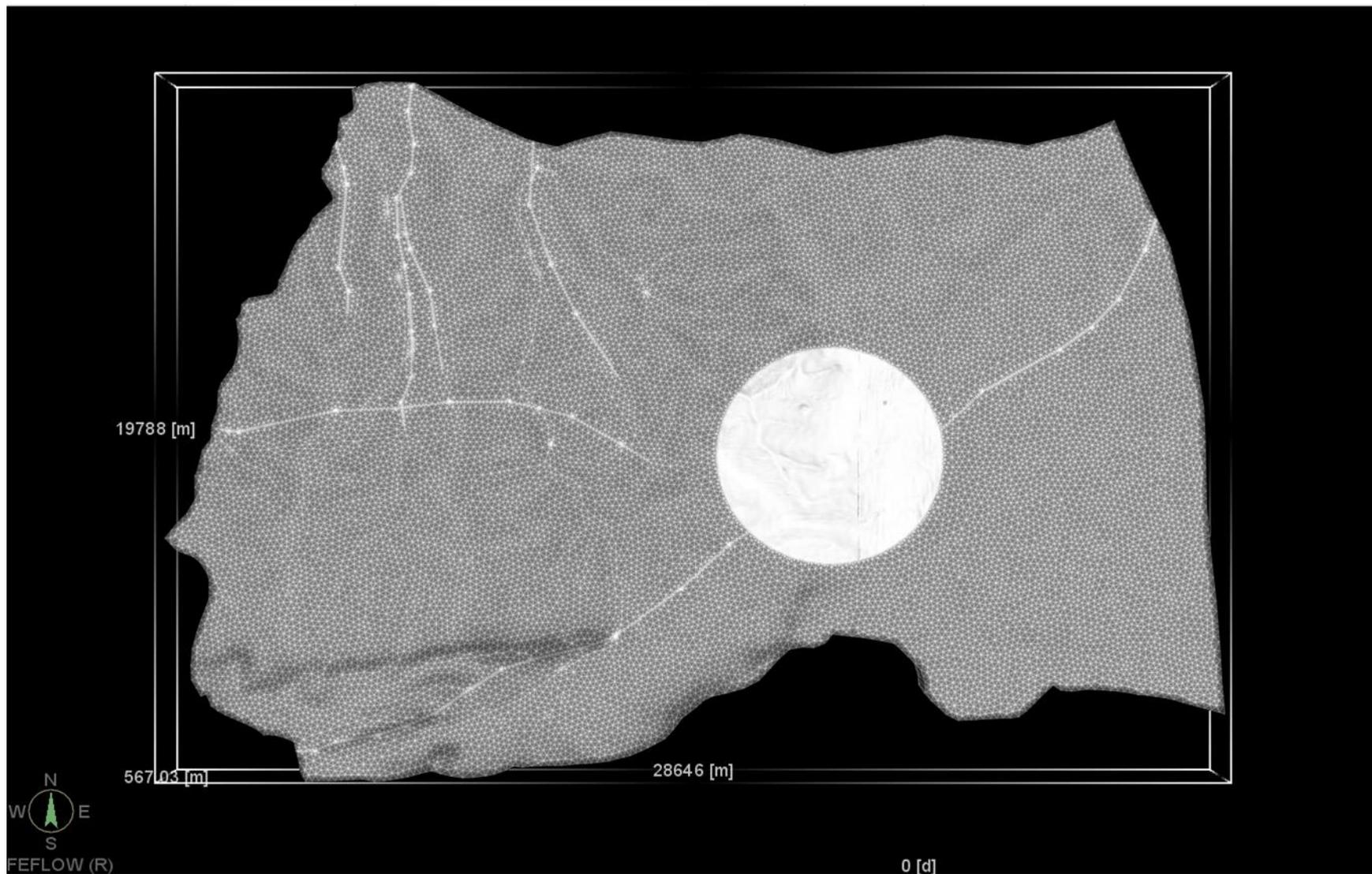
Figure 30: Model domain 3-D FEM mesh view depicting a plan-view south-northern orientation.
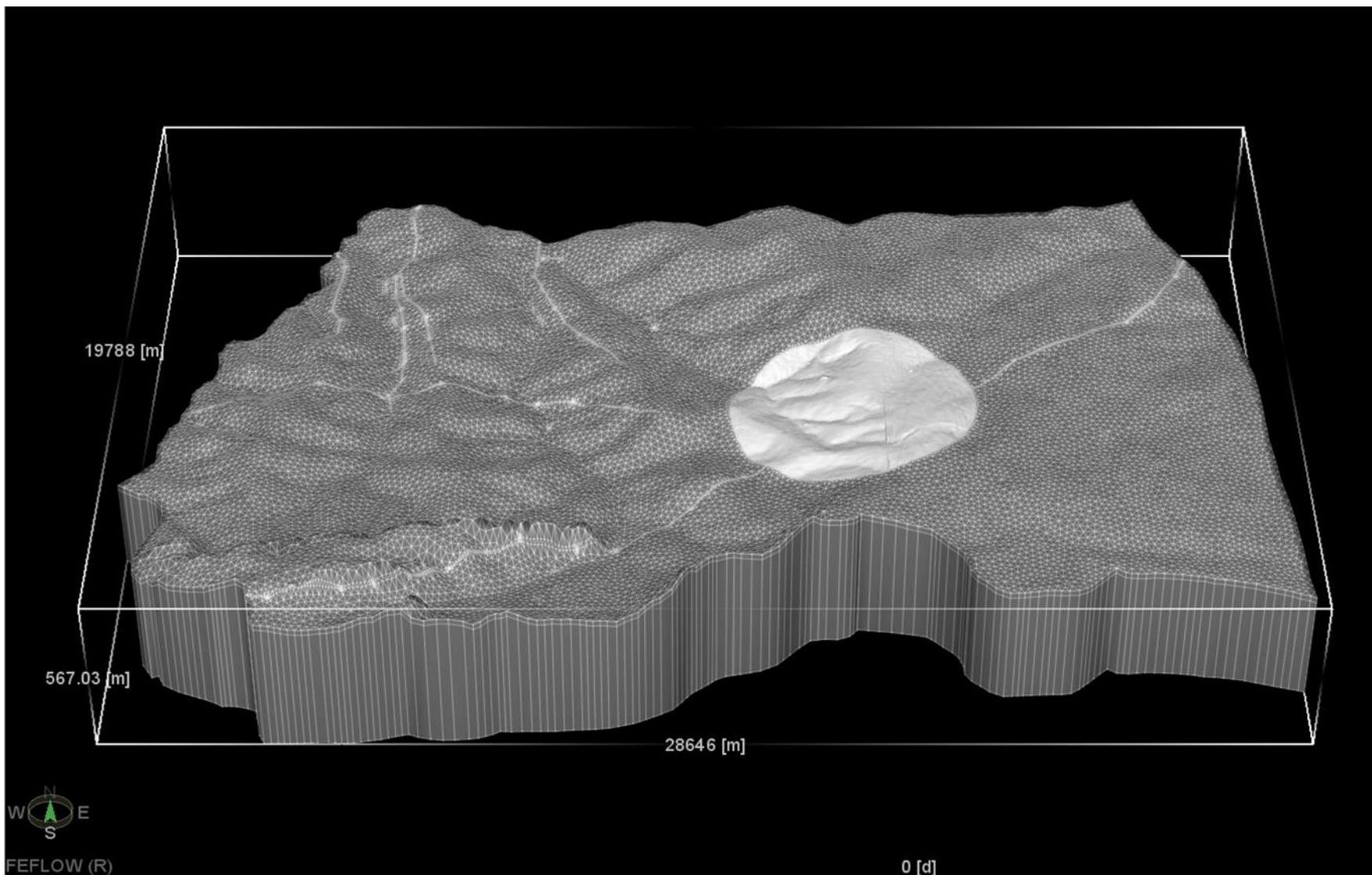
Figure 31: Model domain 3-D FEM mesh view depicting a cross sectional view in a south-northern orientation.
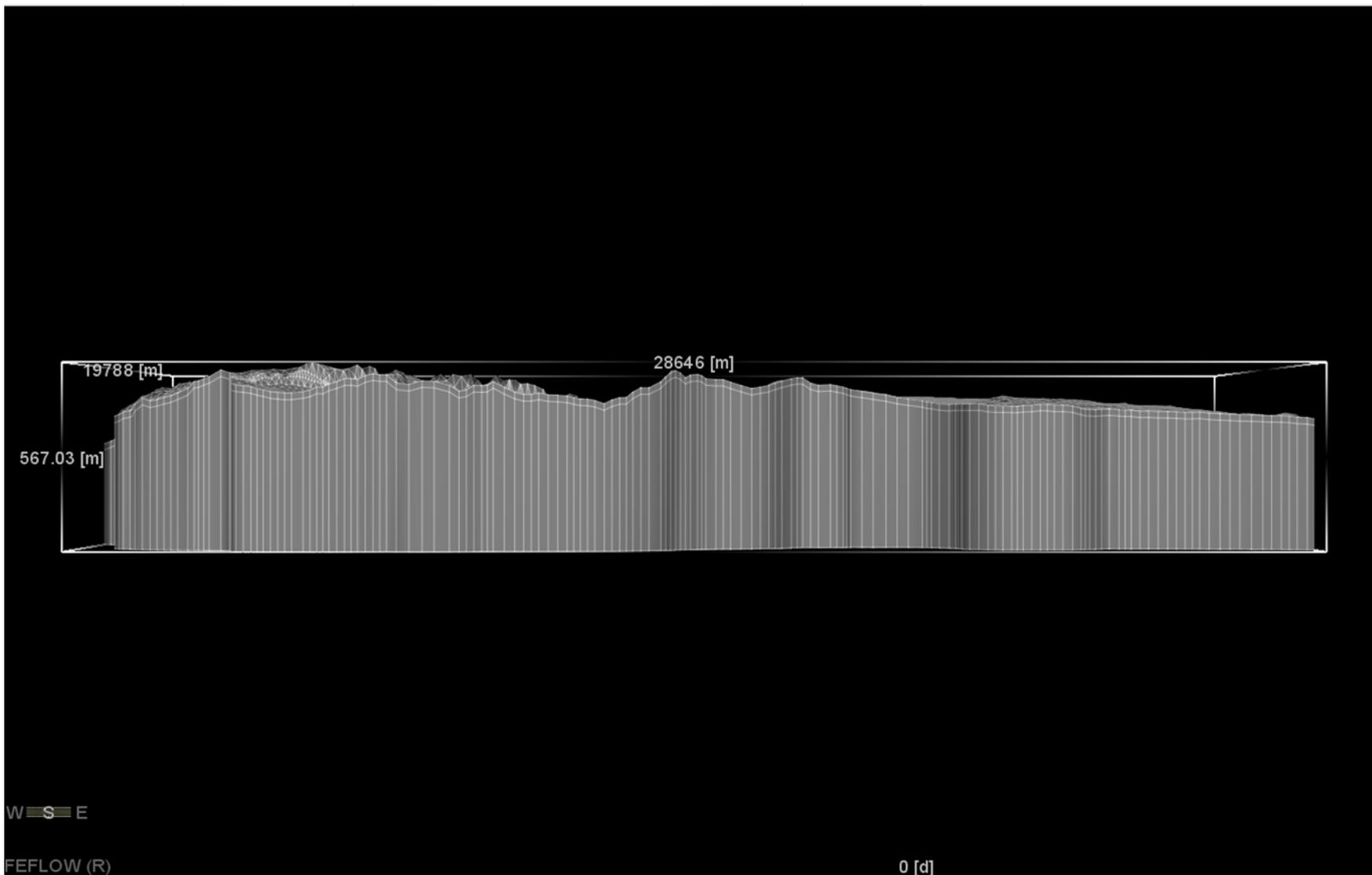
Figure 32: Model domain 3-D FEM mesh view depicting a cross sectional view in a south-northern orientation.

4.3.7.3.3   MODEL LAYERS

The groundwater model consists of two layers, representing identified hydrostratigraphical units. The top layer was based on surface topography with succeeding layers developed horizontally parallel to this layer[3]. Layer sequence and average thickness are listed below (refer to Table 17):

    i.   Layer 01: A shallow, intergranular zone aquifer occurring in the transitional soil and weathered bedrock formations (Average thickness = 30.0m).

    ii.   Layer 02: A deep fractured aquifer where groundwater flow will be dictated by transmissive fracture zones that occur in the relatively competent host rock (Average thickness = ~150.0m).

4.3.7.3.4   BOUNDARY CONDITIONS

For the purposes of this model, it is assumed that the lower perimeter of the model domain i.e., competent granite basement which is generally impermeable and serves to isolate the fractured aquifer from potential deeper aquifer units. Accordingly, this boundary is represented numerically as a "no-flow" boundary condition and was assigned as such. Topographical high perimeters (groundwater divides) were assigned as no-flow boundaries while major rivers i.e., Jukskei River as well as associated drainage system were assigned as specific head boundary conditions (Dirichlet Type I) with a maximum constraint set where baseflow discharge from the model domain[4]. Figure 33 indicates different boundary conditions assigned within the model domain.

4.3.7.4   **MODEL HYDRAULIC PROPERTIES**

The following sections provide a brief overview of the model hydraulic parameters assigned as part of the model development and calibration. It should be noted that the hydraulic parameter values assigned were guided by the site characterisation and aquifer tests phase performed.

4.3.7.4.1   HYDRAULIC CONDUCTIVITY

Hydraulic conductivity (K) values were sourced from historical aquifer characterisation data as well as literature values published for similar hydrogeological environments. The model calibration was also used to guide refinement of aquifer parameter values[5]. The average hydraulic conductivity values assigned for the shallow, intergranular aquifer is 0.27m/d, ranging from 0.028m/d for the denser Swazian granite formations to 0.45m/d for the Malmani doloite formations. The average hydraulic conductivity values assigned for the deeper, fractured aquifer is 0.03m/d. Regional fault zones have been assigned a higher hydraulic conductivity of 0.56m/d and will act as conduits for groundwater flow and contaminant transport. Hydraulic conductivity values were assigned to all major hydrostratigraphic units within the model domain as depicted in Figure 34 and Figure 35. A ratio of 1:1 for hydraulic conductivity (K) in x and y directions have been assigned, with a 1:10 ratio in the z direction i.e., anisotropic aquifer with exception of the alluvial zone which have a ratio of 1:1 i.e., isotropic aquifer. Table 17provides a summary of parameter values per layer.

4.3.7.4.2   SOURCES AND SINKS

The primary source to groundwater is through recharge. The average recharge assigned to the model is estimated at ~20.0mm/a, ranging between 15.0mm/a for the denser granite formations to 30.0mm/a for the dolomitic formations. Figure 36 depicts a spatial distribution of recharge volumes assigned as listed in Table 17. Sinks in the model domain include groundwater abstraction from privately owned and community boreholes as well as groundwater discharge to baseflow.

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[3] Zones where relevant coal seam contours were available i.e., within the Mining Right area, floor elevations were assigned as such.

[4] Refer to "gaining stream" assumption.

[5] Hydraulic parameters assigned for various hydrostratigraphical units correlate well to historical models and literature values published for similar geological environments.

4.3.7.4.3   STORATIVITY AND SPECIFIC STORAGE

Specific storage values were assigned per layer and ranges between $1.00E^{-06}$ for the denser granite formations to $1.00E^{-04}$ for regional fault zones depending on which hydrostratigraphic unit is targeted as listed in Table 17and indicated in Figure 37.

4.3.7.4.4   POROSITY

A porosity value ranging from 0.01% (denser igneous formations) to 10.0-15.0%% (more porous dolomite formations and regional fault zones) was assigned per model layer as listed in Table 17 and indicated in Figure 38. It should be noted that rehabilitated opencast and other modified areas can have porosity values of >15.0% or larger.

4.3.7.4.5   LONGITUDINAL AND TRANSVERSAL DISPERSIVITIES

A longitudinal dispersivity value of 5.0m was specified for the simulations (Spitz and Moreno, 1996). Bear and Verruijt (1992) estimated the average transversal dispersity to be 10 to 20 times smaller than the longitudinal dispersity. An average value of 0.5m was selected for this parameter during the simulations.

Table 17: Model set-up: Hydraulic Parameters.

Model Layer	Hydrostratigraphic unit	Layer thickness (m)	Hydraulic Conductivity (K)		Recharge (Re)	Specific storage (Sc)	Porosity (n)
			Kx,y 1:1 (m/d)	Kz 1:10 (m/d)	In/Outflow on top/bottom (mm/a)	Sc (1/m)	%
Layer 1	Halfway House Granite	30.00	0.141	0.014	20.00	1.00E-05	2.00E-02
	Swazian Erathem		0.028	0.003	15.00	1.00E-06	1.00E-02
	Hospital Hill SbGrp, West Rand Grp		0.413	0.041	17.50	2.00E-05	2.50E-02
	Government SbGrp, West Rand Grp		0.338	0.034	19.00	3.50E-05	4.00E-02
	Klipriviersberg Grp, Ventersdorp SpGrp		0.197	0.020	18.00	3.00E-05	3.00E-02
	Platberg Grp, Ventersdorp SpGrp		0.375	0.038	18.00	4.50E-05	4.00E-02
	Dwyka Grp, Karoo SpGrp		0.300	0.030	16.00	4.50E-05	4.50E-02
	Madzaringwe Fm, Karoo SpGrp		0.356	0.036	18.00	5.00E-05	5.00E-02
	Black Reef Fm, Transvaal SpGrp		0.169	0.017	20.00	6.00E-05	5.50E-02
	Malmani SbGrp, Transvaal SpGrp		0.450	0.045	30.00	7.50E-05	1.00E-01
	Fault zones		0.562	0.056	25.00	1.00E-04	1.50E-01
Layer 2	Halfway House Granite	150.00	0.014	0.001	0.00	1.00E-06	2.00E-03
	Swazian Erathem		0.003	0.000		1.00E-07	1.00E-03
	Hospital Hill SbGrp, West Rand Grp		0.041	0.004		2.00E-06	2.50E-03
	Government SbGrp, West Rand Grp		0.034	0.003		3.50E-06	4.00E-03

Model Layer	Hydrostratigraphic unit	Layer thickness (m)	Hydraulic Conductivity (K)		Recharge (Re)	Specific storage (Sc)	Porosity (n)
			Kx,y (m/d)	1:1 Kz (m/d)	1:10 In/Outflow on top/bottom (mm/a)	Sc (1/m)	%
	Klipriviersberg Grp, Ventersdorp SpGrp		0.020	0.002		3.00E-06	3.00E-03
	Platberg Grp, Ventersdorp SpGrp		0.038	0.004		4.50E-06	4.00E-03
	Dwyka Grp, Karoo SpGrp		0.030	0.003		4.50E-06	4.50E-03
	Madzaringwe Fm, Karoo SpGrp		0.036	0.004		5.00E-06	5.00E-03
	Black Reef Fm, Transvaal SpGrp		0.017	0.002		6.00E-06	5.50E-03
	Malmani SbGrp, Transvaal SpGrp		0.045	0.005		7.50E-06	1.00E-02
	Fault zones		0.056	0.006		1.00E-05	1.50E-02
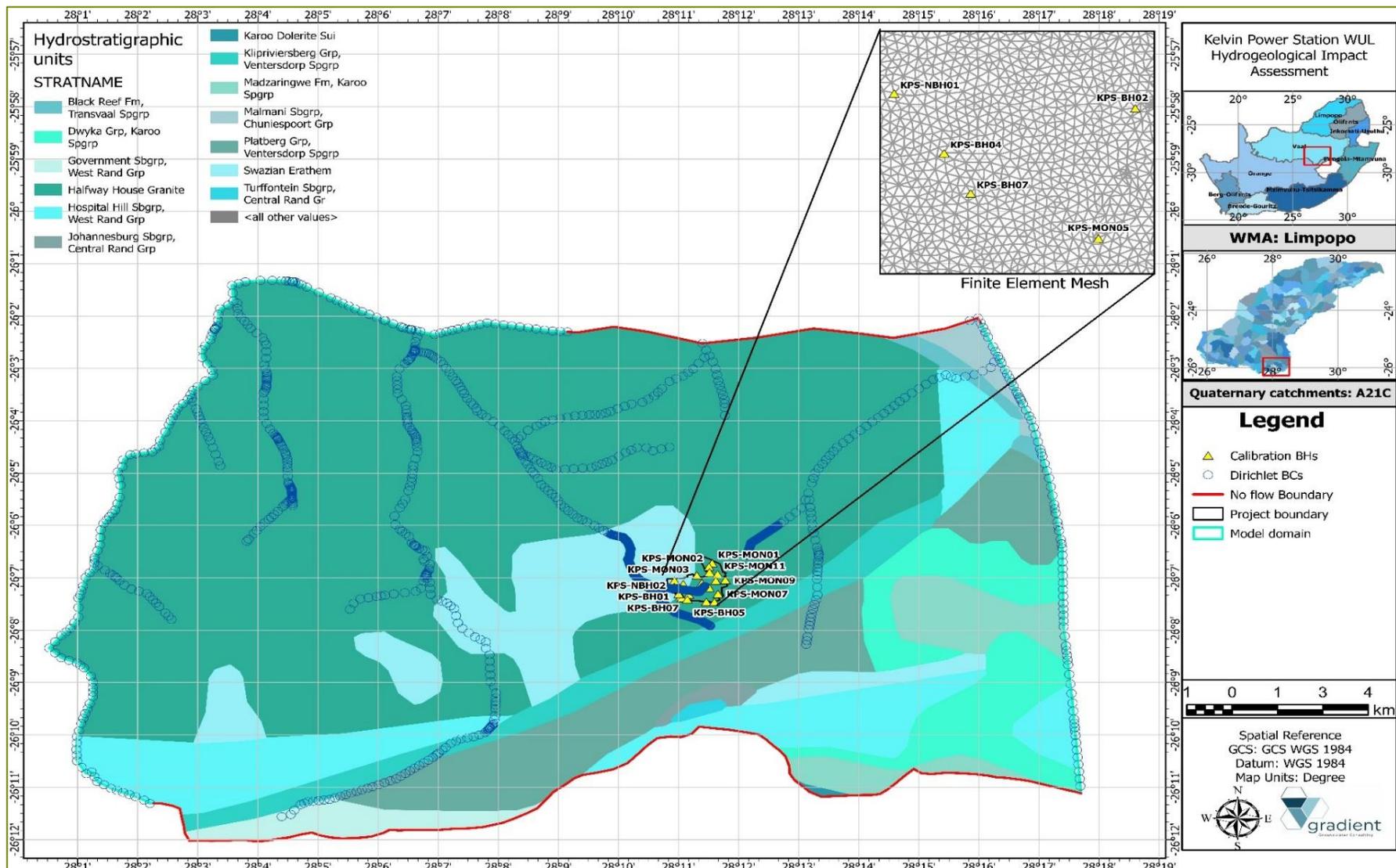
Figure 33: Hydrostratigraphic units and model boundary conditions.
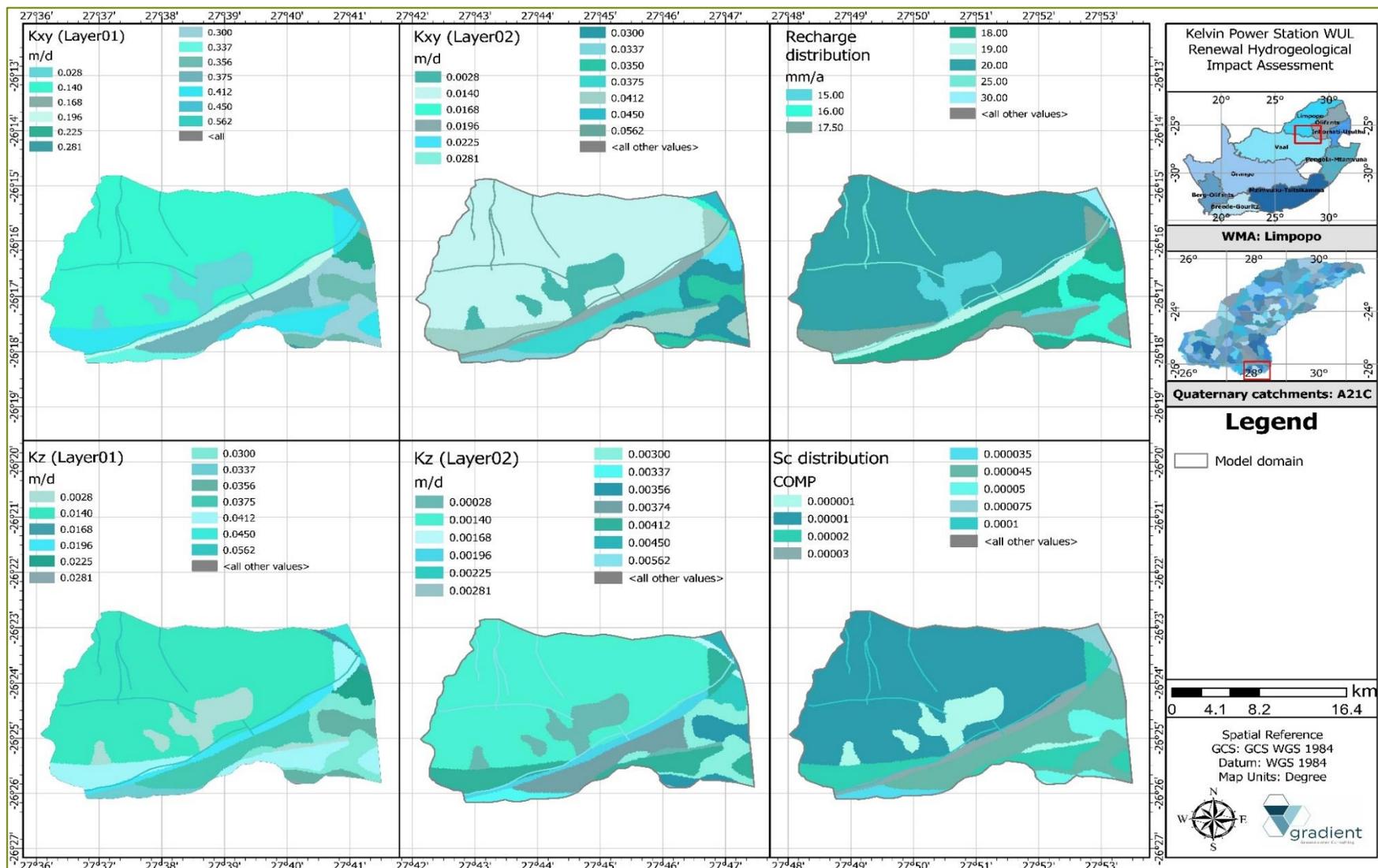
Figure 34: Numerical groundwater flow model: Hydraulic properties.
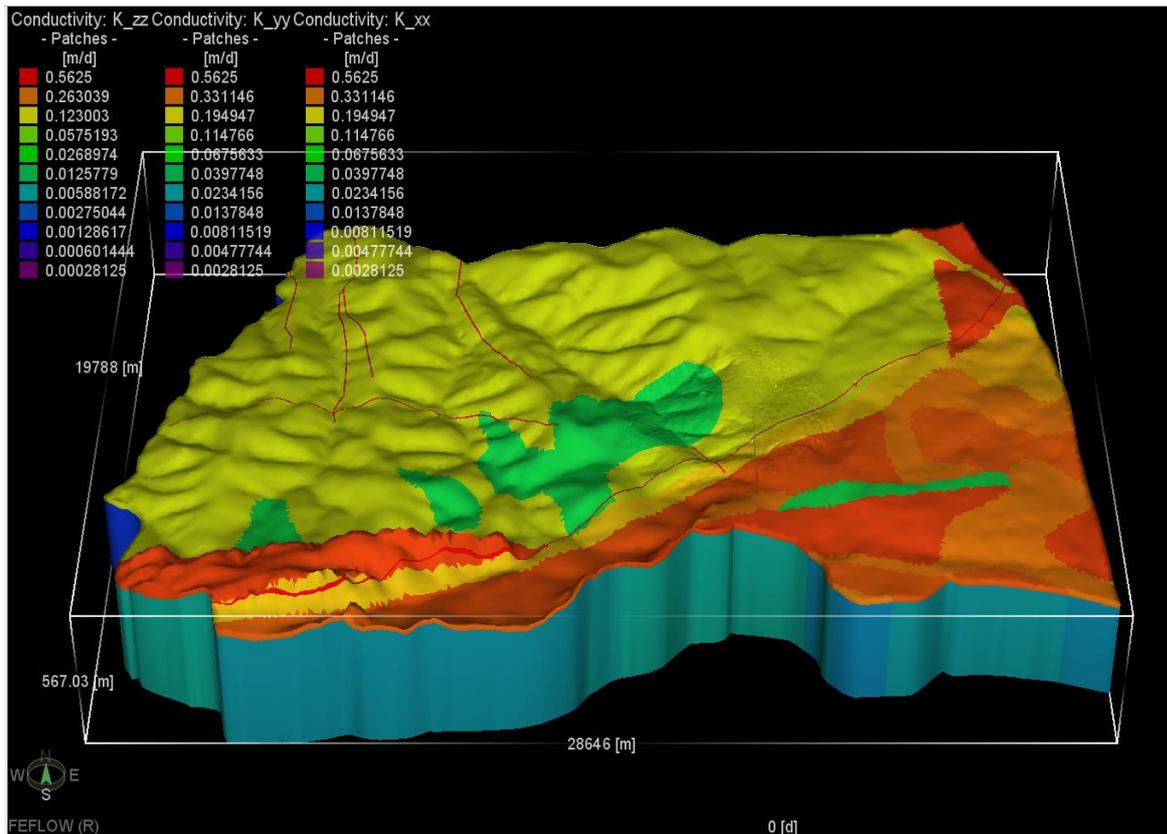
Figure 35: Model development: Numerical groundwater flow model: Hydraulic conductivity distribution.
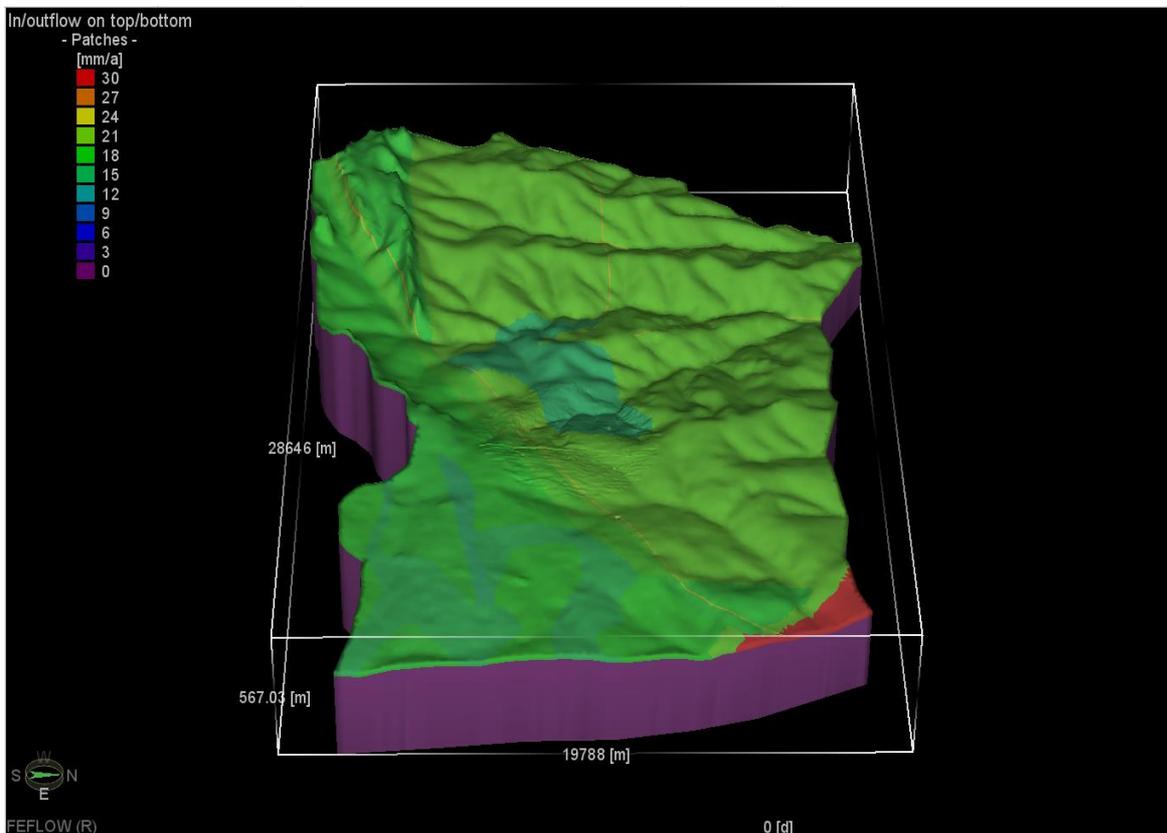
Figure 36: Model development: Numerical groundwater flow model: Recharge distribution.
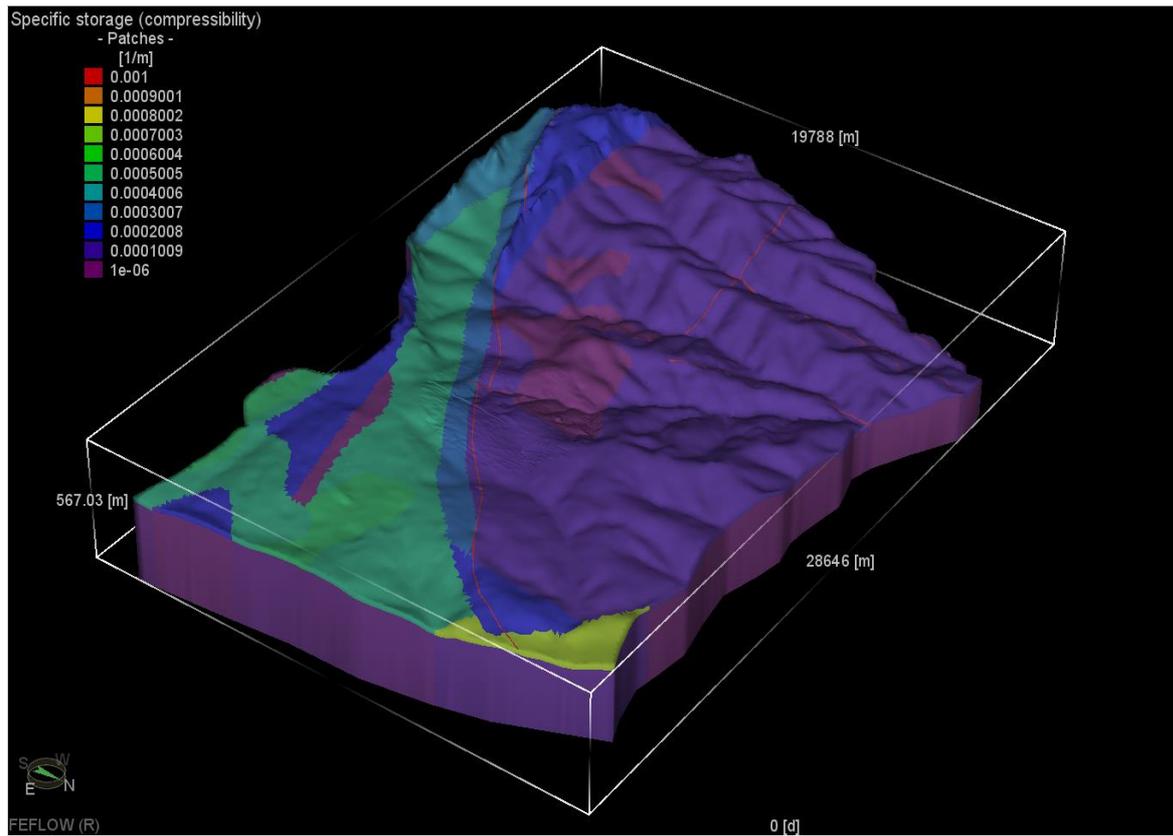
Figure 37: Model development: Numerical groundwater flow model: Specific storage distribution.
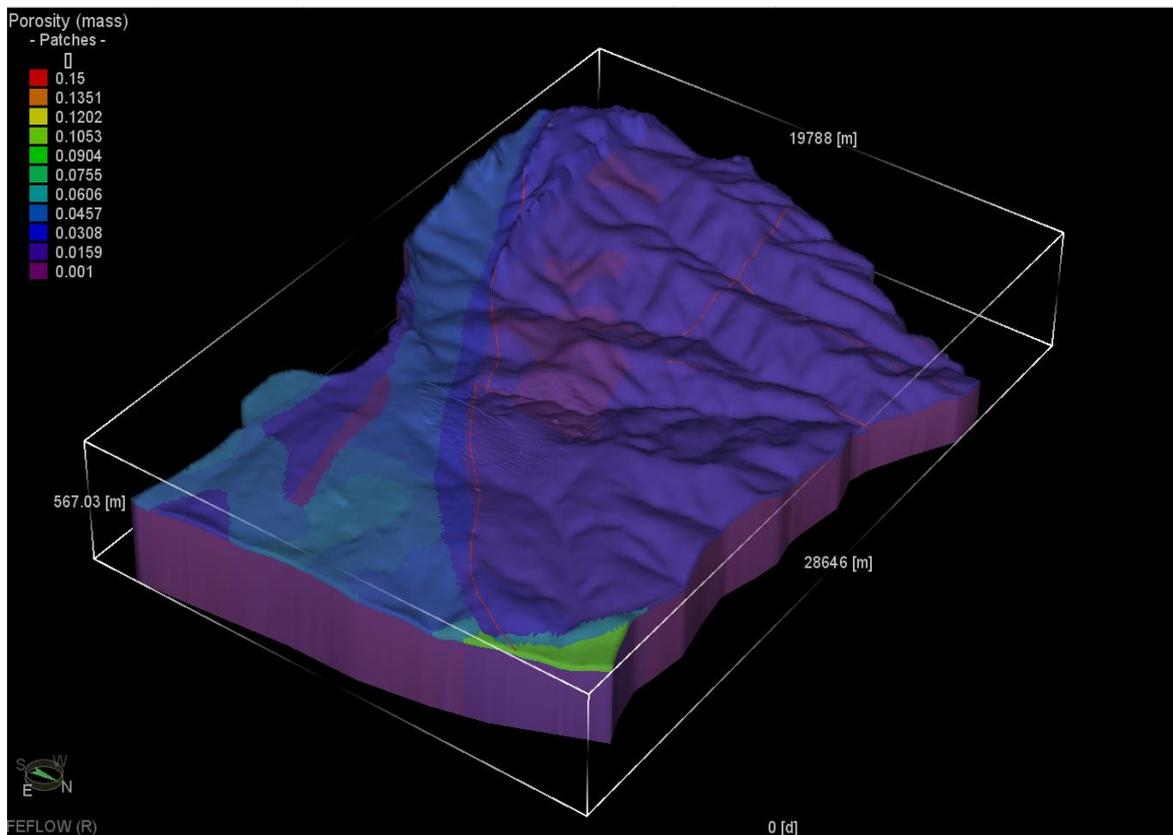
Figure 38: Model development: Numerical groundwater flow model: Porosity distribution.

4.3.7.5 **MODEL CALIBRATION**

4.3.7.5.1 STEADY STATE CALIBRATION

A steady state groundwater flow model was developed to simulate equilibrium conditions, i.e., pre-mining conditions, which will be used as initial hydrogeological conditions for transient simulations. The model was standardised by applying the American Society for Testing Materials (ASTM) guidelines (1993), as well as methods presented in Anderson and Woesner (1992) and Spitz and Moreno (1996) case studies. Under steady state conditions, the groundwater flow equation is reduced to exclude storativity. Groundwater levels of gathered observation boreholes were simulated by varying aquifer parameters (hydraulic conductivity and recharge) until an acceptable fit between the measured and simulated hydraulic heads was obtained as summarised in Table 18. Observed groundwater levels were plotted against measured water levels and a correlation of ~0.98 was obtained (Figure 39, Figure 40 and Figure 41) while Figure 42 indicate calibration error margin per borehole observation locality. Figure 43 depicts a cross-sectional view in a east-west orientation A'-A on which the hydrogeological conceptual model is based with Figure 44 showing steady state hydraulic head contours and groundwater flow directions. Figure 45 indicate the Darcy flow vectors in the direct vicinity of the existing waste infrastructure.

A good correlation indicates that the developed groundwater model will accurately represent on-site conditions. The residual calibration error is expressed through the calculated; mean error (ME), mean absolute error (MAE) as well as the root mean squared error (RMSE) of the observed versus simulated heads. The RMSE was evaluated as a ratio of the total saturated thickness across the model domain and calculated errors are summarised below:

  i.   Mean Error (ME): -1.51m.

  ii.   Mean Absolute Error (MAE): 2.30m.

  iii. Normalised Root Mean Square Deviation (NRMSD): 7.34% i.e., represents the deviation between observed and calibration water levels across the model domain.

Table 18: Steady State Model Calibration – Statistical Summary.

Calibration BH	Topographical Elevation (mamsl)	Water Level (mbgl)	Measured head elevation (mamsl)	Simulated head elevation (mamsl)	Mean Error (m)	Mean Absolute Error (m)	Root Mean Square Error (m)
KPS BH01	1630.64	3.00	1627.64	1630.65	-3.00	3.00	9.03
KPS BH05	1654.97	2.84	1652.13	1657.43	-5.30	5.30	28.10
KPS MON01	1668.91	8.77	1660.14	1661.21	-1.07	1.07	1.15
KPS MON02	1668.17	5.98	1662.19	1661.00	1.19	1.19	1.42
KPS MON03	1663.89	5.70	1658.19	1657.59	0.60	0.60	0.36
KPS MON04	1647.19	2.39	1644.80	1644.50	0.30	0.30	0.09
KPS MON06	1656.29	2.04	1654.25	1658.54	-4.29	4.29	18.37
KPS MON07	1660.51	1.90	1658.61	1663.40	-4.79	4.79	22.96
KPS-MON09	1666.95	4.99	1661.96	1664.51	-2.55	2.55	6.52
KPS-MON10	1666.89	4.95	1661.94	1664.48	-2.54	2.54	6.45

Calibration BH	Topographical Elevation (mamsl)	Water Level (mbgl)	Measured head elevation (mamsl)	Simulated head elevation (mamsl)	Mean Error (m)	Mean Absolute Error (m)	Root Mean Square Error (m)
KPS-MON11	1669.41	4.79	1664.62	1662.36	2.26	2.26	5.13
KPS-MON12	1668.44	6.17	1662.27	1662.00	0.27	0.27	0.07
KPS-MON13	1659.65	4.78	1654.87	1656.12	-1.25	1.25	1.57
KPS-MON14	1668.43	5.46	1662.97	1660.85	2.12	2.12	4.48
KPS-MON16	1639.51	3.97	1635.54	1638.11	-2.57	2.57	6.60
KPS-NBH02	1631.45	1.78	1629.67	1631.68	-2.01	2.01	4.05
KPS-NBH03	1662.89	3.41	1659.48	1662.46	-2.98	2.98	8.88
Average	**1657.89**	**4.29**	**1653.60**	**1655.11**	**-1.51**	**2.30**	**7.37**
Minimum	**1630.64**	**1.78**	**1627.64**	**1630.65**	**-5.30**	**0.27**	**0.07**
Maximum	**1669.41**	**8.77**	**1664.62**	**1664.51**	**2.26**	**5.30**	**28.10**
Correlation		**0.98**					
∑					**-25.61**	**39.11**	**125.24**
1/n					**-1.51**	**2.30**	**7.37**
Root Mean Square Deviation (RMSD)					**1.23**	**1.52**	**2.71**
Normalised Root Mean Square Deviation (NRMSD) (% of water level range)							**7.34**
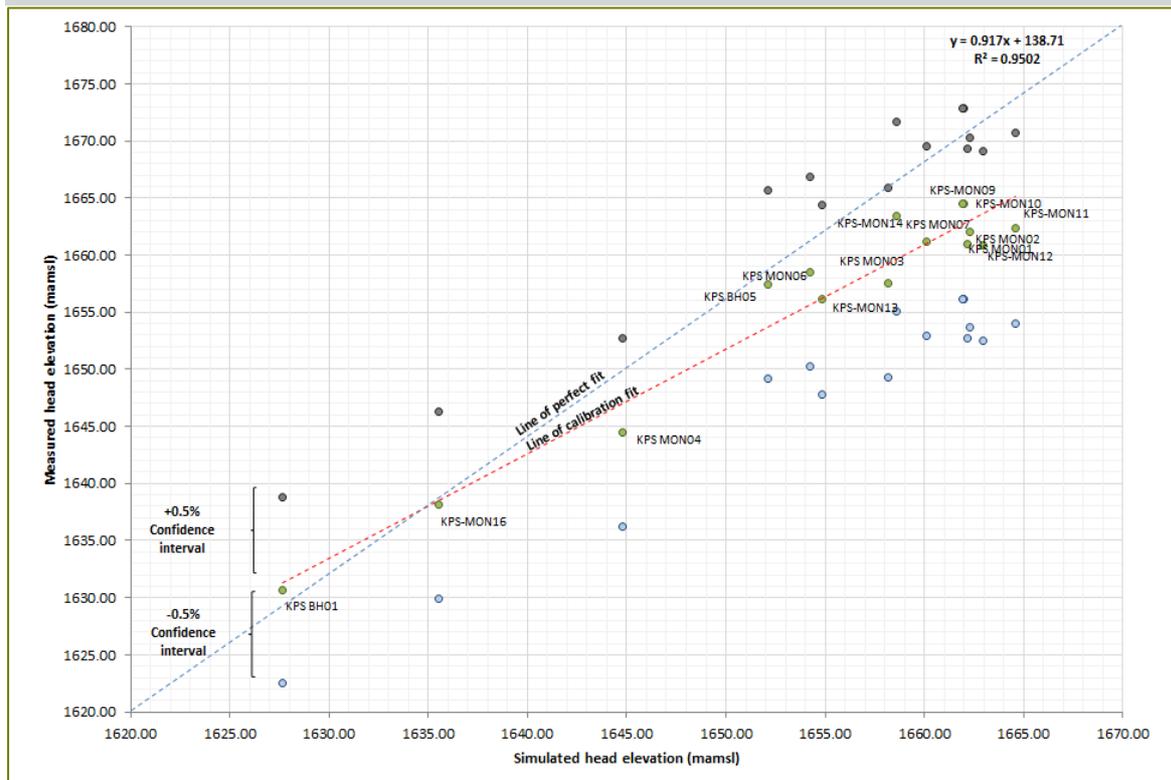
Figure 39: Model steady state calibration: Scatter plot of simulated vs. measured hydraulic head elevation.
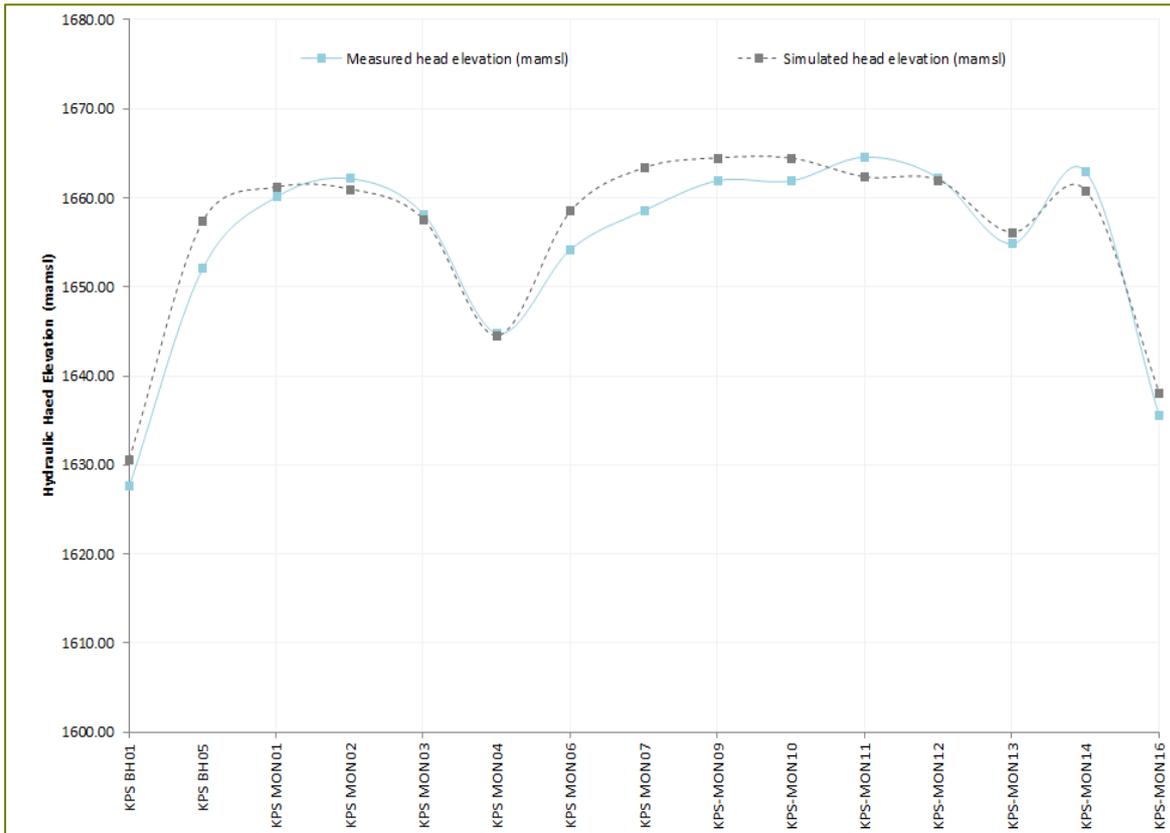
Figure 40: Model steady state calibration: curve of simulated vs. measured hydraulic head elevation.

Figure 41: Model steady state calibration: Bar chart of simulated vs. measured hydraulic head elevation.

Figure 42: Model steady state calibration: Bar-chart of simulated vs. measured hydraulic head elevation.

Figure 43: Model domain 3-D FEM mesh view (cross sectional view in a NW-SE orientation A-A'.

Figure 44: Model calibration: steady state hydraulic heads and groundwater flow direction.
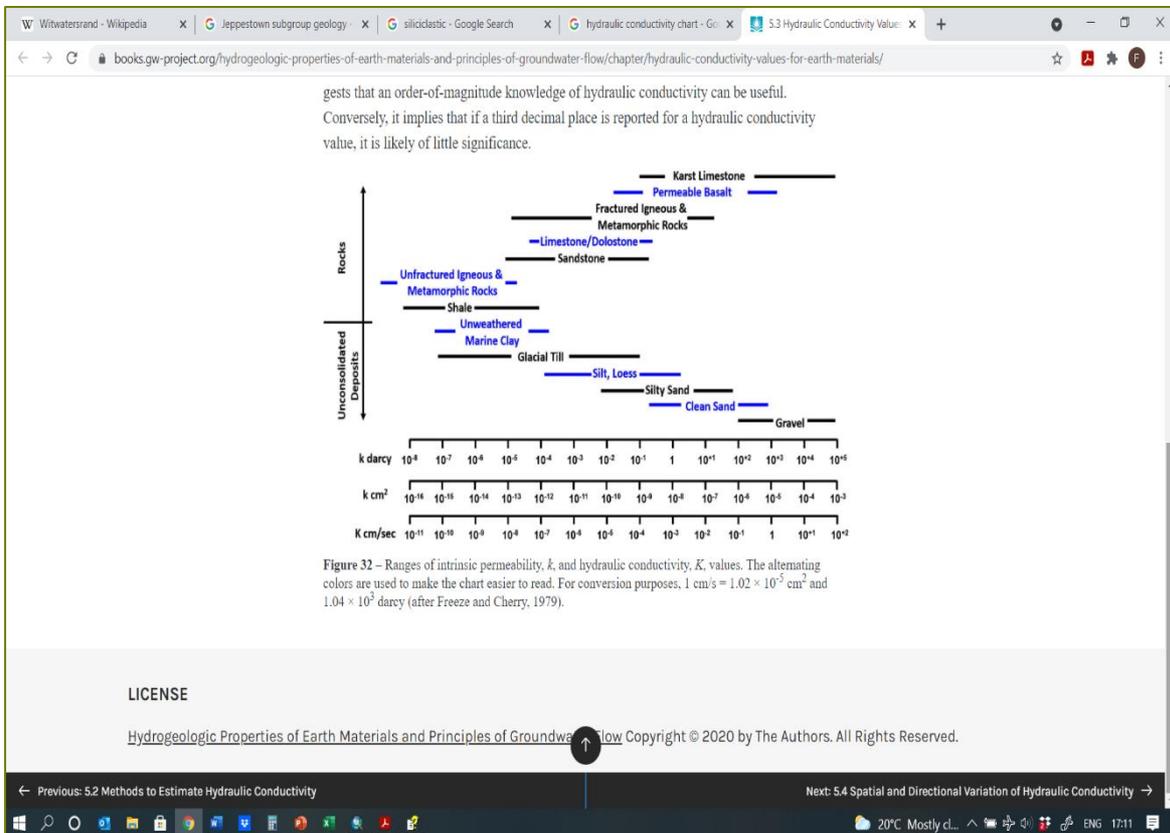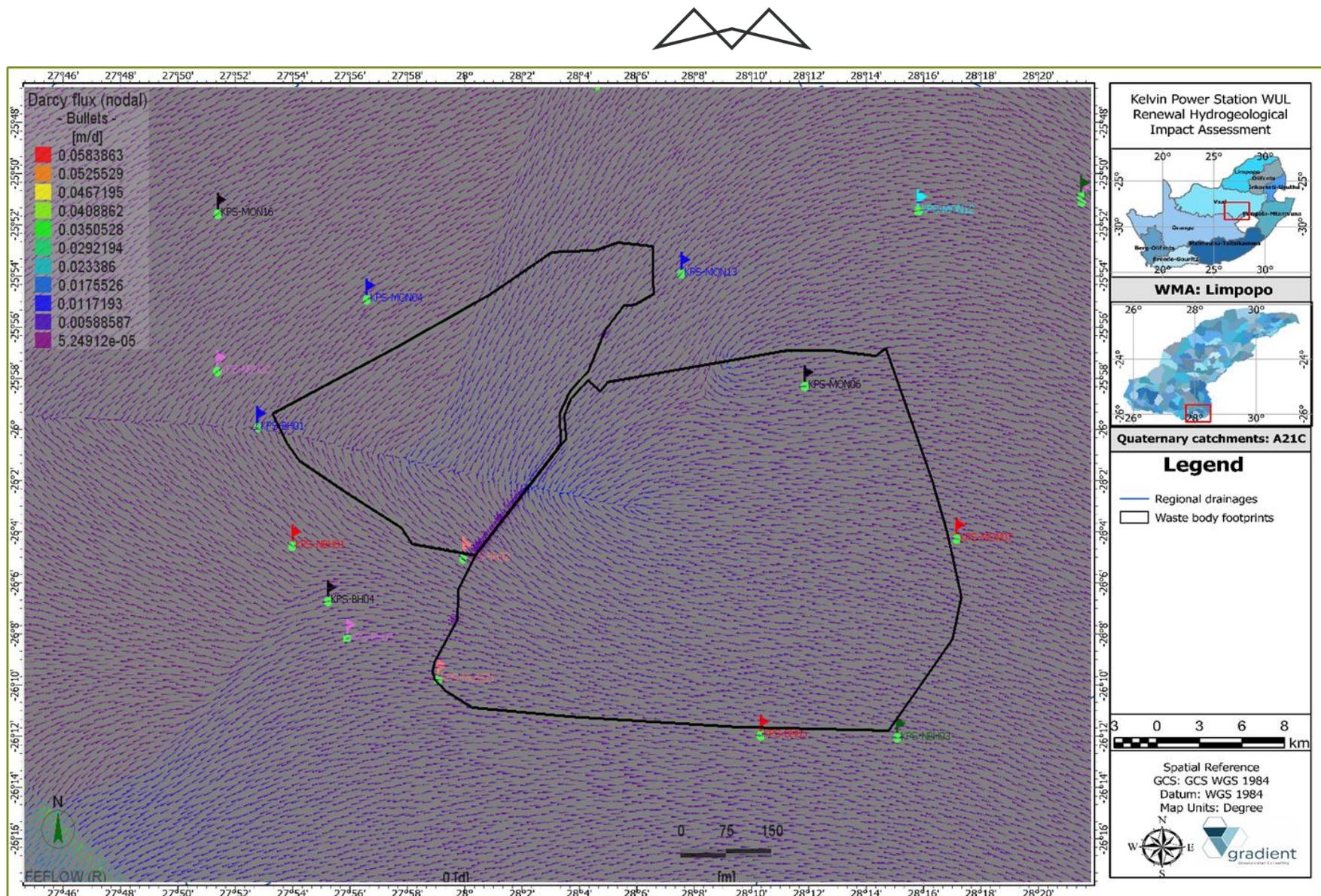
Figure 45: Model calibration: Map indicating the Darcy flow-vectors in the vicinity of the waste infrastructure.

Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs (Saltelli, 2002). The process of recalculating outcomes under alternative assumptions to determine the impact of a variable under sensitivity analysis can increase the understanding of the relationships between input and output variables in a system or model as well as reduce the model uncertainty (Pannell, 1997). In order to verify the sensitivity of the calibrated model in terms of hydraulic stresses, aquifer parameters (i.e., recharge and transmissivity) were adjusted while the impact on the hydraulic head elevation evaluated at relevant on-site borehole localities. As summarised in Table 18 The model tends to be more sensitive to an increase in hydraulic conductivity as well as a downward change in recharge(Figure 46, Figure 47 andFigure 48)[6].

Table 19: Steady State Model Calibration – Sensitivity analysis.

Parameter	Scenario: Base Case	Scenario: -25.0% of calibrated value	Scenario: K-+25.0% calibrated value	-Scenario: of25.0% K-calibrated recharge	-Scenario: of+25.0% calibrated recharge	of
Correlation	0.98	0.98	0.96	0.96	0.98	
Mean Error	-1.51	1.98	5.85	5.30	-1.61	
Mean Abs Error	2.30	2.84	6.20	5.65	2.18	
RMSD	2.71	3.39	7.20	6.64	3.49	
NRMSD	7.34%	9.16%	19.46%	17.96%	7.73%	

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[6]Recharge remains an uncertain parameter and it is difficult to estimate groundwater recharge accurately. The accurate quantification of natural recharge uncertainty is critical for groundwater management.
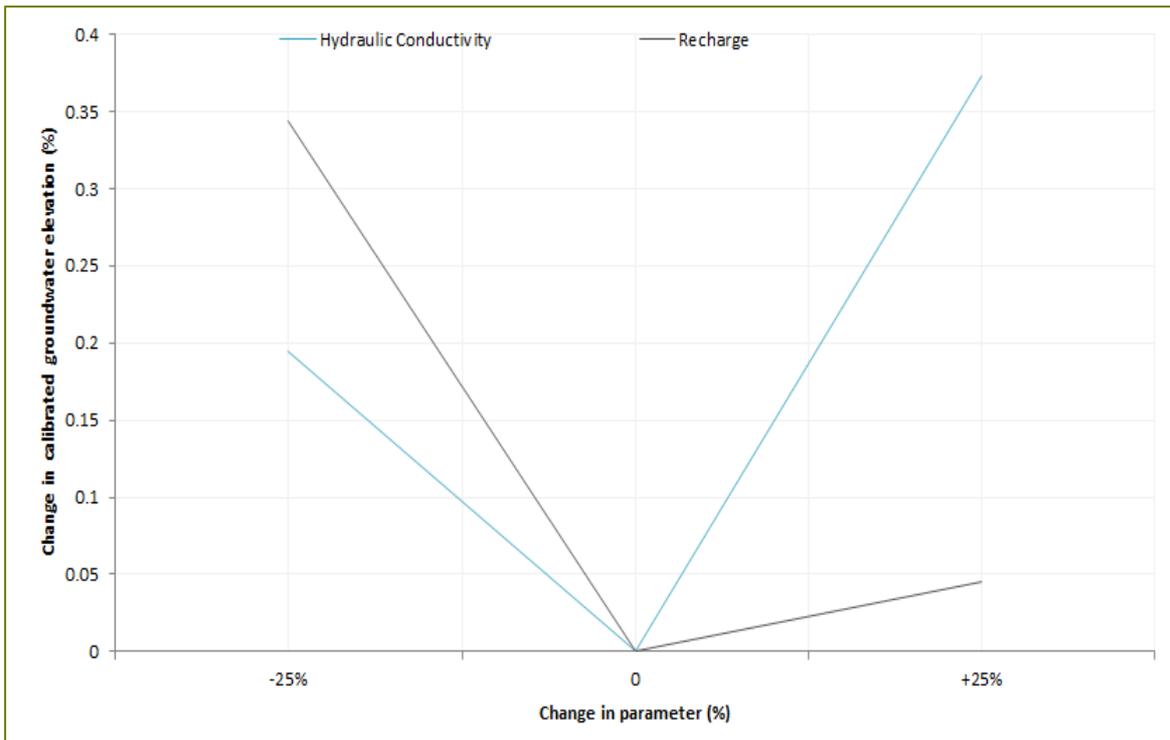
Figure 46: Model steady state calibration: sensitivity analysis for monitoring locality KPS BH05.
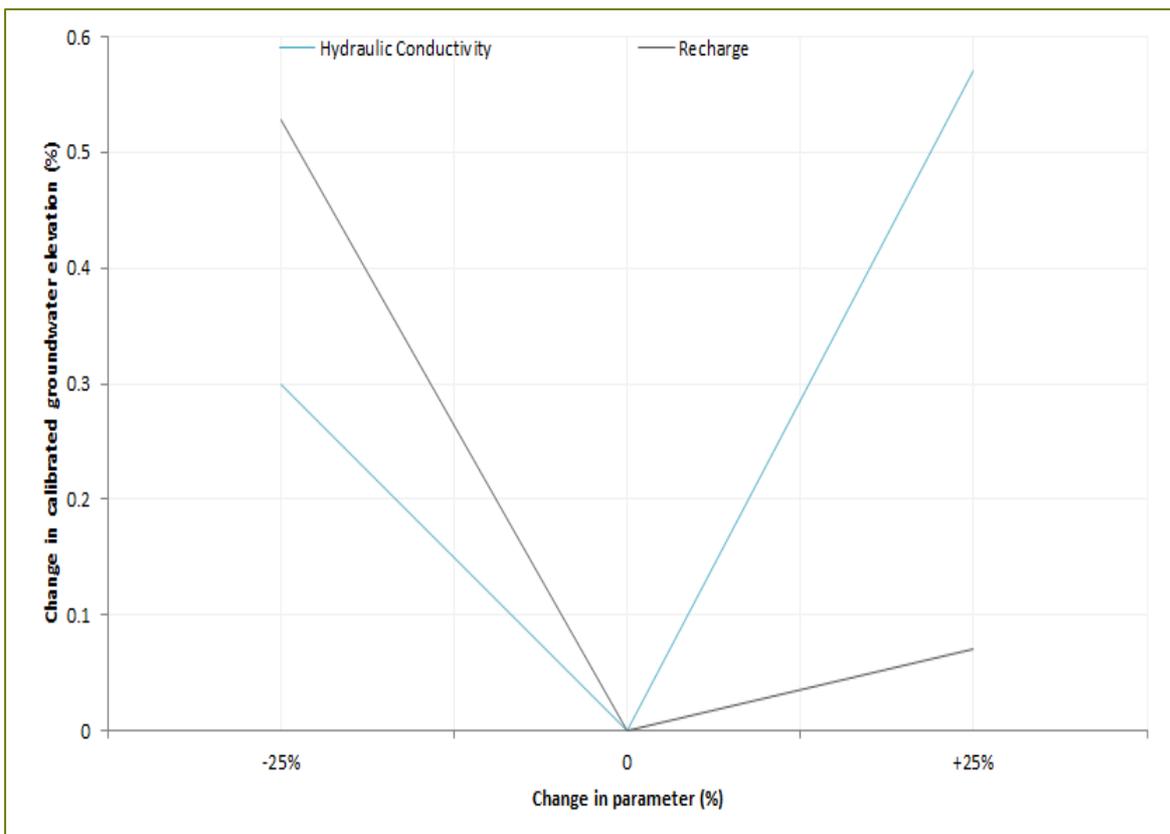
Figure 47: Model steady state calibration: sensitivity analysis for monitoring locality KPS MON09.
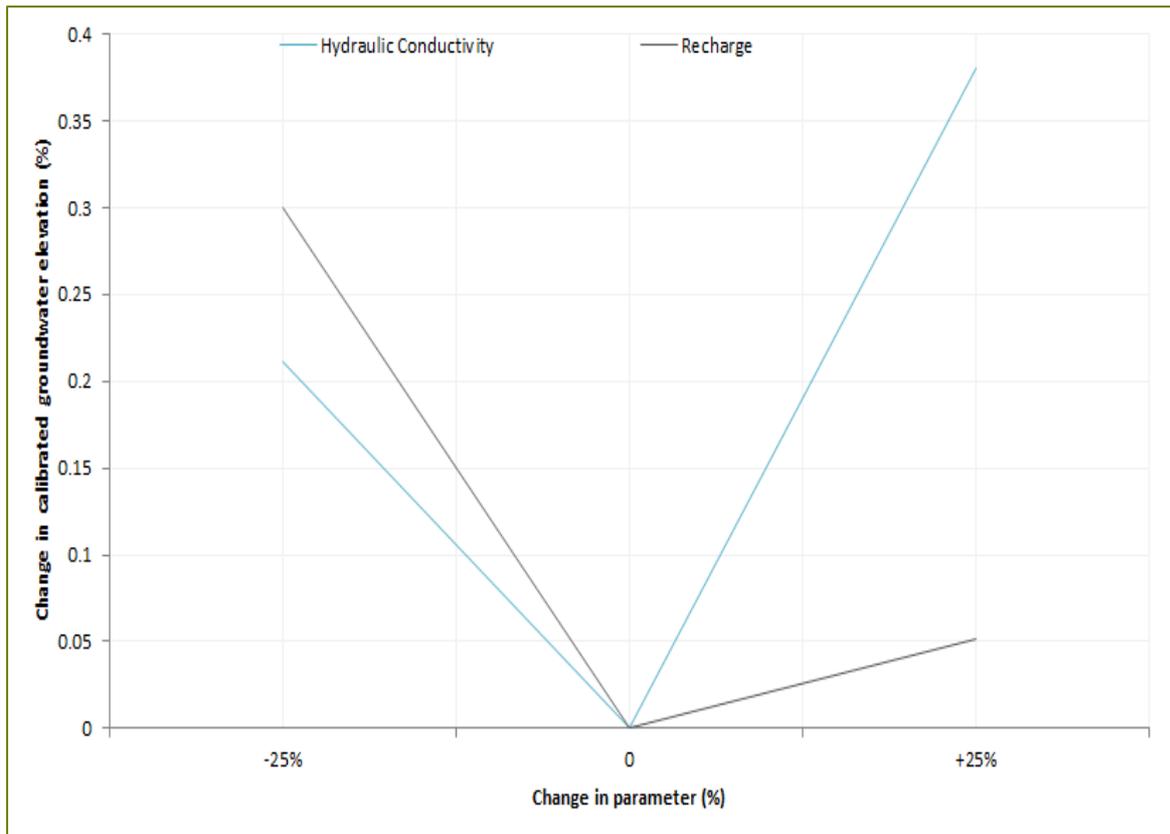
Figure 48: Model steady state calibration: sensitivity analysis for monitoring locality KPS ON16.

4.3.7.6 NUMERICAL GROUNDWATER FLOW MODEL

The groundwater model is based on three-dimensional groundwater flow and may be described by the following equation (Darcy, 1856):

Equation 4 Groundwater flow.

$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})\pm W=S\frac{\partial h}{\partial t}$$

where:

h = hydraulic head [L]

Kx,Ky,Kz = Hydraulic Conductivity [L/T]

S = storage coefficient

t = time [T]

W = source (recharge) or sink (pumping) per unit area [L/T]

x,y,z = spatial co-ordinates [L]

4.3.7.6.1 MODEL SIMULATION SCENARIOS

Various management scenarios were modelled for the purposes of planning and decision making with stress periods listed in Table 20:

    i.   Scenario 01: Baseline pre-development conditions.

ii. Scenario 02: TDS pollution plume migration within the host aquifer for the operational phase(s) without implementation of mitigation or management measures.

iii. Scenario 03: TDS pollution plume migration within the host aquifer for the post-closure phase(s) without implementation of mitigation or management measures.

iv. Scenario 04a (mitigation and management): Implementation of a cut-off/ fracturing trench down-gradient of existing waste body footprints.

v. Scenario 04b (mitigation and management): Establishment of a series of seepage capturing or scavenger boreholes situated down-gradient of existing waste body footprints.

Table 20: Summary of model stress-periods.

Stress period	Description
1966 -2025	Operational phase
2026 - 2076	50-Years Post-closure phase
2077-2126	100-Years Post-closure phase

4.3.7.6.2 SCENARIO 01: BASELINE PRE-MINING CONDITIONS

Scenario 01 simulated the site baseline and pre-mining conditions. Table 21 summarises the groundwater catchment water balance representing steady state conditions. Recharge is assumed the only source of inflow to the system and has been simulated at $2.235E^{+04}$ m^3/d, while the largest loss to the groundwater system is via baseflow, $2.234E^{+04}$ m^3/d. Water removed from storage accounts to $7.819E^{+00}$ while water captured as storage accounts to $1.00E^{+00}$. Imbalance ignoring internal transfers equates to $8.20E^{+04}$ m^3/d.

Table 21: Catchment water balance: Scenario 01 – Baseline pre-mining conditions.

Scenario 01 – Catchment water balance: Steady state baseline			
Parameter	Inflow (m³/d)	Outflow (m³/d)	Balance (m³/d)
Recharge (m³/d)	2.235E+04	0.000E+00	2.235E+04
Dirichlet BC's discharging as baseflow (m³/d)	0.000E+00	2.234E+04	-2.234E+04
Storage Capture(-)/Release(+)(m3/d)	1.000E+00	7.819E+00	-6.819E+00
Imbalance (m³/d)	8.200E-01	0.000E+00	8.200E-01
Total (m³/d)	**2.235E+04**	**2.235E+04**	**0.000E+00**

4.3.7.7 NUMERICAL MASS TRANSPORT MODEL

The mass balance equation (Bear and Verruijt, 1992) (advection-dispersion equation) of a pollutant can be expressed as follows:

Equation 5   Advection-dispersion.

$$\frac{\delta nc}{\delta t} = - \Delta \bullet q_{c,total} - f + n\rho\Gamma - P_c + R_c$$

where:

nc = mass of pollutant per unit volume of porous medium;

n = porosity of saturated zone;

c = concentration of pollutant (mass of pollutant per unit volume of liquid (water));

$\Delta \bullet q_{c,total}$ = excess of inflow of a considered pollutant over outflow, per unit volume of porous medium, per unit time;

f = quantity of pollutant leaving the water (through adsorption, ion exchange etc.);

$n\rho\Gamma$ = mass of pollutant added to the water (or leaving it) as a result of chemical interactions among species inside the water, or by various decay phenomena[7];

Γ = rate at which the mass of a pollutant is added to the water per unit mass of fluid;

p = density of pollutant;

Pc = total quantity of pollutant withdrawn (pumped) per unit volume of porous medium per unit time;

Rc = total quantity of pollutant added (artificial recharge) per unit volume of porous medium per unit time.

Advection and hydrodynamic dispersion are the major processes controlling transport through a porous medium. Advection is the component of contaminant movement described by Darcy's Law. If uniform flow at a velocity V takes place in the aquifer, Darcy's law calculates the distance (x) over which a labelled water particle migrates over a time period t as x = Vt. Hydrodynamic dispersion refers to the stretching of a solute band in the flow direction during its transport by an advecting fluid and comprises mechanical dispersion as well as molecular diffusion. Contaminant transport scenarios serve as tools for management purposes and the simulation results indicate the expected plume migration. The latter can be used to establish additional monitoring points to be applied as transient input for model updates and re-calibration.

The calibrated groundwater flow model was used as basis to perform the solute/mass transport scenarios. Total Dissolved Solids (TDS) was applied as the proxy source with source term assumptions based on existing hydrochemical analysis. Monitoring boreholes situated in close proximity to the waste body footprints suggest a salt load of approximately 2000mg/l. Model domain background values were interpreted from the hydrochemical data analysis as gathered during the hydrocensus user survey and assigned as ~ 450.0 mg/l.

4.3.7.7.1 SCENARIO 02: TDS POLLUTION PLUME MIGRATION WITHIN THE HOST AQUIFER FOR THE OPERATIONAL PHASE(S) WITHOUT IMPLEMENTATION OF MITIGATION OR MANAGEMENT MEASURES.

This scenario simulated a TDS pollution plume for the existing ash dumps for the operational phase(s) without implementation of mitigation and/or management measures. Figure 49 depicts a model cross section of the pollution plume migration within the aquifer and it is evident that the mass transport of the pollution plume is mostly limited to the shallow, intergranular aquifer, however, does migrate to the deeper, fractured aquifer as well. Figure 50 shows the simulated particle tracking and expected flow pathways of contaminants within the shallow, intergranular aquifer originating from potential pollution sources for the operational phase. The dominant pollution plume migration is towards the west and northwest.

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[7] This investigation and contaminant transport model are based on a "worst-case" scenario and as such, it is assumed that no decay and/or retardation are taking place in the aquifer.
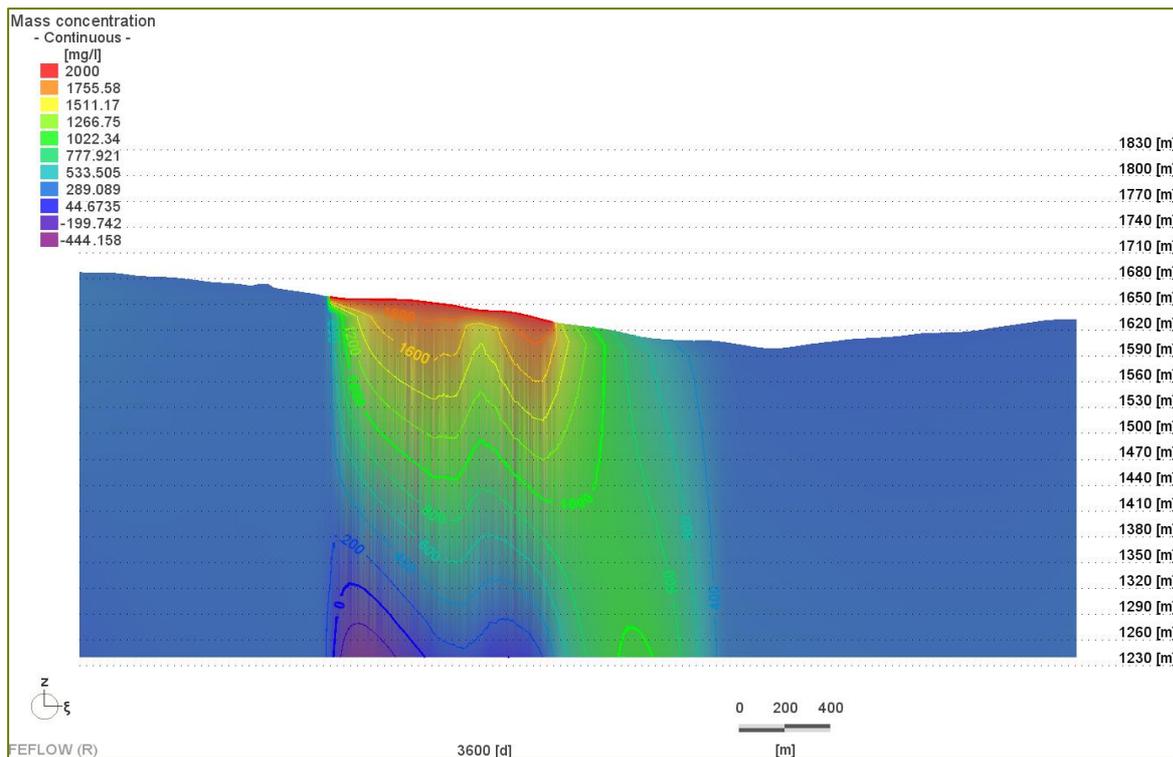
Figure 49: Scenario04: Cross sectional view of the simulated sulphate pollution plume for the operational phase (A-A').
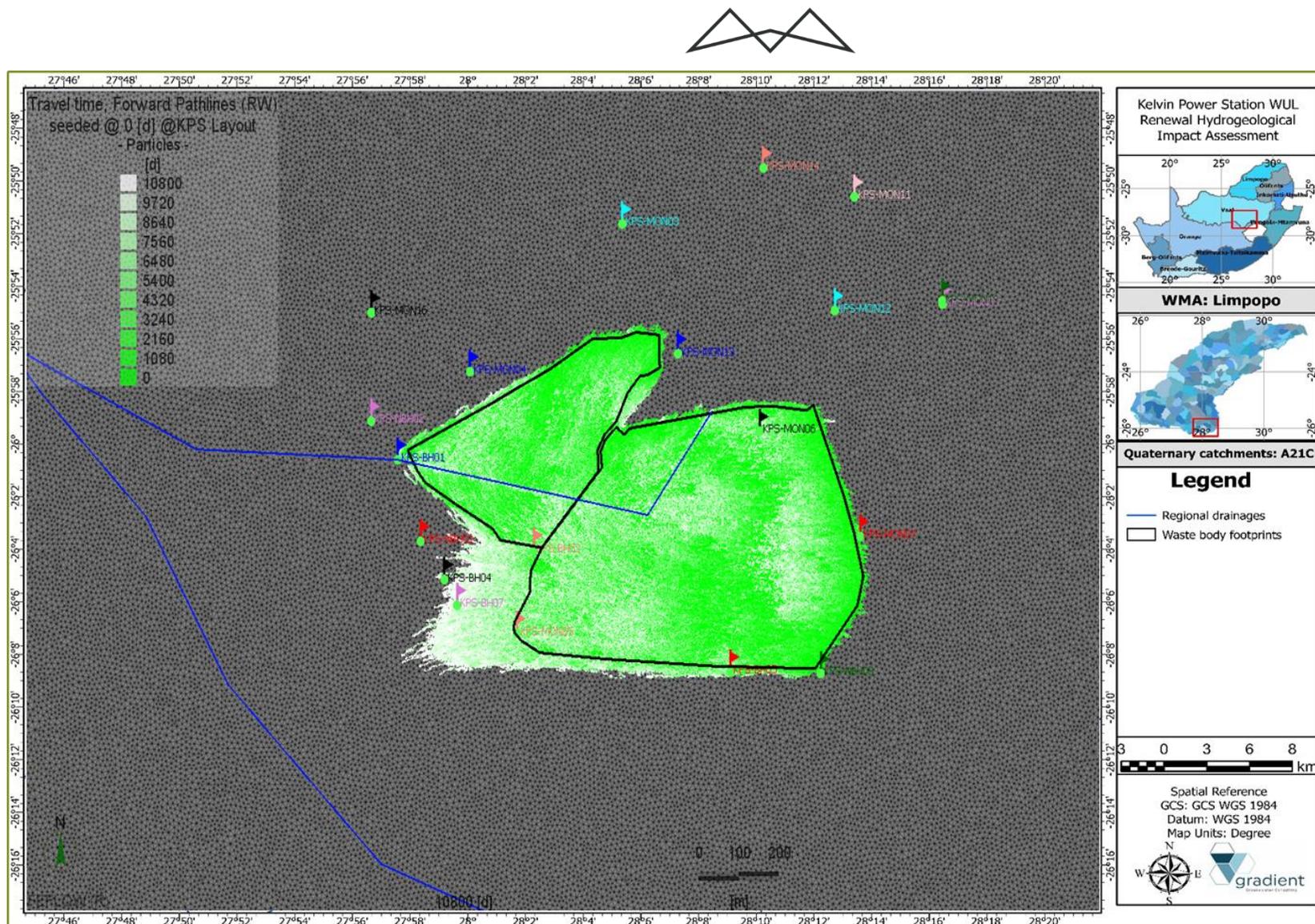
Figure 50: Scenario02: Simulated particle tracking of contaminants within the shallow, intergranular aquifer originating from waste footprints for the operatinal phase.

The simulated pollution plume extent covers a total area of approximately 1.05km^2 reaching a maximum distance of ~650.0m migrating in a general southwestern direction from where it propagates northwest following the lower laying drainage system of the Modderfonteinspruit. Potential receptors include monitoring boreholes situated down-gradient from the source as well as the Modderfonteinspruit and associated riparian zone. It is noted that no private owned boreholes are impacted on.

Figure 51 indicate a time-series graph of the TDS mass load contribution to down-gradient borehole receptors within the intergranular aquifer host for the operational period. It can be observed that the TDS mass load contribution to all the observation boreholes breaks through the SANS 241:2015 threshold after a simulation period of approximately 5-10 years increasing steadily to a maximum concentration of between ~1100.0 to 1550.0mg/l.

As mentioned, it is also noted that the simulated pollution plume reaches the riparian zone of the Modderfonteinspruit. Figure 52 summarises a time-series graph of the mass load contribution to down-gradient receptors i.e., wetland and associated drainage system. The simulated TDS mass load contribution to this receptor reaches a steady sate concentration of approximately 980.0mg/l after a simulation period of ~12 years, however remains below the SANS 241:2015 limit for the operational phase. Figure53 depicts various phases of the simulated TDS pollution plume migration within the host, emanating from the exiting ash dump footprints while Figure 54 shows the current TDS pollution plume (2025).
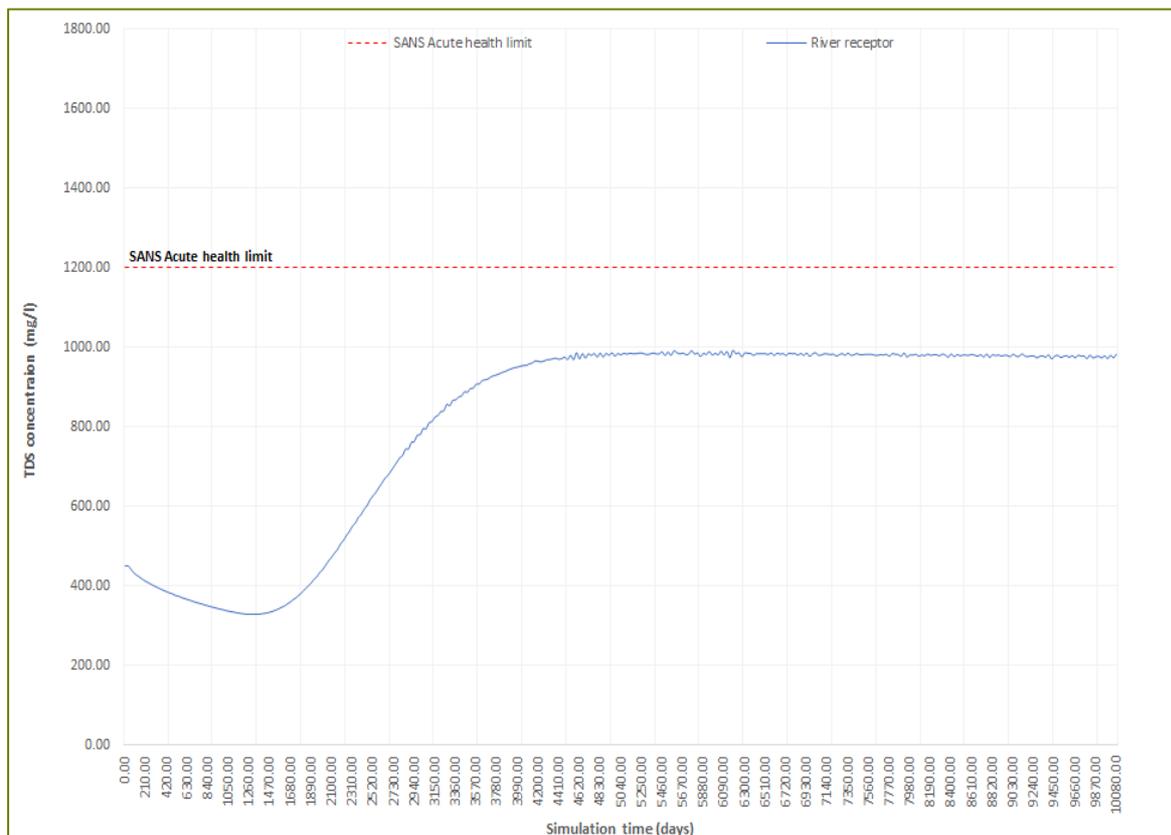
Figure 51: Scenario 02: Time-series graph indicating the TDS mass load contribution to down-gradient borehole receptors within the intergranular aquifer host during the operational phase.
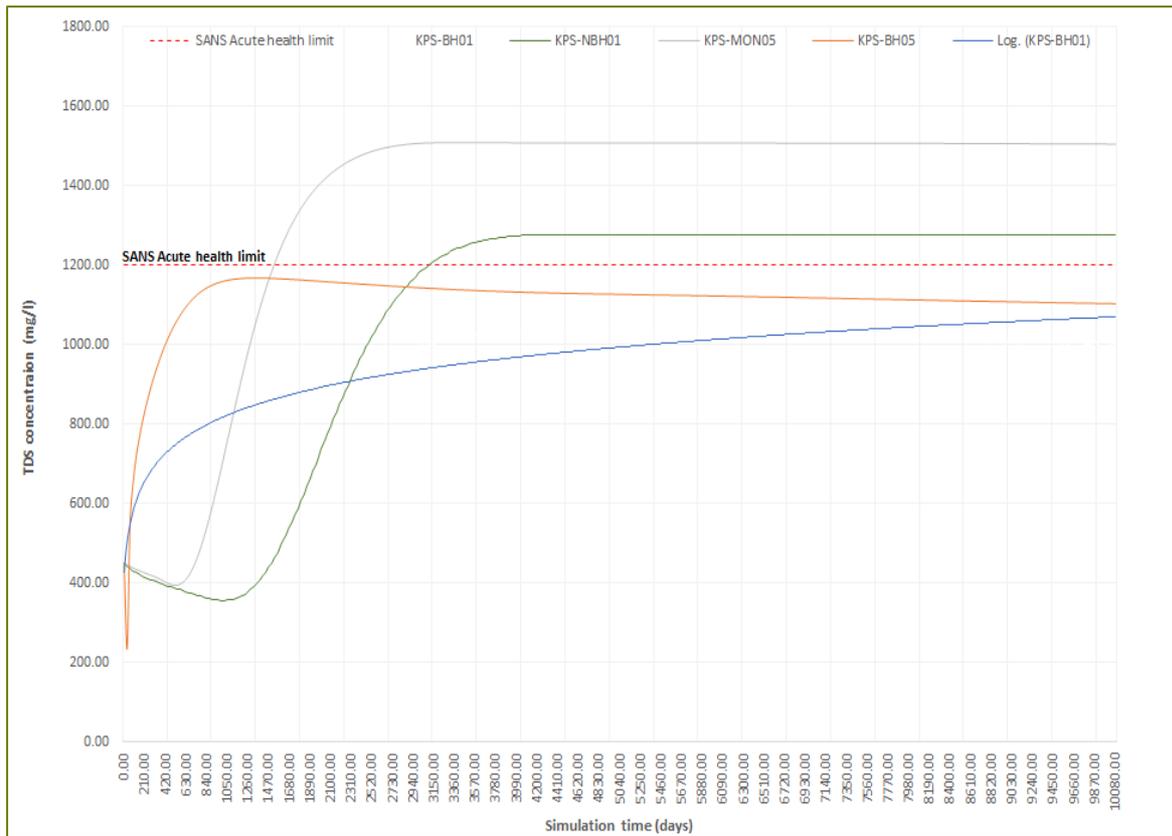
Figure 52: Scenario 02: Time-series graph indicating the TDS mass load contribution of opencast footprints to down-gradient wetland receptors within the intergranular aquifer host during the operational phase.
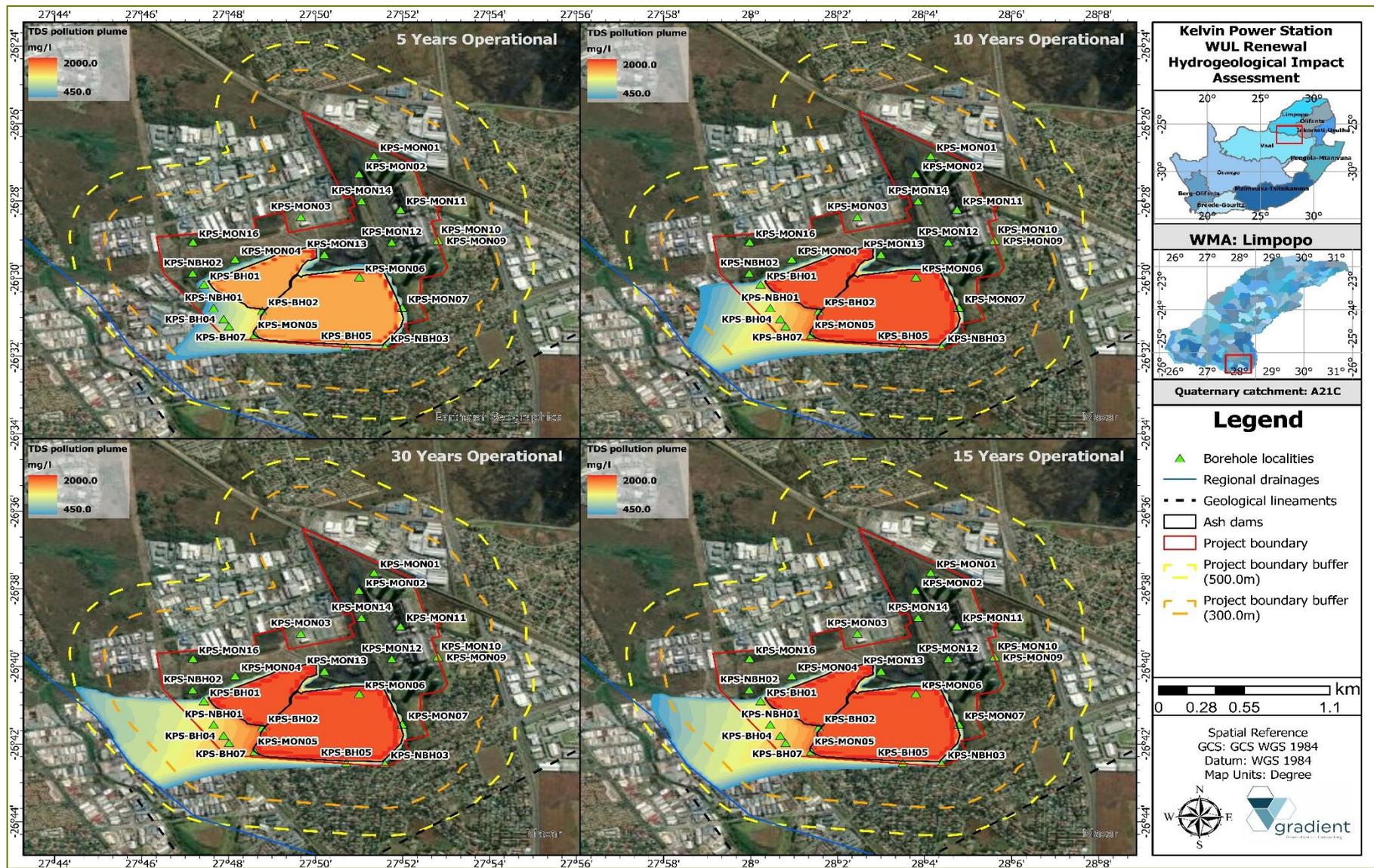
Figure53: Scenario 02: TDS pollution plume migration within the host aquifer for various stages during the operational phase.
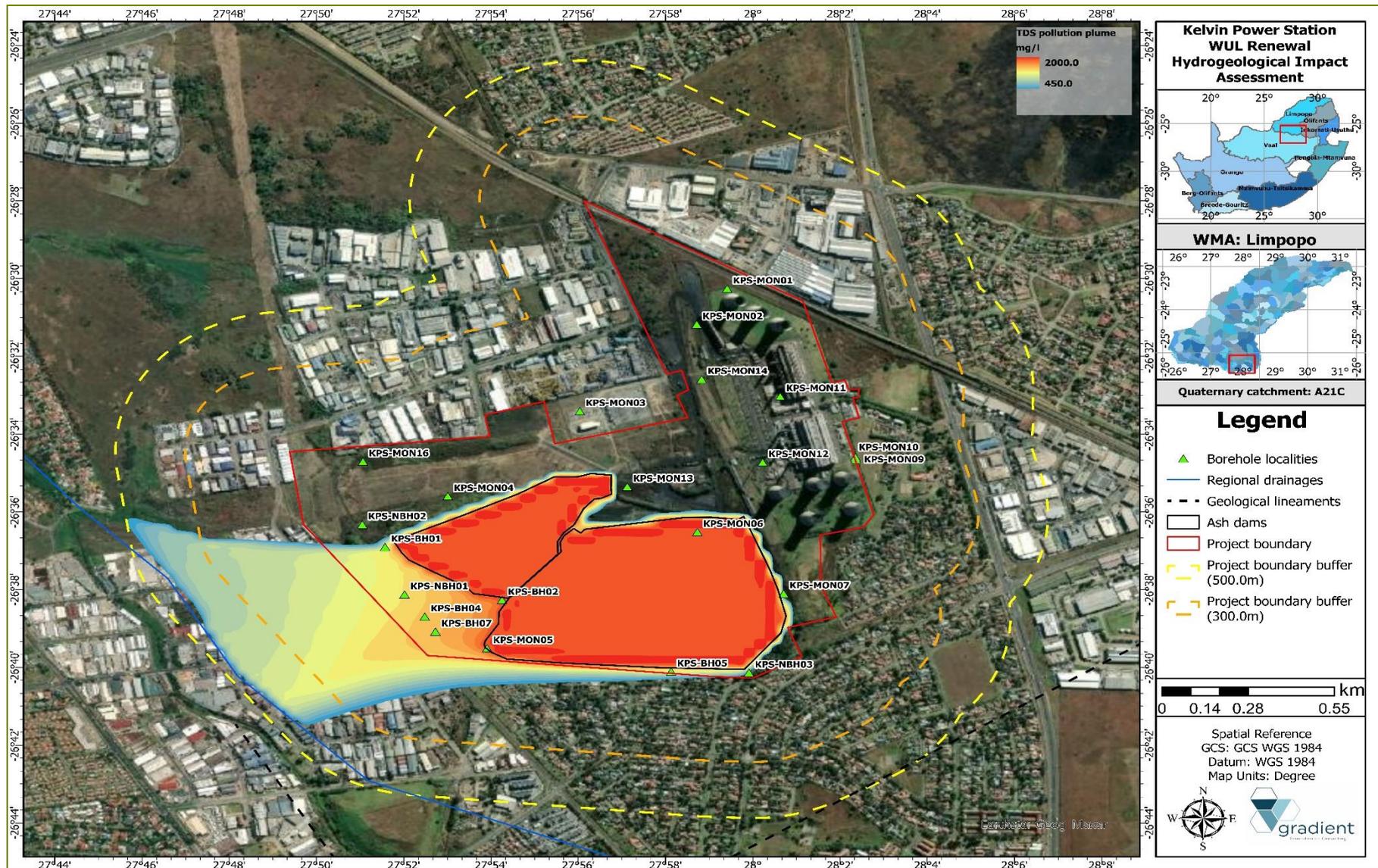
Figure 54: Scenario 02: TDS pollution plume migration within the host aquifer for the operational phase (Current plume).

4.3.7.7.2 SCENARIO 03: TDS POLLUTION PLUME MIGRATION WITHIN THE HOST AQUIFER FOR THE POST-CLOSURE PHASE(S) WITHOUT IMPLEMENTATION OF MITIGATION OR MANAGEMENT MEASURES

A post-closure scenario was simulated to evaluate the TDS pollution plume migration within the intergranular aquifer host after discontinuing of mining activities. The 50-year simulation period suggest that the pollution plume extent covers a total area of approximately 1.25km^2, reaching a maximum distance of ~750.0m in a general northwestern direction towards the lower laying drainage systems. The 100-year simulation period indicate that the pollution plume extent covers a total footprint of approximately 1.35km^2, reaching a maximum distance of ~950.0m in a general northwestern direction towards the lower laying drainage systems. Potential receptors include monitoring boreholes situated down-gradient from the source as well as the Modderfonteinspruit and associated riparian zone. It is noted that no private owned boreholes are impacted on.

Figure 55 indicate a time-series graph of the TDS mass load contribution to down-gradient borehole receptors within the intergranular aquifer host for the post-closure phase. It can be observed that the TDS mass load contribution to all the observation boreholes remains relatively constant at concentration of between 950.0 to 1250.0mg/l for the duration of the simulation.

Figure 56 shows the simulated particle tracking and expected flow pathways of contaminants within the shallow, intergranular aquifer originating from potential pollution sources for the post-closure phase. Figure 57 depicts various phases of the simulated TDS pollution plume migration within the host, emanating from the exiting ash dump footprints.

Figure 55: Scenario 03: Time-series graph indicating post-closure mass load contribution to borehole receptors.
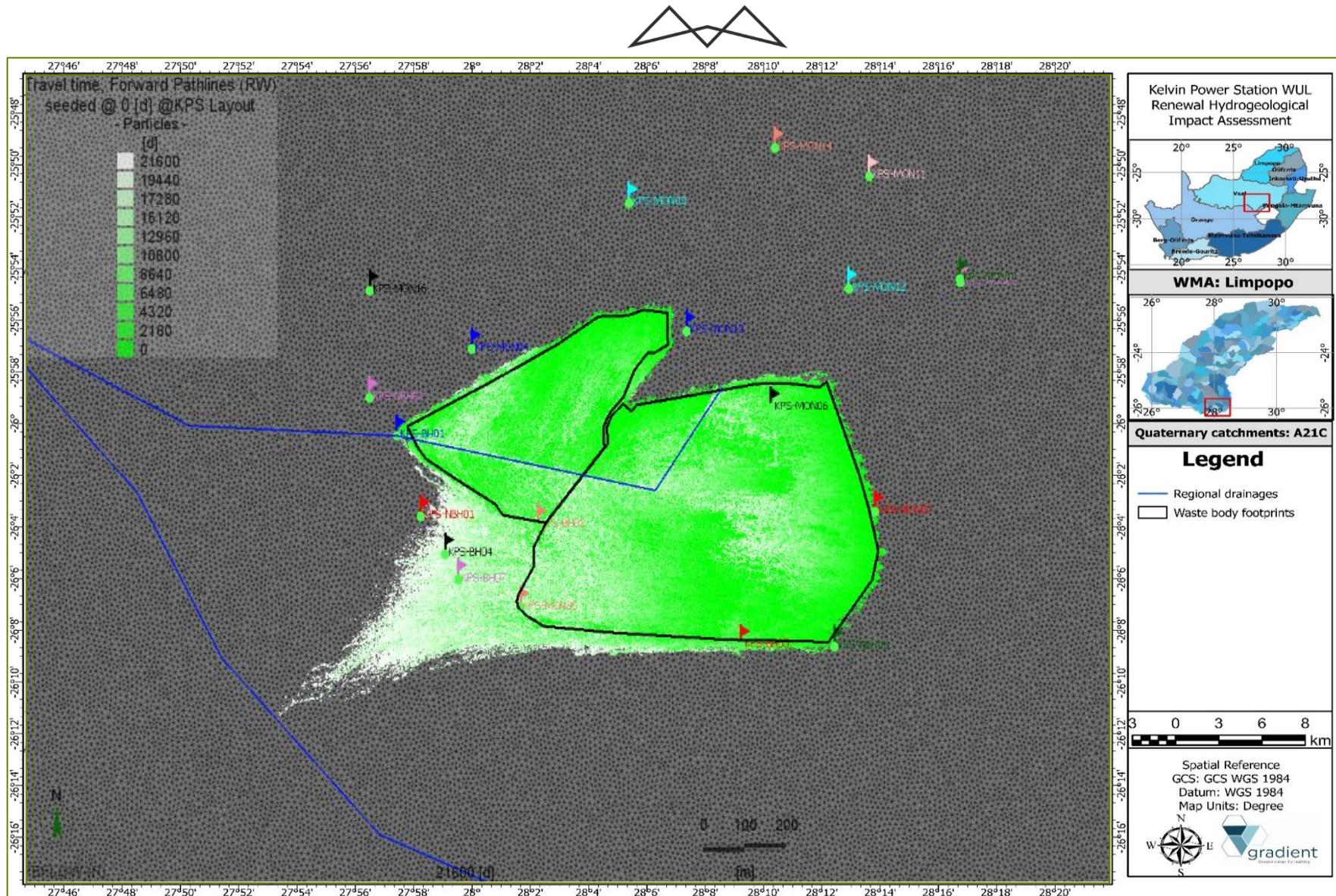
Figure 56: Scenario 03: Simulated particle tracking of contaminants within the shallow, intergranular aquifer originating from waste footprints for the post-closure phase.
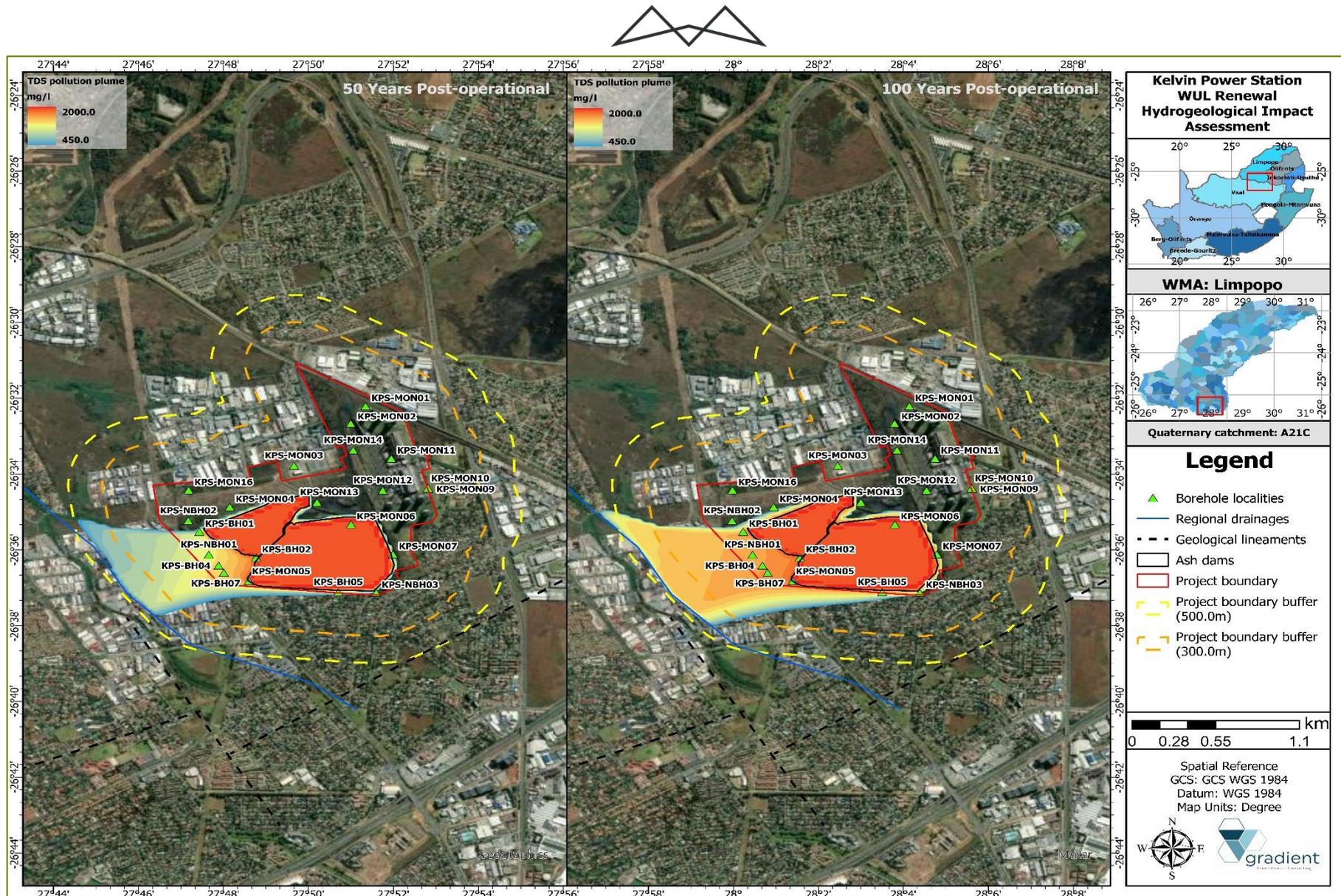
Figure 57: Scenario 03: TDS pollution plume migration within the intergranular aquifer for the post-closure phase(s).

4.3.7.7.3   SCENARIO 04: MITIGATION AND MANAGEMENT

Two alternative management and mitigation scenarios which include active as well as passive water management strategies were simulated to evaluate the remedial options available. Table 22 provides a summary of the mitigatory effect and effectiveness of proposed management alternatives on the pollution plume migration while Figure 58 shows a time-series graph indicating mass load contribution on down-gradient receptors (Pre-mitigation vs Post-mitigation scenarios).

4.3.7.7.4   SCENARIO 04A: IMPLEMENTATION OF A SERIES OF SEEPAGE CAPTURING BOREHOLES DOWN-GRADIENT OF EXISTING WASTE BODY FOOTPRINTS

An active management scenario evaluating the mitigating effect of establishment of a series of seepage capturing or scavenger boreholes situated down-gradient of the existing waste body footprints simulated as depicted in Figure 59. Due to the negative hydraulic gradient formed locally at each seepage capturing borehole, the gradient curtain constrains the propagation of the pollution plume and effectively reduce the footprint by ~35.0% to ~0.65km^2. Intercepted groundwater volumes expected is approximately 151.20m^3/d and will be a function of the borehole yields. Water intercepted may be re-introduced into the contact water circuit for reuse in the mining process. It is recommended that newly established seepage capturing boreholes be subjected to constant discharge pump tests in order to determine borehole safe yields and optimal abstraction duty cycles.

4.3.7.7.5   SCENARIO 04B: IMPLEMENTATION OF A CUT-OFF/ FRACTURING TRENCH DOWN-GRADIENT OF EXISTING WASTE BODY FOOTPRINTS

An active management scenario evaluating the mitigating effect of a sub-surface cut-off trench/fracturing curtain[8] on the plume migration was simulated as depicted in Figure 60 and Figure 61.

. Due to shallow groundwater levels i.e., relatively thin vadose zone, this mitigation alternative will intercept adequate water to create a negative gradient within these zones, effectively constraining the plume migration reducing its footprint by ~25.0% to ~0.75km^2. Intercepted groundwater volumes expected is approximately 143.81m^3/d and will be a function of the depth of the proposed cut-off trench. Water intercepted may be re-introduced into the contact water circuit for reuse in the mining process. Based on the constraining effects of these mitigation scenarios on the pollution plume migration, both alternatives can be viewed as the remedial options for implementation. It can be noted that a collective approach can also be evaluated combining these alternatives for a cumulative impact.

Table 22: Scenario 04: Effectiveness of mitigation and management alternatives on pollution plume areas.

Mitigation and management scenarios	Combined plume area (pre-mitigation)(km^2)	Combined plume area (post-mitigation)(km^2)	Improvement (%)	Intercepted contact water volume (m^3/d)
Scenario 04a: Implementation of a series of seepage capturing boreholes down-gradient of existing waste body footprints	1.00	0.65	35.00	151.20
Scenario 04b: Implementation of a cut-off/ fracturing trench down-gradient of existing waste body footprints	1.00	0.75	25.00	143.81

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[8] A boundary condition with seepage faces equal to elevation – 5mbgl has been simulated for this scenario, however effectiveness of this mitigation measures will be dependent on the practical implementation on site.
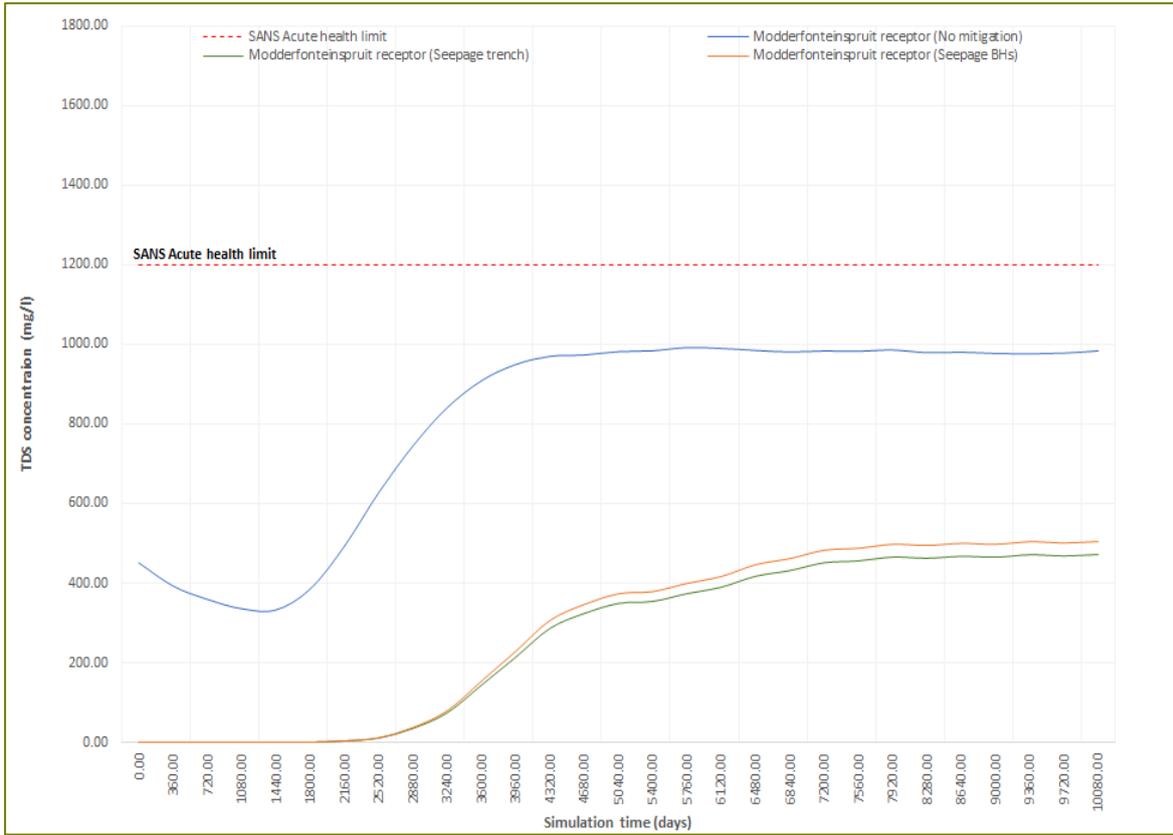
Figure 58: Scenario 04: Time-series graph indicating TDS mass load contribution on down-gradient receptors (Pre-mitigation vs Post-mitigation scenarios).
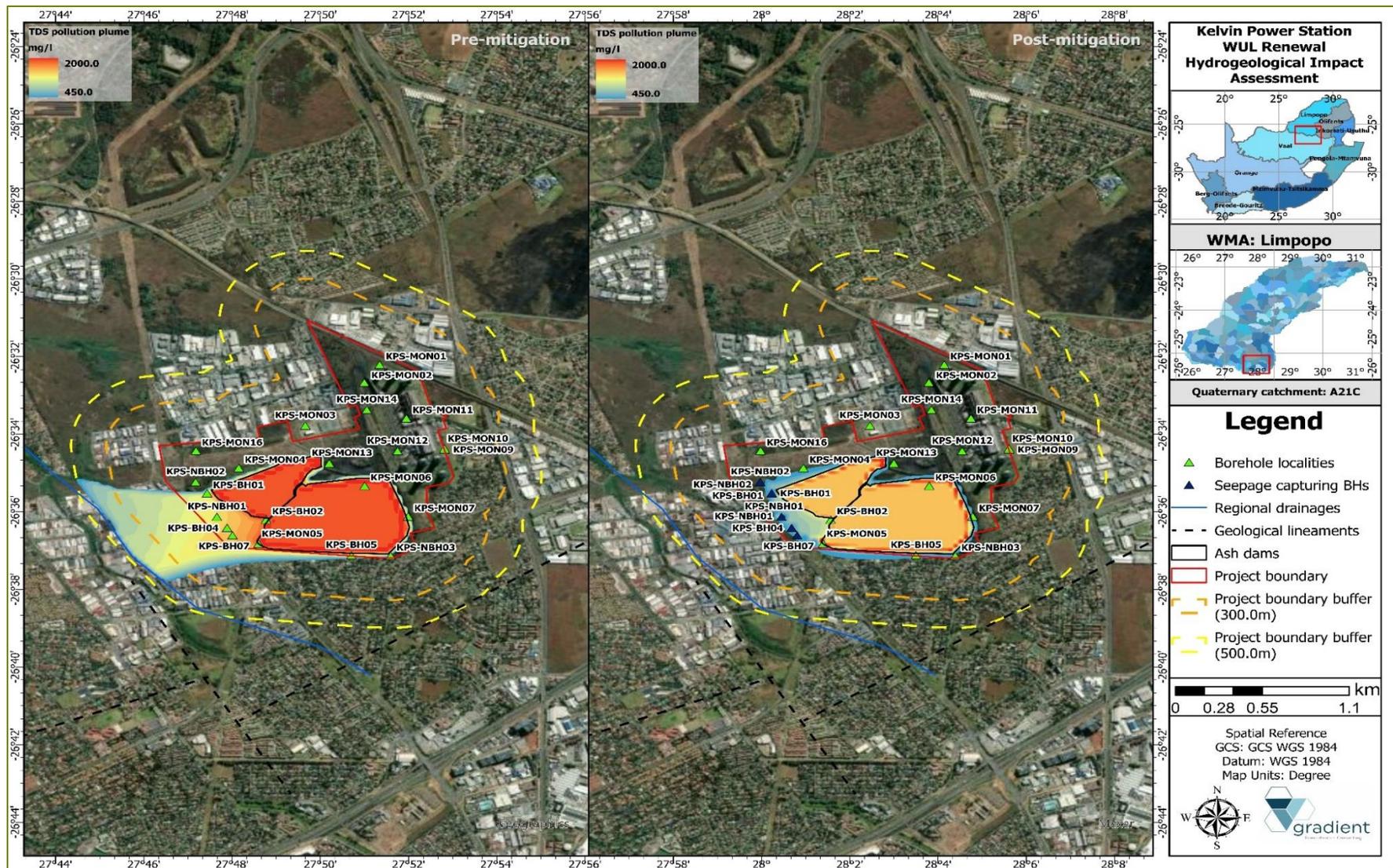
Figure 59: Scenario 04a: Mitigation and management- Implementation of seepage capturing boreholes down-gradient of existing infrastructure.
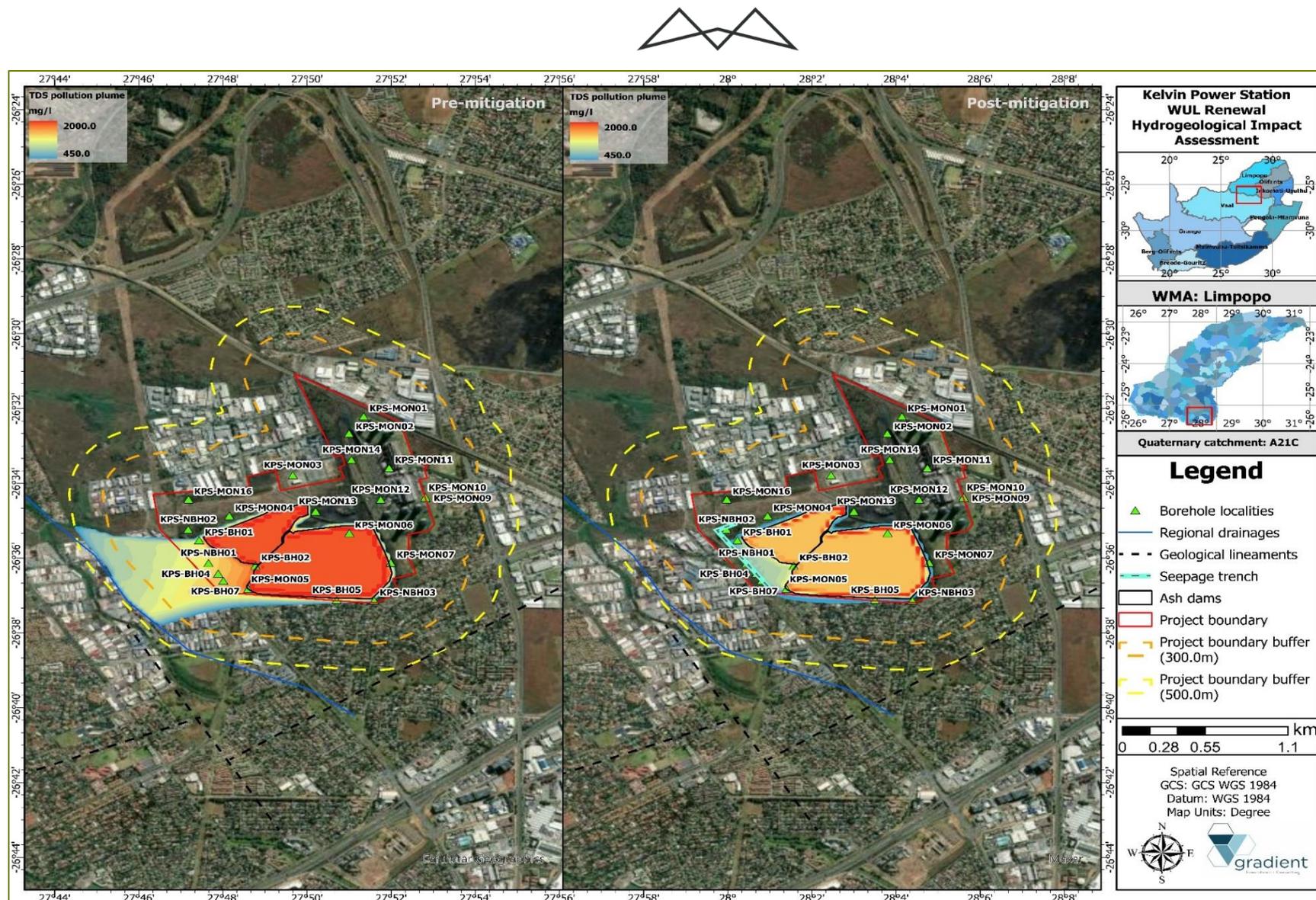
Figure 60: Scenario 04b: Mitigation and management- Implementation of a cut-off/ fracturing trench down-gradient of existing infrastructure.
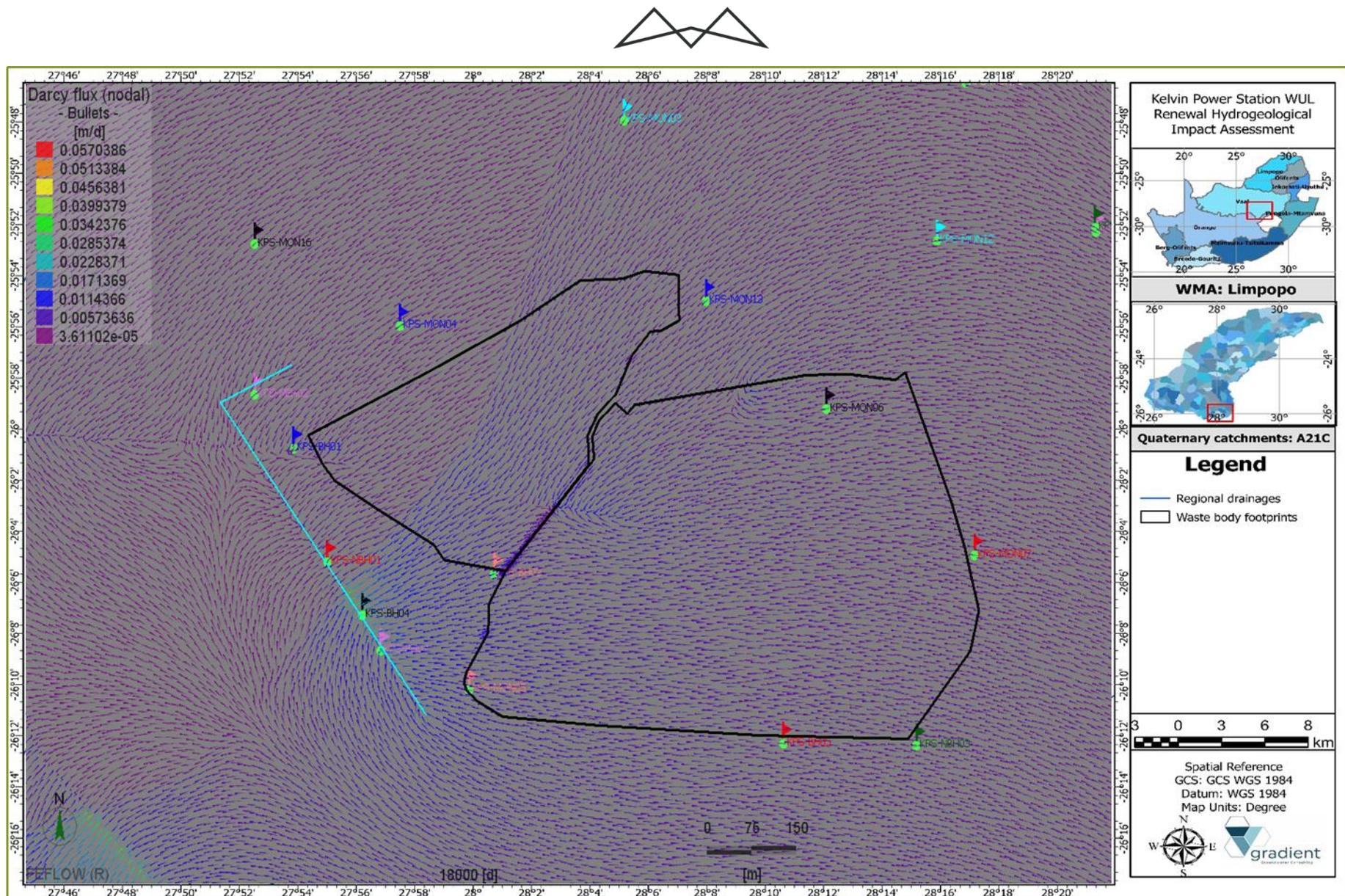
Figure 61: Scenario 04b: Map indicating the Darcy flow-vectors in the vicinity of the porposed seepage trench.

4.4   SOCIO-ECONOMIC ENVIRONMENT

Kelvin Power is located within Kempton Park and in close proximity to O.R. Tambo International Airport. It thus falls under The City of Ekurhuleni Municipality.

The City of Ekurhuleni is a Category A municipality which exercises legislative and executive authority within its jurisdiction, as determined by the Constitution of the Republic of South Africa. The City is one of three (3) metropolitan municipalities in the Gauteng Province, a province which has a total land mass 16 548 km². Ekurhuleni covers 1975 km² which represents 12% of the province's land mass; while housing 27% of Gauteng's population, representing 7% of South Africa's total population. The city is exceptionally densely populated with 1609.4 persons per km^2 as compared to Gauteng (675.12 persons per km^2) and the national population (42.8 persons per km^2). The highest population density of Ekurhuleni is in previously disadvantaged areas such as: Daveyton, Tsakane, KwaThema, Tokoza, Katlehong, Tembisa, Vosloorus and Duduza (City of Ekhurhuleni, 2024).

4.4.1   DEMOGRAPHIC INFORMATION

According to Statistics South Africa's recent census 2022, approximately 4 066 691 people reside in the City of Ekurhuleni with 1 421 003 households. The gender distribution of the population is 51% male and 49% female. Figure 63 below shows the population by growth and gender over the last three (3) years. Refer to Figure 62 and Figure 63 visualise the gender and age distribution as well as the percentage male and female, respectively.

Table 23: Ekurhuleni population growth and gender (City of Ekurhuleni, 2024).

2021/ 2022			2022/ 2023			2023/ 2024		
Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
1971 815	1886 332	3858 147	2006 178	1920 499	3926 677	2040 990	1955 133	3996 123
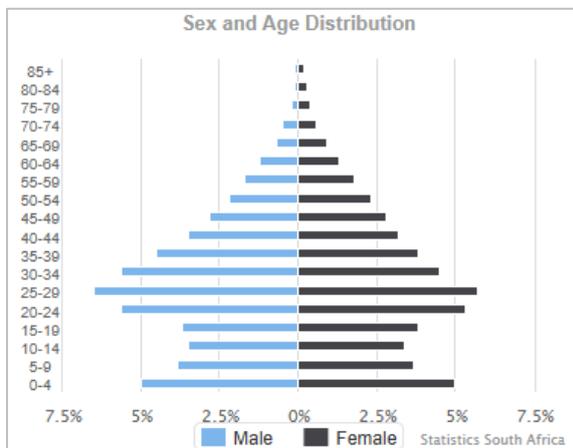
Figure 62: Ekurhuleni gender and age distribution (STATSSA, 2025).
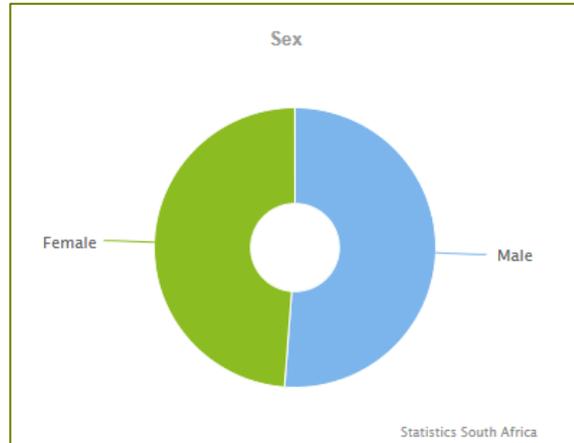
Figure 63: Percentage male and female in Ekurhuleni (STATSSA, 2025).

The average annual population growth rate within the metro currently stands at 2.47%. The population increased by 28% from 3.18 million in 2011 to 4.07 million in 2022. The increase in the population has adverse implications for the already ageing infrastructure and further heightens the demand for provision of basic services. Other implications of the population growth include growing service backlogs and a heightened demand for economic opportunities to address the poverty challenge. The population is divided into 78.7% Black Africans, 15.8% Whites, 2.7% Coloured, 2.1% Indian/ Asian and 0.6% other (Figure 64) with the most prominent language being spoken is IsiZulu (28.6%) followed by English (11.9%) and Afrikaans (11.8%), see Figure 65**.**
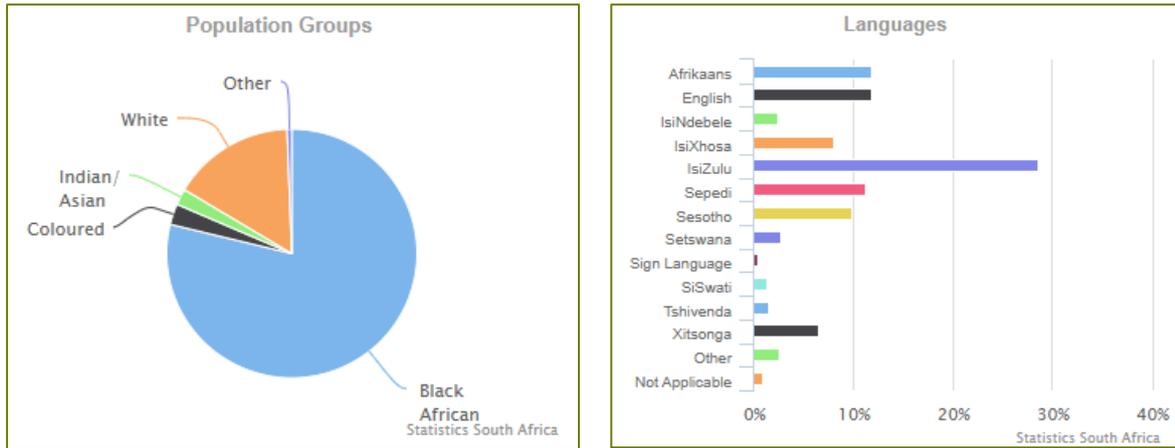
Figure 64: Population groups of Ekurhuleni (STATSSA, 2025).

Figure 65: Language distribution in Ekurhuleni (STATSSA, 2025).

4.4.1.1 **ECONOMIC INFORMATION**

The socio-economic indicators for the city reveal a complex and evolving landscape. The housing backlog has been exacerbated by a growing population and increased demand for adequate housing, with a notable rise of 1.3% between 2021/ 22 and 2022/ 23, and a further 0.8% increase between 2022/ 23. The prevalence of HIV and AIDS has seen a slight increase from 15.7% to 16.1% over the past three years, highlighting ongoing challenges despite various mitigation programs.

The unemployment rate has been increasing since 2020, and this is due to the fact that a greater number of the economically active population have either given up on the search for employment or have become discouraged from doing so. The official unemployment rate in the City (36.4%) is higher than that of the Gauteng province (34%) and the national figure (32.7%). The unemployment rate has increased by 2.1% from 2020 to approximately 37.1% in 2022 whilst in the year 2023, the percentage decreased by 0.7% to 36.4%.

Germiston has recorded the lowest official youth unemployment rate of 60.9% from 2020 to date among all the towns in the city, while Nigel has the highest rate of 75.2%, which is higher than the city's average of 64.6%. The Coloured population in Nigel experienced the highest unemployment rate of 80% in 2023, while the City's coloured youth unemployment average was 39.5%. The Springs recorded the highest youth unemployment rates for the White population at 42.5%, which is greater than the city's white youth unemployment average of 33%. The black youth population recorded 77.8%, while the City's average was 69.5%. The Asian youth population experienced the greatest youth unemployment rate of 38.7%, which is twice the City's average of 19.7%.

In the City of Ekurhuleni, the number of people living below the poverty line decreased from 942 617 in 2020/ 21 to 925 856 in 2022/ 23. This number however rose to 1 077 140 in 2023/ 24, raising concerns about food security within the city. The figure below shows the trend in persons living below the food poverty line within the city over the last three years. The data indicates that there has been a 3% increase in 2023/ 24, from a percentage of 24% recorded for both 2021/ 22 and 2022/ 23. The majority of households found living below the poverty line are predominantly found in townships, informal settlements and peri-urban areas of the city. Figure 66 indicates the employment for those aged 15 – 64 years old whereas Figure 67 indicates the average household income for the City of Ekurhuleni.
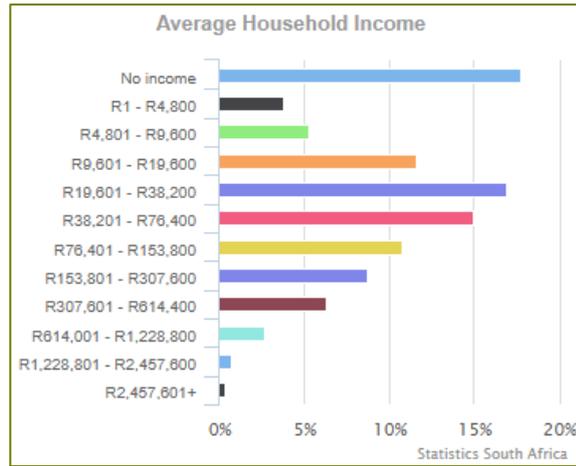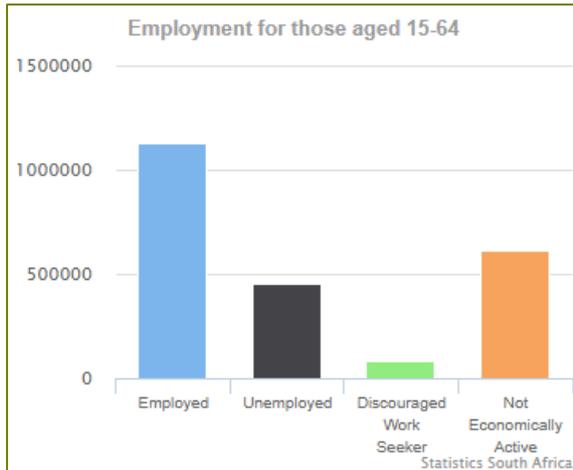
Figure 66: Employment for those aged 15 – 64 (STATSSA, 2025).

Figure 67: Average household income in Ekurhuleni (STATSSA, 2025).

5 ANALYSIS AND CHARACTERISATION OF THE WATER USE ACTIVITY

5.1 SITE DELINEATION FOR CHARACTERISATION

For the purpose of site delineation and characterisation of an IWWMP a facility has been selected as the unit activity. The facilities at Kelvin Power have been identified and delineated based on the following criteria:

- A facility within the overall power station must display a measure of homogeneity;

- In terms of its spatial extent, a facility should be confined as far as possible to define a direct interaction/ relationship with the receiving water environment;

- The sum of the facilities must represent the total activity of the power station which could affect the receiving water body; and

- Clear management responsibility must be assignable to a facility.

The performance of the individual facilities is governed by a site-wide management framework that comprises site-wide performance objectives, associated strategies, as well as management measures (Golder, 2021). Hence, site-wide management requirements are aligned with facility-level management requirements and vice versa. The geographical extent of the facilities is indicated in Figure 5and described in Table 24**.** The facilities identified at Kelvin Power are as follows; Facility 1: Power Station (Station A and Station B); Facility 2: Ash dams and coal storage area, and Facility 3: Remainder of the area.

Table 24: Facility characterisation at Kelvin Power Station (Golder, 2021).

No.	Name of Facility	Description
1	Power Station.	The Power Station area is characterised by the following key components: 88kV Switchyard; - A station (under extended care and maintenance); - B station (operational); - Eight (8) cooling towers, only five (5) of which are operational; - Change house; - Mill store; - Workshop and contractor facilities; - Electrical workshop; and

No.	Name of Facility	Description
		• Admin buildings.
2	Coal storage stockpiles.	This area is characterised by the B station coal stockpile, the B station coal dry store and the coal store situated east of the currently non-operation A station cooling towers.
	Ash dams.	This reflects the area where the ash produced at Kelvin is stored. This area is divided into Ash Dam A and Ash Dam B, and is further characterised by the Astro Bricks facility, a pump house, storm water canals and other water management infrastructure such as the Return Water Dam and the De-silting reservoir.
3	Remainder of the area.	The remainder of the area is characterised by the following key components: • Pump station; and • Reservoir.

5.1.1 POWER STATION PLANT

This area covers an aerial extent of 27.3 ha and is subdivided into Station A and Station B (see Figure 5), with Station A currently being demolished. Station A is situated to the north of the site and Station B is situated to the south of the site. This facility is further characterised by several sub-facilities:

- 88kV Switchyard;

- Eight (8) cooling towers, only five (5) of which are operational;

- Change house;

- Mill store;

- Workshop and contractor facilities;

- Electrical workshop; and

- Admin buildings.

The main resources used at the power station are coal and water. Coal is burned inside the boiler to produce super-heated steam (SHS) which is transported via pipes to the turbines. SHS drives the turbines which spins the rotor at high speed. This turns the generator which generates electricity. The electricity is sent from the generator to the transformers which increase the voltage, and it then goes to the high voltage yard. From there, it is sent out to the users via power lines. Bottom ash and fly ash are generated from the boilers as well as baghouse dust which is used to make cement. Water is sent to and cooled down using the five (5) cooling towers (Figure 68).

A demineralisation plant (Figure 69) uses potable water from Rand Water to produce demineralised water in sequential cationic and anionic resin columns. The demineralised water is discharged to the main channel to desilting dams. Treated water from the Northern Treatment Plant in Dieplsloot is also used in process, after it is dosed with additional chemicals to make it fit for use. Roughly 1 500 m^3/d of treated water reports to Kelvin Power to be used.

Figure 68: Base of a cooling tower at Station B.   Figure 22: Section of the demineralisation plant.

5.1.2 ASH DAMS AND COAL STORAGE AREAS

5.1.2.1 ASH DAMS

There are two ash dams at Kelvin Power. Ash Dam B is a historic dump and no deposition is currently taking place there. Some of the ash from Ash Dam B is being reclaimed. Ash Dam A (Figure 69) is currently being utilised for deposition of ash slurry. Since Ash Dam A is close to reaching maximum capacity due to ongoing ash slurry deposition, once dry, some of the ash from Ash Dam A is transported by truck, via a ramp to Ash Dam B (Figure 70).

A pipeline traverses and transports water to Ash Dam B, which is used for irrigation purposes to minimise liberation of dust from the ash dam. Irrigation systems are also present on Ash Dam A (Figure 71). The water used to irrigate the slopes of both ash dams is obtained from the desilting dam.

Ash Dam A and B are unlined disposal facilities, and it was reported in the 2024 groundwater monitoring report compiled by Groundwater Complete that there is seepage (Figure 72) from the ash dams, which migrates along the fault and fracture zones at depth below the ash dams, thus impacting negatively on the quality of groundwater in the area, with the major or most problematic contaminant being sulphide.

Figure 69: Top of Ash Dam A.   Figure 70: Top of Ash Dam B.

Figure 71: Dust suppression on Ash Dam A.

Figure 72: Drainage trench on toe of Ash Dam A.

There are several groundwater monitoring boreholes situated in the vicinity of both ash dams to assess the potential impact the ash dams have on the groundwater resource. The latest hydrocensus undertaken for the site indicated that there are no borehole water users situated in the vicinity of the power station. Since the pollution plume below the ash dams is migrating in a north-westerly direction, it is unlikely that groundwater users residing to the south of the site will be affected by the pollution plume.

5.1.2.2 COAL STOCKPILES

Coal is brought in via road and deposited on one of the two coal storage areas. An open coal stockpile is situated between Station B and Ash Dam A (Figure 73). The second coal storage area is located under the rail siding and is under cover. Coal is brought in via rail and tipped into the storage area. This is used mainly in summer as there is the risk of rain wetting coal on the open stockpile. The coal is fed to the bunkers via the conveyor belts. From the bunker, it is sent to the mills and then to the boiler.

The area where the coal that is used in the power generation process is stockpiled is neither lined nor concreted, and the coal stockpile has hence been identified as a potential groundwater pollution risk. Several groundwater monitoring boreholes are situated around the coal stockpile area to assess the potential impact it may have on the groundwater resource. It should also be noted that no formalised storm water infrastructure was observed around the stockpile area (Figure 73), which could pose a threat to groundwater, resulting from seepage during rainfall events.

Water management facilities in the ash dams and coal storage area consist of the desilting dam, the return water dam and the main and secondary channels.

Figure 73: Open coal stockpile area.

Figure 74: Trench adjacent to open coal stockpile area.

5.1.2.3   DESILTING DAM

The desilting dam is a concrete-lined dam that acts as a silt trap and comprises of two compartments (Figure 75). Water that reports to the de-silting dam comes from the demineralisation plant. Once one compartment is silted up, water stored in the dam is transferred to the next compartment, enabling the cleaning of the system. A compartment was busy being cleaned and observed during the site visit, see Figure 76. The silt from the de-silting dam is then removed using front-end loaders, where after it is temporarily stockpiled adjacent to the dam and subsequently transported and deposited on Ash Dam B. Information regarding the desilting dam is summarised in Figure 76**.**

The water that reports to the desilting dam is used to irrigate the slopes on Ash Dam A and B. It is recommended that a hard stand be constructed for the removed silt or that the silt be directly deposited onto Ash Dam B immediately after removal from the de-silting dam. Alternatively, a liner can be constructed to minimise the likelihood of seepage. It is also recommended that Kelvin Power looks at constructing a bund wall around the desilting dam to prevent potential spill to the canal during high rainfall periods.

Figure 75: Desilting dam.
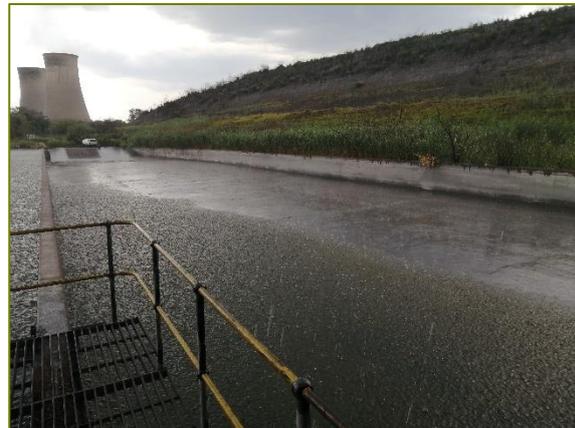
Figure 76: Desilting of a compartment of the Desilting Dam.

Table 25: Desilting Dam technical information.

Description of Water Use	Design Capacity (m³)	Annual Throughput (m³/ annum)
Desilting Dams: Compartments 1 and 2 combined.	12 794	4 891 000

5.1.2.4   RETURN WATER DAM

The Return Water Dam (RWD) (Figure 77) has two streams and receives water from the de-silting dam and Ash Dam A, via a pipeline connected to the penstock on the ash dam. The ash water has a relatively high pH. From the RWD, the ash water is pumped back to the plant, where it is re-used in the process. Before entering the RWD, water from the Desilting Dam first goes through a settling (Figure 78) system, which traps sediment.

Water in the RWD that originates from the Desilting Dam and is considered clean and is discharged into the Modderfonteinspruit. after it is conveyed through the settling pond system. There is pump station situated next to the discharge point that measures the pH and flow of the water, amongst other parameters, prior to discharge into the stream. A section of the stormwater channel used to channel stormwater and surface runoff from the surrounding suburbs have been destroyed and prevents this water from reaching the Modderfonteinspruit discharge point. It is important that Kelvin Power repair this section of the channel as soon as possible to prevent clean water from reaching contaminated areas.

There are biomonitoring points upstream and downstream of the Modderfonteinspruit. The aim of the biomonitoring process is to assess the potential impact that the wastewater discharged into the stream has on aquatic life.

Water discharged into the RWD is measured on a continuous basis. Although the rate of discharge varies, the average rate is approximately 2 112 m³/d. See Table 26 for technical information on the RWD.

Figure 77: Return Water Dam.

Figure 78: Return Water Dam silt trap.

Figure 79: Discharge point into the Modderfonteinspruit.

Figure 80: Damaged stormwater channel.

Table 26: Return Water Dam technical information.

Description of Water Use	Design Capacity (m³)	Annual Throughput (m³/ annum)
Ash Return Water Dam.	7 200	7 426 800

5.1.2.5 STORMWATER

Kelvin Power uses a single stormwater system, where all the stormwater from dirty and clean areas of the plant is collected within the single stormwater system to the Desilting Dam. Given the confined area within which Kelvin Power is built and date of establishment this type of stormwater system is justifiable however continual water quality monitoring and desilting of the Desilting Dama must be implemented for protection of downstream users.

According to the WUL 03/A21C/FGH/1110 of 24 June 2011 Kelvin Power is authorised to discharge 2 599 380 m³/ annum of water through the secondary channel via a concrete channel to the Modderfonteinspruit. Based on the latest Salt and Water Balance (Dihlashana, 2024) and average of 2222 m³/ day is discharged into the Modderfonteinspruit, which is an average total of 811 030 m³/ annum (far below the authorised limit).

Stormwater generated at Station B is directed to the main channel via a subterranean collection pipeline. At Station A, both process and stormwater runoff are also collected via the same system and flow directly into the main channel.

All the runoff emanating from the areas surrounding the power station buildings also drains into the main channel via an underground pipe system. The main channel discharges into the Desilting Dam. The effluent channel discharges through the outlet monitoring and measuring flume directly into the Modderfonteinspruit.

The secondary channel currently conveys a number of flows, including:

- The bleed-off water from the cooling tower system;

- Stormwater runoff emanating from a portion of Kelvin Power discharges to the secondary channel via a system of underground pipes and a trapezoidal concrete lined channel and ultimately into the Modderfonteinspruit;

- Runoff emanating from the residential suburb of Croydon and Kempton Park to the south of Kelvin Power is also discharged into the secondary channel at three (3) locations behind Ash Dam A (Figure 81 and Figure 82). The secondary channel discharges into the Modderfonteinspruit upstream of the flume; and

- High rainfall flow event greater than the 1:2-year recurrence interval storm peak flowrate from the main channel.

Figure 81: Inflow to the secondary channel.

Figure 82: Pollution in the secondary channel.

5.1.3 REMAINDER OF THE AREA

The remainder of the area excludes the residential area, but includes the parking areas, and veld areas. The extent of the area is shown in Figure 5.

The two water storage reservoirs and pump station are included in this area. Water is provided to the station via these reservoirs.

5.2 WATER AND WASTE MANAGEMENT

5.2.1 PROCESSING PLANTS

5.2.1.1 POWER GENERATION PLANT (PGP)

The Power Generation Plant (PGP) receives coal and burns this coal in the boilers to produce steam. Coal is burned inside the boilers to form superheated steam which is transported via pipes to the turbines. The superheated steam drives the turbines which spins the rotor at high speed. This in turn turns the generator which generates electricity. The electricity generated is sent from the generator to the transformers which increase the voltage before being sent to the high voltage yard.

Coal can be delivered via the road to Kelvin Power. Road deliveries can only be delivered directly to the open stockpile. The open stockpile is situated between Station B and Ash Dam A, to the west of Station B. The dry store is an underground storage bunker consisting of 60 storage bays and is situated between Station B and the

open stockpile. The purpose of the dry store is to store coal in for use during the rainy season. From the various coal storage facilities coal is transported to the boiler coal bunkers, using a series of conveyor belts. The coal is then gravity fed to the mills where it is crushed, classified, dried and then fed to the boiler.

5.2.1.2   DEMINERALISATION PLANT

Potable water from RWB is sent to the Demineralisation Plant to produce demineralised water in a sequential cationic and anionic resin column. The demineralised water is stored in tanks for use in the boilers. The effluent that is produced from the Demineralisation Plant is sent to the high-pressure reservoir overflow sump, where it is mixed with water used for slurrying.

5.2.2   PROCESS WATER

Kelvin Power obtains its water supply from two main sources: the Rand Water Board (RWB) and the Northern Wastewater Treatment Works (NWWTW), situated 2 km outside of Diepsloot. RWB water is demineralised before being used for steam generation in the boilers and domestic purposes throughout the station. The existing power plant includes the still operational Station B, which comprises seven 60 MW steam turbines and eight pulverised coal boilers. On the other hand, NWWTW water is used to cool the condensate and perform tasks such as ash quenching, ash slurrification, and general services.

The majority of the ash water recycled and reused in the Ash Handling System (AHS) comes from the desilting dam, which overflows into the ash return water dam. From the ash return water dam, water is pumped to the ash water buffer reservoir, where it is used for various functions, including efficiently clearing ash accumulation in the ash hoppers and conveying ash in the sluiceway to the ash slurry sump. From the ash slurry sump, it is pumped as a slurry by ash transfer pumps to the Ash Dam. In the Ash Dam, the ash particles settle, and the water is decanted via a penstock into a sump before discharging back into the ash return water dam.

The secondary and main channels collect runoff from the coal stockpiles. The channels also collect stormwater. The main channel diverts flow to either the desilting dam or the ash return water dam for reuse in the AHS or directs it to the effluent channel to be discharged into the Modderfonteinspruit. The secondary channel discharges directly into the Modderfonteinspruit. The flow reticulation diagram presented in Figure 83 was developed and confirmed by Ms Nelly Makhalanyane, Kelvin's plant performance engineer. The diagram was annotated with the location of the site meters that corresponded with the central Supervisory Control and Data Acquisition (SCADA) system. The Block Flow Diagram distinguishes circuits and meters relevant to the level at which the water balance models the system. The green flowmeters indicate the data provided, internal circuits within the plant were not modelled (Dihlashana, 2025).

5.2.2.1   STEAM GENERATION

The RWB water is treated to specified limits in the Demineralisation Plant before it is fed into the boilers for steam generation. The steam is then used to turn the turbine blades which will then turn the electromagnetic generator coupled shaft for power generation.
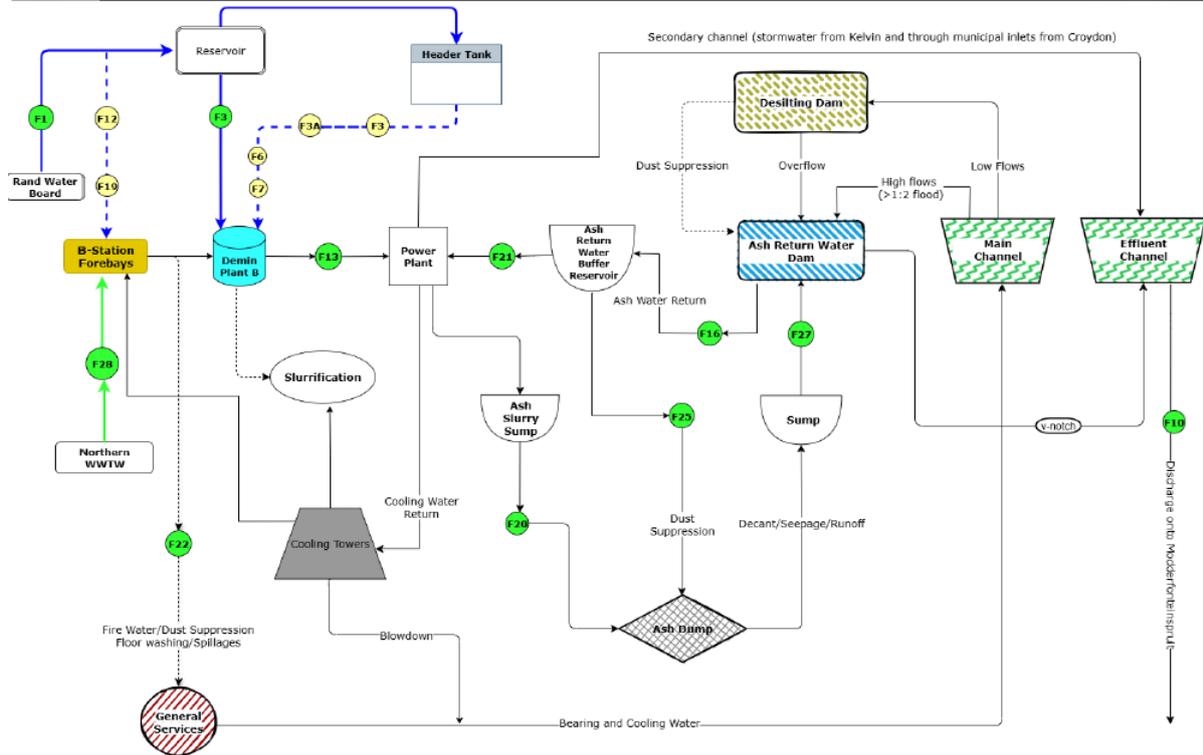
Figure 83: Kelvin Power water reticulation flow diagram (Dihlashana, 2025).

5.2.2.2   COOLING WATER SYSTEM

Water from NWWTW is primarily used for condenser heat exchanging, where the heat rejected (from the steam) in the condenser is transferred to the cooling water. This cooling water (CW) is on the tube side of the condenser, is treated to inhibit corrosion and to prevent scaling inside the tubes. The water is also used for oil cooling and distilled water cooling (Golder, 2021).

5.2.2.3   ASH WATER SYSTEM

The bulk of the ash water is provided from the Ash RWD. The remainder is supplied from the cooling water system. The water is used for the following applications in the Ash Water system:

- Remove any ash build-up from the ash hoppers into the sluiceway, using rear and front target nozzles; and

- Transport the ash in the sluiceway to the ash sump where it is pumped by ash transfer pumps as slurry to ash dam. The ash settles on the ash dam and water is drained via the penstock to the Ash RWD.

5.2.2.4   WATER AND SALT BALANCE

5.2.2.4.1   WATER BALANCE

The annual water balance has been updated with the available daily flow meter data for 2024/2025 provided by Kelvin Power Station. Some of the assumptions made to guide this study (Dihlashana, 2025) include:

- A tonnage of 20.9 t/hr is used to support power generation;

- Slurry density of 1.01 t/m³ and specific gravity of 1.05;

- Seepage rate of 6.32×10^{-5} m/s accounts for seepage in the ash dam;

- Evaporation rate from cooling towers is based on four circulation pumps, resulting in a combined evaporation loss of 449.236 m³/hr;

- Modern cooling towers maintain drift rates between 1% and 2% of the circulating water flow. A drift rate of 1% was used for Station B's cooling towers;

- Dust suppression is applied at 1 mm/ha/day;

- Runoff volume is based on the average quaternary Mean Annual Runoff (MAR) of 24.52 mm; and

- Potable water demand is based on a year-round schedule and assumes a daily consumption of 70 litres/person for an estimated number of 714 people.

The outputs from the water balance were assessed against the applicable WUL limits. Key findings from the study include:

- The 2024/2025 water balance shows a total inflow of 33 058 m³/day and a total outflow of 33 059 m³/day, indicating less than 1% error;

- Approximately 4 686 m³/day is unaccounted for, and it is assumed that this inflow is lost at the ash handling facility to achieve a balance; and

- The station generates an average daily salt load of 3 198 kg from an inflow of 1 168 kg/day, indicating that 2 030 kg/day is generated within the plant.

It is recommended that:

- The Ash Handling Facility requires more metered values to calibrate the facility better;

- Flow meters should be optimised for maximum data collection across all components, especially the Ash Handling Facility;

- A water conservation and demand management plan should be implemented to reduce wastewater and improve recycling, particularly in the cooling towers;

- Stormwater management should be enhanced to improve recovery from the Ash Dam and reduce groundwater recharge; and

- Verify that meter placement in the Supervisory Control and Data Acquisition system (SCADA) is commensurate with the actual location onsite and address calibration issues.

Table 27 details key input variables and constants, which were used to calculate the water balance. The assumptions made include:

- Seepage is based on a permeability of 6.32×10^{-5} m/s;

- Dust suppression is applied at 1 mm/ha/day;

- Runoff volume is based on the average quaternary Mean Annual Runoff (MAR) of 24.52 mm;

- Evaporation rate from the Cooling Towers is assumed to be 70% of water inflow;

- Modern cooling towers are designed to minimise drift losses, typically maintaining drift rates between 1% and 2% of the circulating water flow. A drift rate of 1% was used for Station B's cooling towers; and

- The calculation for potable water demand is based on a year-round schedule and assumes a daily consumption of 70 litres/person for an estimated number of 714 people.

Table 27: Assumptions used in the water balance (Dihlashana, 2025).

Water Storage Facilities	Area (m²)
Return water dam	1 998
Desilting Dam	5 615
Ash Dam A	132 000
Runoff catchment extent	**Area (m2)**
Main channel	28 000
Ash dam	14 500
Slurry Characteristics	
Tonnage	20.9 t/hr
Slurry density	1.01 t/m³
Specific gravity	1.05
Volume water	1 908 m³/day
Ash Dam	
Area of ash dam A	132 000
Seepage rate (m/s)	6.32×10^{-5}
Interstitial storage	235 m³/day
Evaporation of wet beach (factor)	0.7
Evaporation of dry beach (factor)	0.4
% pool	5
%wet beach	15
%dry beach	80

The water balance of the current power plant infrastructure was updated to simulate the current water uses and efficiencies. This update focused on improving the accuracy of the water balance in terms of representing actual water reticulation, management practices, and the precision of input and variable data. All data and information required as inputs into the water balance model were provided by Kelvin Power personnel. This included rainfall records, process water meter readings, and operational data from the SCADA system.

A significant portion of the water use reflected in the water balance is currently metered. Where direct measurements were unavailable, water use was estimated through calculations based on associated meter data and operational assumptions. The flow meters used to develop the water balance, along with those potentially contributing to identified discrepancies, are presented in Table 28 of the report.

Table 28: Flow meter readings and descriptions (Dihlashana, 2025).

Meter ID	Description	From	To	Average Flow (m³/day)
F1	Supply from RWB to the Reservoir	RWB	Reservoir	2 076
F2	NNWTW supply to the Station Forebays	NWTW	B-Station Forebays	1 921

Meter ID	Description	From	To	Average Flow (m³/day)
F3	RWB supply to the Header Tank	Header Tank	Demin Plant	1 414
F7	Supply from the Header Tank to the Demin at B-Plant	Header Tank	B-Station Demin	368
F10	Final effluent into the Modderfonteinspruit	Final Effluent Channel	Modderfonteinspruit	6 768
F14	Supply from the Demin to the Plant	Station Demin	Plant	1 305
F19	Supply from RWB to the B-Station Forebays	RWB	B-Station Forebays	5 141
F22	Supply from the Cooling Towers for use as makeup water for slurrification	Cooling Tower	Slurrification Makeup Water	789

All data and information required as inputs into the water balance were updated with the data described above. The water balance results were then validated. Figure 84 illustrates the water balance input and output volumes.

The balance and the inflow and outflow volumes in the diagram are simulated averages.
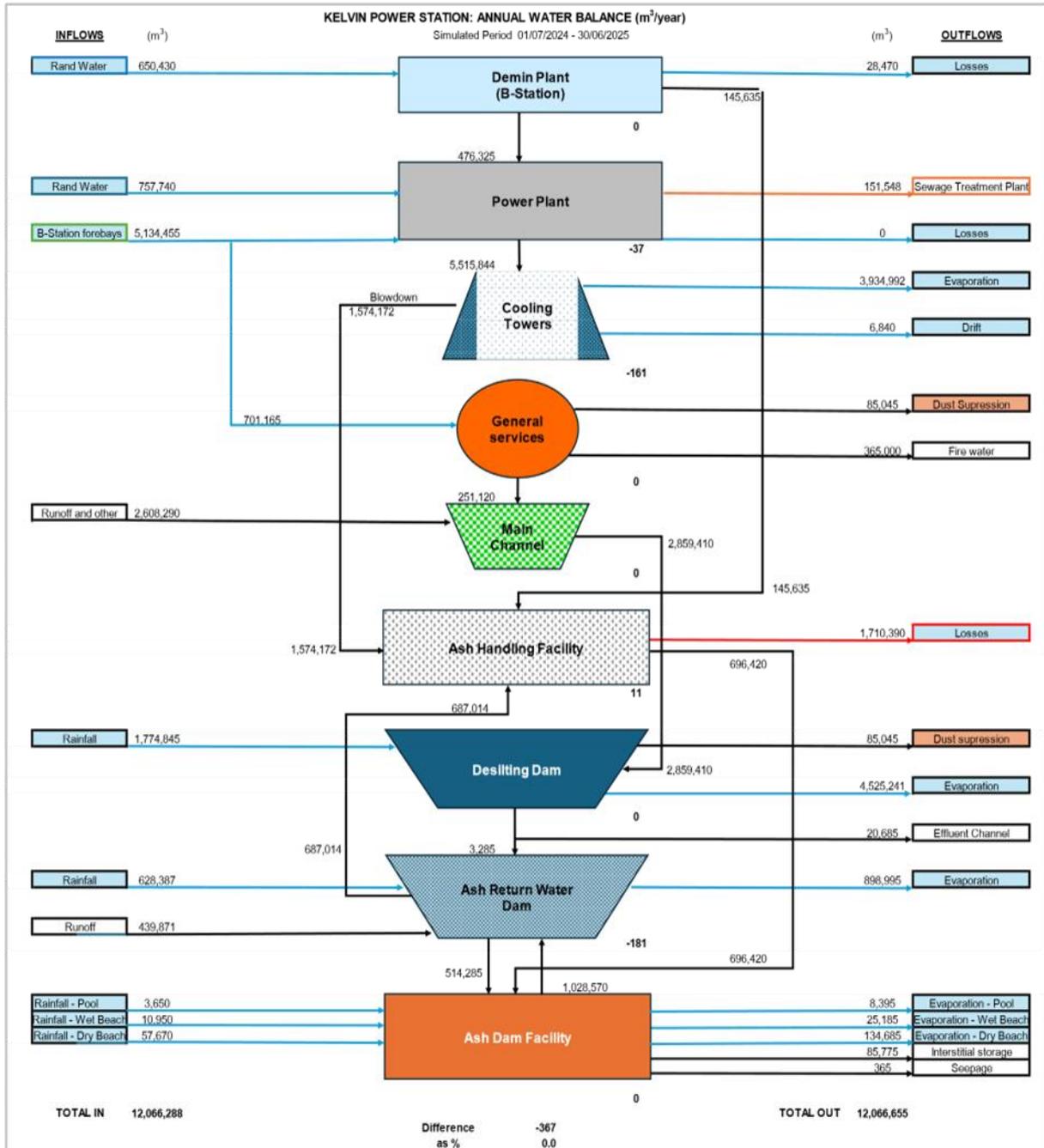
Figure 84: Average annual water balance (m^3/d) for the year 2024/2054 (Dihlashana, 2025).

5.2.2.4.2   WATER BALANCE RESULTS

Demineralisation Plant
On average, the Demineralisation Plant receives an estimated inflow of **2 822 m³/day** from Rand Water. Approximately **25% (695 m³/day)** of this inflow is lost during the demineralisation process, and **399 m³/day** is discharged as resin regeneration water. The remaining **1 706 m³/day** is utilised in the Power Plant.

Power   Plant
The Power Plant receives an average of **5 297 m³/day** of potable water from Rand Water, of which **25% (1 324 m³/day)** is discharged as sewage. Additionally, the Northern Wastewater Treatment Works supplies **15 338 m³/day** for use in the plant. Of this, **3 835 m³/day** is lost during power generation, while **14 475 m³/day** is

directed to the cooling towers for heat dissipation. An estimated **3 790 m³/day** of blowdown water is discharged to the ash handling system for reuse.

Cooling Towers

Kelvin Power Station operates **five (5)** active cooling towers. On average, **14 475 m³/day** is received from the Power Plant. Of this, **10 540 m³/day** is lost through evaporation, and **145 m³/day** is lost as drift. The remaining **3 790 m³/day** is discharged as blowdown water to the ash handling facility.

Ash Handling Facility

The Ash Handling Facility receives a total inflow of **7 797 m³/day**. The slurry transported to the ash dam contains approximately **4 000 m³/day** of water. An estimated **3 608 m³/day** is unaccounted for and presumed lost during the process.

Desilting Dam

The main channel contributes an inflow of **7 146 m³/day** to the Desilting Dam. Of this, **2 222 m³/day** (over 30%) is discharged into the Modderfonteinspruit via the effluent channel.

Ash Return Water Dam

The Ash Return Water Dam receives an estimated **8 524 m³/day** for on-site reuse. Of this, **3 608 m³/day (42%)** is recycled for use in the Ash Handling Facility.

Ash Dam

The Ash Dam receives an average flow of **4 862 m³/day**. Approximately **80% (4 000 m³/day)** is decanted into the Ash Return Water Dam for reuse, while **20%** is lost through evaporation and seepage.

5.2.2.4.3   SALT BALANCE ANALYSIS

Table 29 shows the average water quality results for the year 2024/2025 compared with the WUL requirements. The exceedances are highlighted in red (this information was used in the development of the salt balance). Figure 85; Annual salt balance. illustrates the salt balance input and output volumes. The concentration and the salt load in the diagram are simulated sulphate averages (Dihlashana, 2025).

Table 29: Water quality limits.

Variable	Secondary channel	Desilting dam	Ash Seepage	Tower B	Northern Waste Treatment Works	Croydon	Effluent	Upstream of Modderfonteinspruit	Downstream of Modderfonteinspruit	WUL Limit
pH	8.23	8.4	**10.43**	7.95	7.16	7.71	8.93	8.71	8.42	5.0 - 9.5
Electrical Conductivity [EC] (µS/cm)	**1 261**	**1 650**	**1 660**	**2 167**	**727**	**613**	**1 644**	**1 598**	**1 255**	115
Sulphate (SO$_4$) mg/ℓ	92	96	103	95	52	52	104	100	92	200
Chloride (Cl) mg/ℓ	**120**	**167**	**183**	**252**	69	44	**168**	**151**	**118**	103.4
Sodium (Na) mg/ℓ	17	26	24	30	11	7	21	25	20	49.5
Magnesium (Mg) mg/ℓ	**289**	**144**	35	**198**	**68**	**169**	**104**	**111**	**131**	61.6
Calcium (Ca) mg/ℓ	**138**	**243**	**253**	**324**	90	73	**274**	**263**	**209**	100
Nitrate (NO$_3$) mg/ℓ	6	**23**	**12**	**34**	**10**	**7**	**15**	**15**	**12**	6
Fluoride (F) mg/ℓ	**0.6**	**1.4**	**0.5**	**3.4**	**1.1**	**1**	**1.7**	**2.9**	**1.1**	0.3
Suspended Solids mg/ℓ	5	24	8	43	22	13	14	15	10	40
F. Coli CFU/mℓ	695			3 492	400 628	32 946	2 029			
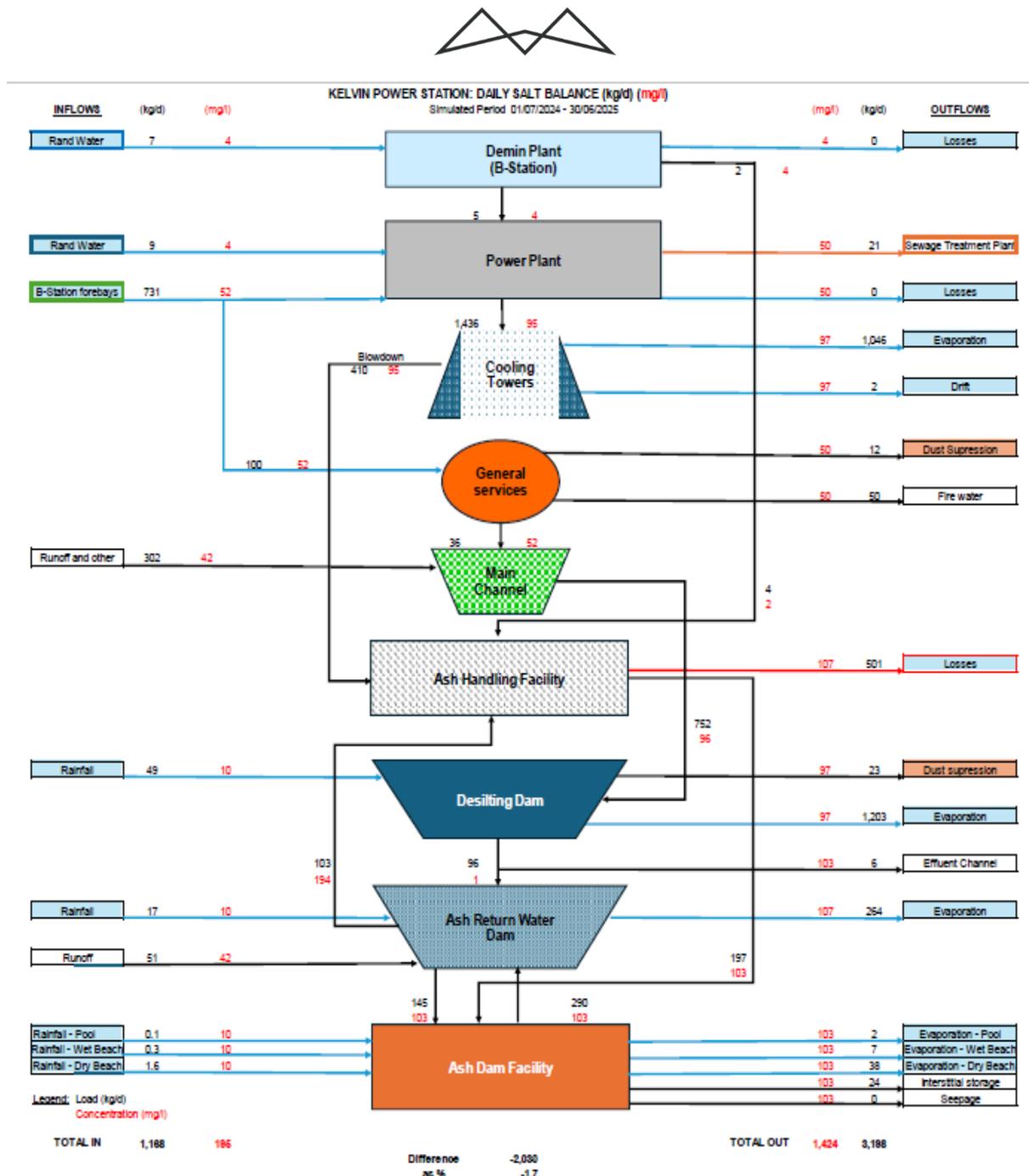
Figure 85; Annual salt balance.

5.2.2.5 WATER CONSERVATION AND WATER DEMAND STRATEGY

Opportunities to increase water use efficiency in all water use sectors is important thus the Water Conservation and Demand Management (WC/ WDM) Strategy is a fundamental step in promoting water use efficiency and is consistent with the NWA (Act 36 of 1998) which emphasises effective management of our water resources. Water Conservation is the minimisation of loss or waste, the care and protection of water resources and the efficient and effective use of water. Water Demand Management is the adaptation and implementation of a strategy by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.

Kelvin Power is not in possession of a WC/ WDM Strategy and must endeavour to develop one as soon as possible. This will be important as Kelvin Power is planning on decommissioning the entire facility within the next 10 years.

5.2.3 STORMWATER

Kelvin Power uses a single stormwater system (Figure 86), where all the stormwater from dirty and clean areas of the plant is collected within the single stormwater system to the Desilting Dam. Given the confined area within which Kelvin Power is built and date of establishment this type of stormwater system is justifiable however continual water quality monitoring and desilting of the Desilting Dam must be implemented for protection of downstream users.

According to the WUL 03/A21C/FGH/1110 of 24 June 2011 Kelvin Power is authorised to discharge 2 599 380 m^3/ annum of water through the secondary channel via a concrete channel to the Modderfonteinspruit. Based on the latest Salt and Water Balance (Dihlashana, 2025) and average of 6 768 m^3/ day is discharged into the Modderfonteinspruit, which is an average total of 2 470 320 m^3/ annum.

Stormwater generated at Station B is directed to the main channel via a subterranean collection pipeline. At Station A, both process and stormwater runoff are also collected via the same system and flow directly into the main channel (Figure 74).

All the runoff emanating from the areas surrounding the power station buildings also drains into the main channel via an underground pipe system. The main channel discharges into the Desilting Dam. The effluent channel discharges through the outlet monitoring and measuring flume directly into the Modderfonteinspruit.

The secondary channel currently conveys a number of flows, including:

- The bleed-off water from the cooling tower system;

- Stormwater runoff emanating from a portion of Kelvin Power discharges to the secondary channel via a system of underground pipes and a trapezoidal concrete lined channel and ultimately into the Modderfonteinspruit;

- Runoff emanating from the residential suburb of Croydon and Kempton Park to the south of Kelvin Power is also discharged into the secondary channel at three (3) locations behind Ash Dam A (See Figure 81 and Figure 82). The secondary channel discharges into the Modderfonteinspruit upstream of the flume; and

- High rainfall flow event greater than the 1:2-year recurrence interval storm peak flowrate from the main channel.
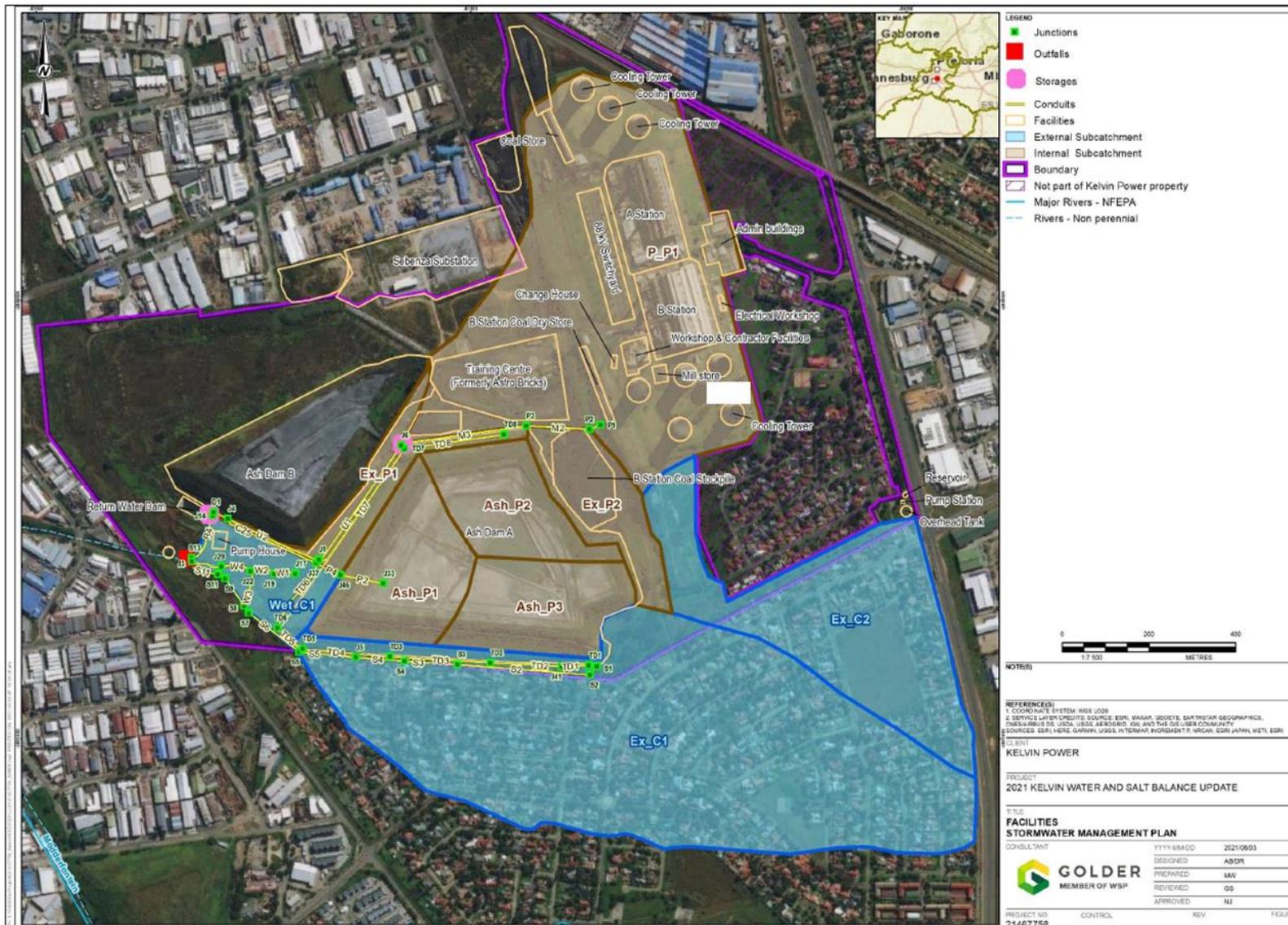
Figure 86: Stormwater catchment delineation (Golder, 2021).

5.2.4 GROUNDWATER

A groundwater-monitoring programme is undertaken at Kelvin Power to indicate any potential contamination from operational activities. No groundwater is used for any purpose other than monitoring at Kelvin Power. Mitigation measures to be applied to prevent groundwater contamination include:

- Compaction of foundation at all lay down sites, as well as the development of a new stormwater management plan to preventing pooling at laydown;

- Housekeeping practices on site should be very neat and all potential contaminants should be disposed of in the appropriate manner; and

- New rehabilitation plan to decrease dirty water areas (Divhani, 2024).

The groundwater model update undertaken by Gradient Consulting (2025) the following recommendations in respect of groundwater were made:

- It is recommended that the management and mitigation measures be implemented as part of the integrated groundwater management plan. The Licensee shall appoint a suitably qualified and responsible person and make all of the necessary and reasonable financial, human and equipment resources available to him/her to give effect to all recommendations as stipulated in specialist reports to ensure compliance to licence conditions pertaining to activities to ensure that potential impact(s) are minimised, and mitigation measures proposed are functioning effectively.

- It is recommended that the revised monitoring network and program as set out in this report should be implemented and adhered to. It is imperative that monitoring be conducted to serve as an early warning and detection system. Monitoring results should be evaluated on a quarterly basis by a suitably qualified person for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation.

- Additional monitoring boreholes, as recommended, should be established to replace demolished boreholes down-gradient of existing waste infrastructure in order to evaluate the groundwater drawdown as well as mass load contribution to environmental and sensitive groundwater receptors. Drilling localities should be determined by means of a geophysical survey in order to target lineaments and weathered zones acting as preferred groundwater flow pathways and contaminant transport mechanisms.

- Newly established monitoring boreholes should be subjected to aquifer hydraulic parameters to supplement and verify existing hydraulic parameters interpreted as part of the first phase drilling and testing run.

- Groundwater flow modelling assumptions should be verified and confirmed. The calibrated groundwater flow model should be updated on a biennial (once every two years) basis as newly gathered site characterisation data and monitoring results become available in order to be applied as groundwater management tool for future scenario predictions.

An amendment to the current groundwater monitoring programme has been recommended by the geohydrologist as further discussed in section 5.4.2.

5.2.5 WASTE

The waste streams within Kelvin Power include general/ domestic waste, industrial/ hydrocarbon waste and hazardous waste. A system for waste management at the site includes waste collection from sources, waste separation (into general and hazardous waste) and waste storage for disposal. Waste is managed at site to ensure that no detrimental impacts result from the generated waste. The section below provides a summary of the waste management characterisation which includes identification of the waste streams, their characterisation and measures used to manage the generated waste. Kelvin Power takes reasonable measures to minimise the generation of waste, and all waste generated is stored before disposal (Divhani, 2024).

Waste is managed to meet the following objectives:

- Identify and supply the areas with waste bins for the different waste streams managed by the site;

- Focus on separation and management of waste at source and separate and dispose of waste in a safe and responsible manner;

- Maximise recyclable waste products;

- Minimize the impact of waste on the environment; and

- Provide a structure for waste management at Kelvin Power.

5.2.5.1 GENERAL WASTE

General waste (as per the NEM:WA, 2008) means waste that does not pose an immediate hazard or threat to health or to the environment and includes (a) domestic waste; (b) building and demolition waste; (c) business waste; and (d) inert waste.

Inert waste (as per the NEM:WA, 2008) means waste that (a) does not undergo any significant physical, chemical or biological transformation after disposal; (b) does not burn, react physically or chemically biodegrade or otherwise adversely affect any other matter or environment with which it may come into contact; and (c) does not impact negatively on the environment, because of its pollutant content and because the toxicity of its leachate is insignificant. The identified general waste types (Table 30) to be generated on site are the following (but not limited to):

Table 30: General waste at Kelvin Power.

Waste Category	Waste	Management Measures	Disposal Methods
Domestic waste.	Cans, paper, plastics, and cardboard.	This type of waste is stored for recycling by a third party.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors.
	Garden waste.	This type of waste is stored for recycling by a third party.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors.
Industrial waste.	Salvageable scrap (metal, tyres, sheeting, bricks, etc.).	Reduce (minimisation), recycled and reused.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors. Tyres are recycled by an approved contractor.
	Equipment and materials.	Reduce (minimisation), recycled and reused.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors
	Refurbishable equipment.	Reduce (minimisation), recycled and reused.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors
	Timber/ wood.	Reduce (minimisation), recycled and reused.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors

5.2.5.2 HAZARDOUS WASTE

Hazardous waste (as per the NEM:WA, 2008) means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment. It must be noted that due to the age of Kelvin Power, asbestos is still present in some of the infrastructure. Specialised teams are used to safely remove the asbestos and dispose of it via accredited contractors. Potentially hazardous waste types (Table 31) present on site include:

Table 31: Hazardous waste at Kelvin Power.

Waste Category	Waste	Management Measures	Disposal Methods
Industrial/ workshop waste.	Batteries, lightbulbs, oil (used and clean), degreaser, brake fluid, transmission fluid, various chemicals, etc.	Recycled as far as possible and disposal.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors. Waste that can be recycled is collected by the appropriate contractor.
	Asbestos.	Dispose.	Waste collected in demarcated skips. Waste is removed by accredited waste collectors and taken to hazardous material site.
Sewage and sewage waste.	Sewage effluent and solids.	Reduce (minimisation), recycled and reused.	Sewage waste from the operation is pumped into the municipal wastewater system.
Dirty water areas (trenches, channels and dams).	Dirty water runoff and seepage from the various stockpiles.	Reuse.	Dirty water is used at the processing plant and for dust suppression.
Mineral stockpiles.	Mineral residue stockpiles (Ash Dams).	Reuse.	Stockpiles to be rehabilitated. Ash can be sold to various industries.

Kelvin Power currently has several waste management procedures in place on site. Additionally, waste management training has been incorporated in the environmental training of Kelvin Power staff since September 2006. In 2007 Kelvin Power completed a comprehensive investigation to identify and catalogue all dangerous and hazardous substances. Based on this, a Hazardous Substances Register was compiled, detailing all the hazardous substances used on site. Kelvin is undertaking the investigation of a Dangerous and Hazardous Substances Minimisation and Management Programme.

Coarse ash from Station A was sold at Kelvin Power's gate to various users. Hardly any coarse ash is being stored on site for permanent disposal purposes. It is recommended that a waste assessment/ classification be conducted on the ash dams to enable a more realistic prediction of the potential effects on the groundwater resource.

5.2.5.3 WASTE REMOVAL

Waste is removed from site by an appointed contractor as required (as stated within Kelvin Power's Waste Management Procedures), depending upon the waste stream. General waste is removed at least monthly, if not more regularly depending on the volumes generated. No general or industrial waste is stored for a long period of time on site. The appointed waste collection contractor undertakes waste collection and takes the waste to the approved waste dump sites.

5.3 OPERATIONAL MANAGEMENT

The succeeding sections provide further detail on the operational management of the waste and water management activities, organisational structure, competency development and awareness, as well as internal and external communication.

5.3.1 ORGANISATION STRUCTURE

The organisational structure of Kelvin Power is indicated in Figure 7 above. Responsibility for implementation of the environmental management, which include the implementation of the approved Environmental Management Programme (EMPr), IWUL, Environmental Authorisations (EA), other authorisations connected to environmental management and all associated environmental laws and regulations rests with Kelvin Power and with the Environmental Manager on site.

The General Manager, in his day to day running of the site, which include environmental management, is assisted by his technical team that include the Environmental Manager, Safety Manager, section heads, foremen and supervisors who in turn manage their teams. Kelvin Power has appointed an environmental team for the site who overlooks the environmental management.

The Environmental Manager ensures that all environmental activities delegated to contractors operating on site are implemented, ensure that all conditions of the approved IWUL, EMPr and EAs are implemented, and resolves any conflicts that may arise between the facility and contracting parties regarding environmental issues and implementation of the EMPr. The Environmental Manager also briefs contractors about no development/ no go areas at the site. The Environmental Manager also brings to the attention to the general manager any environmental incident or breach of the conditions of the EMP, WUL or EAs. The Environmental Manager is also responsible for all internal audits that must be conducted for all relevant EAs, licenses and approvals.

Copies of the IWUL, EMPr and any other authorisations related to environmental management are always kept at the offices.

5.3.2 RESOURCE AND COMPETENCE

Resources for environmental management are provided in different forms, which are outlined below.

- Budgeting: On commencement of the financial year, a budget for the undertaking of the environmental management and monitoring of environmental impacts from the site are determined and funds put aside for this purpose. This budget is revised regularly in order to cater for any deficiencies that may arise; and

- Human Resources: Kelvin Power employs personnel for the control of the environmental issues at the site i.e. the Environmental Manager, Health, Safety etc. The Environmental Manager will advise on the operational environmental management at the power station, which gives support to the employed personnel (i.e. Environmental Officer/ Coordinator).

5.3.3 EDUCATION AND TRAINING

Kelvin Power bases training and education off there Environmental and Social Policy, as well as their Occupational Health and Safet Policy. However, they can consider the following forms of trainings:

- Skills Development Plan: which includes the Adult Basic and Educational Training (ABET) classes and life skills programme;

- Career Progression and Mentorship Plans: where clearly defined career paths and development routes for employees at all levels in the organisation;

- Coaching and Mentoring Plan: for employees, where employees are offered the opportunity to be mentored/ coached as part of the Talent Management and Personal Development Planning Processes;

- Internship and Bursary Plan: which ensures an interface with secondary and tertiary institutions to ensure a continuous flow of learners from school level to tertiary level to promote the advancement of skills within the organization and in the broader mining industry; and

- Adding environmental and water awareness to the induction video to ensure that visitors and contractors are made aware of the plans, policies and procedures that are in place at Kelvin Power.

The environmental awareness training conducted should include taking employees to environmental seminars and undertaking in-house and on-the-job training on environmental matters.

Depending on the employee's job category, training must be performed on significant aspects pertinent to the employee's work area. All personnel performing tasks which can cause significant or major environmental impacts are made competent based on training, education and/ or experience.

Further to the above, environmental days celebrations are done to enhance awareness to employees and local communities (Water week, environmental week, arbour week etc.).

5.3.4 INTERNAL AND EXTERNAL COMMUNICAITON

5.3.4.1 INTERNAL COMMUNICATION

Internal communication takes place primarily through scheduled meetings. Employees situated on site hold safety meetings/ toolbox talks daily. Environmental feedback meetings are held regularly. These meetings are used to provide feedback to senior management for decision- making.

E-mail is the main communication medium used between management and consultants located offsite and personnel located onsite. This form of communication is used to ensure that minor decisions can be made immediately and that feedback meetings can be used to discuss more matters that are serious.

5.3.4.2 EXTERNAL COMMUNICATION

Kelvin power has a 24-hour call line. Should a member of the public wish to raise an issue they can contact Kelvin Power reception, and they are directed to the relevant staff member who will assist in resolving the query. Any calls that come in after hours are directed to the control room and the call is then handed over to the relevant staff member.

Communication with stakeholders, relevant authorities, and various members of the public are conducted regularly via in person meetings, telephonic communication and email. Kelvin Power also participates in the Hennops Catchment Forum on a quarterly basis.

5.3.5 AWARENESS RAISING

Kelvin Power training, awareness and competence procedure is set out to achieve the following objectives:

- Ensure that employees, including contractor employees, are trained and competent to correctly perform their duties. Therefore, the probability of incidents occurring that have the potential to negatively impact on product quality, the environment, the health and safety of staff and the community will be reduced;

- Ensure the knowledge, skills and experience levels of employees are assessed against validated performance criteria or relevant nationally accredited Unit Standards for Competency; and

- Ensure strategies, systems and programmes that are designed to fill identified gaps in training, awareness and competency are developed and implemented.

These strategies, systems and programmes must conform to the requirements of the power station.

The procedure is applicable to the identification of training needs, the provision of staff development and training programmes and the maintenance of systems equipping workers to perform at levels that shall not compromise product quality, their health and safety and that of the community or the well- being of the environment.

5.4 MONITORING AND CONTROL

5.4.1 SURFACE WATER MONITORING

Water localities are sampled and analysed monthly. Surface water localities are situated both upstream and downstream to detect any pollution that might occur. The surface water monitoring programme also monitors the quality of the main process water localities and variables. The objective of surface water monitoring at Kelvin Power is to:

- Demonstrate that the receiving surface water course is not impacted on by the operation;

- Confirm effectiveness of the on-site storm water management systems;

- Assess compliance with licence conditions;

- Provide early indication of surface water contamination; and

- Compare surface water quality in terms of the physical and chemical characteristics with baseline values to identify possible trends and/ or changes with regard to surface water quality.

Condition 11.1.1 under Appendix II (WUL: 03/A21C/FGH/1110) states: "*The Licensee shall monitor surface water resources at the points indicated in the table below to determine the impact of the facility and other activities on the water quality in the Edenvale Spruit and the Modderfontein Spruit by taking samples at the monitoring points.*" Table 32 below indicates the monitoring points set out in *Table 3* of the WUL. The location and monitoring frequency of these monitoring points (which are also the biomonitoring points) is given in Table 9 and indicated in Figure 13 above.

It should be noted that the Edenvale Spruit is situated very far from Kelvin Power, and it was requested that all the reference to Edenvale Spruit be removed in the 2018 Amendment request. It should also be noted that no coordinates or frequencies were specified in the WUL.

Table 32: WUL Table 3 monitoring points.

Monitoring Point Number	Locality
1	Discharge point into the Edenvale Spruit.
2	Point upstream in the Edenvale Spruit.
3	Point downstream of the Edenvale Spruit.
4	Discharge point prior to entering the Modderfontein Spruit.
5	Point upstream from the Modderfontein Spruit.
6	Point downstream in the Modderfontein Spruit.
7	Secondary channel.
8	Desilting dams.

Condition 2.5 under Appendix II (WUL: 03/A21C/FGH/1110) states: "*The quality of the water containing waste disposed of into the return water dams shall not exceed the qualities as specified in Table 2 below.*" Table 33 below indicates the water qualities as set out in *Table 2* of the WUL.

Table 33: WUL Table 2 quality of wastewater to be disposed.

Variable	Limit
pH	6.5 – 8.5
Electrical conductivity (EC)	80 mS/m
Total Suspended Solids (TSS)	40 mg/l
Chemical Oxygen Demand (COD)	50 mg/l
Sulphate (SO$_4$)	200 mg/l
Sodium (Na)	25 mg/l
Calcium (Ca)	25 mg/l
Magnesium (Mg)	15 mg/l
Free Residual Chlorine (Cl)	0.2 µ/l
E. coli/ Faecal Coliforms	0 cfu/ 100ml
Ammonia (ionised and un-ionised) as Nitrogen (NH$_3$ as N)	2 mg/l
Nitrate/ Nitrite as Nitrogen (NO$_3$/ NO$_2$ as N)	6 mg/l
Ortho-Phosphate as Phosphorous (PO$_4$ as P)	0.1 mg/l

Condition 11.7.1 under Appendix II (WUL: 03/A21C/FGH/1110) states: "*The impact of the activities of the Licensee on the Edenval and Modderfontein Spruit shall not exceed the following in-stream water quality objectives (or resource quality objectives) as stipulated in the water quality reserve of the area.*" Table 34 below indicates the Resource Quality Objectives (RQO) as set out in *Table 5* of the WUL.

Table 34: WUL Table 5 RQO's.

Variable	RQO
pH	6.5 – 8.5
Electrical conductivity (EC)	80 mS/m
Total Suspended Solids (TSS)	40 mg/l
Chemical Oxygen Demand (COD)	50 mg/l
Sulphate (SO$_4$)	200 mg/l
Sodium (Na)	25 mg/l
Calcium (Ca)	25 mg/l
Magnesium (Mg)	15 mg/l
Free Residual Chlorine (Cl)	0.2 µ/l

Variable	RQO
E. coli/ Faecal Coliforms	0 cfu/ 100ml
Ammonia (ionised and un-ionised) as Nitrogen (NH_3 as N)	2 mg/l
Nitrate/ Nitrite as Nitrogen (NO_3/ NO_2 as N)	6 mg/l
Ortho-Phosphate as Phosphorous (PO_4 as P)	0.1 mg/l

Surface water sampling is conducted on a weekly basis according to a surface water sampling protocol.

Surface water samples are analysed by an accredited laboratory in order to ensure credibility of the analysis. The methods of analyses utilised by the laboratory are SANAS approved and in accordance with any regulatory requirements.

5.4.2   GROUNDWATER MONITORING

5.4.2.1   PRESENT GROUNDWATER MONITORING PROGRAM

The purpose of a groundwater monitoring network is to provide an early warning of possible adverse effects of the proposed activities on both quantity and quality of the affected groundwater systems. In addition, the objective for the groundwater monitoring is as follows:

- Assessment of the source, pathway and receptor water quality in the groundwater system in order to identify possible trends and/or changes with regard to groundwater quality by tracking constituents of concern;

- To monitor the water quality of the boreholes in order to gather more data to inform a numerical groundwater model; and

- To investigate the potential contamination of groundwater resulting from activities.

Condition 11.4.5 under Appendix II (WUL: 03/A21C/FGH/1110) states: "*The Licensee shall monitor ground water quality at the boreholes set out in the table 4, in the following page:*" Table 35 below indicates the Resource Quality Objectives (RQO) as set out in *Table 4* of the WUL.

Table 35: WUL Table 4 groundwater quality monitoring points.

Borehole No.	Description	Coordinates	Monitoring Frequency	Constituents to be Sampled
KPS-MON01	-	-	Quarterly	pH, EC, TDS, Alkalinity, SO_4, Ca, Mg, Na, Cl, K, F, Si, V, Al, Fe, Mn, NO_3, Ammonia, Ecoli.
KPS-MON02	-	-		
KPS-MON03	-	-		
KPS-MON04	-	-		
KPS-MON05	-	-		
KPS-MON06	-	-		
KPS-MON07	-	-		
KPS-BH-01	-	-	Annually	

Borehole No.	Description	Coordinates	Monitoring Frequency	Constituents to be Sampled
KPS-BH-02	-	-		As, Ni, Fe, Al, As, Cu, Cd, Cr, Zn.
KPS-BH-04	-	-		
KPS-BH-05	-	-		
KPS-BH-06	-	-		
KPS-BH-07	-	-		

The monitoring points as stipulated in the WUL forms part of the current groundwater monitoring programme; however additional monitoring boreholes have been implemented. The position of the boreholes that are currently being monitored are described in Table 36 and depicted in Figure 87. Groundwater monitoring is conducted on a quarterly basis as per *Table 4* of WUL 03/A21C/FGH/1110 and the results are submitted to DWS.

All field work is conducted based on the protocols and specifications, and code of practice contained in SABS ISO 5667-1-15. Sampling procedures are based on SABS standards, namely:

- ISO 5667-1: 1980 Part 1: Guidance on the design of sampling programs;

- ISO 5667-2: 1991 Part 2: Guidance on sampling techniques; and

- ISO 5667-3: 1994 Part 3: Guidance on preservation and handling of samples.

Groundwater samples are analysed by a SANAS accredited laboratory in order to ensure credibility of the analysis. The methods of analyses utilised by the laboratory are SANAS approved and in accordance with any regulatory requirements. Kelvin Power captures all the available water quality data in an annual monitoring report and water qualities are compared with the SANS 241:2015 for drinking water purposes.

Table 36: Groundwater sampling register for Kelvin Power Q2 2025 (Aquatico, 2025).

BH	Description	Coordinates (WGS 84)		Sampled	Water level (mbs)	Comment
		South	East			
KPS-BH01	Western perimeter - toe of Ash Dam B	-26.1201	28.1828	Yes	3.1	Clear, no lid
KPS-BH02	Southern toe of Ash Dam B	-26.1218	28.1862	Yes	1.3	Clear
KPS-BH04	Western perimeter	-26.1224	28.1840	Yes	1.1	Clear
KPS-BH05	Southern perimeter - south of Ash Dam A	-26.1241	28.1910	Yes	2.9	Clear
KPS-BH07	South-western perimeter	-26.1228	28.1843	Yes	3.3	Clear
KPS-MON01	Northern perimeter next to Coal Stockpile	-26.1118	28.1927	Yes	8.9	Clear, no lid

BH	Description	Coordinates (WGS 84)		Sampled	Water level (mbs)	Comment
		South	East			
KPS-MON02	Northern perimeter south of Coal Stockpile	-26.1130	28.1917	Yes	6.2	Clear
KPS-MON03	North of Ash Dump – north-western perimeter	-26.1157	28.1884	Yes	5.7	Clear
KPS-MON04	Western perimeter between the Ash Dump and Ash Dam B	-26.1185	28.1846	Yes	2.9	Slightly turbid
KPS-MON05	Southern perimeter on southern toe of Ash Dam A	-26.1234	28.1857	Yes	2.3	Slightly turbid
KPS-MON06	Between Ash Dam A and Southern Coal Stockpile	-26.1196	28.1918	Yes	2.1	Clear
KPS-MON07	South-east of Southern Coal Stockpile	-26.1216	28.1942	Yes	2.3	Turbid
KPS-MON09	Background deep	-26.1173	28.1964	Yes	5.1	Clear
KPS-MON10	Background shallow	-26.1173	28.1963	Yes	4.6	Clear
KPS-MON11	Fuel storage	-26.1153	28.1942	Yes	4.8	Slightly turbid
KPS-MON12	HFO storage	-26.1173	28.1937	Yes	6.6	Clear
KPS-MON13	Brick Yard (Footprint)	-26.1182	28.1898	Yes	4.8	Clear
KPS-MON14	Switch Yard	-26.1147	28.1920	Yes	5.7	Clear
KPS-MON16	Clinker Dump (replace KPS-MON03)	-26.1174	28.1822	Yes	3.8	Clear
KPS-NBH01	Newly drilled borehole	-26.1217	28.1834	Yes	1.8	Slightly turbid
KPS-NBH02	Newly drilled borehole	-26.1194	28.1822	Yes	1.9	Slightly turbid
KPS-NBH03	Newly drilled borehole	-26.1242	28.1933	Yes	3.6	Slightly turbid

5.4.2.1.1   GROUNDWATER LEVELS

Groundwater level measurements were taken at all monitoring boreholes listed in the groundwater sampling register for June 2025 (Table 36). Contour maps of the June 2025 groundwater level depths and elevations are

provided in Figure 88 and Figure 89respectively. The blue circles indicated on the two abovementioned figures represent the positions of the monitoring boreholes, while the sizes of the circles are proportional to the groundwater level depth/elevation (i.e. the largest circle represents the deepest water level and highest elevation). Groundwater level elevations were calculated by subtracting the measured water level depth from the surface elevation measured at the position of each borehole. Note that elevations were obtained from the Chief Surveyor-General, which are considered accurate enough for this level of assessment.

The following observations are made from the water level data:

- Groundwater level depths varied between 1.1 and 8.9 meters below surface (mbs), while the elevations were estimated to have varied between 1 619 and 1 666 meters above mean sea level (mamsl).

- The shallow water level depths measured directly downgradient from the two ash dams are most probably a result of artificial aquifer recharge in the form of seepage from the dams. The deepest water level was measured in KPS-MON01, which is situated north of the Plant.

- Significant water level variations are observed in some boreholes (e.g. KPS-MON01, KPS-MON02, KPS-MON03 and KPS-MON14) when considering the entire data record, which seem to be mostly seasonally driven. Water levels rise during the wet summer rainfall months and drop again during the dry winter months.

- Furthermore, boreholes KPS-MON01, KPS-MON02 and KPS-MON03 display long-term decreasing water level trends when considering the entire data record – the exact cause/s of which is unclear at this time.

- Groundwater flow from the ash dams is towards the west/south-west in the direction of a tributary of the Jukskei River. Flow from the plant area is predominantly towards the west, but may also occur towards the north-east as it is located on a local groundwater divide.
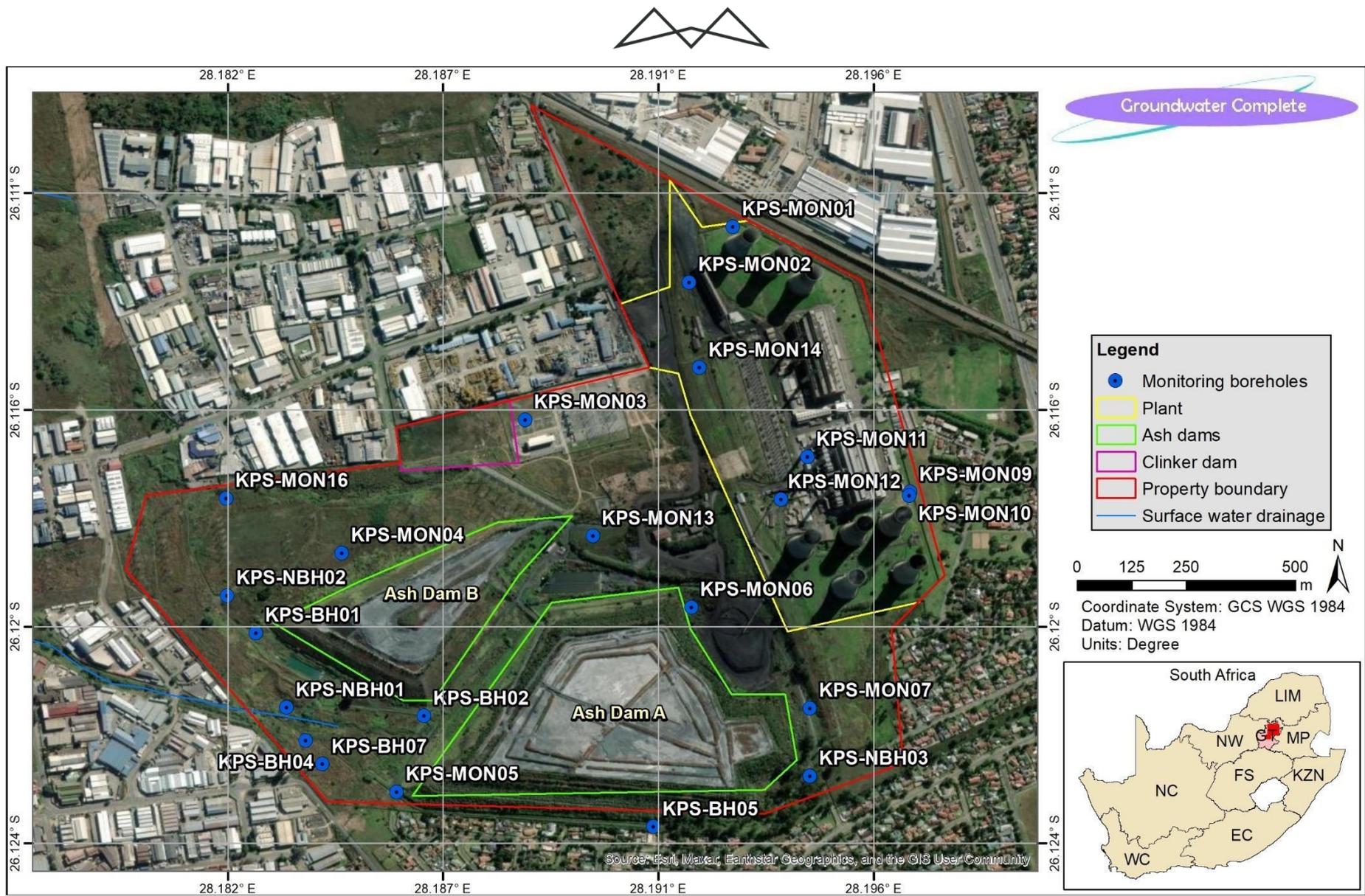
Figure 87: Kelvin Power groundwater monitoring localities (Aquatico, 2025).
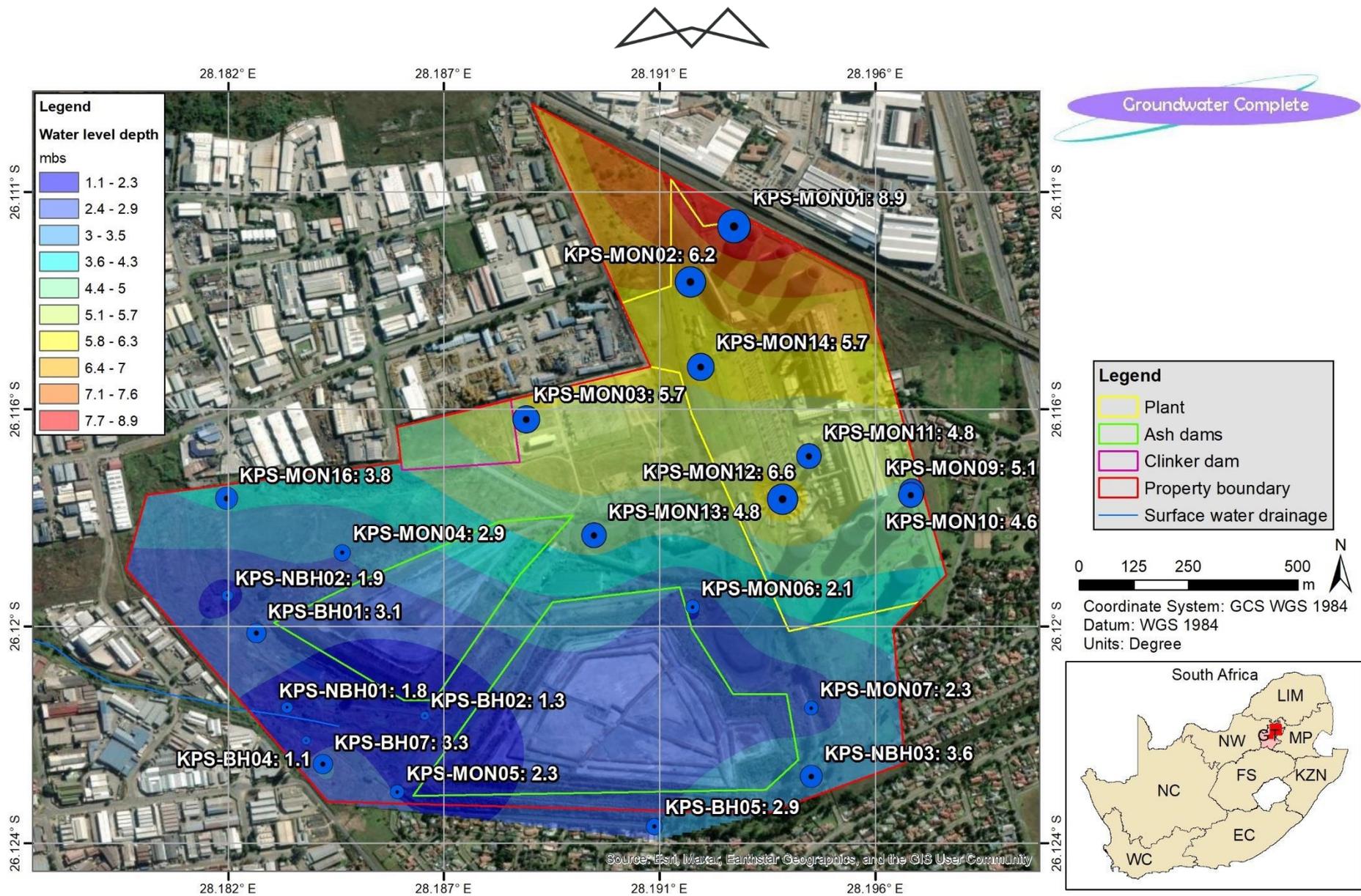
Figure 88: Contour map of the June 2025 groundwater level depths.
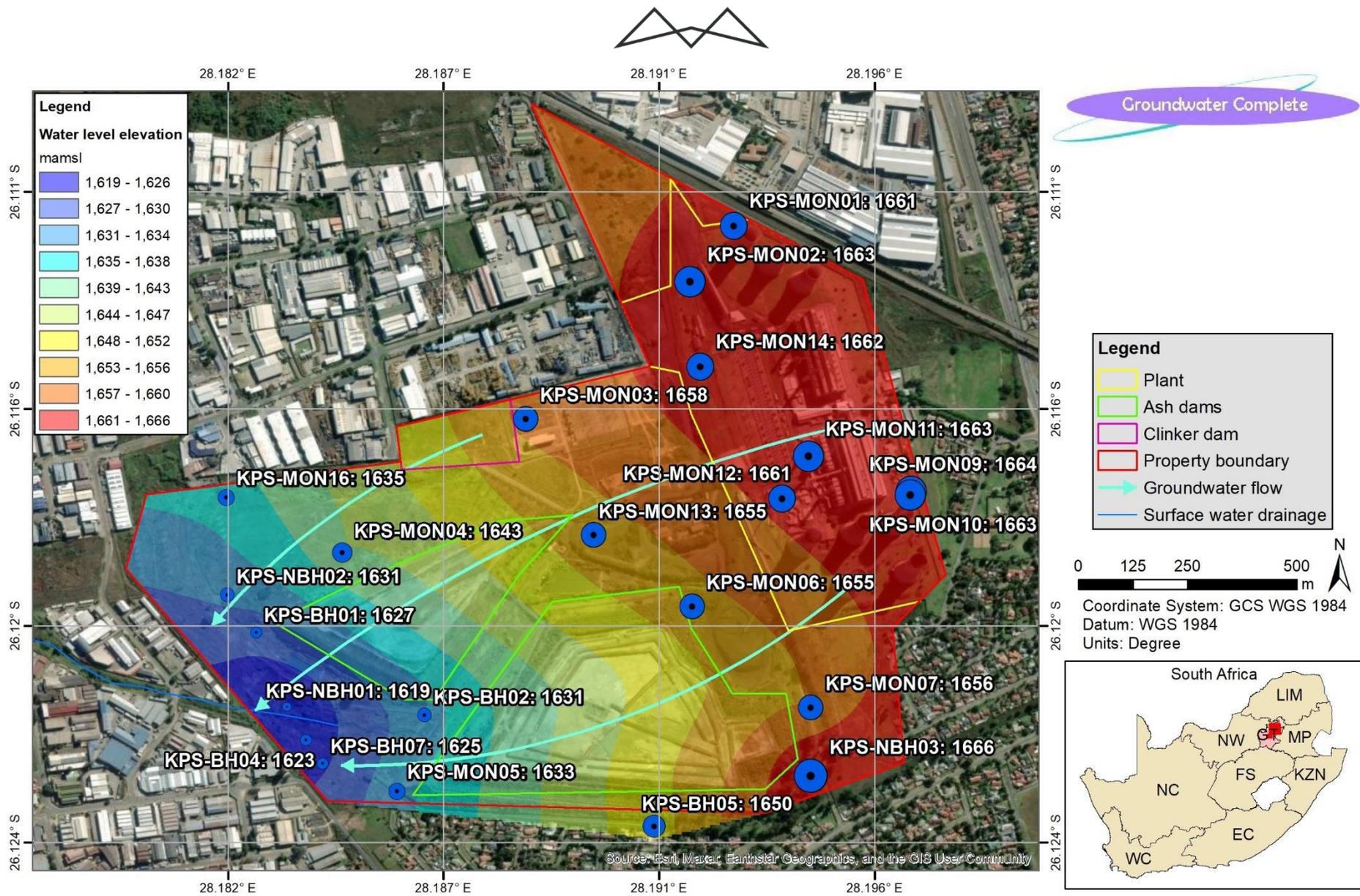
Figure 89: Contour map of the June 2025 groundwater level elevations.

5.4.2.1.2   GROUNDWATER QUALITY

A total of 22 monitoring boreholes are listed in the groundwater sampling register for June 2025, all of which were sampled for monitoring purposes. Borehole positions are indicated on Table 36 and Figure 87, together with the concentrations of the four chosen physical and chemical indicator parameters. These indicator parameters include pH, total dissolved solids (TDS), sulphate (SO_4) and nitrate (NO_3), however, all inorganic parameters will be assessed, and anomalies will be analysed and discussed if necessary.

The groundwater quality data was evaluated with the aid of diagnostic chemical diagrams and by comparing the inorganic concentrations with the *South African National Standards* for drinking water (Table 38). Exceedances of the drinking water limits, along with the probable source of contamination, are also summarised in Table 37. The probable source is determined by considering the measured groundwater level monitoring information and local flow directions, but sources are not always conclusive. The results of the June 2025 groundwater analyses are provided in Table 39.

Table 37: Exceedances of the SANS 241:2015 limits for June 2025.

BH	pH	TDS	SO_4	NO_3	Other	Probable Source
KPS-BH01					EC, B	Ash Dam B
KPS-BH02					T. coli	Unknown source of bacteria
KPS-BH04					Cd	Unknown source of bacteria
KPS-BH05					T. coli	Unknown source of bacteria
KPS-MON01					T. coli	Diffuse sources at plant
KPS-MON03					T. coli	Unknown source of bacteria
KPS-MON06					Na	Ash Dam A/Coal stockpile
KPS-MON12					EC, NH_4, Pb	Diffuse sources at plant
KPS-MON13					EC, Ni	Brick yard footprint
KPS-MON14					T. coli	Unknown source of bacteria
KPS-MON16					EC	Clinker dump
KPS-NBH03					NH_4	Ash Dam A

Table 38 : South African National Standards for drinking water (SANS 241:2015).

Parameter	Risk	Unit	Standard limits
Physical and aesthetic determinants			
Free chlorine	Chronic health	*mg/l*	≤5
Monochloramine	Chronic health	*mg/l*	≤3
Conductivity at 25 °C	Aesthetic	*mS/m*	≤ 170
Total dissolved solids	Aesthetic	*mg/l*	≤ 1 200

Parameter	Risk	Unit	Standard limits
Turbidity	Operational	*NTU*	≤ 1
	Aesthetic	*NTU*	≤ 5
pH at 25 C	Operational	*pH units*	≥ 5 to ≤ 9.7
Chemical determinants - macro-determinants			
Nitrate as N	Acute health – 1	*mg/l*	≤ 11
Nitrite as N	Acute health – 1	*mg/l*	≤ 0.9
Sulphate as SO_4^{2-}	Acute health – 1	*mg/l*	≤ 500
	Aesthetic	*mg/l*	≤ 250
Fluoride as F^-	Chronic health	*mg/l*	≤ 1.5
Ammonia as N	Aesthetic	*mg/l*	≤ 1.5
Chloride as Cl^-	Aesthetic	*mg/l*	≤ 300
Sodium as Na	Aesthetic	*mg/l*	≤ 200
Zinc as Zn	Aesthetic	*mg/l*	≤ 5
Chemical determinants - micro-determinants			
Aluminium as Al	Operational	*µg/l*	≤300
Antimony as Sb	Chronic health	*µg/l*	≤20
Arsenic as As	Chronic health	*µg/l*	≤10
Barium Ba	Chronic health	*µg/l*	≤700
Boron B	Chronic health	*µg/l*	≤2400
Cadmium as Cd	Chronic health	*µg/l*	≤3
Total chromium as Cr	Chronic health	*µg/l*	≤50
Cobalt as Co	Chronic health	*µg/l*	≤500
Copper as Cu	Chronic health	*µg/l*	≤2000
Cyanide (recoverable) as CN^-	Acute health – 1	*µg/l*	≤70
Iron as Fe	Chronic health	*µg/l*	≤2000
	Aesthetic	*µg/l*	≤300
Lead as Pb	Chronic health	*µg/l*	≤10

Parameter	Risk	Unit	Standard limits
Manganese as Mn	Chronic health	*µg/l*	≤400
	Aesthetic	*µg/l*	≤100
Mercury as Hg	Chronic health	*µg/l*	≤6
Nickel as Ni	Chronic health	*µg/l*	≤70
Selenium as Se	Chronic health	*µg/l*	≤40
Uranium as U	Chronic health	*µg/l*	≤15
Vanadium as V	Chronic health	*µg/l*	≤200
Total organic carbon	Acute health – 1	*mg/l*	≤ 10

BH	pH	TDS mg/l	SO4 mg/l	NO3 mg/l	BH	pH	TDS mg/l	SO4 mg/l	NO3 mg/l
KPS-BH01	7.4	1914.0	960.7	<0.459	KPS-MON07	8.3	382.6	59.7	<0.459
KPS-BH02	7.6	660.8	180.1	1.655	KPS-MON09	7.6	273.3	24.1	2.496
KPS-BH04	7.8	712.2	205.8	0.461	KPS-MON10	7.1	307.0	57.6	2.067
KPS-BH05	8.0	557.6	97.7	0.629	KPS-MON11	7.1	70.9	15.6	<0.459
KPS-BH07	7.6	297.2	103.6	<0.459	KPS-MON12	6.9	1485.4	569.3	11.334
KPS-MON01	8.0	532.0	174.7	<0.459	KPS-MON13	7.0	2019.3	1235.7	5.221
KPS-MON02	8.9	126.5	51.1	<0.459	KPS-MON14	8.3	607.3	354.5	1.685
KPS-MON03	9.3	158.8	43.7	<0.459	KPS-MON16	7.0	1560.5	887.4	3.747
KPS-MON04	9.0	523.0	280.0	<0.459	KPS-NBH01	8.0	506.4	115.0	<0.459
KPS-MON05	8.4	959.4	429.4	6.833	KPS-NBH02	8.1	793.4	376.8	<0.459
KPS-MON06	7.5	848.5	307.9	<0.459	KPS-NBH03	8.9	402.6	84.0	<0.459

Figure 90: Positions of monitoring boreholes and concentrations of indicator parameters for June 2025.

Table 39: Results of the June 2025 groundwater analyses for physical and chemical parameters and bacteriological counts.

BH	pH	EC mS/m	TDS mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	MALK CaCO$_3$/l	Cl mg/l	SO$_4$ mg/l	NO$_3$ mg/l	F mg/l	Al mg/l	Fe mg/l	Mn mg/l	NH$_4$ mg/l
KPS-BH01	7.4	**239.9**	**1914.0**	215.1	184.0	116.7	26.7	501.7	79.0	**960.7**	<0.459	<0.466	<0.005	<0.009	<0.001	0.041
KPS-BH02	7.6	109.3	660.8	44.5	113.1	15.2	<0.05	250.0	103.6	180.1	1.655	<0.466	<0.005	<0.009	<0.001	0.036
KPS-BH04	7.8	103.6	712.2	51.8	112.0	16.1	0.3	331.9	73.3	205.8	0.461	<0.466	<0.005	<0.009	<0.001	0.053
KPS-BH05	8.0	87.8	557.6	29.5	97.9	6.4	2.2	295.1	87.6	97.7	0.629	<0.466	<0.005	<0.009	<0.001	0.033
KPS-BH07	7.6	47.0	297.2	13.1	44.9	20.3	<0.05	133.0	14.2	103.6	<0.459	<0.466	<0.005	<0.009	<0.001	0.060
KPS-MON01	8.0	86.1	532.0	7.4	50.4	95.9	7.3	185.1	71.6	174.7	<0.459	<0.466	<0.005	<0.009	0.288	0.059
KPS-MON02	8.9	23.2	126.5	4.2	14.9	14.2	1.0	36.1	16.8	51.1	<0.459	<0.466	<0.005	<0.009	0.016	0.868
KPS-MON03	9.3	29.6	158.8	3.5	30.5	5.9	1.3	66.1	31.4	43.7	<0.459	<0.466	<0.005	<0.009	0.005	0.039
KPS-MON04	9.0	77.2	523.0	7.6	96.7	10.8	<0.05	120.6	49.1	280.0	<0.459	<0.466	<0.005	<0.009	<0.001	0.034
KPS-MON05	8.4	143.7	959.4	65.1	16.2	182.9	34.4	85.6	127.6	429.4	6.833	<0.466	<0.005	<0.009	<0.001	0.061
KPS-MON06	7.5	147.5	848.5	22.1	0.6	**246.8**	44.4	103.0	160.9	307.9	<0.459	<0.466	<0.005	<0.009	0.063	0.983
KPS-MON07	8.3	61.7	382.6	16.1	69.9	21.3	0.8	263.5	41.9	59.7	<0.459	<0.466	<0.005	<0.009	0.030	0.030
KPS-MON09	7.6	40.8	273.3	7.2	46.9	4.3	0.2	161.5	25.8	24.1	2.496	<0.466	<0.005	<0.009	<0.001	0.131
KPS-MON10	7.1	44.1	307.0	6.4	51.9	5.6	<0.05	145.2	35.3	57.6	2.067	<0.466	<0.005	<0.009	<0.001	0.029
KPS-MON11	7.1	10.9	70.9	8.4	4.3	3.5	0.3	32.4	<1.62	15.6	<0.459	<0.466	<0.005	<0.009	0.017	0.029
KPS-MON12	6.9	**199.8**	**1485.4**	152.7	166.6	54.3	7.6	508.7	109.8	**569.3**	**11.334**	<0.466	<0.005	<0.009	0.049	**9.604**
KPS-MON13	7.0	**237.1**	**2019.3**	39.6	357.7	46.1	<0.05	337.4	53.4	**1235.7**	5.221	<0.466	<0.005	<0.009	<0.001	0.153
KPS-MON14	8.3	86.5	607.3	9.9	109.7	14.2	<0.05	106.6	32.1	354.5	1.685	<0.466	<0.005	<0.009	<0.001	0.025
KPS-MON16	7.0	**197.6**	**1560.5**	122.4	247.1	15.9	<0.05	238.3	57.6	**887.4**	3.747	<0.466	<0.005	<0.009	<0.001	0.078
KPS-NBH01	8.0	94.3	506.4	29.0	99.0	8.0	<0.05	214.0	114.7	115.0	<0.459	<0.466	<0.005	<0.009	0.073	0.047
KPS-NBH02	8.1	119.0	793.4	37.3	137.5	12.5	<0.05	228.1	85.1	376.8	<0.459	<0.466	<0.005	<0.009	0.085	0.023
KPS-NBH03	8.9	67.6	402.6	11.8	85.8	8.8	0.7	248.4	54.4	84.0	<0.459	<0.466	<0.005	<0.009	0.054	**2.408**

Table 40: Results of the June 2025 groundwater analyses for physical and chemical parameters and bacteriological counts (continue)

BH	THard mg/l	PO$_4$ mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cr^{6+} mg/l	Cu mg/l	Ni mg/l	Pb mg/l	V mg/l	Zn mg/l	T.coli/ 100ml	E.coli/ 100ml	F.coli/ 100ml
KPS-BH01	1294.9	<0.01	**4.141**	0.033	<0.005	<0.007	<0.007	<0.01	<0.005	0.028	<0.009	<0.002	<0.005	0	0	0
KPS-BH02	576.8	<0.01	0.325	0.040	<0.005	<0.007	<0.007	<0.01	<0.005	0.017	<0.009	<0.002	<0.005	**20**	0	0
KPS-BH04	590.5	<0.01	0.142	0.045	**0.006**	<0.007	<0.007	<0.01	0.045	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-BH05	476.9	<0.01	0.094	0.058	<0.005	<0.007	<0.007	<0.01	<0.005	0.019	<0.009	<0.002	<0.005	**30**	0	0
KPS-BH07	217.8	0.048	0.162	0.020	<0.005	<0.007	<0.007	<0.01	0.015	0.012	<0.009	<0.002	<0.005	0	0	0
KPS-MON01	226.2	<0.01	0.115	0.009	<0.005	<0.007	<0.007	<0.01	0.017	0.015	<0.009	<0.002	<0.005	**10**	0	0
KPS-MON02	71.6	0.033	<0.042	0.007	<0.005	<0.007	<0.007	<0.01	<0.005	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-MON03	134.3	<0.01	<0.042	0.008	<0.005	<0.007	<0.007	<0.01	<0.005	<0.005	<0.009	<0.002	<0.005	**100**	0	0
KPS-MON04	417.3	<0.01	<0.042	0.009	<0.005	<0.007	<0.007	<0.01	0.040	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-MON05	229.1	0.012	1.009	0.059	<0.005	<0.007	<0.007	<0.01	<0.005	0.009	<0.009	0.032	<0.005	0	0	0
KPS-MON06	57.6	0.328	1.685	0.017	<0.005	<0.007	<0.007	<0.01	<0.005	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-MON07	328.2	0.030	2.357	0.012	<0.005	<0.007	<0.007	<0.01	0.022	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-MON09	211.4	<0.01	0.168	0.049	<0.005	<0.007	0.013	0.012	0.015	<0.005	<0.009	<0.002	<0.005	0	0	0
KPS-MON10	229.7	<0.01	0.056	0.074	<0.005	<0.007	<0.007	<0.01	0.016	0.023	<0.009	<0.002	<0.005	0	0	0
KPS-MON11	38.8	0.029	0.049	0.027	<0.005	<0.007	<0.007	<0.01	<0.005	<0.005	<0.009	<0.002	0.196	0	0	0
KPS-MON12	1067.3	1.350	1.236	0.056	<0.005	<0.007	<0.007	<0.01	0.065	0.059	**0.036**	<0.002	0.012	0	0	0
KPS-MON13	1571.6	<0.01	1.429	0.018	<0.005	<0.007	0.015	<0.01	0.098	**0.111**	<0.009	<0.002	<0.005	0	0	0
KPS-MON14	476.6	0.031	0.137	0.015	<0.005	<0.007	<0.007	<0.01	0.046	0.008	<0.009	<0.002	<0.005	**10**	0	0
KPS-MON16	1323.4	0.044	0.316	0.020	<0.005	<0.007	<0.007	<0.01	0.079	0.017	<0.009	<0.002	<0.005	0	0	0
KPS-NBH01	480.1	<0.01	0.149	<0.006	<0.005	<0.007	<0.007	<0.01	0.041	0.016	<0.009	<0.002	<0.005	0	0	0
KPS-NBH02	659.1	0.052	0.167	0.022	<0.005	<0.007	<0.007	<0.01	0.054	0.007	<0.009	<0.002	<0.005	0	0	0
KPS-NBH03	382.8	<0.01	0.227	<0.006	<0.005	<0.007	<0.007	<0.01	0.031	<0.005	<0.009	<0.002	<0.005	0	0	0

5.4.2.1 PROPOSED GROUNDWATER MONITORING PROGRAM

As part of the groundwater model update undertaken by Gradient Consulting, a proposed change in monitoring program has been recommended as follows.

It should be noted that the applicant is operating under an approved WUL with monitoring a condition of the existing licence. Accordingly, Kelvin Power (Pty) Ltd does currently have an existing monitoring program and network which is being honoured.

It is noted that some monitoring boreholes have been demolished and should be re-incorporated into the existing monitoring network by means of a geophysical survey in order to target lineaments and weathered zones acting as preferred groundwater flow pathways and contaminant transport mechanisms. Depending on the outcome of the geophysical survey, proposed boreholes can be established as a pair in order to target the shallow, intergranular or primary porosity as well as fractured aquifer units should it be applicable. The revised monitoring network proposed, as summarised in Table 41 and depicted in Figure 91 serve to expand on the existing monitoring network programme. Due to the close proximity of the waste body footprints to the Modderfonteinspruit drainage system, it is recommended that additional upstream and downstream surface water monitoring points be established in order to assess the potential impacts of the operation and activities on this sensitive environmental receptor.

5.4.2.1.1 DETERMINANTS FOR ANALYSIS

Baseline and background water quality results should be evaluated in order to set a site-specific limit per parameter and applied as benchmark for monitoring purposes. Supplementary guidelines i.e., Water Use Licence (WUL) conditions as well as WMA Resource Quality Objectives (RQO) should also be considered as part of the monitoring protocol. All monitoring localities should be subjected to an initial comprehensive water quality analysis to evaluate hydrochemical composition and identify potentially elevated parameters going forward[9]. Chemical variables to form part of the sampling run are listed below. Groundwater monitoring boreholes and spring localities should be analysed for the following chemical constituents:

i. *Physical and aesthetic determinants:* pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Total Hardness.

ii. *Macro determinants:* Total Alkalinity (MAlk), Sulphate (SO_4), Nitrate (NO_3), Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na).

iii. *Micro determinants:* Aluminium (Al), Iron (Fe), Manganese (Mn), Cadmium (Cd), Total Chromium (Cr), Chromium (VI), Arsenic (As), Cyanide (CN), Boron (B), Copper (Cu), Nickel (Ni), Lead (Pb), Cobalt (Co), Mercury (Hg) as well as Zinc (Zn).

5.4.2.1.2 WATER LEVELS

Water levels should be monitored in order to evaluate the impact, IF ANY, of the power generation development on aquifer storage and replenishment. It is important to note that the impact on the local and regional groundwater environment can only be determined accurately if comparisons are performed based on static water level conditions. Thus, all production borehole pumps should be switched off and water levels should be allowed to recover prior to water level recordings.

5.4.2.1.3 MONITORING FREQUENCY

Groundwater monitoring i.e., quality analysis should be conducted on a quarterly basis whereas water level monitoring is conducted on a monthly basis. Water quality reports summarising monitoring results should be submitted to the Regional Head of the Department on a quarterly and annual basis.

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[9] It is recommended that a comprehensive water quality analysis be repeated annually. Also note that should additional parameters be requested in existing permits/licence conditions, these should be adhered to.

5.4.2.1.4   SAMPLING PROCEDURE

The sampling procedure for groundwater should be done according to the protocol by Weaver, 1992. The actions can be summarised as follows:

i. Calibrate the field instruments before every sampling run. Read the manufacturers manual and instructions carefully before calibrating and using the instrument.

ii. Bail the borehole.

iii. Sample for chemical constituents – remove the cap of the plastic 1 litre sample bottle, but do not contaminate inner surface of cap and neck of sample bottle with hands. Fill the sample bottle without raising the bottle.

iv. Leave sample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before examination.

v. Replace the cap immediately.

vi. Complete the sample label with a water-resistant marker and tie the label to the neck of the sample bottle with a string or rubber band. The following information should be written on the label.

    a. A unique sample number and description

    b. The date and time of sampling

    c. The name of the sampler

vii. Place sample in a cooled container (e.g., cool box) directly after collection. Try and keep the container dust-free and out of any direct sunlight. Do not freeze samples.

viii. Complete the data sheet for the borehole.

See to it that the sample gets to the appropriate laboratory as soon as possible, samples for chemical analysis should reach the laboratory preferably within seven days.

Table 41: Revised monitoring network and programme.

Monitoring locality	Latitude	Longitude	Locality description	Monitoring frequency		Parameters
				Water quality	Water level	
Existing monitoring boreholes (KPS-BH)						
KPS-BH01	-26.120128	28.182828	Borehole on Western Perimeter - Toe of Ash Dam	Quarterly	Monthly	
KPS-BH02	-26.121835	28.186184	Borehole on Southern Toe of Ash Dam	Quarterly	Monthly	
KPS-BH04	-26.122372	28.183966	Borehole on Western Perimeter	Quarterly	Monthly	As in Section
KPS-BH05	-26.124138	28.191035	Borehole on Southern Perimeter	Quarterly	Monthly	15.3
KPS-BH06	-26.121860	28.183440	Borehole demolished. Recommended that replacement borehole be drilled	Quarterly	Monthly	
KPS-BH07	-26.122852	28.184274	Borehole on South Western Perimeter	Quarterly	Monthly	
Existing monitoring boreholes (KPS-MON)						
KPS-MON01	-26.111814	28.192642	Borehole on Northern Perimeter next to Coal Stockpile	Quarterly	Monthly	
KPS-MON02	-26.112960	28.191769	Borehole on Northern Perimeter South of Coal Stockpile	Quarterly	Monthly	
KPS-MON03	-26.115755	28.188415	Borehole North of Ash Dump - North Western Perimeter	Quarterly	Monthly	
KPS-MON04	-26.118493	28.184629	Borehole on Western Perimeter between the Ash Dump and Ash Dam	Quarterly	Monthly	
KPS-MON05	-26.123390	28.185756	Borehole on Southern Perimeter on southern toe of Ash Dam	Quarterly	Monthly	
KPS-MON06	-26.119647	28.191788	Between Ash Dam A and Southern Coal Stockpile	Quarterly	Monthly	
KPS-MON07	-26.121628	28.194263	Borehole South East of Southern Coal Stockpile	Quarterly	Monthly	As in Section
KPS-MON09	-26.117300	28.196333	Background borehole targeting the deep aquifer	Quarterly	Monthly	15.3
KPS-MON10	-26.117236	28.196324	Background borehole targeting the shallow aquifer	Quarterly	Monthly	
KPS-MON11	-26.115280	28.194163	Fuel storage area	Quarterly	Monthly	
KPS-MON12	-26.117401	28.193660	HFO storage area	Quarterly	Monthly	
KPS-MON13	-26.118187	28.189777	Brick Yard	Quarterly	Monthly	
KPS-MON14	-26.114729	28.191912	Switch yard	Quarterly	Monthly	
KPS-MON16	-26.117377	28.182194	Clinker dump (replace KPS-MON03)	Quarterly	Monthly	
Existing monitoring boreholes (KPS NBH)						
KPS-NBH01	-26.121657	28.183386	Newly established monitoring borehole evaluating the impact on the confined & fractured aquifer	Quarterly	Monthly	As in Section
KPS-NBH02	-26.119402	28.182175	Newly established monitoring borehole evaluating the impact on the intergranular & unconfined aquifer	Quarterly	Monthly	15.3
KPS-NBH03	-26.124178	28.193269	Newly established monitoring borehole evaluating the impact on the confined & fractured aquifer	Quarterly	Monthly	
Newly proposed surface water monitoring points						
KPS-US	-26.130645	28.183964	Newly established monitoring point representative of the Modderfonteinspruit upstream water quality.	Quarterly	Monthly	As in Section
KPS-DS	-26.118131	28.173001	Newly established monitoring point representative of the Modderfonteinspruit downstream water quality.	Quarterly	Monthly	15.3
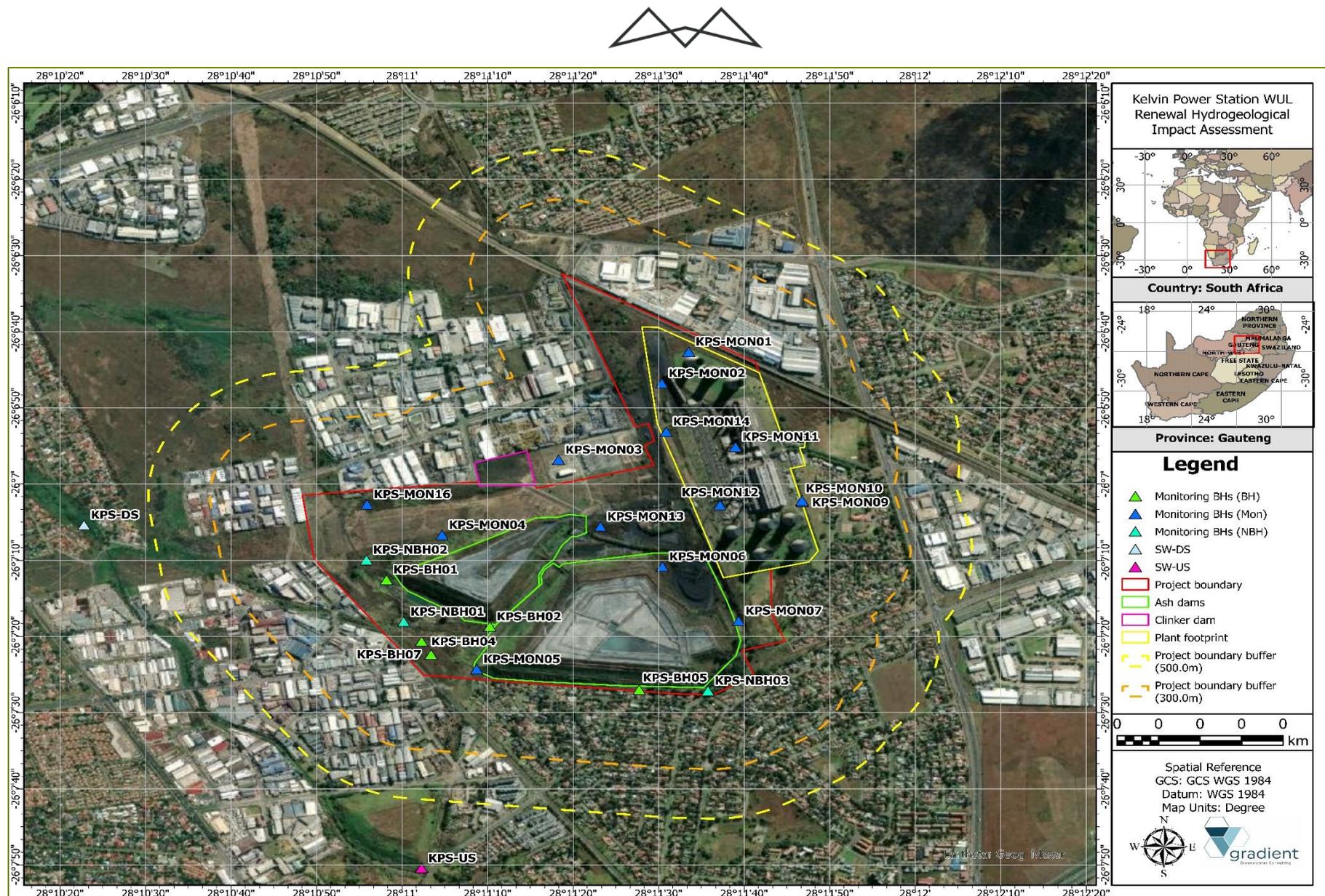
Figure 91: Revised monitoring network.

5.4.3 BIOMONITORING

The objectives of the biomonitoring programme include the following:

- Characterisation of the biotic integrity of aquatic ecosystems in the area;

- Evaluation of the extent of site-related effects in terms of selected ecological indicators; and

- Identification of impacts and recommendation of suitable mitigation measures.

The WUL specifies the following biomonitoring and toxicity monitoring requirements under Appendix II (WUL 03/A21C/FGH/1110):

- Condition 11.2.1: "*An Aquatic Scientist approved by the Regional Head must establish a monitoring programme for the following indices: Invertebrate Habitat Assessment System (IHAS) and the latest SASS (South African Scoring System). Sampling must be done once during the summer season and once during the winter season, annually, to reflect the status of the river upstream and downstream of the industrial activities*".

- Condition 11.2.2: "*Toxicity testing to be performed on the effluent leaving the site at the desilting dams, the secondary channel and effluent entering the Edenvale Spruit on a quarterly basis in order to determine the risks to the receiving environment. The data gathered in the investigation must be reported annually during July of each year to the Regional Chief Director. If any toxicity levels as specified is exceeded, the Licensee must institute an investigation to determine the cause of toxicity*".

- Condition 11.2.3: "*Toxicity testing must be conducted quarterly on the wastewater stream from the Ash Dam and Return Water Dam when returned back to the Power Station for use as process water*".

- Condition 11.2.4: "*The Licensee shall participate in any initiative such as Direct Estimation of Ecological Effect Potential (DEEEP) to determine the toxicity of complex tailings waste discharges. Both acute and chronic toxicity must be addressed and at least three taxonomic groups must be present when toxicity tests are performed*".

- Condition 11.2.5: "*The Licensee shall determine the accumulative impact due to both past and present activities on the Edenvale Spruit and the Modderfontein Spruit*".

- Condition 11.2.6: "*Analysis shall be carried out in accordance with methods prescribed by and obtained from the South African Bureau of Standards (SABS), in terms of the Standards Act, 1982 (Act 30 of 1982)*".

The current biomonitoring and toxicity monitoring taking place on site is tabulated in Table 9 and indicated on Figure 13.

5.4.4 WASTE MONITORING

The various waste streams arising from Kelvin Power are monitored according to volumes generated and disposed and this is recorded and documented. Hazardous waste is disposed of at an external licensed site and records are kept of volumes generated. The following information was sourced from the most recent contaminated land assessment conducted in 2016 by Golder Associates Africa (Pty) Ltd.

Based on the assessment the main source of contamination relates to coal and ash prominent on site. Most of organic constituents detected in waste and soil samples were largely attributed to burning of coal. Based on the initial soil screening level assessment (targeted samples at each suspected area) the concentration of Fe, Mn, Ni, Cr, Co, Pb, Sb, As and Cu exceeded the soil screening value (SSV) and/ the Environmental Protection Agency (EPA) screening values.

The findings of the assessment indicate that the high levels of Ni and Cr detected in majority of topsoil and subsoil samples were related to site geology, as the constituents were also high in the reference soil samples. This was also the case for the high levels of Fe, Mn, Co, Sb and As.

Benzene, Trichloroethylene (TCE) and Perchloroethylene (PCE) detected in the samples collected at the workshop, south and southwest of Ash dam B, the Baghouse, Astro Bricks and Station A Cooling Towers exceed the SSV 1 but are likely related to the use of organic solvents on site.

The soil vapour levels of benzene in the surface soils at the Diesel Storage area also exceeded the Vapor Intrusion Screening Level (VISL) and SSV and likely related to possible spillages during refuelling of the tank (the area where the Volatile Organic Compounds (VOCs) were detected is close to a manhole of the cemented area covering the tank). The integrity of the tank was evaluated in May 2013 and was found to the meet the EPA requirements for leak detection (Golder, 2016).

Given the current site information and understanding, the significance of the exceedances found does not indicate a risk requiring immediate remediation. The extent and distribution of these constituents of concern however requires additional sampling to confirm significance of the constituents. The areas most affected were identified as follows:

- Around Station A Cooling Towers;

- Sections of the Baghouse where concrete has disintegrated;

- Sections of the Workshop where soil is exposed;

- South west of Ash Dam B;

- South of Ash Dam B;

- Astro Bricks; and

- The Diesel Storage area.

Based on the above contamination statements, the following recommendations were made (Golder, 2016):

- Before conducting additional soil sampling, the data collected for the groundwater study should be re-evaluated alongside the analytical results obtained from the contaminated land assessment to check whether any of the exceeding constituents (Cu, Pb, benzene, TCE and PCE) in the soil are detectable in the groundwater samples of boreholes near the suspected areas of concern identified above;

- Confirm the occurrence and distribution of Cu and Pb with depth at the Baghouse and Station A Cooling Towers. Station A Cooling Towers will require the inspection and sampling of at least four (4) test pits and soil sampling at three (3) depth intervals. At the Baghouse, two (2) core samples will need to be collected at as well as three (3) core samples around the Baghouse area also at three (3) depth intervals. All samples should be analysed for total and water-soluble Cu and Pb, and topsoil samples for TCE and PCE;

- Confirm the distribution of VOCs at the following areas:

    o Five (5) auger points, and sampling of the top and subsoil around the workshop area where soil is exposed;

    o Five (5) auger points, and sampling of topsoil around initial sampling point south west of Ash Dam B;

    o Five (5) auger points, and sampling of the top and subsoil around the initial sampling point south of Ash Dam B; and

    o Three (3) test pits on the outer west boundary of Astro Bricks, collecting samples of the topsoil and subsoil.

- Monitor the refuelling of the diesel tanks, checking for occurrence of spillages. Also consider an assessment of the integrity of the tank. Also include organic compounds associated with diesel in suite of analysis for groundwater monitoring.

Once the extent and distribution of the exceeding constituents are confirmed, notification may be required as per Part 8 of NEMWA Section 36 (5). Moreover, if the findings of the additional sampling indicate that a detailed Phase II investigation is required, notification should be considered by Kelvin Power management and their legal counsel.

5.5 RISK ASSESSMENT / BEST PRACTICE ASSESSMENT

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The approach may be altered or substituted on a case by case basis if the specific aspect being assessed requires such- such instances require prior EIMS Project Manager approval. The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

5.5.1.1 DETERMINATION OF SIGNIFICANCE

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 42 below.

Table 42: Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. Highly localised, limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).
Duration	1	Immediate (<1 year, quickly reversible)

	2	Short term (1-5 years, less than project lifespan)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources).
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern)
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species)
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring very high time and cost.
	5	Irreversible Impact.

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 43.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

Table 43: Probability/ Likelihood Scoring

Probability		
	1	Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

$$S = C \ x \ P$$

Table 44: Determination of Significance

Consequence		1- Improbable	2- Low	3- Medium/ Possible	4- High/ Probable	5- Highly likely/ Definite
	5- Very High	5	10	15	20	25
	4- High	4	8	12	16	20
	3- Medium	3	6	9	12	15
	2- Low	2	4	6	8	10
	1- Very low	1	2	3	4	5
		Probability				

The outcome of the significance assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in Table 45.

Table 45: Significance Scores

Score	Description
≤4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
>4,25, ≤8.5	Low-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>8.5, ≤13.75	High-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>13.75	High (i.e. where the impact will have a significant environmental risk/ reward).

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.

5.5.1.2 IMPACT PRIORITIZATION

Further to the assessment criteria presented in the section above, it is necessary to consider each potentially significant impact in terms of:

1. Cumulative impacts; and

2. The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 46: Criteria for Determining Prioritisation

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 46. The impact priority is therefore determined as follows:

$$Priority = CI + LR$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table 47).

Table 47: Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375

PriorityPrioritisation Factor	
6	1.5

In order to determine the <u>final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring</u>. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

Table 48: Final Environmental Significance Rating

Significance Rating	Description
<-25	**Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary.**
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated.
0	No impact
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

5.5.2 ASSESSMENT OF IMPACT SIGNIFICANCE

Table 49: Impact assessment

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
Groundwater	**Deterioration of the surrounding groundwater qualities from seepage due to the coal and ash stockpiles at Kelvin Power.**	Operation	-1	3	5	4	4	**-4**	5	-20	-9.75	2	2
	Mitigation Measures • Continue with groundwater monitoring programme. • Reduce dirty footprint area and encourage removal of ash from Ash Dams. • Improve materials handling on site. • Conduct mitigation measures provided in other reports. • Consider lining the coal stockpile area. • Conduct a hydrocensus (surface- and groundwater). • Drill additional boreholes to monitor groundwater pollution further downstream.												
Groundwater	**Seepage into the groundwater as a result of coal spillages along the haul roads.**	Operation	-1	3	2	3	3	-2.75	3	-8.25	-2.5	2	2
	Mitigation Measures: • Ensure coal trucks' tarpaulins are in place before gaining access to the site. • Conduct a contaminated land assessment around the haul road to determine the extent of the contamination. • Any spills must be clean immediately using waste management procedures.												

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
Groundwater	**An unknown source is causing bacteriological contamination of the groundwater.**	Operation	-1	3	2	3	3	-2.75	5	-13.75	-7.5	2	2
	Mitigation Measures: • Investigate to determine the cause of the bacteriological contamination. • Implement the prescribed mitigation measures as soon as possible. • Test additional downstream boreholes (if available) to determine extent of bacteriological contamination.													
Groundwater	**Poor quality leachate may emanate from existing ash dumps, waste-water management infrastructure as well as the plant area which may have a negative impact on groundwater and surface water quality**	Operation	-1	3	4	4	4	-3.75	4	-15	-8.25	1	2
	Mitigation Measures: • Stockpiling of material shall not be done within a 1:100-year flood line, unless where such stockpiling has been authorized in terms of the WUL and relevant GN704 Exemption. • Monitoring results should be evaluated on a quarterly basis by a suitably qualified person for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation. Based on the water quality results, the monitoring network should be refined and updated every three to five years based on hydrochemical results obtained to ensure optimisation and adequacy of the proposed localities.													
Groundwater	**Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of surface water and groundwater resources.**	Operation	-1	2	3	4	4	-3.25	4	-13	-7.5	1	2
	Mitigation Measures: • Heavy vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site. Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.													

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
Groundwater.	**Surface and groundwater deterioration and siltation due to contaminated stormwater run-off.**	Operation	-1	2	3	3	4	-3	3	-9	-6.75	1	2
	Mitigation measures: • Repair broken stormwater management infrastructure as soon as possible. • Develop and implement a stormwater management plan to capture and contain dirty runoff from the stockpile area. • Develop a WC/WDM strategy. • Ensure stormwater management infrastructure is cleaned on a regular basis.												
Groundwater	**Groundwater pollution as a result of wastewater spills and seepage from the de-siltation ponds and return water dams.**	Operation	-1	2	3	3	4	-3	3	-9	-7.5	1	2
	Mitigation Measures: • Continue with groundwater monitoring programme. • Reduce dirty footprint area and encourage removal of ash from Ash Dams. • Improve materials handling on site. • Conduct mitigation measures provided in other reports. • Consider lining the coal stockpile area. • Conduct a hydrocensus (surface- and groundwater). • Drill additional boreholes to monitor groundwater pollution further downstream.												
Surface water	**Discharge of polluted water due to a high rainfall event.**	Operation	-1	3	1	3	3	-2.5	2	-5	-4	2	2

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
	Mitigation Measure: • Desilt facilities regularly to increase storage and regular cleaning of storm water conveyance infrastructure. • Operate dirty water containment facilities as empty as possible or alternatively maintain a minimum freeboard of 0.8 meters. • Conduct an assessment to determine if conveyance and impoundment facilities have adequate capacities to handle the 1:50 year flood event.												
Surface water	**Possible contamination of surface water resources due to leaking pipelines, pump stations, and water transfer points.**	Operation	-1	3	2	3	3	-2.75	3	-8.25	-2.5	2	2
	Mitigation Measure: • Continuous monitoring of the water transfer system. • Leakages must be repaired as soon as possible. • Continuous implementation of the existing surface monitoring programme.												
Surface water	**Contamination of surface water as a result of coal spillages along the haul roads.**	Operation	-1	3	2	3	3	-2.75	3	-8.25	-2.5	2	2
	Mitigation Measure: • Ensure coal trucks' tarpaulins are in place before gaining access to the site. • Conduct a contaminated land assessment around the haul road to determine the extent of the contamination.												
Surface water	**Surface water contamination due to inadequate and broken stormwater management.**	Operation	-1	3	2	3	3	-2.75	5	-13.75	-2.75	2	2
	Mitigation Measure:												

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
	• Repair broken stormwater management infrastructure as soon as possible. • Develop and implement a stormwater management plan to capture and contain dirty runoff from the stockpile area. • Develop a WC/WDM strategy. • Ensure stormwater management infrastructure is cleaned on a regular basis.												
Surface water	**Increased use of water from Rand Water (thus more water being contaminated) due to aging and leaking infrastructure.**	Operation	-1	3	3	3	2	-2.75	5	-13.75	-2.75	2	2
	Mitigation Measure: • Conduct regular inspections of water pipelines. • Repair any leaks as soon as possible.												
Surface water	**Contamination of local surface water resources due to dust fallout from the smokestacks.**	Operation	-1	3	3	3	2	-2.75	5	-13.75	-7.5	2	2
	Mitigation Measure: • Ensure that smokestack filters are maintained and replaced as needed. • Continuous dust suppression as needed. • Continue with surface- and groundwater monitoring.												

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
Surface water	**Removed silt placed directly on bare soil adjacent to desilting dam.** **Seepage from silt removed from the desilting dam into the groundwater.**	Operation	-1	3	2	3	3	-2.75	3	-8.25	-8.25	2	2
	Mitigation Measure: • Ensure that smokestack filters are maintained and replaced as needed. • Continuous dust suppression as needed. • Continue with surface- and groundwater monitoring.												
Surface water	**Risk of failure of ash dams.**	Operation	-1	3	4	4	4	-3.75	2	-7.5	-3.25	2	2
	Mitigation Measure: • Conduct veneer stability to determine risk of failure/ erosion potential. • Quarterly inspections. • Vegetate exposed areas.												
Surface water	**Contaminated surface run-off from the rehabilitated areas.**	Decommissioning	-1	3	4	3	3	-3.25	3	-9.75	-6	2	2
	Mitigation Measure: • Develop a closure and rehabilitation plan. • Remove all contaminated soils. • Revegetate the area as soon as possible.												

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
	• Conduct regular inspections of the rehabilitated area. • Ensure stormwater management is in place until vegetation is well established.												
Groundwater	**Rehabilitation and decommissioning of related infrastructure may have a negative impact on groundwater and surface water quality.**	Decommissioning	-1	3	4	4	3	-3.5	4	-14	-6.75	1	2
	Mitigation Measure: • Ensure ash dams are properly capped. • Develop a closure and rehabilitation plan. • Remove coal and contaminated soils below coal stockpiles to prevent seepage into the groundwater. • Remove all contaminated soils. • Develop a closure and rehabilitation plan. • Remove all contaminated soils. • Revegetate the area as soon as possible. • Conduct regular inspections of the rehabilitated area. • Ensure stormwater management is in place until vegetation is well established.												
Groundwater	**De-mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of surface water and groundwater resources.**	Decommissioning	-1	2	3	3	4	-3	4	-12	-6.75	1	2
	Mitigation Measures:												

Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Post-mitigation Significance Score	Cumulative Impact	Irreplaceable loss
	• Heavy vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site. Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.												
Groundwater	**Poor quality leachate may emanate from existing ash dumps, waste-water management infrastructure as well as the plant area which may have a negative impact on groundwater and surface water quality**	Decommissioning	-1	3	4	4	3	-3.5	4	-14	-7.5	1	2

Mitigation Measure:

- Assess the integrity of lined facilities and consider refurbishment of the infrastructure.

- Continue with groundwater monitoring programme.

- Implement a bunded hard stand next to the desilting dam for the removed silt to effectively dry before being transported to the Ash dams.

6 PUBLIC PARTICIPATION

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&APs and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

6.1 PRE-CONSULTATION WITH THE COMPETENT AUTHORITY

A pre-application meeting with the competent authority (DWS) was requested by the EAP and was held on the 13th of May 2025. The purpose of the pre-consultation was to provide the authorities with background information of the proposed project, confirm NWA triggered listed activities, the process to be followed and details to be included in the WULA such as specialist studies.

6.2 GENERAL APPROACH TO PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the MPRDA, NWA and NEMA EIA Regulations (2014), and in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning.

An existing I&AP database has been updated based on known key I&AP's, Windeed searches, and stakeholder databases provided by the mine. The I&AP database includes amongst others, landowners, communities, regulatory authorities and other special interest groups.

6.3 LIST OF PRE-IDENTIFIED ORGANS OF STATE/ KEY STAKEHOLDERS IDENTIFIED AND NOTIFIED

Government Authorities and other key I&APs were notified of the proposed project and include inter alia:

- Adjacent Landowners and Occupiers;
- Ward Councillors;

- Civil Aviation Authority;
- Afriforum;
- Centre of Environmental Rights;
- The Green Connection;
- Endangered Wildlife Trust;
- Conservation South Africa;
- Federation of Sustainable Environment (FSE);
- Wildlife and Environment Society of South Africa (WESSA);
- Birdlife South Africa;
- Natural Justice;
- Eskom Holdings SOC Limited;
- City of Ekurhuleni;
- City Power;
- City of Johannesburg;
- Gauteng Department of Employment and Labour;
- Gauteng Department of Agriculture, Rural Development and Environment;
- Gauteng Department of Cooperative Governance and Traditional Affairs;
- Gauteng Department of Economic Development;
- Gauteng Department of Human Settlements;
- Gauteng Department of Roads and Transport;
- Gauteng Department of Health;
- Gauteng Department of Community Safety;
- Gauteng Tourism Authority;
- Gauteng Wetland Forum;
- National Department of Public Works, Roads and Transport;
- National Department of Tourism;
- National Department of Agriculture, Forestry, Fisheries and Environment;
- National Department of Mineral and Petroleum Resources and Energy;
- National Department Of Agriculture, Land Reform And Rural Development
- National Department of Human Settlements
- National Energy Regulator of South Africa (NERSA);
- National Department of Water and Sanitation;
- National House of Traditional Leaders;
- Petroleum Agency SA
- PetroSA;
- South African Heritage Resources Agency;
- South African National Roads Agency Limited; and
- Transnet SOC Limited.
- Transnet Freight Rail.

Initial Notification and Public Participation review of the technical report

I&APs have the opportunity to submit their comments during the public review period of the IWWMP of the project for 60 days.

Comments raised will be addressed in a transparent manner and will be included in the final IWWMP. The IWWMP will be made available to all I&APs for 60 days. The public will be notified regarding the renewal of the license and the availability of the report for review with government gazette notices, newspaper notices, site notices, posters, emails, faxes, sms's and registered mail.

Registered Letters, Faxes and Emails

Notification letters (English, Afrikaans and isiZulu), faxes, and emails will be distributed to all pre-identified key I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that might be affected.

The notification letters included the following information to I&APs:

- List of anticipated activities to be authorised;

- Scale and extent of activities to be authorised;

- Information on the intended mining operation to enable I&APs to assess/surmise what impact the activities will have on them or on the use of their land;

- The purpose of the proposed project;

- Details of the affected properties (including details of where a locality map could be obtained);

- Details of the relevant NEMA Regulations;

- Initial registration period timeframes;

- Scoping Report commenting and Review period; and

- Contact details of the EAP.

Newspaper Advertisements / Government Gazette

Advertisements describing the proposed project and EIA process will be placed in the local newspaper with circulation in the vicinity of the study area. The initial advertisement will be placed in the Carletonville Herald Newspaper (in English, Afrikaans and isiZulu) in November 2025. The newspaper advert will include the following information:

- Project name;

- Applicant name;

- Project location;

- Nature of the activity and application;

- Relevant EIMS contact person for the project.

- Period and location of the report IWWMP that can be reviewed.

Site Notice Placement

A1 Correx site notices in English, Afrikaans and isiZulu will be placed at 10 locations within the local project area in November 2025. The on-site notices included the following information:

- Project name;

- Applicant name;

- Project location;

- Map of proposed project area;

- Project description;

- Legislative requirements; and

- Relevant EIMS contact person for the project.

- Period and location of the report IWWMP that can be reviewed.

Poster Placement

A3 posters in English, Afrikaans and Sesotho will be placed at ten local public gathering places in and surrounding the local project area.

The notices and written notification will afford all pre-identified I&APs the opportunity to register for the project as well as to submit their comments on the IWWMP and indicate the contact details of any other potential I&APs that they feel should be contacted. The contact person at EIMS, contact number, email and faxes were

stated on the posters. Comments/concerns and queries were encouraged to be submitted in either of the following manners:

- Electronically (fax, email);

- Telephonically; and/or

- Written letters.

7 MATTERS REQUIRING ATTENTION / PROBLEM STATEMENT

Based upon the above risk assessment and the findings that came out of the process, the following matters (Table 50) requiring attention have been identified for the groundwater, storm water, process water and waste aspects associated with the operation.

Table 50: Summary of matters requiring attention.

Theme	Issue/ Matter
Groundwater.	Seepage from the unlined ash dams.
	No measures in place to intercept migration of groundwater pollution plumes in support of long-term water management.
	High levels of bacteriological contaminants in the groundwater.
Surace water.	No stormwater management infrastructure around the coal stockpiling area.
	Poor quality water discharged into the Modderfonteinspruit.
	Stormwater trenches are destroyed.
	Various pipes are leaking process water.
Waste.	Contaminated soil on site associated with both the raw coal and the coal ash handling on site.

7.1 ASSESSMENT OF LEVEL AND CONFIDENCE OF INFORMATION

Based on the reviewed documentation, specialist study reports and data are considered to be of high confidence. An overall complete historical data set is available which comprises of baseline conditions and progressive data to establish impacts and trend identification.

8   WATER AND WASTE MANAGEMENT

8.1 WATER AND WASTE MANAGEMENT PHILOSOPHY

This section contains the water and waste management philosophies for stormwater, process water, ground water and waste applicable to the activity and is informed by the company's policies and legislation. These philosophies are translated to strategies for stormwater, process water, ground water and waste management for the activity. Goals and objectives are formulated for the water use or waste management of the activity in accordance with the philosophies and strategies to ensure improvement of the status of the water resources.

A range of management measures are identified to reach the set objectives. These measures may be presented to and discussed with the DWS to ensure that all possible measures have been considered. An option analysis may be required in instances where more than one (1) potential management measure has been identified to determine the most appropriate (feasible and sustainable) measure to be implemented.

The outcome of such option analyses will demonstrate the financial feasibility of the preferred selected management option, and form part of the motivation. Management options could also be based on Best Practice Environmental Alternative (BPEA) and Best Available Techniques Not Entailing Excessive Costs (BATNEEC).

The action plan must include the time frame and schedule for the implementation of the selected management measures. The management measures may include priority measures which must be implemented to address major legal non-compliance or a high business risk, and then other short-, medium- and long-term actions.

8.2 WATER AND WASTE MANAGEMENT PHILOSOPHY

As discussed above, Kelvin Power acknowledges the importance of careful water management for successful operations and have developed water management guidelines and standards to carry out the required operations. Kelvin Power adopted the water quality management hierarchy advocated by DWS (Figure 92) and aspire to comply with the following:

- To comply with the relevant Government legislation, strategies and procedures in terms of their obligations;

- To reduce harm to the environment by designing, operating, and closing all the operations in an environmentally sensitive responsible manner;

- Actively identifying and implementing the necessary steps to accomplish the water and waste-related goals;

- Constantly seeking ways to improve performance in terms of consumption, and water related impacts:

  o Water visions aim for zero discharge, enhance water quality and reduced clean water consumption;

  o Maximise, recycling and reuse of dirty stormwater and process water;

  o Segregate clean and wastewater to minimize the impact and optimise the use of recycled water towards the import of clean water;

  o Secure water supply for operations in a sustainable manner; and

  o Practice continual improvement of technology, measurement and processes to reduce water use and counteract pollution.

- To achieve over and above compliance;

- Minimise harm to all factors of the biophysical environment;

- Reduce community impact and identify areas for improvement;

- Acknowledge the waste position and reduce generation;

- Recognise and create dependable collaborations to direct the development of catchment scale water management solutions to increase social acceptance for the benefit of all stakeholders; and

- Use a risk-based assessment technique to define design criteria, risk control strategies, and risk reductions to a manageable level.
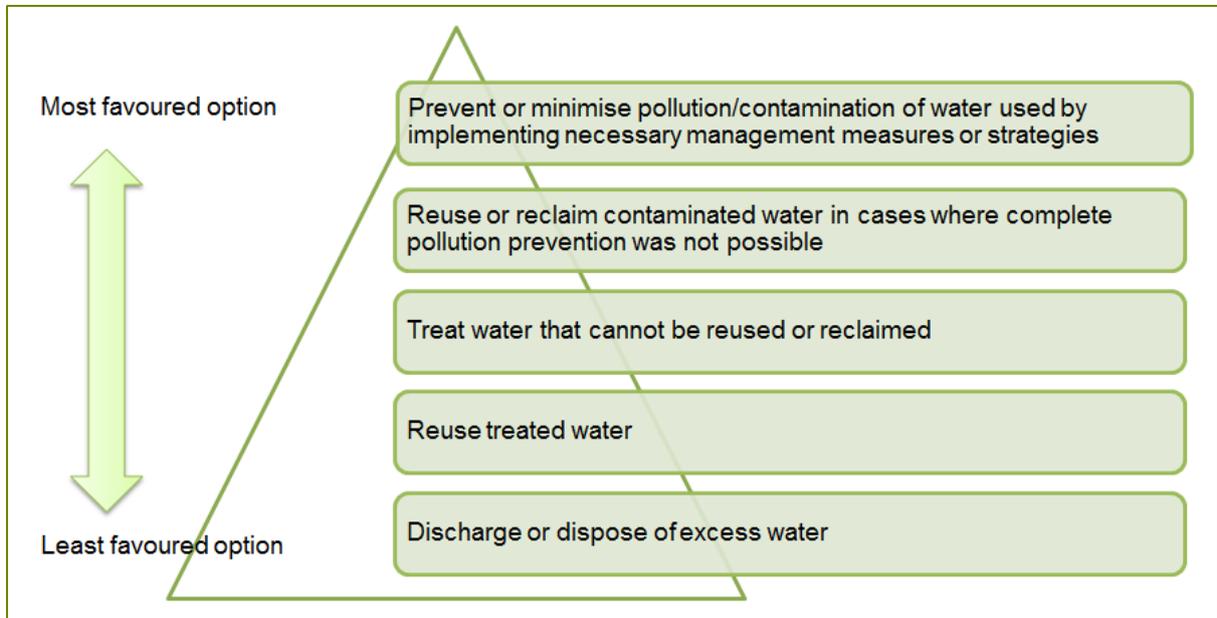

Figure 92: Water quality management hierarchy.

8.3 STRATEGIES (PROCESS WATER, STORMWATER, GROUNDWAT AND WASTE)

8.3.1 PROCESSS WATER

Process water at each facility must be managed such that the utilisation of the affected water is improved, ensuring that the maximisation of dirty water usage at each facility is achieved. Processed water must be managed at each facility to avoid excessive use of clean water from outside sources or clean water areas within the mine.

Process water must be managed such that water losses from the water reticulation system is minimised and that reuse opportunities are maximised. Process water at each facility must be managed to save costs related water use (treat and use, re-use dirty water, etc).

8.3.2 STORMWATER

Surface water must be managed in each facility to ensure the following: that affected properties (including downstream water users) and water resources are protected from pollution by dirty storm water discharges and erosion of watercourses; that pollution of unused areas within the site boundary is protected from pollution; that stormwater management facilities are maintained in good condition; that the conditions of the surrounding water resources are preserved and that the impact on catchment yield is minimised.

8.3.3 GROUNDWATER

Groundwater must be managed to prevent the off-site migration of groundwater pollution plumes; prevent deterioration in baseline groundwater quality that is not fit for purpose; maintain fitness for use of groundwater resource by not only Kelvin Power but also other downstream water users; implement and/ or maintain the integrity of dam liners to prevent impacts on groundwater resource; and ensure ongoing monitoring of groundwater quality and levels to validate groundwater models.

8.3.4 WASTE

Waste must be managed by implementing waste separation at source; by maximising recycling and reuse of waste streams; implementation of a hard stand at the desilting dam for removed silt to dry; disposing of waste on authorised waste disposal facilities in accordance with legal requirements; implement ongoing waste monitoring to inform waste management; and management of ash dams to ensure no contaminated land at closure.

8.4 PERFORMANCE OBJECTIVES OR GOALS

8.4.1 PROCESS WATER

- Maintain the power station reticulation infrastructure used to convey process water;

- Ensure prevention of process water leakages and spillages;

- Ensure record keeping of process water usage at each facility;

- Update water balance regularly with data recoded from water flow records; and

- Develop the post-closure power station water and salt balance that forms the foundation of all closure management actions relating to water.

8.4.2 STORMWATER

- Maximise areas generating clean water and minimise dirty water areas with clean water runoff routed directly to natural watercourses;

- Minimise water retention – allow water to move from the surface as quickly as possible to limit infiltration and potential contamination of groundwater;

- Ensure the reuse of contained dirty water;

- Ensure no discharge of contaminated surface water into the environment;

- Rehabilitate disturbed areas to maximise clean water areas, reduce erosion of disturbed areas and prevention of watercourses damage; and

- Monitor the quality and quantity of water within the site water management system and water bodies within the power station impact zone.

8.4.3 GROUNDWATER

- Identification and characterisation of ground water pollution sources;

- Minimisation of seepage to the groundwater;

- Water pollution prevention measures must be implemented; and

- The monitoring of quality and quantity of water used on site.

8.4.4 WASTE

- Compliance with legislative requirements;

- Optimal recycling and reuse of waste streams generated on site;

- Reduce dirty footprints on site (where possible);

- Effective waste management systems; and

- No residual contaminated land present on the site at closure.

8.5 MEASURES TO ACHIEVE AND SUSTAIN PERFORMANCE OBJECTIVES

The approved SHE policy and this IWWMP outlines the operation's general health, safety, and environmental strategies. The policies and IWWMP aim at pollution prevention and a commitment for ongoing progressive improvement. Kelvin Power thus acknowledges accountability and pledges to abide by all obligations and applicable laws to achieve the set strategy objectives.

8.6 OPTION ANALYSIS AND MOTIVATION FOR IMPLEMENTATION OF PREFERRED OPTIONS (OPTIONAL)

This section is considered not applicable to the current Kelvin Power operation.

8.7 IWWMP ACTION PLAN

Based on the recommendations made in the 2024 IWWMP and 2024 WUL Audit Report (Appendix 2), the following action plan (Table 51) has been set to guide the development and maintenance of the site and to minimise and mitigate impacts. The recommendations from the updated groundwater report have also been incorporated.

Table 51: IWWMP action plan.

Aspect	Requirement	Mitigation for Improvement	Timeline	Responsible Person
Groundwater.	Negative impact in groundwater quality i.e., deterioration of water quality due to introduction of contaminants as part of the power generation development as well as mobilisation of contaminants caused by related activities.	• Development and implementation of an integrated groundwater monitoring program evaluating hydrochemistry as well as water levels will serve as early warning mechanism to implement mitigation measures such as down-gradient of the infrastructure in order to constrain the contamination plume migration as well as manage related impacts. It should be noted that the applicant do have an existing monitoring network and programme in place, however it is recommended that a revised monitoring network, as discussed under Section 15 of this report, should be implemented.	2025/2026	Environmental Manager
		• Waste classification and assessment of all potential waste material handled and disposed of on-site have been determined. Accordingly, all waste material should be handled and disposed of based on the Safety Data Sheets (SDSs) for the respective waste streams with information on the potential hazards, emergency response, protective measures and correct storage methodology.	2025/2026	Environmental Manager
		• Down-gradient seepage capturing alternatives i.e., establishment of seepage capturing cut-off trenches or establishment of scavenger boreholes should be implemented as active waste-water management techniques in order to constrain the migration of pollution plumes emanating from pollution sources during the post-closure phase.	2025/2026	Site Manager Environmental manager
		• Intercepted contact water should be treated to acceptable water quality standards and re-introduced to the catchment water balance.	Ongoing and throughout operation	Site Manager Environmental manager

Aspect	Requirement	Mitigation for Improvement	Timeline	Responsible Person
		• The numerical groundwater flow and pollution plume migration model should be recalibrated with time-series monitoring data on a biennial (once every two years) basis in order to be applied as a water management tool. Scenario predictions and model simulations should be conducted and interpreted by an external and independent specialist.	Bi-annually	Site Manager Environmental manager
		• Heavy vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site. Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.	Daily	Site Manager Environmental manager
		• The use of all materials, fuels and chemicals which could potentially leach into groundwater must be controlled.	Daily	Site Manager Environmental manager
		• Develop and implement a stormwater management plan in accordance with GN704 in order to separate dirty/contact water from clean water circuits. All water retention structures, process water dams; storm water dams, retention ponds etc. should be maintained to have adequate freeboard (0.8m below overflow level) to be able to contain water from 1:50 year rain events.	2025/2026	Site Manager Environmental manager
		• Stockpiling of material shall not be done within a 1:100-year flood line, unless where such stockpiling has been authorized in terms of the WUL and relevant GN704 Exemption.	Ongoing	Site Manager Environmental manager
		• Monitoring results should be evaluated on a quarterly basis by a suitably qualified person for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation. Based on the water quality results, the monitoring network should be refined and updated every three to five years	Quarterly	Site Manager Environmental manager

Aspect	Requirement	Mitigation for Improvement	Timeline	Responsible Person
		based on hydrochemical results obtained to ensure optimisation and adequacy of the proposed localities.		
	Prevent unnecessary seepage of contaminated water into the groundwater.	• Improve materials handling on sites (such as storing hazardous chemical in bunded areas, removal of IBC chemical and oil drums); • Ensure spill kits are available on site; • Consider lining the coal stockpile area; • Drill additional boreholes to monitor groundwater pollution further downstream; • Assess the integrity of lined facilities and consider refurbishment of the infrastructure; • Implement a bunded hard stand next to the desilting dam for the removed silt to effectively dry before being transported to the Ash dams; • Ensure coal trucks' tarpaulins are in place before gaining access to the site; and • Conduct a contaminated land assessment around the haul road to determine the extent of the contamination.	2025/ 2026	Environmental Manager
	Decrease the biological contamination found within various boreholes.	• Investigate to determine the cause of the bacteriological contamination; and • Test additional downstream boreholes (if available) to determine extent of bacteriological contamination.	2025/ 2026	Environmental Manager
Surface water.	Prevent contamination of surface water resources with contaminated runoff.	• Desilt facilities regularly to increase storage and regular cleaning of storm water conveyance infrastructure; • Leakages must be repaired as soon as possible;	2025/ 2026	Environmental Manager

Aspect	Requirement	Mitigation for Improvement	Timeline	Responsible Person
		• Repair the broken stormwater management trenches;		
		• Construct a stormwater management trench around the coal stockpiling area;		
		• Develop and implement a stormwater management plan to capture and contain dirty runoff from the stockpile area; and		
		• Develop a WC/WDM strategy.		
Waste.	Prevent waste from entering the various clean environments.	• Implement a bunded hard stand next to the desilting dam for the removed silt to effectively dry before being transported to the Ash Dams;	2025/ 2026	Environmental Manager
		• Develop and implement a silt management plan;		
		• Conduct veneer stability on the Ash Dams to determine risk of failure/ erosion potential;		
		• Quarterly inspections; and		
		• Vegetate exposed areas of Ash Dam walls.		
	Appendix II, Conditions 2.5, 3.2, and 5.2.	Kelvin Power must implement and maintain the recommendations in the stormwater management plan in order to mitigate pollution of surface runoff emanating from the Kelvin Power activities.	2025/ 2026	Environmental Manager
	Appendix II, Condition 5.1.5.	Kelvin Power must update the stormwater management plan to incorporate the Best Practise Guidelines issued by DWAF.	2025/ 2026	Environmental Manager
	Appendix II, Condition 11.3.1.	Kelvin Power must implement and maintain the recommendations in the stormwater management plan, aquatic study reports in order to mitigate pollution of surface runoff emanating from the KPS activities.	2025/ 2026	Environmental Manager

Aspect	Requirement	Mitigation for Improvement	Timeline	Responsible Person
	Appendix II, Condition 11.7.1.	Kelvin Power must implement and maintain the recommendations in the 2025/ 2026 groundwater study and stormwater management plan in order to mitigate pollution of surface runoff emanating from the KPS activities.		Environmental Manager

8.8 CONTROL AND MONITORING

Monitoring programmes have been developed in order to ensure continuous data retrieval and analysis for appropriate remedial action which allows for the operational impacts on environmental regimes.

8.8.1 MONITORING OF CHANGE IN BASELINE

Continuous monthly, quarterly and bi-annual monitoring is completed in accordance with the WUL requirements as discussed under Section 5.2. A historical data set is present where changes in baseline conditions are assessed within the respective specialist reports.

8.8.2 AUDIT AND REPORT ON PERFORMANCE MEASURES

The following Kelvin Power audit programme is implemented:

- Annual Internal and External WUL Audits for submission to DWS.

The main objective of the audits is to compile an environmental audit for the operations which reflects on the performance of the relevant authorisations. The key audit objectives include inter alia:

- Ensuring compliance with regulatory authority stipulations applicable;

- Providing verifiable findings, in a structural and systematic manner; and

- Compliance with conditions of authorisations.

8.8.3 AUDIT AND REPORT ON RELEVANCE OF IWWMP ACTION PLAN

The IWWMP Action Plan will be reviewed and updated on an annual basis in terms of the WUL. The measures recommended in the IWWMP action plan should be implemented in conjunction with any other authorisations (such as the EMPr).

9 CONCLUSION

This 2025 IWWMP update is specially compiled for Kelvin Powers WUL (03/A21C/FGH/1110) of 24 June 2011 to provide the status of the current water and waste processes on site. The IWWMP update provides guidelines for the Kelvin Power operations to manage the requirements of the WUL conditions accordingly. This 2025 IWWMP update is also submitted as part of the application for renewal of the WUL.

9.1 REGULATORY STATUS OF THE ACTIVITY

Based on present knowledge as it relates to the operations at Kelvin Power, it would seem that all water uses associated with the operation are authorised in terms of a WUL (03/A21C/FGH/1110) dated 24 June 2011. Kelvin Power is committed to apply for any water uses that will form part of the Kelvin Power operation in the future.

9.2 STATEMENT ON WATER USES REQUIRING AUHTORISAION, DISPENSING WITH LICENSING REQUIRMENT AND POSSIBLE EXEMPTION FROM REGULATIONS

All existing water uses have been authorised as per the WUL (03/A21C/FGH/1110) (Table 3 in Section 3 of this report).

9.3 SECTION 27 MOTIVATION

A Section 27 motivation was submitted as part of the original WULA and is not considered applicable to the current 2025 IWWMP update.

9.4 PROPOSED LICENSE CONDITIONS

No new licensing conditions are proposed. It is recommended that Kelvin Power amend certain conditions of their WUL that are no longer applicable.

10 REFERENCES

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11   APPENDICES

Appendix 1: Groundwater Report

Appendix 2: 2024 External WUL Audit Report

Appendix 3: RSIP

Appendix 4: Toxicity Report

Appendix 5: June 2025 Water Quality Monitoring Results

Appendix 6: Water and Salt Balance Update Report