3.7 The necessary precautions must be taken to safeguard traffic during operations. Any accidents due to negligence on your side will be your responsibility.

3.8 If any blasting debris falls into the road reserve, it will be your responsibility to clear the road surface and road reserve as quickly as possible. Any damage to the road must be repaired within 1 week to the satisfaction of the Roads Superintendent.

3.9 You indemnify and hold the Provincial Administration harmless from any claims or damage which may be instituted or suffered by any person, including legal costs, as a result of your blasting operations or traffic control.

3.10 If necessary you must arrange with the local or Provincial Traffic Departments to be present if traffic is stopped.

3.11 All operations must be done to the satisfaction of the Roads Superintendent.

3.12 No blasting may commence before these conditions are accepted in writing.

3.13 This permission is given in terms of the Advertising on Roads and Ribbon Development Act, 1940 (Act 21 of 1940) as amended and the Roads Ordinance, (Ordinance 22 of 1957) as amended, and its regulations and does not exempt you from the provisions of any other law.

3.14 The Roads Branch reserves the right to cancel or alter this permission at any time.

3.15 The conditions are applicable to you as well as to your successor in title. If the right of ownership of the operations is transferred to another person or authority, it is your responsibility to bring these conditions to their attention.

Yours faithfully

HEAD: DEPARTMENT OF PUBLIC WORKS, ROADS & TRANSPORT
SC/GVS-LAND

Distribution

Electrification and Engineering
Pretoria
Menlynpark
P O Box 36099
Menlo Park 0102
Tel: (012) 421-3111
Fax: (012)

ESKOM

The Manager
AMCOAL Landau Colliery
P O Box 78
CLEWER
1036

Fax 0135 656 9016

Date	Your Ref.	Our Ref.	Enquiries
21 April 1997	AJMcL/mmw	SO/74/97	Caroline Erasmus ☎012 421 3171 Faks: 012 421-3283

Sir

SCHOONGEZICHT NO 2 SEAM MINI-PIT MINE

Your letter dated 25 March 1997 refers.

Permission is herewith granted for mining operations as set out in your letter.

Eskom's area representative to be contacted is Mr M Savoury at telephone number 0135-93 3734.

Yours faithfully

C Erasmus
on behalf of I M van Rooyen
ACTING SURVEY MANAGER

COPY: M Savoury, Witbank

AJMcL/mmw

25th March 1997

Mrs Fiona Hodgson
Land Survey Negotiator
Distribution Engineering
ESKOM
P O Box 223
WITBANK
1035

Dear Madam

SCHOONGEZICHT NO 2 SEAM MINI-PIT MINE

As a result of good prevailing economic conditions and the depletion of the current 4 seam mini-pit, Landau Colliery is planning to re-open the 2 seam mini-pit mine during May 1997.

The attached locality plans indicate the locality of the mini-pit which is situated south of the Pretoria-Witbank N4 highway and has the Pretoria/Komatipoort railway line on its eastern boundary.

Permission is hereby requested by Landau Colliery to:

a) Carry out mining operations, including blasting, within 100m from the Old Douglas 21 kV powerline.

b) Carry out mining operations within 100m of the 132 kV Eskom Park, Witbank / Transalloys powerline and to carry out blasting operations within 500m from the same aforementioned line.

A summary of the mining operation is detailed below.

The mini-pit operation will involve the opencast mining of the coal in consecutive cuts 30 to 40 meters in width as per the orientation indicated on the plan. No more than two cuts will be operated at any one time and the largest duration for any one cut to be exposed is six months. The sequence of mining operations can be summarised as follows:

- removal of topsoil and soft overburden
- blasting of the overburden material
- removal of overburden
- blasting of the coal (2 seam)

- removal of the coal
- blasting of parting
- removal of parting
- blasting of coal (1 seam)
- removal of coal (1 seam)
- replacing of the overburden
- rehabilitation

With respect to the following

a) <u>Old Douglas 21 kV powerline</u>

A detailed plan of the portion of the mini-pit within 100m of the aforementioned powerline is attached, along with a cross-section, the position of which is indicated on the plan.

Mining shall proceed to within 10m of the servitude, and effective distance of 21m from the powerline. The cross-section provided illustrates the following:

i) Existing ground level.

ii) Mining horizons and levels during operation.

iii) Post mining ground level.

As the minimum distance at any one time to the powerline will be 21m, the integrity of the aforementioned powerline will remain intact.

When blasting within 100m of the aforementioned powerline, the following precautions will be adhered to:

- A blasting schedule will be submitted to Eskom's area representative at the beginning of each month.

- Peak Particle Velocity (PPV) will be kept below 75 mm/s at the powerline.

- Seismic devices will be installed in the vicinity and the readings from them extrapolated in order to ensure that the aforementioned precaution [illegible]

- Fly rock and air blast will be controlled by means of correct sequencing, stemming and the exclusive use of Nonel (noiseless) trunk lines. To this end independent Blasting Consultants will advise Landau Colliery on this matter to ensure compliance.

It is anticipated that the material in this area is weathered to a greater extent than elsewhere in the pit and where the rock can be removed without blasting (i.e. ripping) it will be done so. However this will only be determined once operations have commenced.

b) <u>Eskom Park, Witbank / Transalloys 132 kV powerline</u>

A detailed plan of the portion mini-pit within 100m of the aforementioned powerline is attached.

Cognisance of the existence of a servitude 3lm wide and 21m to the north of the centre line of the existing powerline is acknowledged, and is reflected on the plan.

As the minimum distance from which blasting is anticipated to take place from the aforementioned power line is in excess of 200m, normal blasting precautions will be observed. These are the same as are applicable to the Old Douglas 21 kV line, except that a monthly schedule would not be submitted.

If at a later date blasting operations advanced to within 100m of the aforementioned powerline, the same precautions as are applicable to the Old Douglas 21 kV powerline will be implemented.

Notwithstanding the aforementioned precautions, the following shall apply:

1. It is acknowledged that Eskom reserve the right to withdraw its consent if blasting becomes hazardous or likely to result in power interruptions.

2. Landau Colliery, South African Coal Estates, is the registered owner of the property, Schoongezicht 308 JS, over which the Eskom servitude is registered.

3. No mechanical equipment, including mechanical excavators and high lifting machinery, may be used within Eskom's servitude area, or within close proximity of Eskom's services and equipment, without prior permission in writing and supervision of Eskom's authorised area representative. Permission must be obtained at least 10 (TEN) days prior to the commencement of any work within the servitude area.

4. No mining activities may be executed closer than 10 metres from any of Eskom's power line structures or stay wires. Excavation must be carried out at a minimum angle of 30° from the vertical.

5. Statutory ground and/or structure to conductor clearances are to be maintained at all times.

6. The Mine accepts costs if:

   - Eskom towers subside or are damaged as a result of mining activities.

   - Eskom has to incur any costs to comply with statutory requirements because of the Mine's works or the presence of the Mine's equipment or plant in the servitude area. Such proven costs shall be refunded on demand.

7. Eskom's rights, services and equipment must be acknowledged at all times and may not be interfered or tampered with.

8. Eskom shall not be liable for the death of, or injury to any person or for the loss of, or damage to any property caused in whatsoever manner by the Mine, its employees, agents or contractors.

9. Eskom shall at all times have unobstructed access to and egress from its servitude area and power line structures.

Yours faithfully

A C JOHNSON
MANAGER (MINING)

AJMcL/mmw/26/03/97
Q:\AJM\97

SUPPLEMENTARY REPORT NO. 4

SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT #2 SEAM MINI PIT

REPORT NO : 3591/1471/1W

Wates, Meiring & Barnard

Consulting Civil, Structural, Process & Geotechnical Engineers and Project Managers
Raadgewende Siviele, Struktuur-, Proses- & Geotegniese Ingenieurs en Projekbestuurders

SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT #2 SEAM MINI PIT

REPORT NO : 3591/1471/1W

MAY 1997

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SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE WATER AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT # 2 SEAM MINI PIT

TABLE OF CONTENTS

SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE WATER AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT # 2 SEAM MINI PIT

1. INTRODUCTION

The Schoongezicht No 2 Seam Mini-pit was opened in 1989/90, but was closed again in 1990 after the box cut was opened. The box cut was shaped and rehabilitated, but the high wall and associated void remained in place. Reserves at the No 4 Seam Mini-pit, to the south-west of the No 2 Seam Mini-pit, have almost been fully exploited. Interest has therefore returned to the continued opencast mining of the Schoongezicht No 2 Seam Mini-pit.

The local area around the Schoongezicht No 2 Seam Mini-pit has been extensively mined by opencast and underground methods. Proposed mining of the No 2 Seam Mini-pit will abut on the old Schoongezicht underground workings. The old Witbank South Mine workings are located to the east of the Mini-pit, while to the south-west opencast mining is currently taking place in the No 4 Seam Mini-pit. The surface and groundwater system of the Schoongezicht No 2 Seam Mini-pit will therefore be evaluated in conjunction with the surrounding mining operations.

This investigation concentrates on the surface water and groundwater aspects of the environmental management of the proposed mini-pit. The impacts of the mining operation at the proposed mini-pit on the neighbouring mine workings are examined in this report, and the environmental management programme for the proposed mini-pit will have to be integrated with that of the neighbouring mining operations.

2. PROJECT DESCRIPTION

The mining of the 3.62 million ROM tons of bituminous coal reserves of the mini-pit will take 4 to 5 years. The mining of the mini-pit will be undertaken by a contractor using truck and shovel techniques. Two small draglines will be used to remove the hard overburden to expose the coal seam. The coal will be removed by trucks and shovels, while scrapers will be used for pre-stripping ahead of the high wall.

The coal will be delivered to either the Klipfontein or Navigation washing plants or directly to the Rapid Loading Terminal by road haulage. Approximately 0.25 million tons per annum will go to the Rapid Loading Terminal as raw coal and 0.89 million tons per annum to the washing plants.

3. PRE-MINING ENVIRONMENT (*Aide Memoire Part 2)*

3.1. Regional Description

Landau Colliery is situated in the Klipspruit catchment of the upper Olifants River basin. The Klipspruit has two tributaries; the Brugspruit and the Blesbokspruit.

The Brugspruit rises to the south-west of Witbank and flows in a northerly direction to the Klipspruit confluence (**Figure 3.1(a)**). Two smaller streams, the Townshipspruit and the Schoongezichtspruit flow into the Brugspruit from the southern part of the catchment. The proposed #2 Seam Mini-pit falls in between these two smaller streams.

The land-use in the southern part of the Klipspruit catchment is dominated by mining, urban and industrial developments.

3.1.1. Mining and industrial development

Mining of the Witbank Coalfields started in the previous century. Underground extraction methods were used to exploit shallow coal seams up until the late 1940's to early 1950's. A number of small opencast pit operations started up in the mid 1970's in order to exploit the remaining fringe coal and boundary pillars. The location of these old mining operations is shown on **Figure 3.1(a)**. The old collieries include Old Tavistock, Middelburg Steam, Coronation, Transvaal and Delgoa Bay, South Witbank, Old Douglas, Kromdraai (currently being re-mined), Schoongezicht (forming part of the Landau Colliery) and Navigation (forming part of the Landau Colliery).

A number of large industries are also located in the Klipspruit catchment. Highveld Steel and Vanadium Corporation Ltd is located on the watershed between the Klipspruit and the Wilge River catchments. Trans Alloys is a division of Highveld Steel and Vanadium Corporation, which is located to the south-east of the main Highveld Steel plant. Ferrobank Industrial Township accommodates a number of large industries. Ferro Metals Limited is an affiliated Samancor company and produces ferrochrome and ferrosilichrome products for the metallurgical industry. Vantra is a division of Highveld Steel and Vanadium Corporation and is located on the western perimeter of the Ferrobank Industrial Township, adjacent to T&DB Colliery.

3.1.2. Urban Development

A large urban area of middle and low income residential development is located in the southern part of the Klipspruit catchment. The Kwa-Guka suburb of Greater Witbank is expanding rapidly in a north-westerly direction and drains towards the Brugspruit and the Klipspruit. Locations of urban developments and associated sewage treatment plants are shown in **Figure 3.1 (b)**.

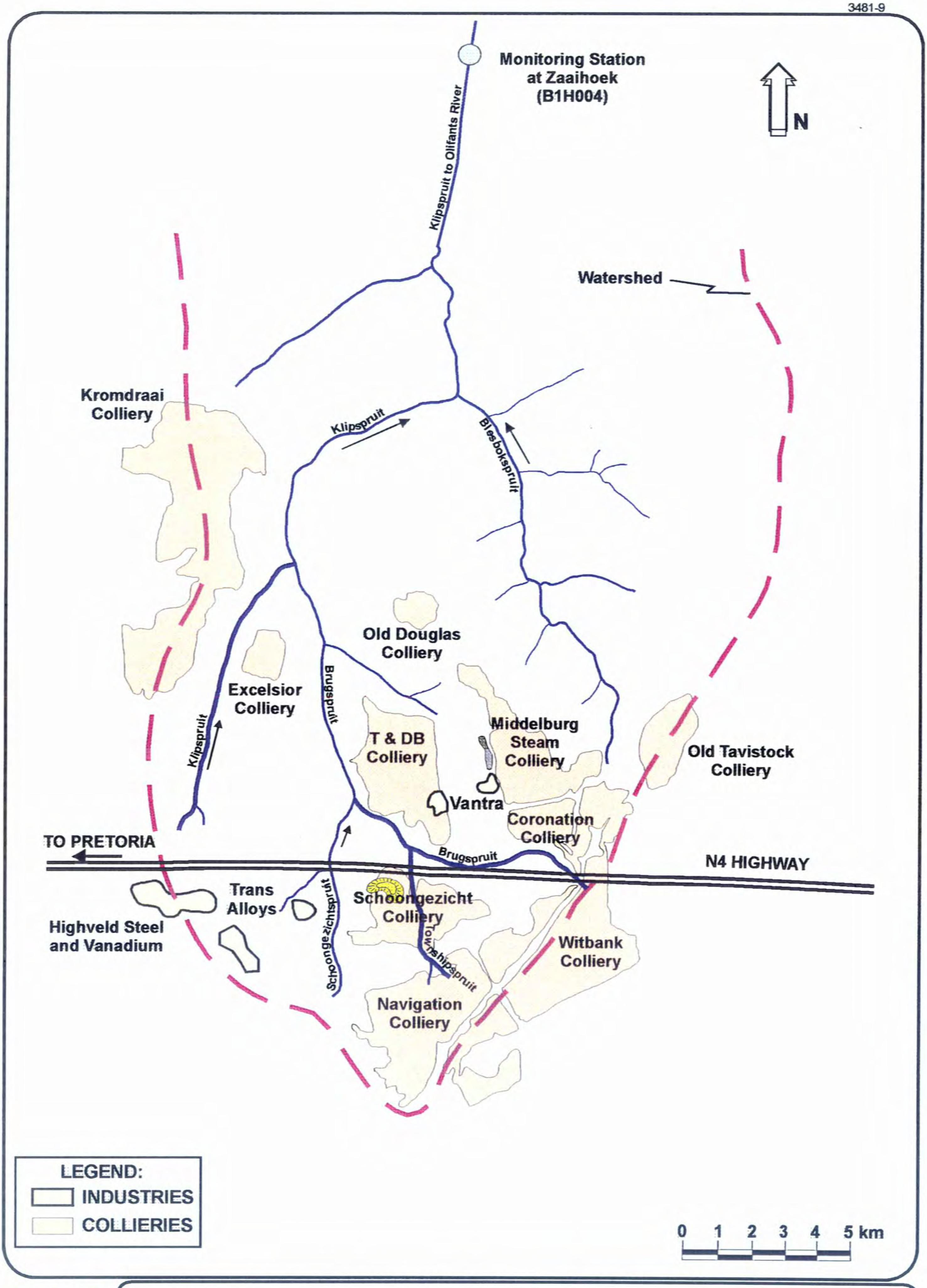

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FIGURE 3.1(a) : REGIONAL CONTEXT OF LANDAU COLLIERY

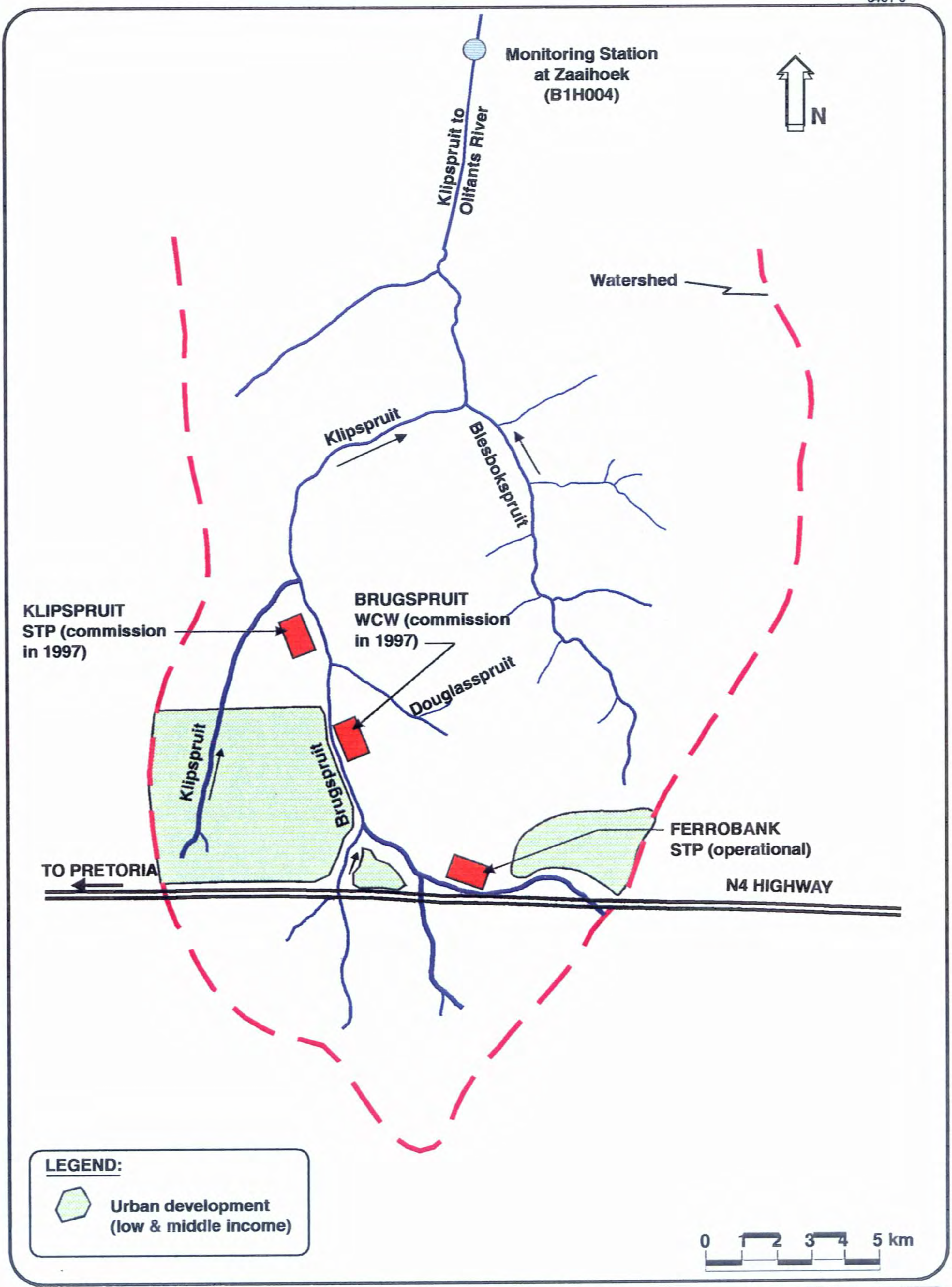


Figure 3.1(b) : LOCATION OF URBAN DEVELOPMENT AND WASTEWATER TREATMENT PLANTS

3.2. Surface Water (*Aide Memoire #2.9)*

3.2.1. Surface Water Quantity (*Aide Memoire #2.9.1)*

The flow in Klipspruit is measured at a Department of Water Affairs and Forestry weir (B1H005) at Zaaihoek some 40 km downstream of the Mini-pit. The catchment area at Zaaihoek weir was measured from a 1 in 250 000 scale map to be 376 km^2. The Mean Annual Runoff (MAR) was measured at the Zaaihoek weir for the period 1985 to 1995 to be 23.4 million m^3.

The base flow in the Klipspruit is strongly influenced by point discharges from local sewage treatment plants and the Brugspruit Water Pollution Control Works treating the acidic seeps from the old mine workings. With the rapid expansion of the urban areas, the runoff volumes and base flow in the Klipspruit can be expected to increase.

Regional Climate

The Schoongezicht Mini Pit area is in a predominantly summer rainfall region with dry winter months. The Mean Annual Precipitation (MAP) is about 720 mm/annum, measured at the Kromdraai Liming Plant. The mean monthly rainfall (mm), average number of rain days per month, and the mean monthly evaporation figures are listed in **Table 3.2 (a)**. The average daily summer temperature range is from 12 ° C to 29 ° C with an average temperature of 20 ° C. The average daily winter temperature ranges from -3 ° C to 20 ° C with an average temperature of 9 ° C. The prevailing winds are from the northwest, with an average wind speed of 2.9 metres per second.

Table 3.2(a) Rainfall and evaporation statistics for the Schoongezicht Minipit area

	Summer						Winter						Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Mean Monthly Rainfall (mm)	86	121	111	110	112	104	32	6	10	4	7	17	720
Number of rain days (#)	7.4	11.7	12.0	10.1	9.3	8.7	4.7	1.1	2.0	0.4	1.1	3.1	71.6
Mean monthly evaporation (mm)*	170	165	174	178	144	136	100	81	68	74	100	136	1526

* **Measured at Witbank Dam (Symons Tank)**

The 20 year, 50 year and 100 year recurrence interval 24 hour rainfall depths as determined by Adamson (1981) for the Witbank rain gauge (Gauge No 515382) are listed below in **Table 3.2(b)**.

Table 3.2(b) The 20 year, 50 year and 100 year recurrence interval 24 hour rainfall depths (mm) at gauge number 515382

Recurrence Interval (yrs)	20	50	100
Rainfall Depth (mm)	96	115	131

The 20 year, 50 year and 100 year recurrence interval flood peaks and volumes were computed for the Townshipspruit at the bridge under the N4 freeway and are presented in **Table 3.2 (c).** The Regional Maximum Flood (RMF) was calculated using the Kovacs Method (Kovacs, 1988) to be 228 m^3/s. The catchment area at the bridge was measured from a 1 in 50 000 scale topographical map to be 8.7 km^2.

Table 3.2 (c) Computed 20 year, 50 year and 100 year recurrence interval Flood peaks and Volumes for Townshipspruit

Recurrence Interval (yr)	Flood Peak (m^3/s)	Flood Volume (m^3)
20	40	180 000
50	65	292 500
100	96	432 000

Flood Lines

The water surface elevations along the Townshipspruit were determined for the 50 year recurrence interval flood peak. The flood line is shown plotted on **Figure 4.1 (a).**

Dry Weather Flows ***(Aide Memoire #2.9.1.3)***

The dry weather flow calculated for the Townshipspruit and the Schoongezichtspruit is the natural dry weather flow not taking into account any discharges or seepages into these streams - refer to **Table 3.2 (d)**.

Table 3.2 (d) Dry Weather flows in the Townshipspruit and the Schoongezichtspruit

Stream	Dry Weather Flows (m^3/s)
Townshipspruit	0.0010
Schoongezichtspruit	0.0012

Upslope Stormwater Drainage

The catchment area upstream of the pit was measured from 1 in 10 000 scale orthophotos to be 1.4 km^2. The surface runoff from the upstream catchment will be partially intercepted by the railway line which runs in an east - west direction across the catchment almost immediately upslope of the pit. The runoff water will be diverted by the railway line from the pit towards the Townshipspruit (See **Figure 3.2 (a)**)

3.2.2. Surface Water Quality (*Aide Memoire 2.9.2*)

The Schoongezichtspruit and the Townshipspruit are impacted by numerous coal mining related activities on the Landau Colliery complex and neighbouring mines.

The Department of Water Affairs and Forestry prepared an interim Water Quality Management Plan for the Klipspruit catchment in 1992. A White Paper was tabled in Parliament which outlined the strategy to specifically deal with AMD emanating from old defunct mines in the area. The strategy involved a three-phased approach:

- Phase 1 which focused on more intensive water pollution control at source.
- Phase 2 which incorporated the construction of an acid mine drainage collection and treatment works
- Phase 3 which involved the re-mining and/or rehabilitation of the mining-impacted areas.

The historical water quality in the Townshipspruit to the east of the Mini-pit and in the Schoongezichtspruit to the west of the Mini-pit was analysed. The historical water quality at the Zaaihoek weir was also analysed to give an indication of the baseline water quality in the Klipspruit catchment.

A number of interim and acceptable water quality guidelines were stipulated in the White Paper and these were compared to the historical water quality found in the Townshipspruit, Schoongezichtspruit and at Zaaihoek weir on the lower Klipspruit.

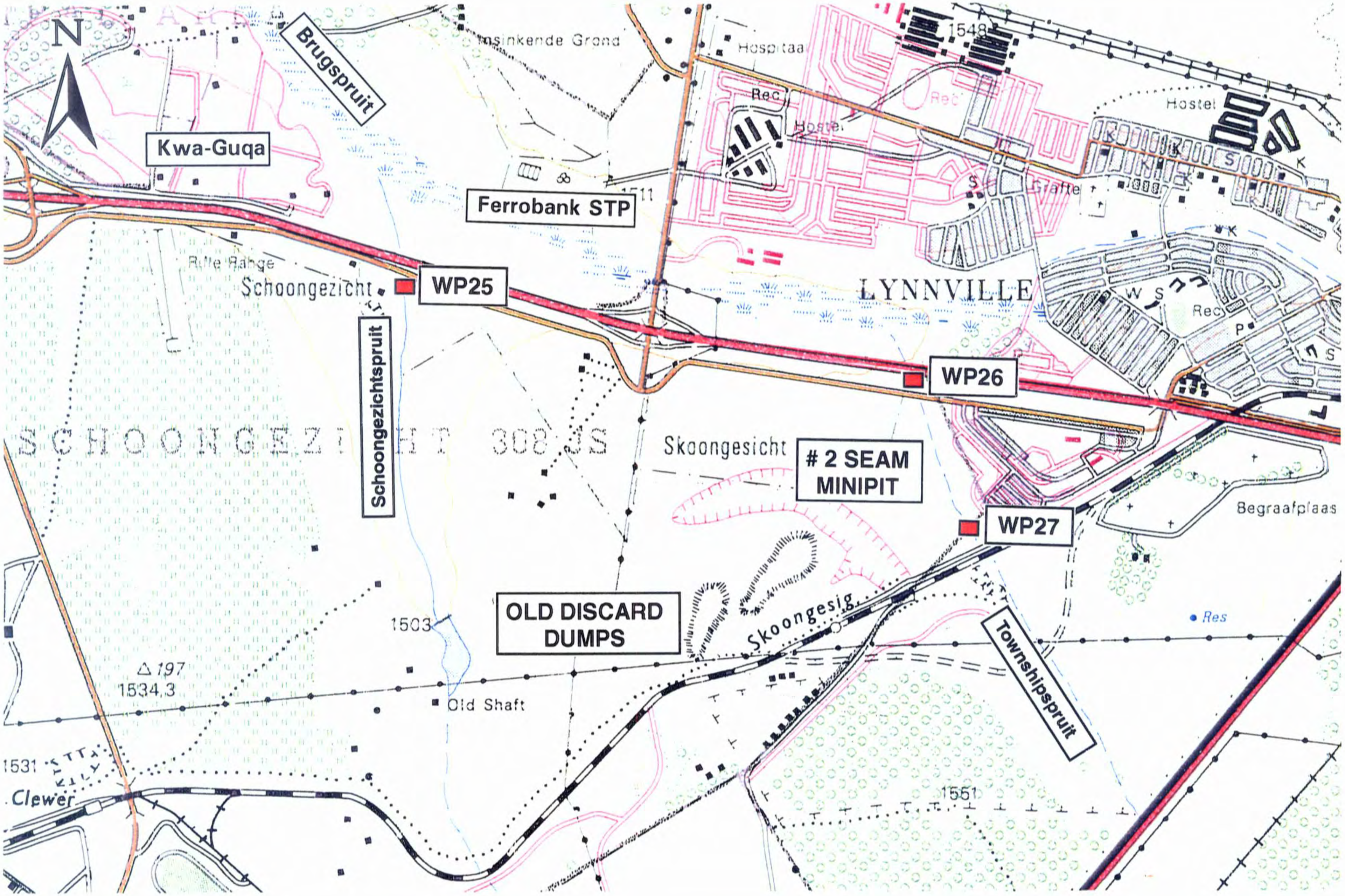


Figure 3.2 (a) : Monitoring points on the Townshipspruit and the Schoongezichtspruit.

Water quality records collected by SACE at two monitoring stations on the Townshipspruit were analysed from January 1990 to establish the baseline situation in this stream (refer to **Figure 3.2(a)** for the location of stations):

- WP026 - at the point where the Townshipspruit leaves the SACE property
- WP027 - at the point where the Townshipspruit enters the SACE property

The baseline water quality in the Townshipspruit is summarised below in **Table 3.2(c)** and **Table 3.2(d)**.

Table 3.2(c) Baseline Water Quality in the Townshipspruit entering SACE property

Water Quality Variable (mg/ℓ)	Townshipspruit entering SACE (WPO27)				White Paper Guidelines	
	5% tile	50% tile	95% tile	Range	Interim	Acceptable
pH	2.3	4.0	6.4	1.9 - 8.5	6.0 - 9.0	6.5 - 8.5
Electrical Conductivity (mS/m)	50	151	378	38 - 452	120	100
Calcium, Ca	31	200	493	0.0 - 530	-	-
Magnesium, Mg	0.0	94	284	0.0 - 286	-	-
Sodium, Na	19	34	48	17 - 48	250	150
Potassium, K	1.3	5.4	15	0.8 - 19	-	-
Sulphate, SO_4	221	1687	2888	31 - 4751	500	250
Chloride, Cl	4	14	65	4 - 70	320	100
Iron, Fe	0.01	0.85	96	0.0 - 226	1.0	0.3
Aluminium, Al	0.0	5.7	24	0.0 - 30	0.2	0.1
Manganese, Mn	5	13	30	5 - 30	1.0	0.2

Exceeds the Interim Guideline

Table 3.2(d) Baseline Water Quality in the Townshipspruit leaving SACE property

Water Quality Variable (mg/ℓ)	Townshipspruit leaving SACE (WPO26)				White Paper Guidelines	
	5% tile	50% tile	95% tile	Range	Interim	Acceptable
pH	2.2	4.7	7.1	2.1 - 7.8	6.0 - 9.0	6.5 - 8.5
Electrical Conductivity (mS/m)	39	106	356	20 - 383	120	100
Calcium, Ca	42	139	460	32 - 517	-	-
Magnesium, Mg	20	71	234	17 - 292	-	-
Sodium, Na	22	30	45	20 - 46	250	150
Potassium, K	0.8	3.7	12	0.5 - 15	-	-
Sulphate, SO_4	104	1073	2658	61 - 2695	500	250
Chloride, Cl	6.7	18	50	6 - 60	320	100
Iron, Fe	0.05	1.6	84	0.01 - 174	1.0	0.3
Aluminium, Al	0.4	6.4	17	0 - 20.6	0.2	0.1
Manganese, Mn	2.4	6.5	12	2 - 14	1.0	0.2

Exceeds the Interim Guideline

The historical sulphate concentration and pH profiles for the Townshipspruit entering and leaving the SACE property are shown graphically on **Figures 3.2 (b)** and **3.2 (c)** respectively.

Figure 3.2 (b) Historical Sulphate water quality profile in the Townshipspruit entering and leaving the SACE property

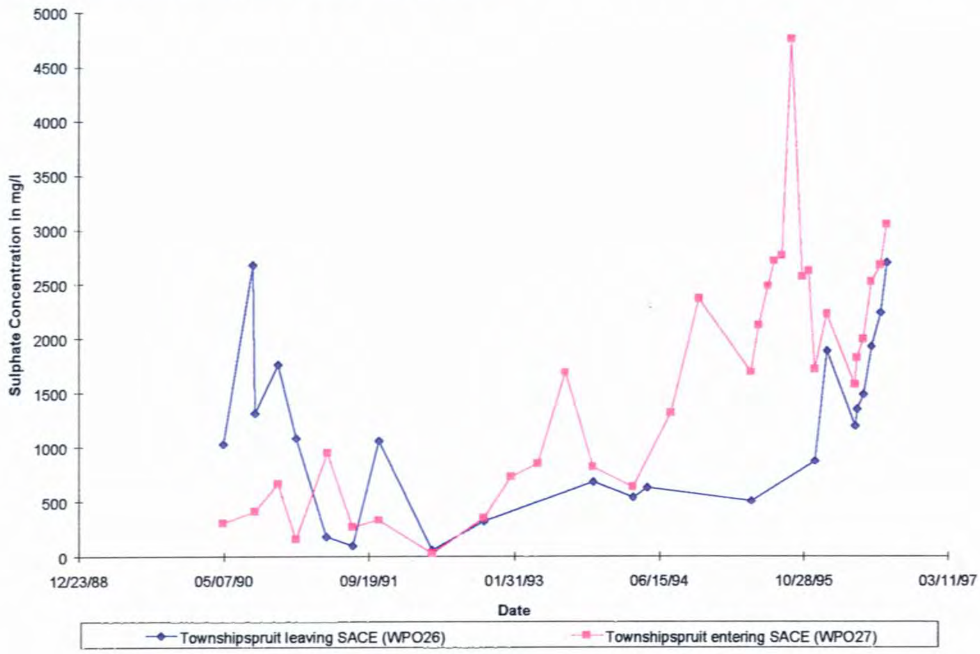
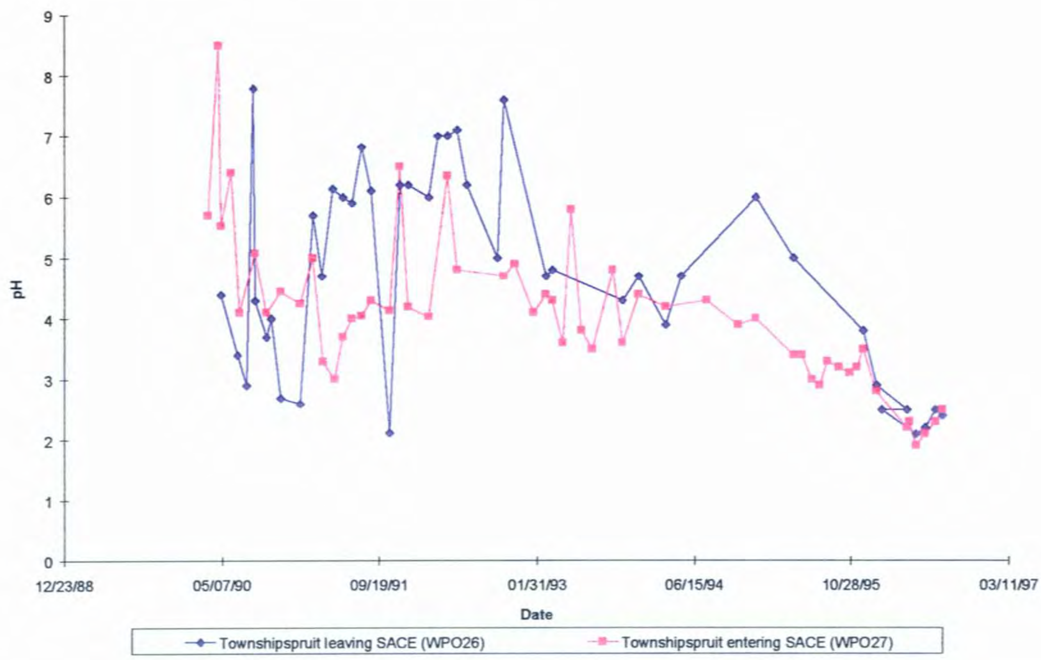


Figure 3.2 (c) Historical pH water quality profile in the Townshipspruit entering and leaving the SACE property



The Townshipspruit water quality is already impacted, by the time it flows onto the SACE property. The water is at times highly acidic and saline. The water quality improves marginally as the spruit flows across the SACE property. The Townshipspruit water quality in general does not meet the salinity-related or the acidity-related water quality guidelines, set for the Klipspruit catchment. A significant deterioration in water quality was noticed during the early months of 1996, after a plug/dam burst at the upslope South Witbank Colliery. This resulted in acid mine drainage entering the stream on a continuous basis.

Water quality records collected by SACE from the Schoongezichtspruit, which is on the western side of the Mini-pit, were also analysed from 1992 to 1996 (refer to **Figure 3.2(a)** for location of the monitoring point):

- WP025 - Schoongezichtspruit

The baseline water quality in the Schoongezichtspruit is summarised below in **Table 3.2(e)**.

Table 3.2(e) Baseline Water Quality in the Schoongezichtspruit

Water Quality Variable (mg/ℓ)	Schoongezicht (WP025)				White Paper Guidelines	
	5% tile	50% tile	95% tile	Range	Interim	Acceptable
pH	2.5	3.1	3.9	2.0 - 4.5	6.0 - 9.0	6.5 - 8.5
Electrical Conductivity (mS/m)	53	199	368	46 - 395	120	100
Calcium, Ca	68	220	469	67 - 492	-	-
Magnesium, Mg	24	83	148	23 - 151	-	-
Sodium, Na	15	30	43	14 - 44	250	150
Potassium, K	1.5	3.6	8.0	0.7 - 8.9	-	-
Sulphate, SO_4	356	1324	1989	315 - 2080	500	250
Chloride, Cl	5	12	43	4 - 50	320	100
Iron, Fe	0.9	11	37	0.3 - 40	1.0	0.3
Aluminium, Al	13	18	27	12 - 28	0.2	0.1
Manganese, Mn	1.7	6.3	8.6	1.6 - 9.5	1.0	0.2

Exceeds the Interim Guideline

The water quality in the Schoongezichtspruit is also at times very poor. Acidic mine water seeping and decanting from the upslope mine workings at times impacts on the spruit. A collapse of an under-mined area associated with the old Schoongezicht Section took place after the 1995/96 wet summer. This resulted in a continuous flow of acid mine drainage down the stream. The acidity-related (pH, Al, Fe, Mn) and salinity-related (sulphate and conductivity) water quality variables exceed the White Paper interim guidelines.

The Department of Water Affairs and Forestry maintains a flow and water quality monitoring station at Zaaihoek on the Klipspruit. The water quality at this weir was taken as being representative of the baseline water quality of the Klipspruit catchment. The general profile of the historical water quality over the period 1 October 1992 to 30 September 1995 in the Klipspruit at Zaaihoek is summarised in **Table 3.2(f)**.

The impact of upstream polluted streams on the Klipspruit was assessed by comparing the baseline water quality of the Klipspruit with the White Paper guidelines. The main water quality variables of concern at Zaaihoek were found to be pH and sulphates. The water quality, specifically of the acidity-related variables, will improve after commissioning of the Brugspruit Water Pollution Control Works.

Figure 3.2(f) Baseline Water Quality in the Klipspruit at Zaaihoek Monitoring weir.

Water Quality Variable	Zaaihoek Weir on the Klipspruit			White Paper Guidelines	
(mg/ℓ)	5% tile	50% tile	95% tile	Interim	Acceptable
pH	3.9	6.2	8.0	6.0 - 9.0	6.5 - 8.5
Electrical Conductivity (mS/m)	44	74	118	120	100
TDS	285	485	808	820	680
Calcium, Ca	24	42	66	-	-
Magnesium, Mg	12	19	28	-	-
Sodium, Na	39	73	126	250	150
Potassium, K	5	8	12	-	-
Sulphate, SO_4	153	265	512	500	250
Chloride, Cl	23	38	65	320	100
Fluoride, F	0.3	0.5	0.9	1.7	1.0
Ammonia as N	0.02	0.04	0.13	2.0	1.0
Phosphate as P	0.004	0.01	0.02	-	-
Nitrate as N	0.03	0.06	0.8	10	6
Manganese, Mn	-	-	-	1.0	0.2
Iron, Fe	-	-	-	1.0	0.3
Aluminium, Al	-	-	-	0.2	0.1

Exceeds the Interim Guideline

3.2.3. Drainage density of the catchments (*Section 2.9.3 in Aide Memoire)*

The drainage densities for the Townshipspruit and the Schoongezichtspruit are presented in **Table 3.2 (g)**

Table 3.2 (g) Drainage Densities for the Townshipspruit and the Schoongezichtspruit catchments

Stream	Drainage Length (km)	Surface Area (km^2)	Drainage Density (km/km^2)
Townshipspruit	2.15	8.7	0.25
Schoongezichtspruit	2.9	11.3	0.26

3.2.4. Surface Water Use (*Section 2.9.4 in Aide Memoire)*

The Schoongezichtspruit and Townshipspruit flow into the Brugspruit which flows into the Klipspruit. The two water users in this catchment are informal domestic use and aquatic life.

The Klipspruit flows through the informal settlement of Kwa-Guqa which is on the outskirts of Witbank. This informal settlement has a ready supply of potable water in the form of stand-pipes. The Klipspruit is therefore mainly used for domestic in the form of stand-pipes. The Klipspruit is therefore mainly used for domestic purposes in the form of clothes washing and cleaning. Cropping within the Klipspruit catchment is mainly dryland as irrigation using the stream water has ceased due to the poor water quality. The poor water quality has also had an effect on the aquatic life of this catchment with stretches of stream becoming devoid of the expected aquatic life (IWQS, 1996).

At present the rehabilitation of the Klipspruit catchment is being undertaken in three phases:

- **Phase I** - Prevention of any further deterioration of water quality and involves the withholding of further effluent discharge permits and re-assessment of existing permits.

  Pollution control strategies include the construction of a dam just south of the N4 highway to control AMD from the Navigation and Schoongezicht collieries.

  Acid Mine Drainage from the abandoned Excelsior colliery is also to be collected and pumped to a liming plant at the Kromdraai collieries, whereafter it is to be discharged to the adjacent catchment.

- **Phase II** - Improve the water quality of the Klipspruit to the interim objectives specified in White Paper F-92 within 5 years of the implementation of this phase. To achieve this, a treatment plant at Brugspruit will collect and treat Acid Mine Drainage from abandoned mines.

- **Phase III** - Improve water quality to the acceptable objectives specified in White Paper F-92 within the long term (15 years). To achieve this, stabilisation and sealing of severely collapsed surfaces as well as re-mining of remnant coal reserves and then sealing of the surface will be implemented.

3.3 Groundwater (*Aide Memoire 2.10*)

3.3.1 General geology

The Schoongezicht No 2 seam Mini Pit is situated in the Central Block of the Witbank Coalfield **(Figure 3.3.1)**.

The geology of the coalfield is dominated by a nearly horizontally-bedded, gently undulating succession of shales, sandstones and coal developed at the base of the Ecca Group of the Karoo Sequence. The Ecca Group comprises sediments deposited in shallow marine and fluvio-deltaic environments with the coal accumulated as peat in swamps and marshes associated with these environments. The sediments generally overlie the conglomerate/diamictite Dwyka Formation.

Two coal seams are developed at Schoongezicht. The lower coal seam, termed the No 1 seam, lies on the Dwyka diamictites or poorly-sorted sandstone. It is approximately 1 m thick. Locally, a thin sandstone or shaly parting is developed which splits the seam into the No 1 seam and No 1A seam which overlies it. The No 1A seam is generally less than 0.3 m thick.

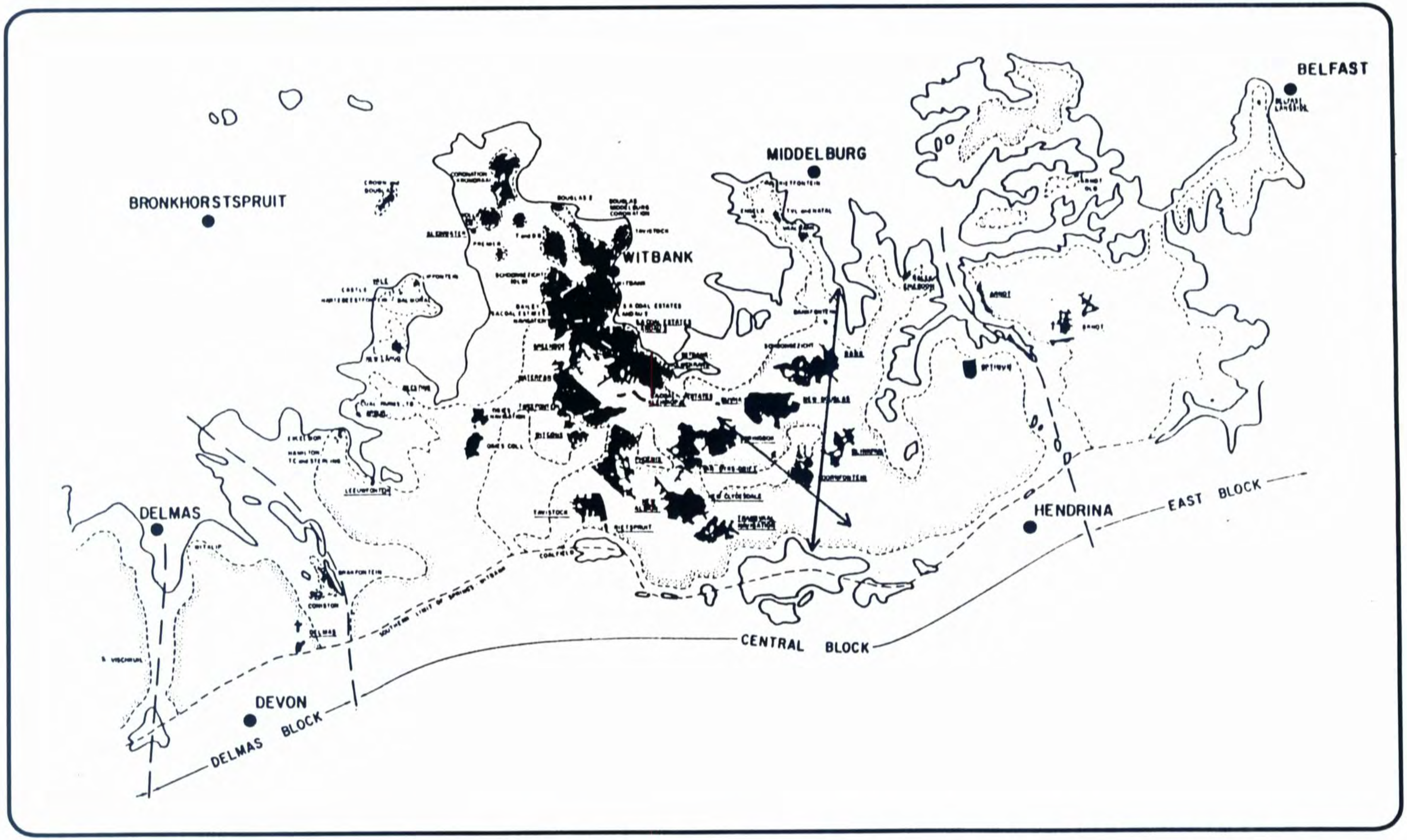


FIGURE 3.3.1 : Regional distribution of the #2 coal seam and the Witbank Coalfield Central Block

The No 2 seam is separated from the No 1A seam by a sandstone parting and is in excess of 6 m thick although a carbonaceous shale or sandstone parting may separate the No 2 seam into a No 2 Upper ("roof coal") and a No 2 Lower seam.

No dolerite intrusives have been noted in the area of the No 2 seam Mini Pit. Schematic representations of the geology in the pit are indicated in **Figure 3.3.2 (a)** and **(b)**, which are referenced to **Figure 3.3.2.**

3.3.2 Water aquifers

Previous experience in the area indicates that the regional piezometric surface is topographically controlled with groundwater draining towards the surface stream channels. Locally, dewatering associated with existing and abandoned underground mine workings can lower the piezometric surface to the discharge elevation of the workings.

Six boreholes were drilled around the Mini Pit to obtain geohydrological information. The locations of boreholes EMP 01 to EMP 06 are indicated in **Figure 3.3.2** and borehole logs are included in Appendix A. Water levels recorded in four of the boreholes are presented in **Table 3.3.1**. No other groundwater level data are available beyond the discharge elevation of the Schoongezicht underground workings - approximately 1480 m above msl.

Table 3.3.1 : Measured groundwater levels

Borehole	Collar elevation (masl)	Water table elevation (masl)
EMP 02	1504.4	1496
EMP 04	1532.7	1523
EMP 05	1525.7	1510
EMP 06	1522.5	1515

The following aquifer types may be inferred from the geology of the area:

Shallow, perched aquifer: This shallow (± 10 m) aquifer is essentially independent of the underlying geology and is found perched within the permeable and very highly weathered residual sandstone above the residual sandstone-bedrock interface.

Drilling results indicate the presence of a very shallow (±2 m) pedogenic ferricrete horizon which may allow a perched water body to develop locally. However, this water body is not significant with respect to groundwater flow around the Mini Pit.

Experience of Karoo geohydrology indicates that recharge to the shallow groundwater aquifer is relatively high, up to 3 per cent of Mean Annual Precipitation (MAP). The porosity of the sediments is estimated to be in the order of 40 percent, resulting in a high storativity. Permeability values can vary considerably, depending on the nature of the overburden material, but values of 10^{-4} to 10^{-8} m/s are typical.

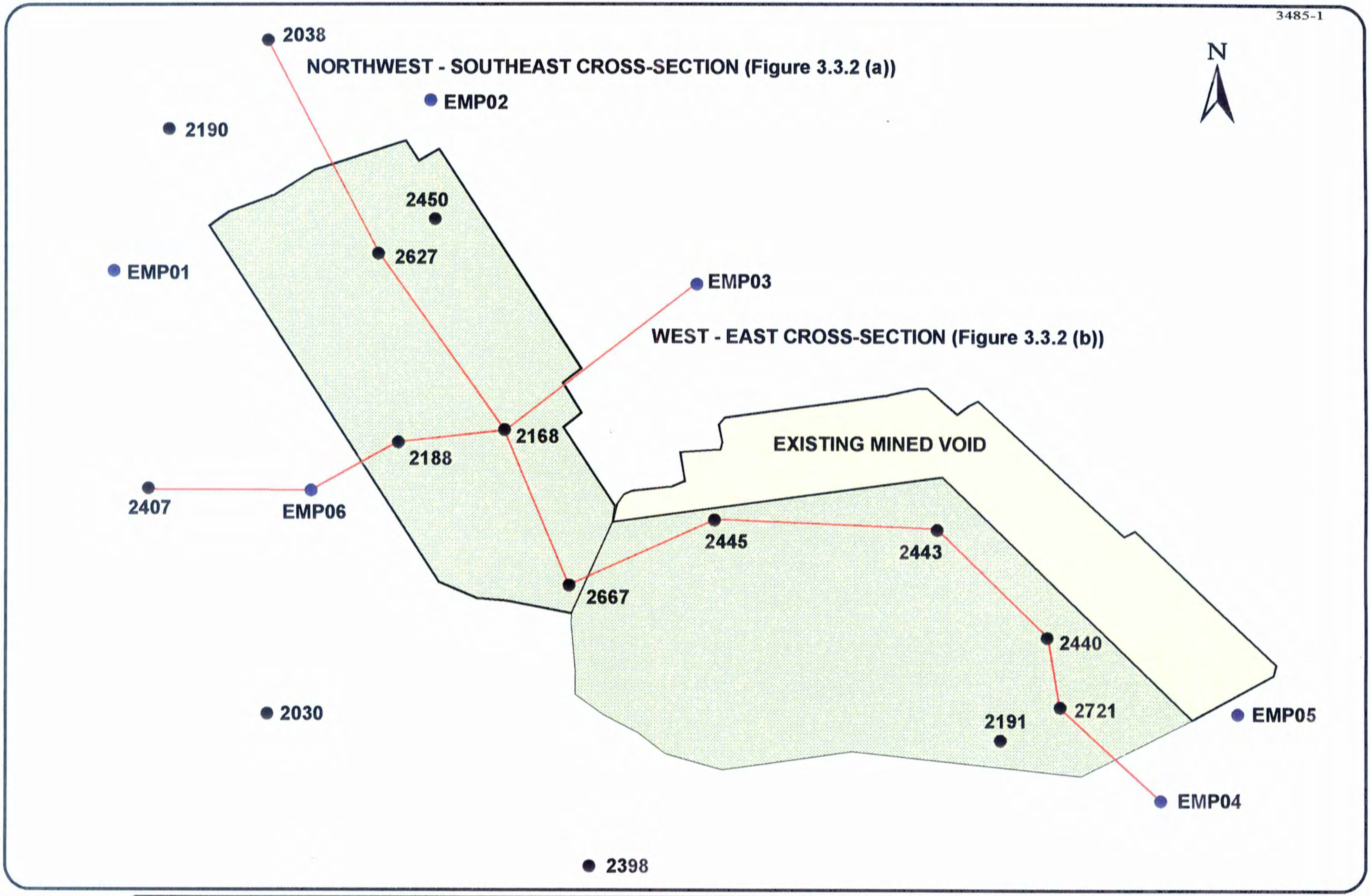


Figure 3.3.2 : Schoongezicht #2 seam minipit - Position of geohydrological boreholes (EMP01 - EMP06) and referenced geological exploration boreholes

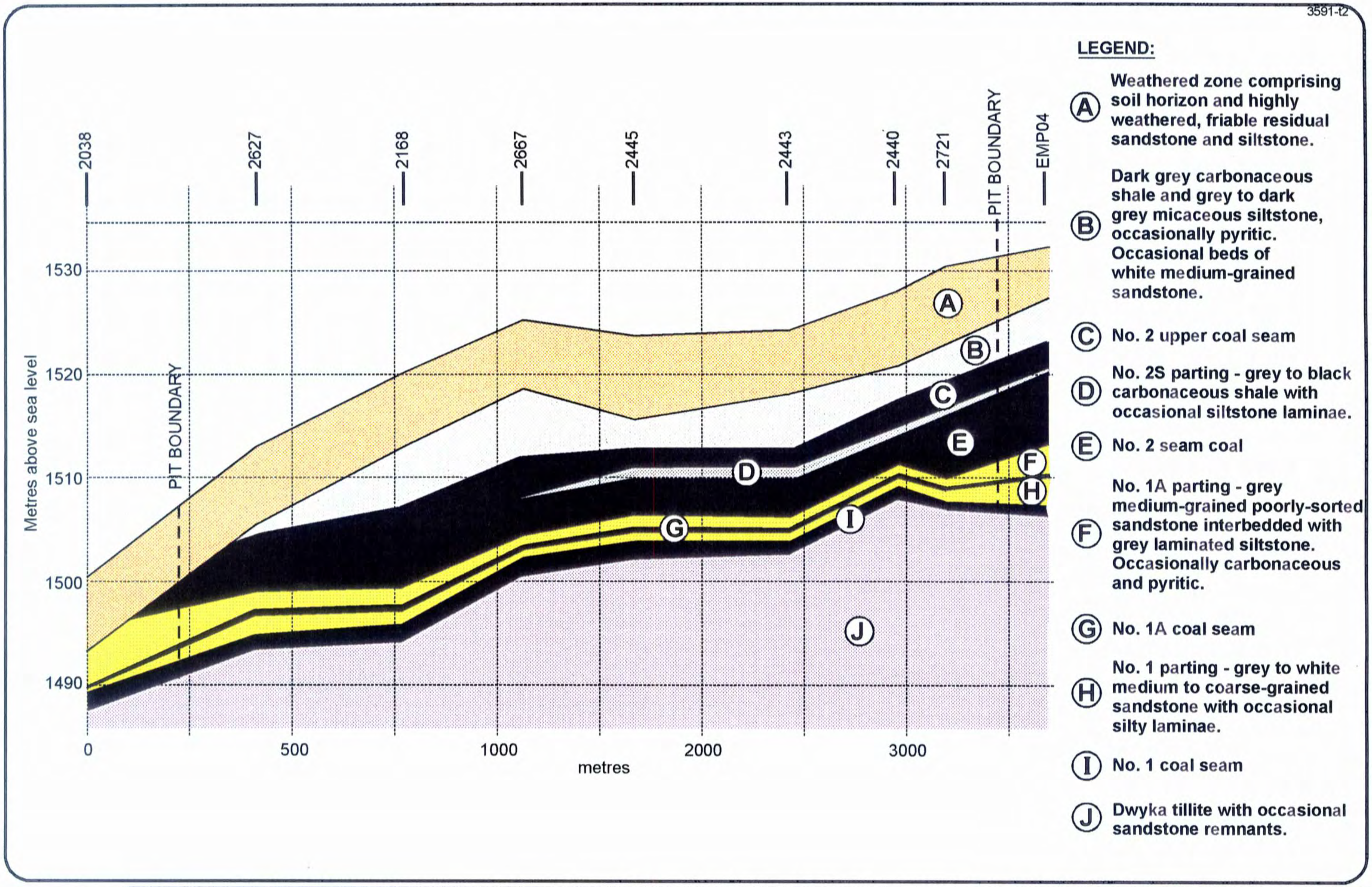


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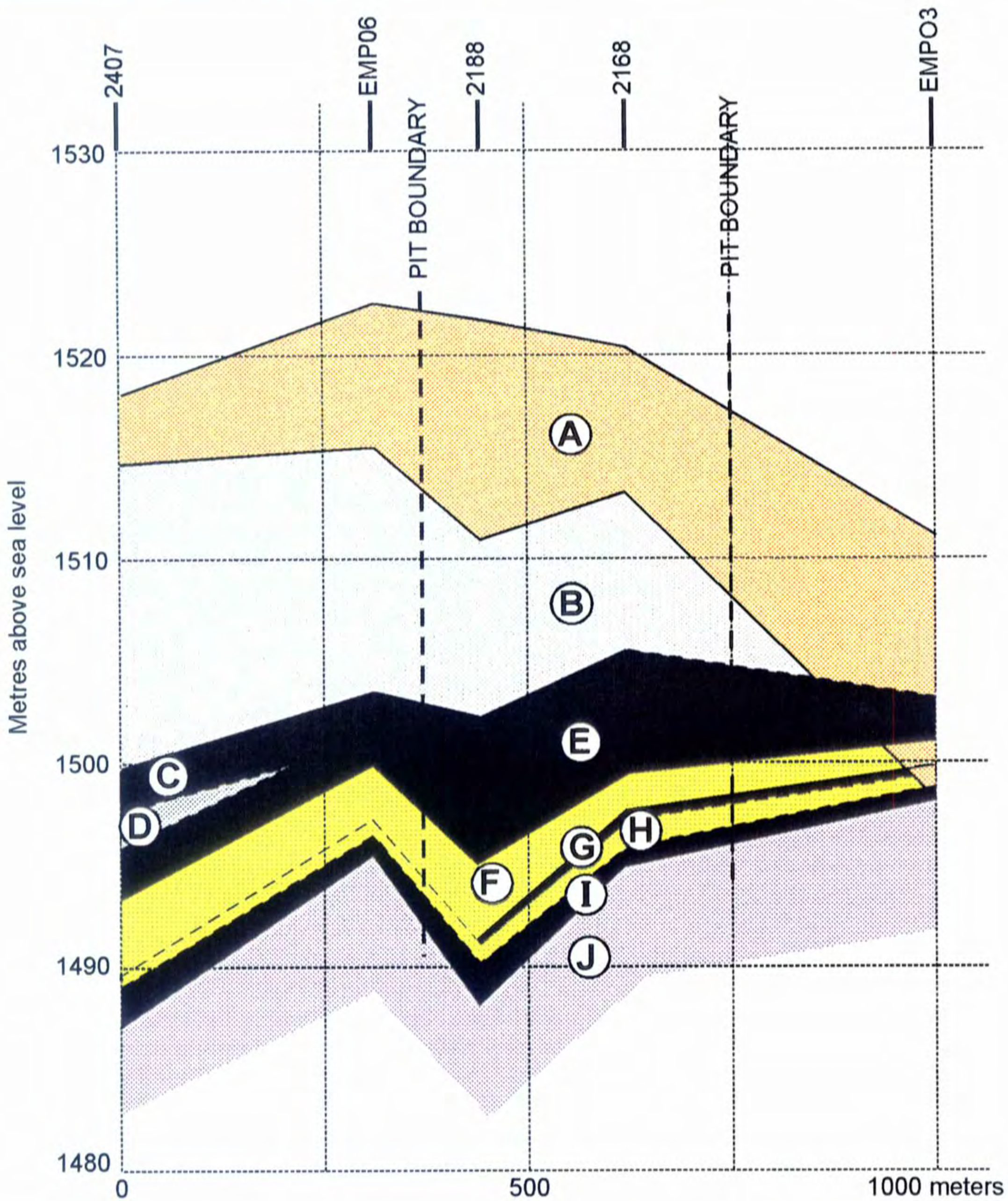
Figure 3.3.2 (a) : Schoongezicht #2 seam minipit - Northwest to Southeast geological cross-section



LEGEND:

- **(A)** Weathered zone comprising soil horizon and highly weathered, friable residual sandstone and siltstone.
- **(B)** Dark grey carbonaceous shale and grey to dark grey micaceous siltstone, occasionally pyritic. Occasional beds of white medium-grained sandstone.
- **(C)** No. 2 upper coal seam
- **(D)** No. 2S parting - grey to black carbonaceous shale with occasional siltstone laminae.
- **(E)** No. 2 seam coal
- **(F)** No. 1A parting - grey medium-grained poorly-sorted sandstone interbedded with grey laminated siltstone. Occasionally carbonaceous and pyritic.
- **(G)** No. 1A coal seam
- **(H)** No. 1 parting - grey to white medium to coarse-grained sandstone with occasional silty laminae.
- **(I)** No. 1 coal seam
- **(J)** Dwyka tillite with occasional sandstone remnants.

Figure 3.3.2 (b) : Schoongezicht #2 seam minipit - West to East geological cross-section

Fractured Karoo Rock aquifer: Extractable groundwater held within the sandstones and shales is usually associated with water-bearing fractures within the rocks or the fractured contacts adjacent to intrusive dykes or sills. Overall, the groundwater potential of these aquifers is moderate to low.

Recharge to the deeper fractured rock aquifer is estimated to be in the order of 1 per cent of the Mean Annual Precipitation (MAP). The porosity of the Vryheid formation in the Karoo Sequence typically ranges from 5 to 15 per cent. However, the specific retention of the interstitial water in Karoo sandstones and shales is high, resulting in a low yield. Typically, only approximately 10 per cent of the interstitial water is released. Permeability values range from 10^{-6} to 10^{-8} m/s.

Aquifers associated with dolerite intrusives: Groundwater commonly occurs within the upper portion of weathered and jointed dolerite sills or the fractured margins of dolerite dykes. No significant dolerite intrusives have been noted at the #2 seam Mini Pit.

Aquifer associated with coal seams: The margins of coal seams or clastic partings within coal seams are often associated with groundwater. The coal itself tends to act as an aquitard allowing the flow of groundwater at the margins. The groundwater potential for such aquifers is generally regarded as low.

Permeability values along the coal seams range from 10^{-6} to 10^{-7} m/s. There is generally a microstructure associated with the coal seam which gives it a relatively higher permeability than the adjacent sediments. The exploitability of the groundwater may be regarded as moderate to low.

Figure 3.3.3 shows a simplified stratigraphic column of the Schoongezicht No 2 seam Mini Pit and relates the stratigraphy to the results of permeability testing conducted on boreholes EMP 02, EMP 04, EMP 05 and EMP 06. Permeability test results are tabulated by borehole in Appendix B.

3.3.3 Groundwater quality (*Aide Memoire 2.10.3)*

No analyses of groundwater quality in the vicinity of the Mini Pit are available. Monitoring boreholes have been drilled recently (mid-March 1997). The boreholes have been used for permeability testing and water of different quality was pumped into the boreholes. After a suitable period to allow the "foreign" water to be displaced (approximately 2 weeks), groundwater in the boreholes will be sampled for chemical analysis. The results of the analyses will provide an indication of the current groundwater quality around the Mini Pit.

3.3.4 Groundwater use (*Aide Memoire 2.10.4)*

Land use in the vicinity of the Mini Pit is devoted exclusively to mining, with the exception of urban development associated with Witbank and the national highway to the north and northeast. Consequently, no groundwater users have been identified within a 3 km radius of the Mini Pit.

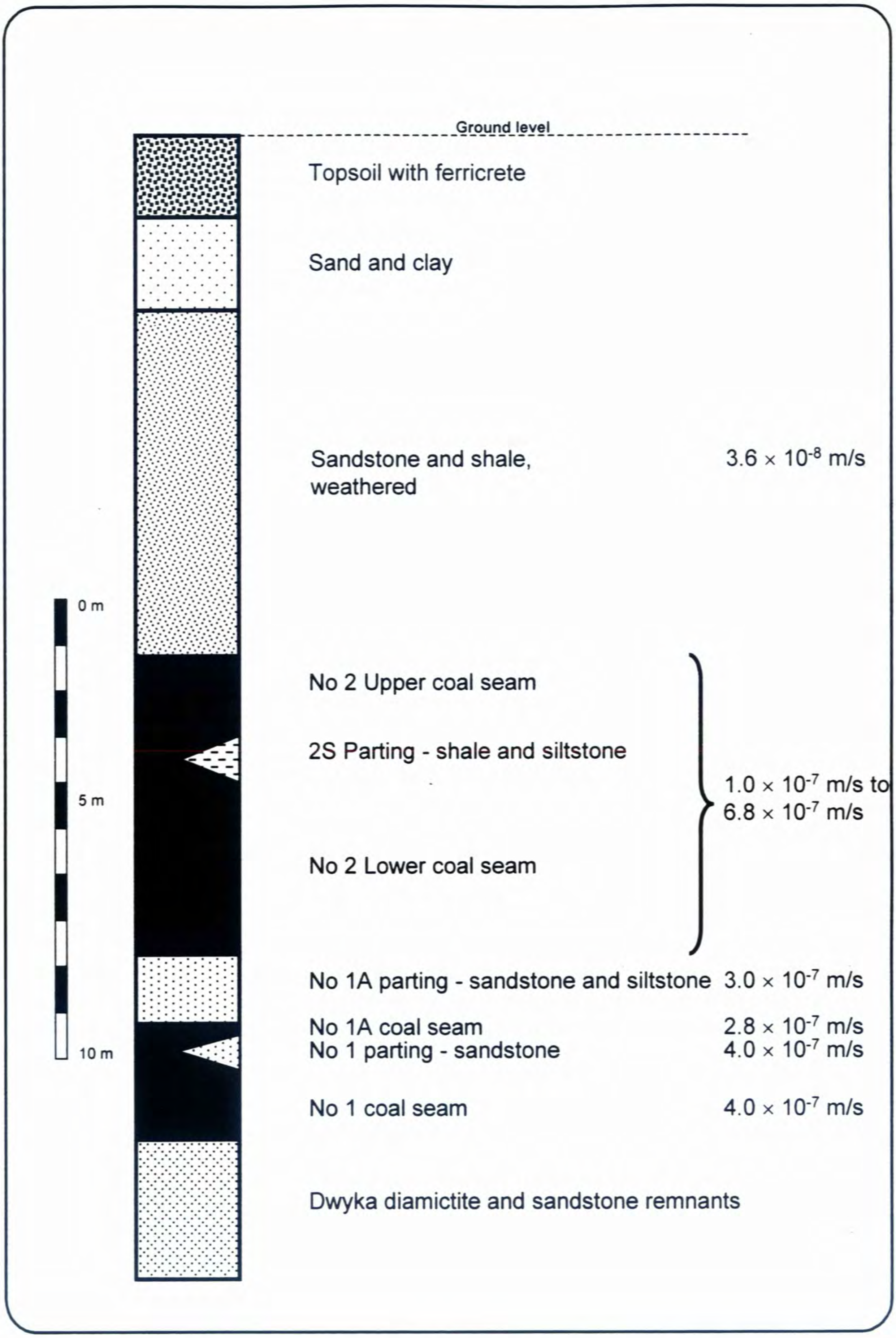


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FIGURE 3.3.3 : Schoongezicht #2 seam minipit - simplified stratigraphy and related hydraulic properties

3.3.5 Geohydrological model

A conceptual geohydrological model for the area has been developed. The geohydrology of the Mini Pit depends on the relative geometry of geohydrological units with respect to the pit. The floor contours of the No 1 coal seam indicate that inflowing groundwater will collect in the northwestern branch of the pit (**Figure 3.3.4**). The pre-mining topography indicates the lowest point on the pit perimeter from which decant will occur should the pit fill (**Figure 3.3.5**). The flow diagram in **Figure 3.3.6** identifies the groundwater flows into and out of the opencast pit. These may be listed as follows:

- Recharge through the overburden spoils of the backfilled pit (Q_1)
- Recharge from the perched aquifer (Q_2)
- Recharge along the No 2 coal seam (Q_3)
- Recharge along the No 1A parting (Q_4)
- Recharge along the No 1 coal seam (Q_5)
- Seepage from the Witbank South underground workings (Q_6)
- Discharge from the flooded pit to the perched aquifer (Q_7)
- Seepage from the pit down-dip along the unmined No 1 coal seam (Q_8)
- Seepage from the pit down-dip along the unmined No 2 coal seam (Q_9)
- Seepage from the pit down-dip along the No 1A parting (Q_{10})
- Seepage to the Schoongezicht underground workings (Q_{11})

It should be noted that the Mini Pit will not be mined to intersect the underground workings. A barrier pillar of between 50 m and 100 m width will be maintained between the pit and the old underground workings.

Two scenarios have been considered to estimate the groundwater flows in the area of the Mini Pit:

- The first scenario analyses the situation during mining and estimates the groundwater flow contributions to the rate of pit filling.
- The second scenario analyses the groundwater flows subsequent to mining and immediately prior to decant of the filled pit at surface.

Hydraulic conductivities of the coal seams and associated partings range from 10^{-7} to 10^{-6} m/s. Based on permeability test results at the Mini Pit, a hydraulic conductivity of 4×10^{-7} m/s was used for the estimation of groundwater flows. The hydraulic conductivity of the perched aquifer ranges from 10^{-8} to 10^{-6} m/s depending on the degree of weathering and clay development. A value of 4×10^{-8} was used to estimate groundwater flows since significant clay development was observed in this unit during borehole drilling.

In the first scenario, the effect of the proposed opencast mining operation on the local geohydrology would be to create a local depression in the piezometric surface towards which groundwater can flow (**Figure 3.3.7**).

In the second scenario, the northern section of the Mini Pit is flooded and the head developed drives water in the downdip direction. Dewatering is maintained in the southern section of the pit because of the geometry of the floor contours and groundwater continues to contribute to pit filling (**Figure 3.3.8**).

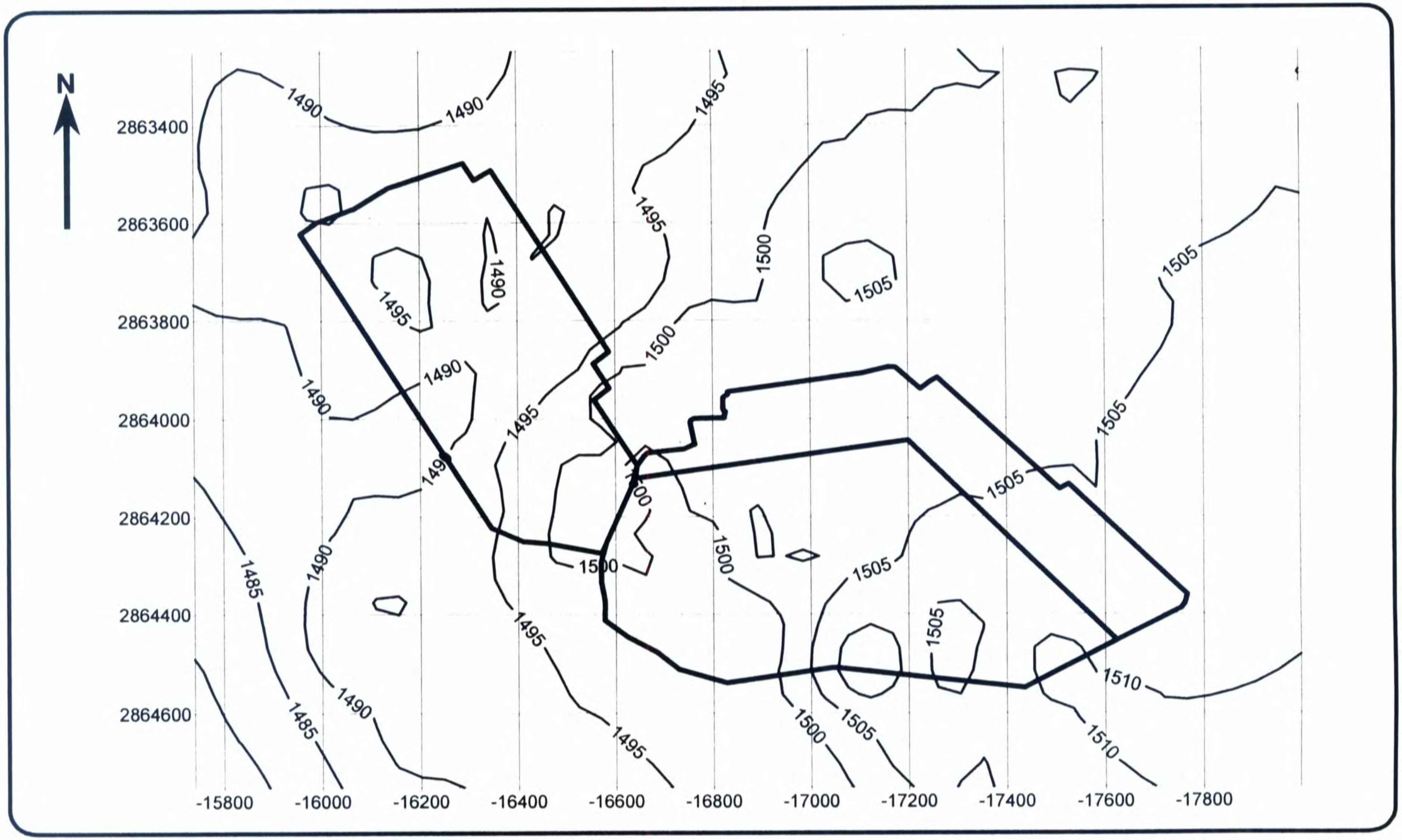


FIGURE 3.3.4 : Schoongezicht #2 seam minipit - No 1 coal seam floor contours

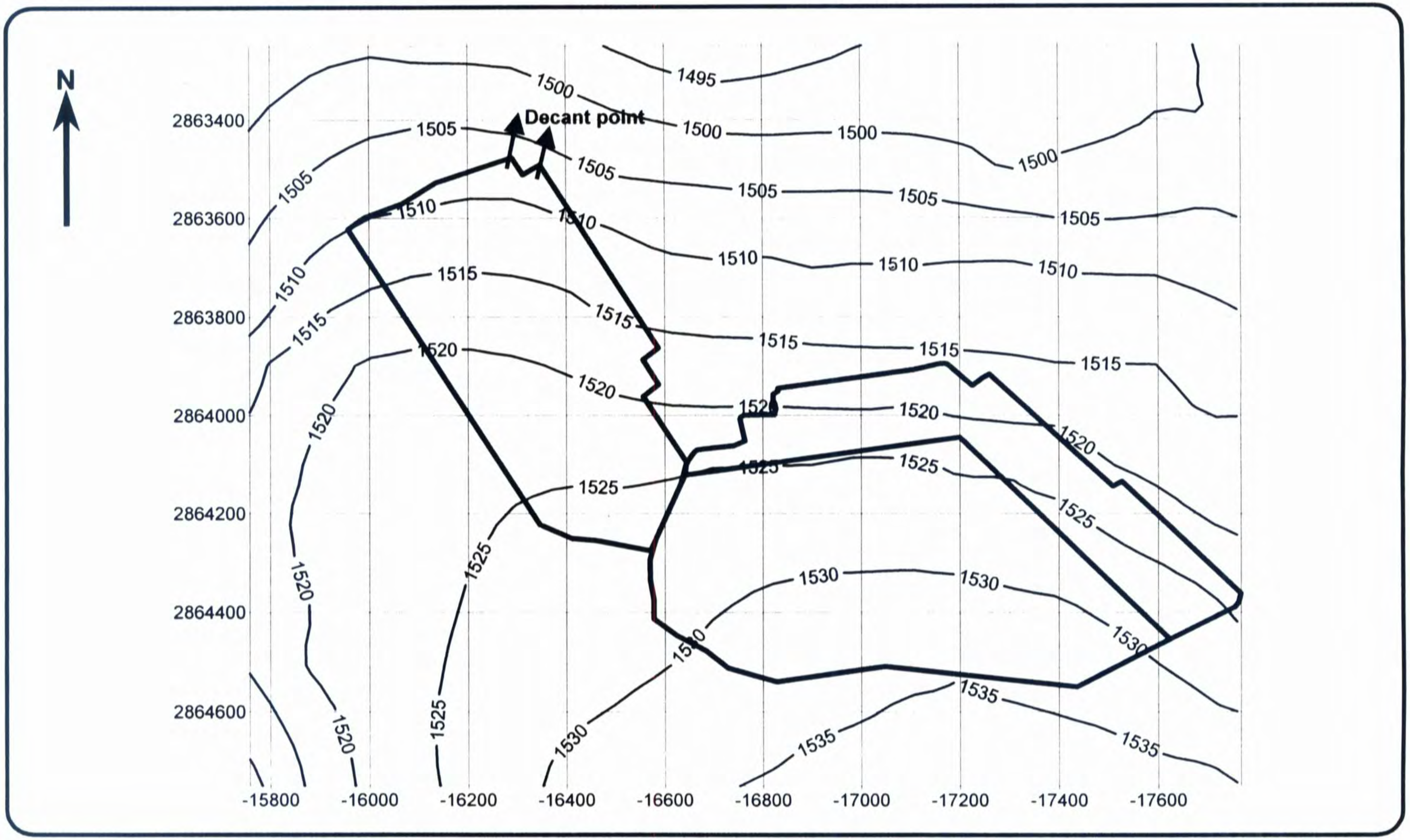


FIGURE 3.3.5 : Schoongezicht #2 seam minipit - Pre-mining topography and decant points

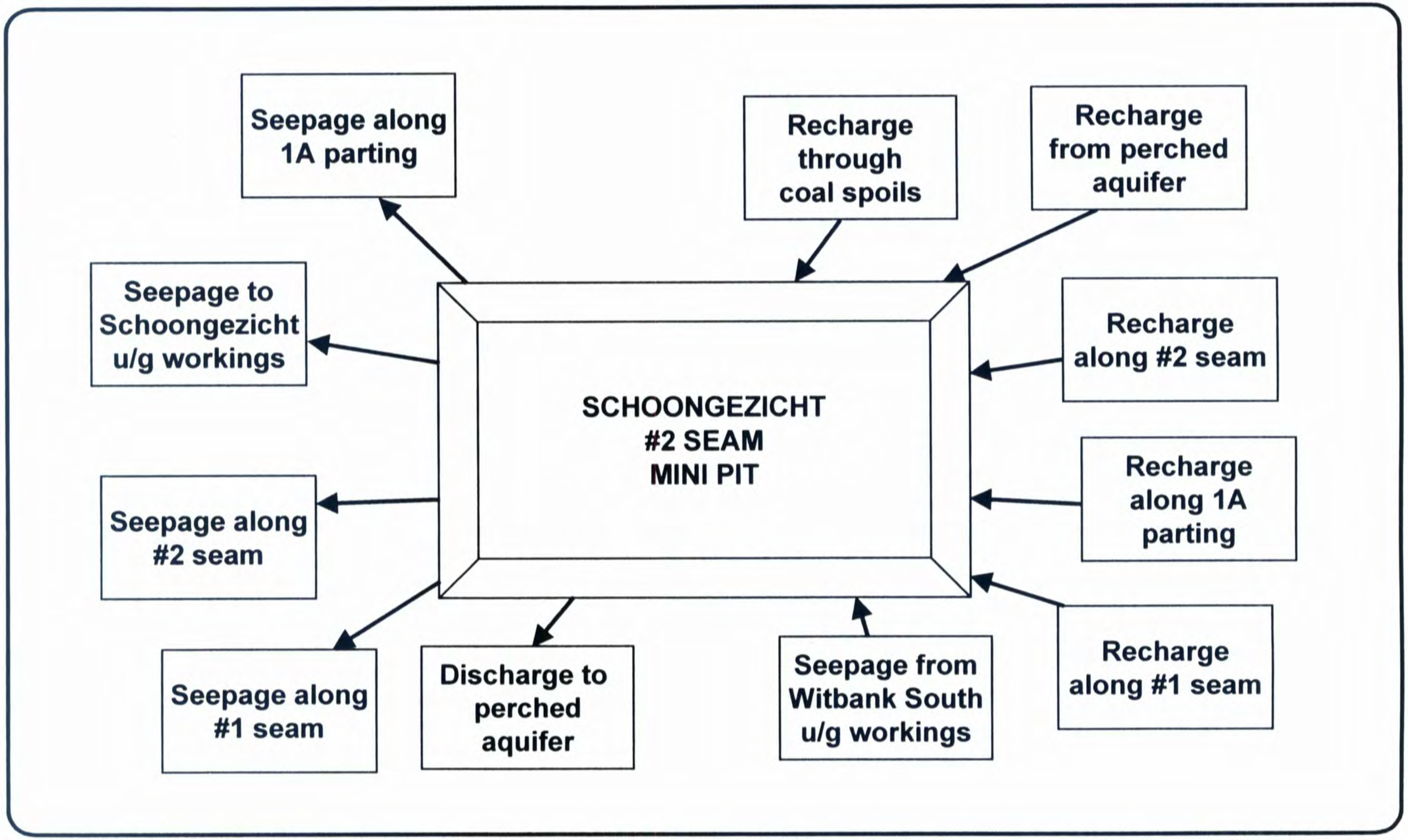


FIGURE 3.3.6 : Schoongezicht No 2 seam Mini Pit - Flow diagram showing sources and destinations of groundwater flows

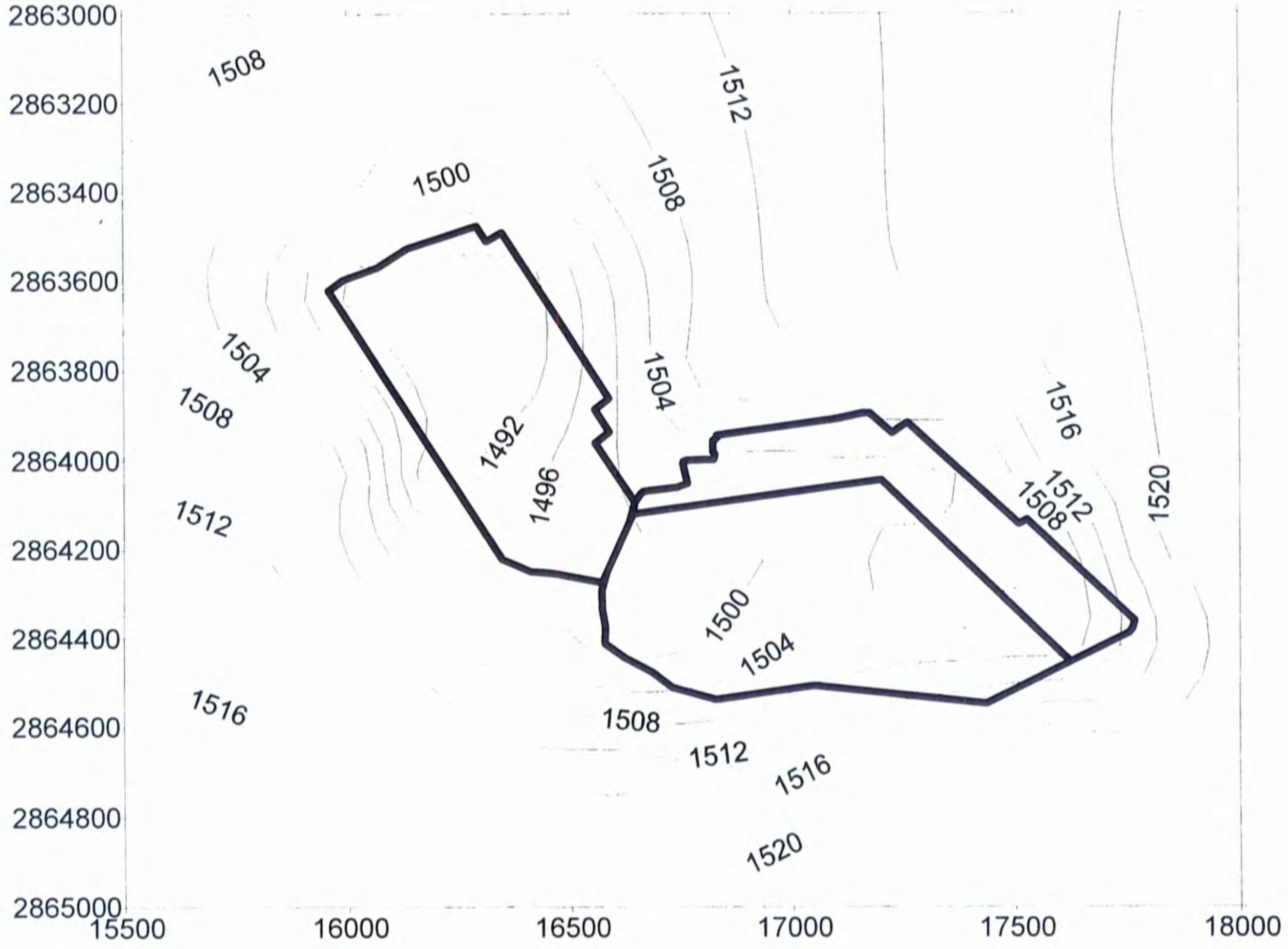


Figure 3.3.7 : Schoongezight No 2 Seam Mini-Pit - Postulated effect of mine dewatering on water level contours.

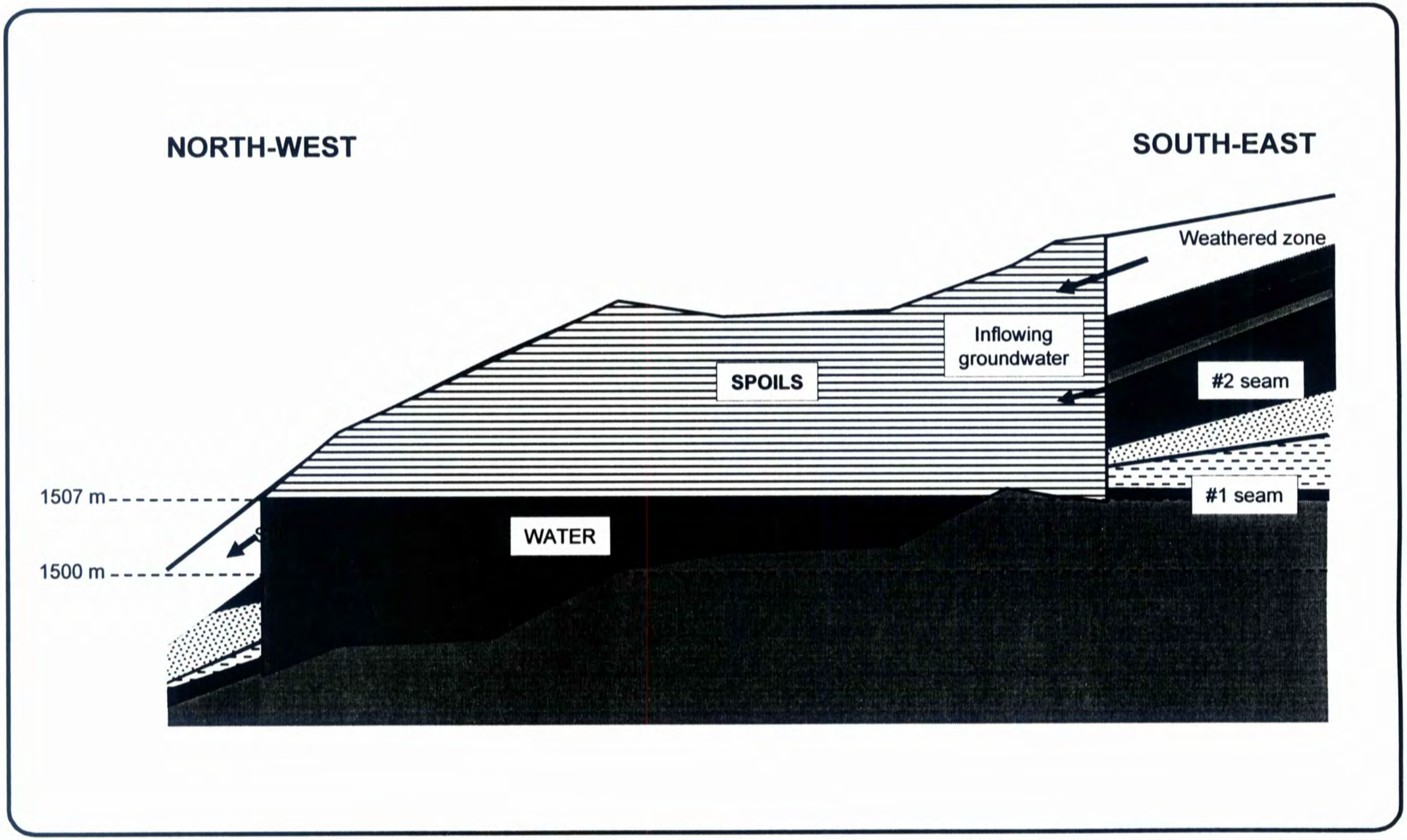


FIGURE 3.3.8 : Schoongezicht #2 seam minipit - Schematic diagram of post-mining situation

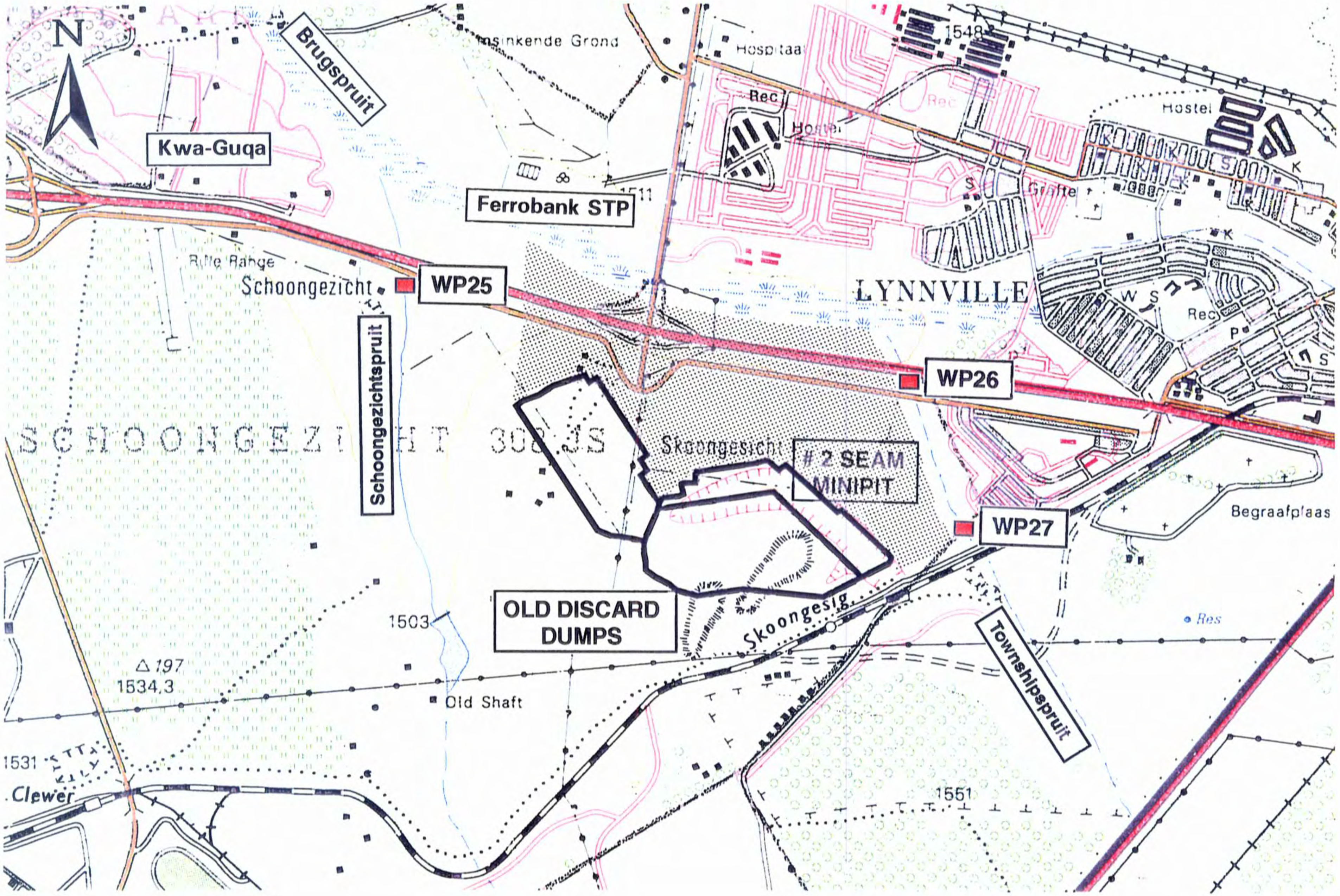


Figure 3.3.9 : Groundwater affected zone around the Mini Pit

Table 3.3.2 presents the estimated groundwater flow for the two scenarios.

Table 3.3.2 : Estimated groundwater flows for two mining scenarios

	Pit filling scenario	Pit decant scenario
Inflow	(m^3/day)	(m^3/day)
Recharge from perched aquifer	3.8	-
Recharge along #2 seam	34.6	17.3
Recharge along 1A parting	9.2	1.7
Recharge along #1 seam	13.0	1.7
Seepage from Wit South u/g	8.6	8.6
Total	69.2	29.3
Outflow		
Seepage to u/g workings	-	51.8
Seepage along #2 seam	-	8.6
Seepage along 1A parting	-	777.6
Seepage along #1 seam	-	2592.0
Seepage to perched aquifer	-	69.1
Total		3499.1

Recharge through the overburden spoils is addressed in Chapter 4. Rainfall recharge through the spoils will be substantially higher than the anticipated groundwater flows (**Figures 4.3 (a), (b) and (c)**).

The groundwater flows associated with the neighbouring mine workings are difficult to assess due to lack of information concerning the Witbank South workings. The flows between mines and the Mini Pit depend on the relative water levels which control the hydraulic gradient between the workings and the Mini Pit. The current underground water level in the Witbank South workings is not known, but has been estimated at 1530 m above msl.

The post-mining surface decant level for the Schoongezicht No 2 seam Mini Pit is 1507 m above msl. Seepage decant is expected to occur in the weathered zone approximately 7 m below this level (1500 m).

3.3.6 Affected zones (*Aide Memoire 2.10.5)*

The preceeding sections demonstrate the geohydrological interaction between the neighbouring mines and the proposed Mini Pit. It is not pragmatic to consider the zone of influence of any one mine or a section of a mine in isolation. The extent and quantification of the affected groundwater zone of the Schoongezicht No 2 seam Mini Pit should be undertaken on a regional scale incorporating the surrounding mines.

The affected zone is expected to include the area between the Townshipspruit and the Schoongezichtspruit to the east and west and the Brugspruit to the north. The regional hydraulic gradient drives water from south to north over the area of the Mini-pit and the southern boundary of the affected zone runs approximately along the railway line south of the Mini-pit - refer to **Figure 3.3.9**.

4. ENVIRONMENTAL IMPACT ASSESSMENT (*Aide Memoire Part 5)*

4.1. Opencast Pit Water Balance

4.1.1. Introduction

The Schoongezicht Mini-pit is to be re-opened to mine the No 1 and No 2 seams. The coal reserves will be exploited over a 48 month period starting in April 1997 and ending in March 2001, followed by 10 months of rehabilitation.

The following information was provided by Landau Colliery:

- A contour plan reflecting the state of the Mini-pit at closure in 1990.
- A mining plan showing the block layout and the proposed schedule of mining.
- A plan showing the floor contours of the No 1 and No 2 seams.
- A plan showing the post mining surface contours.
- A soil survey of the Mini-pit site.

4.1.2. Description of Mini-pit

The existing Mini-pit consists of a box cut, an access ramp, two topsoil stockpiles to the north of the box cut and two discard dumps positioned on top of the proposed future mining area. The box cut was opened during the initial phase of mining, which ended in 1990. Some rehabilitation work was carried out on the box cut. The low wall has been insloped to a gradient of 1 in 2, paddocked, topsoiled and vegetated. No rehabilitation of the high wall, ramp and the pit floor was undertaken. The pit created by these original mine workings has filled with water to a level of 1509.8 m as measured in February 1997.

Discard has been stockpiled on the proposed Mini-pit site. Acid-base accounting of the material in the two discard dumps showed that the material is likely to be acid producing. Care should therefore be taken if the discard is to be worked into the Mini-pit as part of the spoils body. The two topsoil stockpiles located to the north of the existing box cut will be used in the rehabilitation program.

The surface area of the Mini-pit, including the existing box cut, was measured from the 1 in 5000 scale drawings to be 84,6 ha. The surface area and the volume of the existing box cut at level 1516 were estimated to be about 9 ha and 619 057 m^3 respectively. The volume of water that has accumulated in the pit since 1990 was estimated to be 208 039 m^3. This information was used as a check on the pit water model. The calibration procedure followed is described in section 4.1.4.

The Mini-pit consists essentially of an eastern and a western portion. These two portions are to be mined as separate entities. The natural surface topography slopes from south to north across the pit (**See Figure 4.1 (a)**). The surface runoff currently generated on the eastern portion flows into the existing box cut, while the runoff from the western portion currently flows north towards the N4 freeway. The Mini-pit floor contours show that there will be a low point at a level of 1490 m running across the northern corner of the western portion of the Mini-pit (**Figure 4.1 (b)**). The tendency will be for the surface recharge and groundwater inflow to the Mini-pit to collect in the low point. The surface topography and the floor contours indicate that the surface decant level will be between 1506 m and 1507 m on the northern corner of the western portion of the Mini-pit. The level of the subsurface decant will depend on the depth of weathering, and is estimated to be at level 1500 m.

A soil survey of the Mini-pit site was undertaken by Amcoal Environmental Services. Hutton and Bainsvlei (Red) and the Clovelly and Avalon (yellow-brown) soil forms were found on the site. The orthic A and apedal B horizons associated with both soil types were considered to be suitable for use as topsoil for rehabilitation. However, the soft plinthic materials were not recommended for use as topsoil. Based on the depth class map of soil suitable for use for rehabilitation, a rehabilitated topsoil thickness of about 400 mm will be achievable during rehabilitation.

4.1.3. Mining Plan

The coal reserves are to be mined in cuts starting at the junction between the western and eastern portions of the Mini-pit. The cuts will start in an easterly direction across the eastern portion and a westerly direction across the western portion of the mini-pit (**See Figure 4.1 (a)**). The mining will start from the existing box cut and progress in a southerly direction. The Mini-pit was divided into 166 separate mining blocks with an average 3 to 4 blocks mined per month. A single cut across a portion of the pit will take about 4 months. The pit will be continually mined through the low floor contour running across the western portion of the Mini-pit. The water that collects in the spoils body will decant into the open pit floor from where it will be pumped to the existing polluted water system on Landau Colliery.

The existing box cut will be filled and rehabilitated towards the end of the first year of mining. This will be achieved by using the overburden and hards from the mining of the first series of new blocks, further insloping of the low wall and the available stockpiles of topsoil.

The proposed mining plan allows for a single row of unrehabilitated spoils behind the open pit floor. Any particular row of unrehabilitated spoils will be in existence for about 4 to 6 months before being levelled. The status of the mining blocks after the first and third years of mining are shown in **Figures 4.1 (c)** and **4.1 (d)** respectively. The levelling and topsoiling will be done to ensure that the post-mining topography will be free draining. The post-mining topography is shown in **Figure 4.1 (e)**. Due to the further flattening of the box cut low wall, a drainage line will be created on the northern part of the Mini-pit, which will collect the surface runoff and direct it to the Schoongezichtspruit. During mining, the upslope surface runoff will be prevented from entering the pit by means of berms constructed along the southern edge of the opencast pit.

4.1.4 Calibration of Water Balance Model

The previous mining operation ceased in 1990. During the period January 1990 to January 1997 the box-cut filled up with water to a level of 1509.8. Based on the survey information provided by Landau Colliery, a level of 1509.8 corresponds to a water volume of 208 039 m^3 in the box-cut. This represents a net gain of water in the open box cut over an 85 month period.

The monthly pit water balance model was set up to represent the state of mining at closure in 1990. A schematic diagram showing the sources and sinks of water in the box cut is presented in **Figure 4.1(f).**

The sources of water shown in the schematic diagram are the surface runoff from upslope, recharge from the in-sloped rehabilitated low wall of the box cut, rainfall falling directly into the box cut and groundwater entering the box cut from the high wall. Due to the paddocks created on the low wall during rehabilitation, the surface runoff from this area was assumed to be zero. The groundwater inflow into the box cut was also assumed to be insignificant (See Section 3.3.2) and was not considered in the water balance. The rainfall records from the plant at Navigation Colliery combined with the record at the Witbank rain gauge were used as input to the water balance.

The sinks for water from the box cut are evaporation from the water surfaces and seepage from the box cut to the surrounding aquifers . The seepage from the floor was not included in the water balance as it was considered to be small in relation to the evaporative losses. The average monthly evaporation figures listed in **Table 3.2(a),** adjusted by a pan-factor, were used to estimate the evaporation from the water stored in the box cut.

The monthly recharge percentages used to determine the volume of recharge water entering the box cut from the rehabilitated low wall are given in **Table 4.1(a).** The effective annual recharge of rainfall was assumed to be 11% of MAP.

Table 4.1(a) : Monthly percentages of annual rainfall used to estimate recharge from the rehabilitated area of low wall

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Recharge (%)	1.6	1.4	1.1	0.7	0.3	0.3	0.3	0.3	1.0	1.2	1.3	1.5

The surface areas contributing water to the box cut are listed in **Table 4.1(b).**

Table 4.1(b) : Catchment areas (ha) contributing to the box cut water balance

Description	Upslope Catchment	Area Ramp	Rehabilitated low wall	Total box cut floor area
Area (ha)	32	0.9	2.7	63

The unit runoff depths from the upslope catchment, the ramp and the box cut floor were computed on a daily basis and totalled to give monthly figures for input to the water balance. The computed volume in the box cut at the end of the simulation period was 230 199 m^3. This is within 10 % of the measured volume of 208 039 m^3 stored water. This was considered to be adequate and the model parameter values were used in the pit water balance modelling.

4.1.5 Modelling of the Pit Water Balance

A generic mine water model developed to assess the pit water make during active opencast mining operations was used to simulate the Mini-pit water balance. The pit was represented by the 166 blocks with the status of each block in each of the 58 months of the mining and rehabilitation operation being input to the model. The coal reserves were assumed to be exploited after 48 months of mining. A further 10 months were allowed for the final rehabilitation of the pit to give a total of 58 months for the life of the mine. The block status types that are catered for in the model include natural conditions, prestripped, pit floor, unrehabilitated spoils, levelled spoils, levelled and topsoiled, and fully rehabilitated (vegetated) spoils. Besides the individual mining blocks, the generic mine water model allows in-spoil water storage, local depressions on the rehabilitated surface, polluted water dams and a pit floor sump which can be incorporated to represent the Mini-pit water system. An in-spoils storage area and a pit floor sump were used together with the individual blocks to model the Mini-pit. The surface recharge water was routed to the in-spoils water storage area and the surface runoff from the prestripped areas and the unrehabilitated spoils was routed to the pit floor. The runoff from the upslope natural areas was assumed to be diverted around the Mini-pit water system by berm walls. Similarly the surface runoff from the rehabilitated areas was assumed to flow out of the system, due to the free draining post-mining topography created behind the mining front

The generic configuration of the Mini-pit water system model is shown on **Figure 4.1 (g)** The Mini-pit water system model was used to simulate the production of excess pit water during the active operational life of the Mini-pit

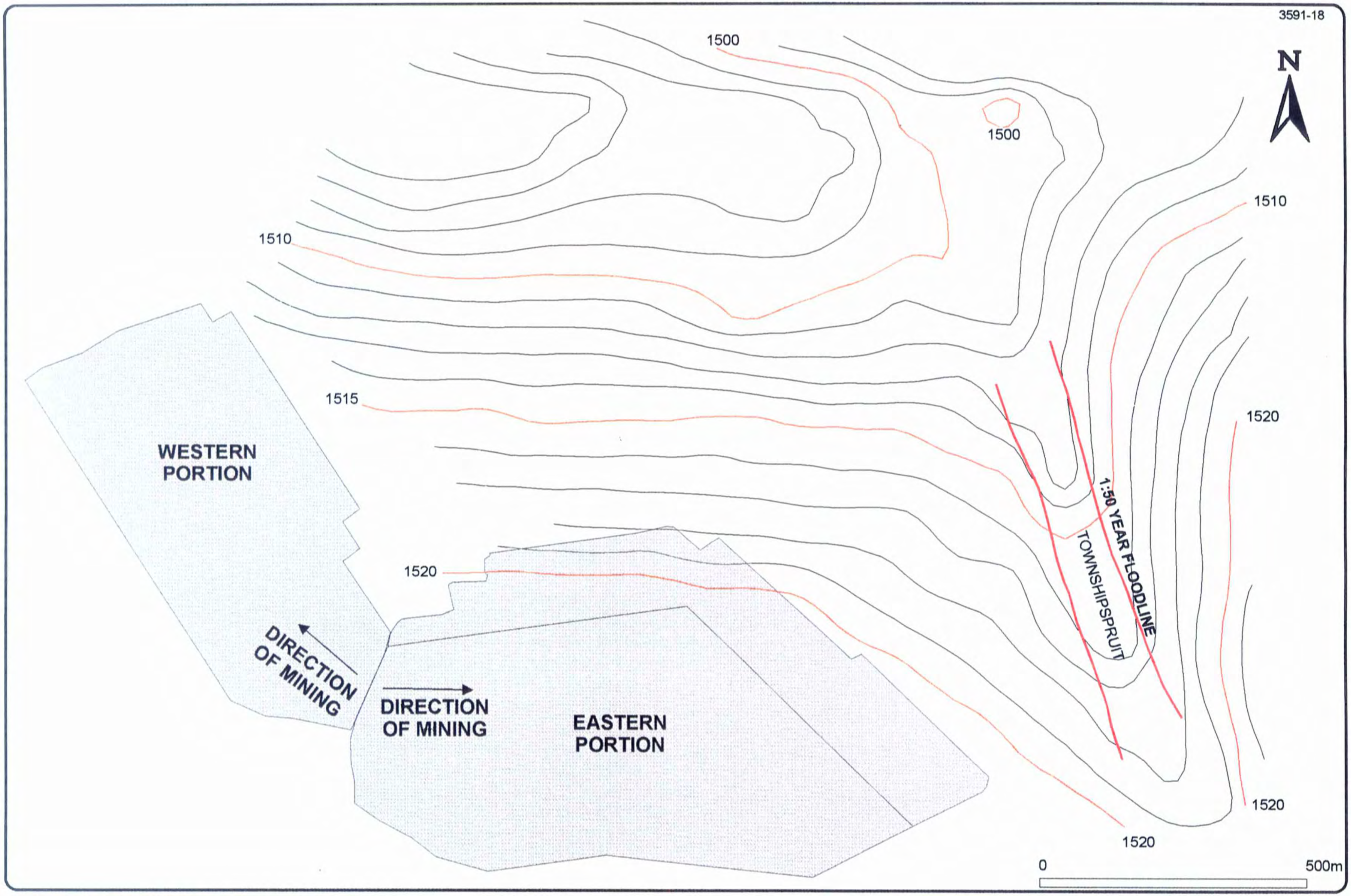


FIGURE 4.1(a) : FLOODLINES AND MINE PLAN SHOWING DIRECTION OF MINING

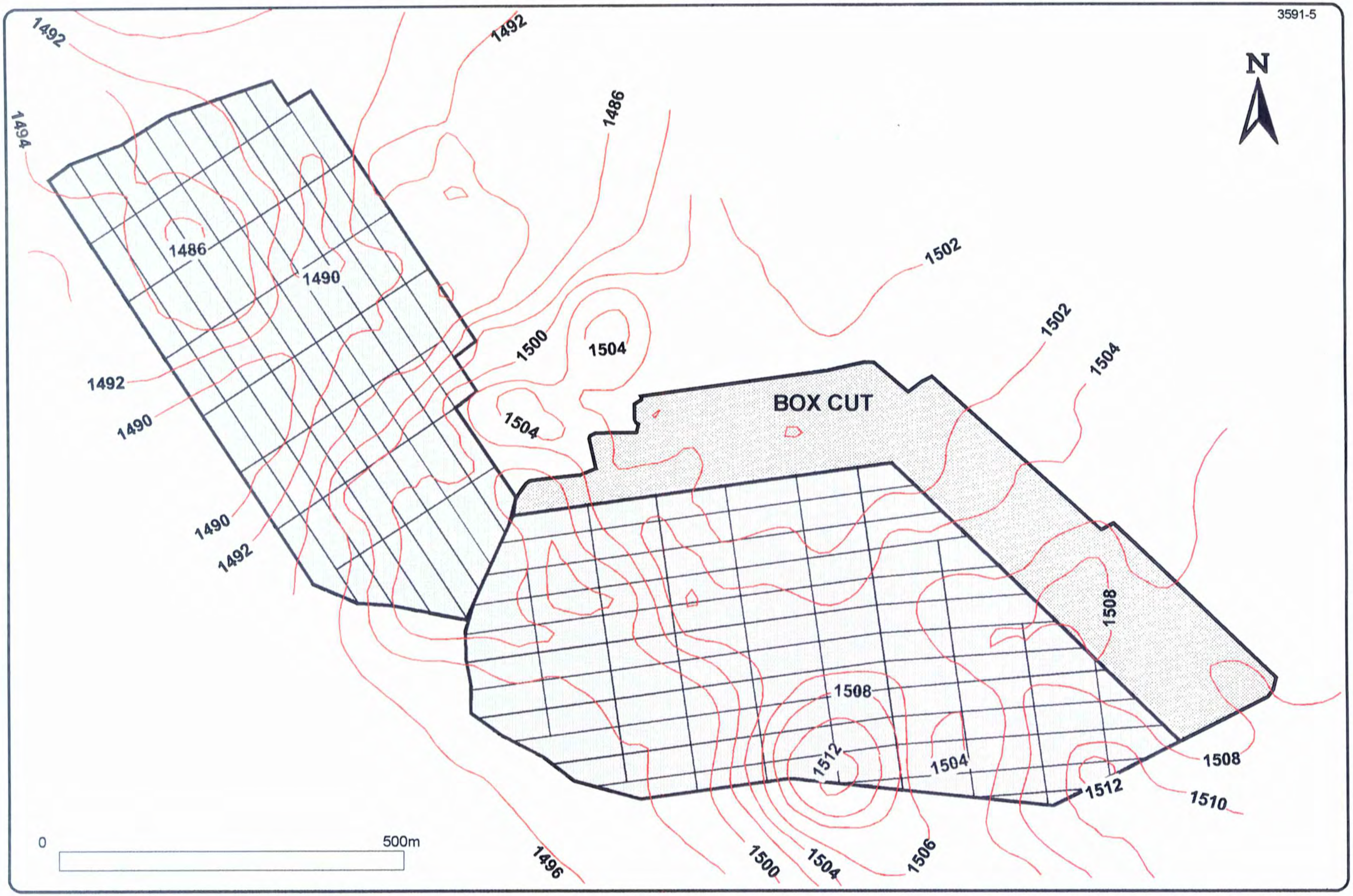


FIGURE 4.1(b) : SCHOONGEZICHT No 2 SEAM - MINI-PIT FLOOR CONTOURS

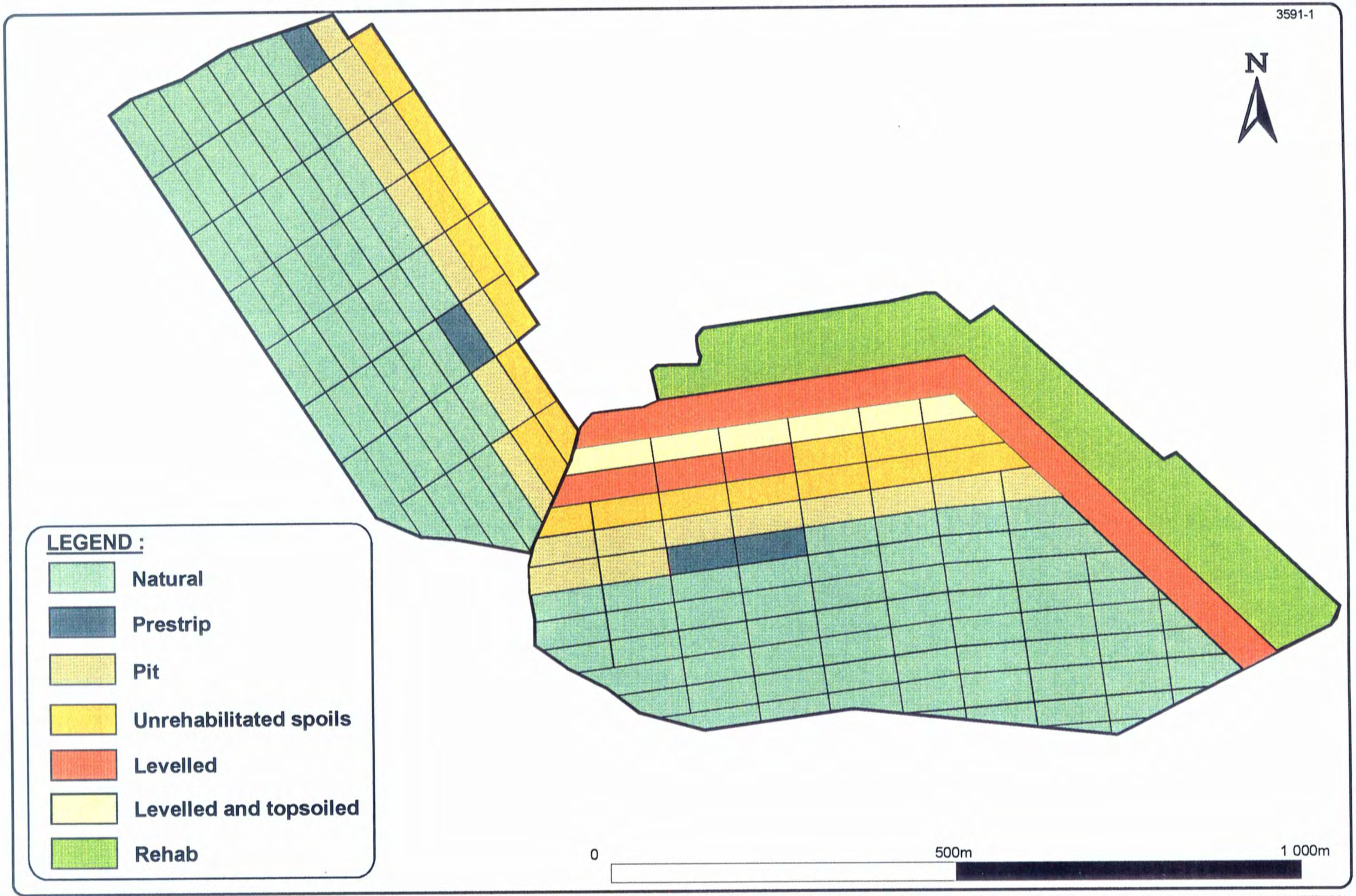


FIGURE 4.1(c) : STATUS OF MINING BLOCKS AFTER FIRST YEAR OF MINING

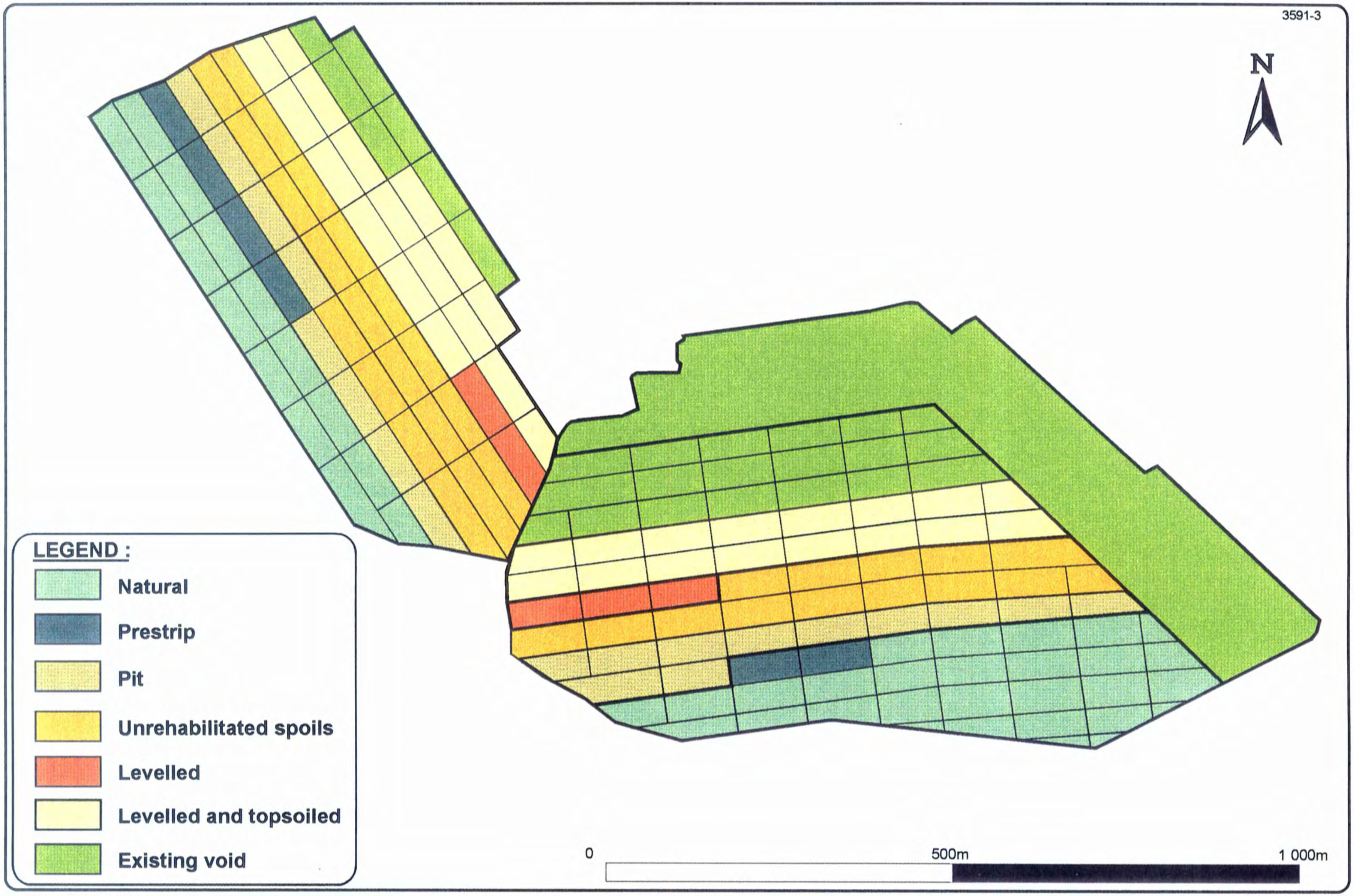


FIGURE 4.1(d) : STATUS OF MINING BLOCKS AFTER THIRD YEAR OF MINING

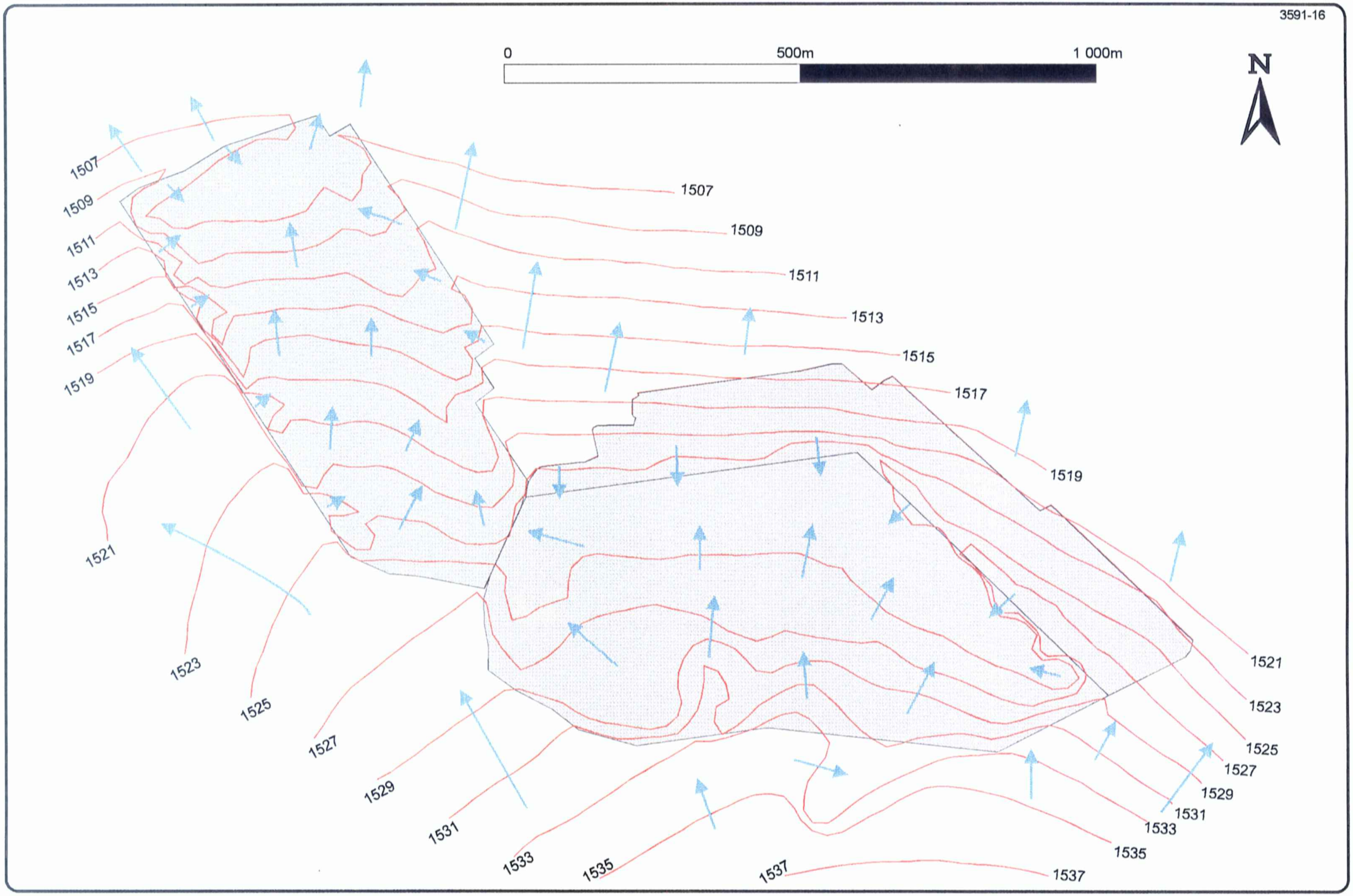


FIGURE 4.1(e) : SCHOONGEZICHT No 2 SEAM MINI-PIT - POST-MINING TOPOGRAPHY

Figure 4.1 (f) - Schematic of box cut water sources and sinks

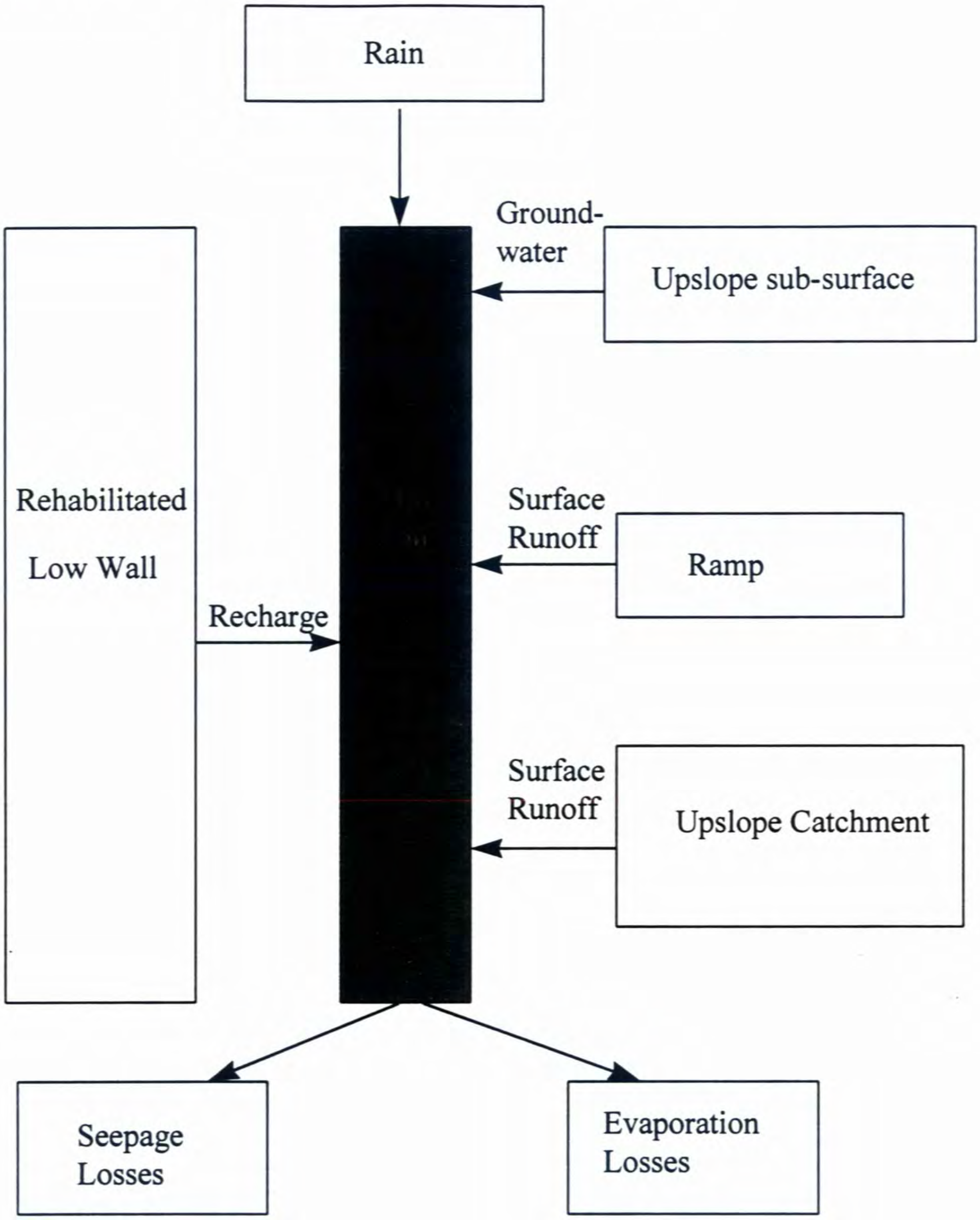
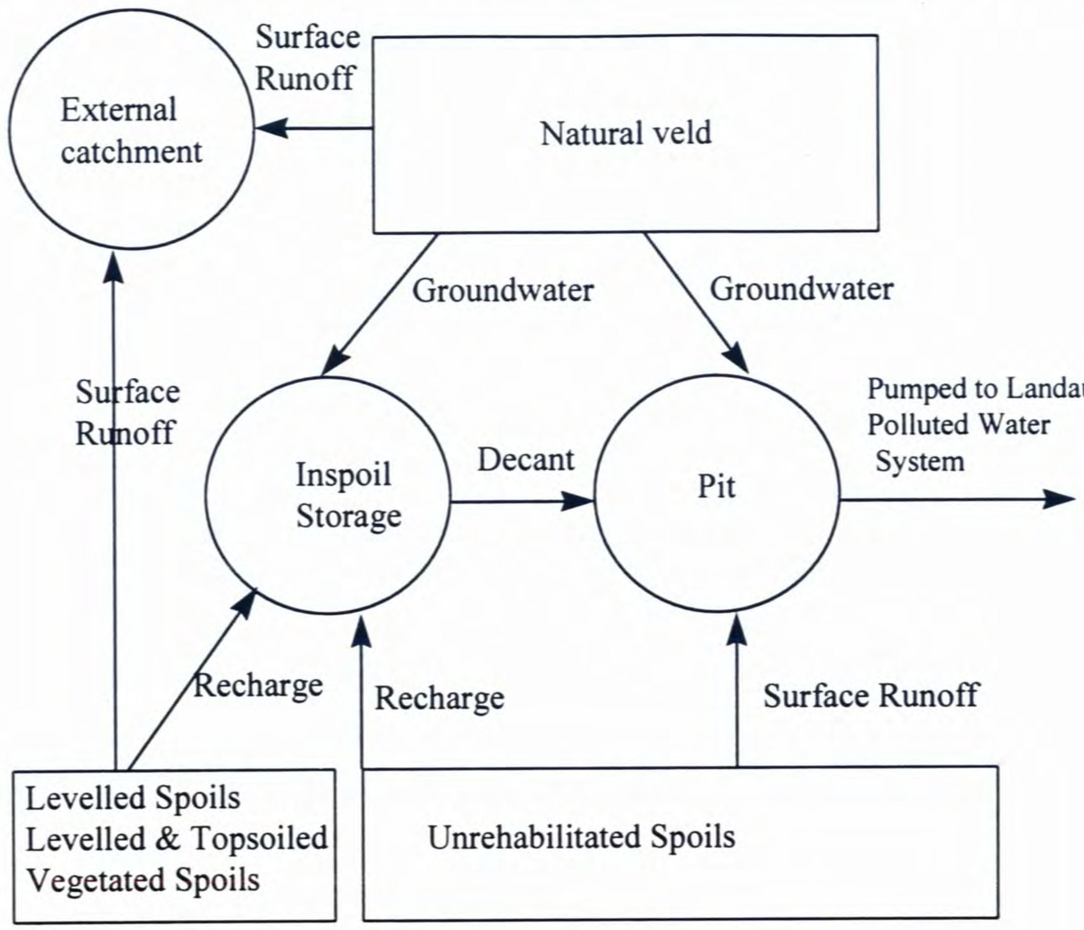


Figure 4.1 (g) - Generic model configuration of Mini-Pit water system during operation



4.2. Geochemistry of the Mini-pit

The geochemistry of an opencast coal mine is largely determined by sulphide mineral (pyrite) oxidation and associated acid generation, as well as neutralization by calcareous minerals (calcite and dolomite). Factors that may influence the quality of drainage from an opencast pit include:

- The total pyrite and calcareous mineral content of the overburden and pit spoils material will influence spoils water quality.
- The relative sulphide and calcareous mineral content will influence the acidity and salinity of the drainage.
- The variability of the mineral contents throughout the spoils profile will influence spatial variation in water quality.
- Sulphide mineral oxidation may be oxygen diffusion controlled over the long term and the type of rehabilitation cover will influence the rate of pyrite oxidation and resulting water quality.

Acid/base accounting (ABA) tests were conducted on samples from three borehole cores taken from the proposed Minipit area. A total of ten samples were taken from the three boreholes. The existing mined box cut at Schoongezicht may potentially be filled using discard material. Ten ABA samples were also taken from the two discard piles on the site to determine if this material could be utilised as pit fill. The locations of the sampled boreholes and the discard dump samples are indicated in **Figure 4.2(a).**

The acid/base accounting test measures the acid potential (AP) and neutralisation potential (NP) of a geological sample in units of kg $CaCO_3$/ton. This allows direct comparison of the NP and AP values and the ratio NP/AP.

Based on a stoichiometric relationship, a NP/AP value of 2 would be required to neutralise acidity at elevated carbon dioxide (CO_2) pressures such as would exist below a spoils surface. An NP/AP ratio of 1 would be required to neutralise acidity in a mine water system open to the atmosphere. Open pit spoils exist within these two extremes.

Long term acidification of opencast pit spoils is indicated as follows:

- $NP/AP < 1$ - Spoils are potentially nett acid generating.
- $3 > NP/AP > 1$ - Uncertainty exists as to long term acidity of the spoils and further kinetic testing is required.
- $NP/AP > 3$ - Spoils are potentially acid consuming

The range of uncertainty in the above criteria is mainly due to variability in local spoils characteristics, environmental conditions (O_2, CO_2, moisture, etc) in the spoils, kinetic constraints on the oxidation and neutralisation reactions, etc.

The acid/base accounting results from the borehole cores and discard piles are summarised in **Table 4.2(a)** and illustrated graphically in **Figures 4.2(b) and 4.2(c).**

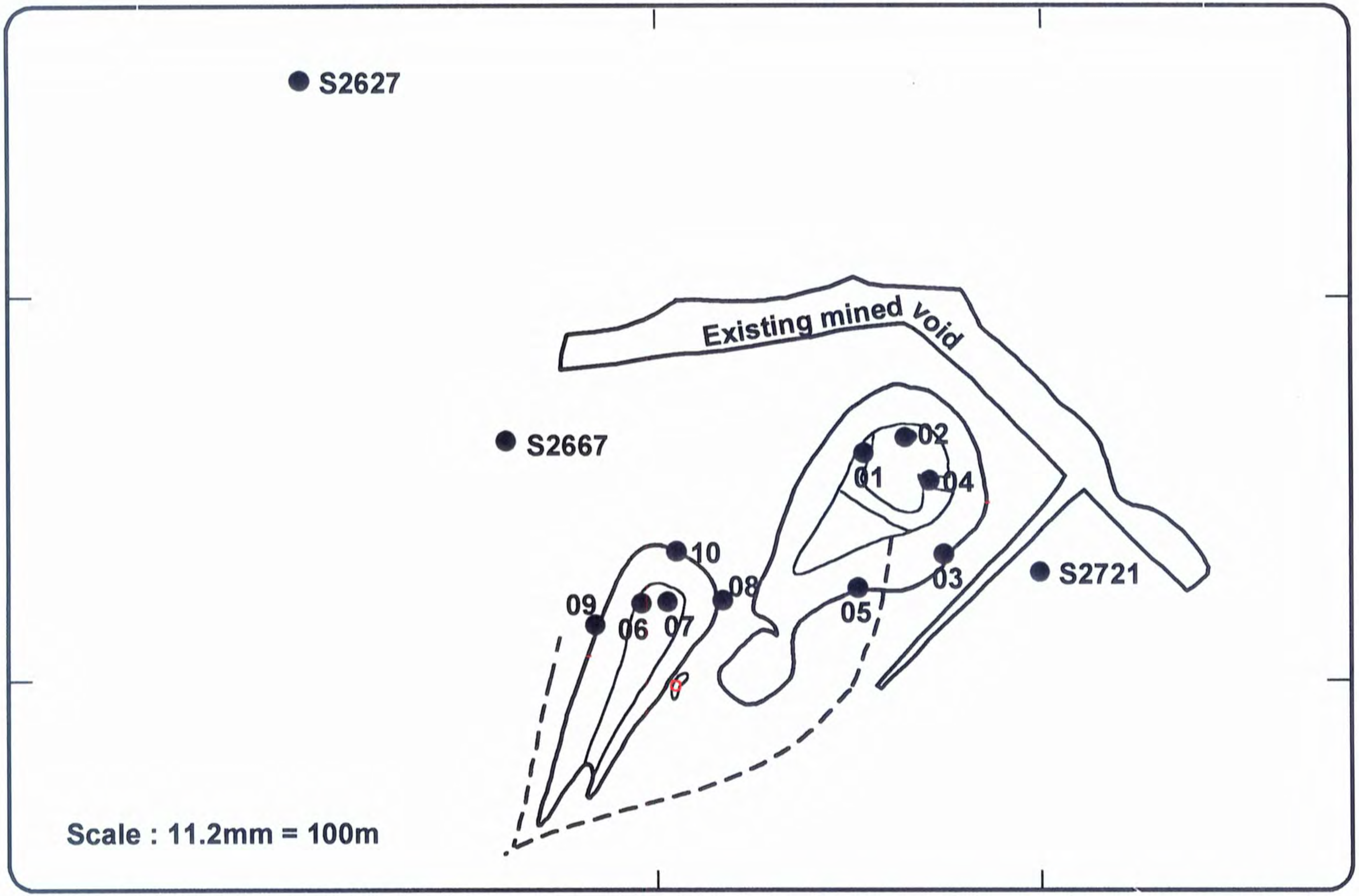


Figure 4.2 (a) : Schoongezight No 2 Seam Mini-Pit - Location of ABA Sample sites.

Table 4.2(a) : Acid/base accounting results for exploration borehole and discard samples from the Schoongezicht No 2 Seam Mini pit.

Sample	Material	AP (kg $CaCO_3$/ton)	NP (kg $CaCO_3$/ton)	NP/AP	Conclusion
SCH01	discard	30.3	2.33	0.08	Acidic
SCH02	discard	92.7	49.4	0.53	Acidic
SCH03	discard	82.7	8.9	0.11	Acidic
SCH04	discard	50.6	-5.27	-0.10	Acidic
SCH05	discard	57.7	15.9	0.28	Acidic
SCH06	discard	25.3	-16.2	-0.64	Acidic
SCH07	discard	33.4	-2.8	-0.08	Acidic
SCH08	discard	13.7	-2.16	-0.16	Acidic
SCH09	discard	29	-4.71	-0.16	Acidic
SCH10	discard	112	-11.7	-0.10	Acidic
S2627/01	carbonaceous shale	2.65	2.02	0.76	Acidic
S2627/02	carbonaceous shale	3.75	17	4.53	Neutral
S2627/03	pyritic sandstone/siltstone	0.78	1	1.28	Uncertain
S2667/01	pyritic siltstone	12.2	185	15.16	Neutral
S2667/02	carbonaceous shale	2.84	2.5	0.88	Acidic
S2667/03	pyritic sandstone	1.12	1.1	0.98	Acidic
S2667/04	carbonaceous shale	4.06	2.47	0.61	Acidic
S2721/01	pyritic siltstone	1.75	1.26	0.72	Acidic
S2721/02	pyritic siltstone	3.43	4.52	1.32	Uncertain
S2721/03	pyritic sandstone	5.62	2.51	0.45	Acidic

The acid generation potential of the discard material is approximately an order of magnitude higher than the samples taken from the exploration boreholes (future spoils material). The spoils material is already generally acid-generating by nature, and this will be substantially enhanced by the introduction of discard material into the pit spoils.

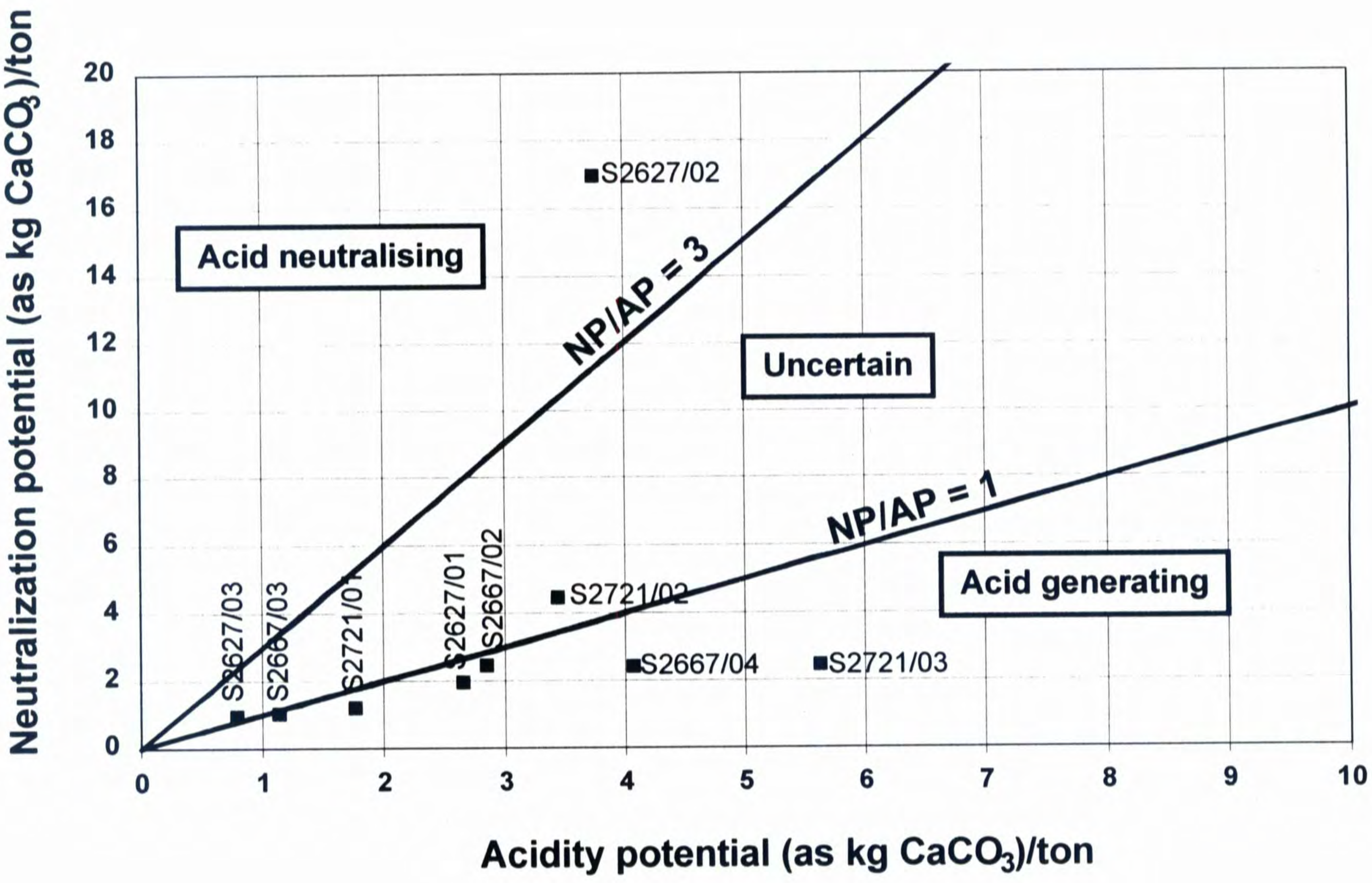
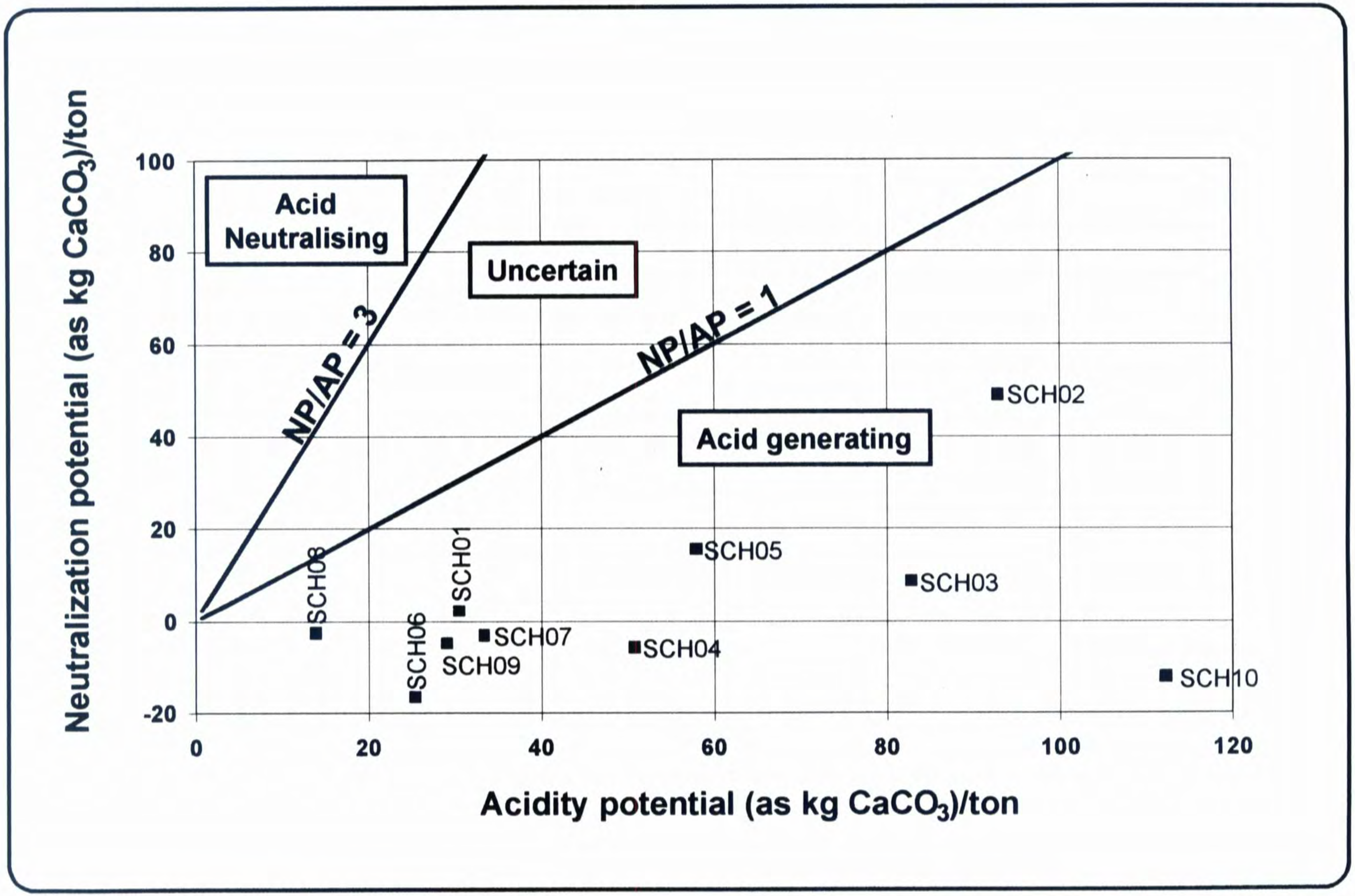


Figure 4.2 (b) : Schoongezicht No 2 Seam Mini-pit - Graph of ABA results selected exploration boreholes.



WKB Figure 4.2 (c) : Schoongezicht No 2 Seam Mini-pit - Graph of ABA results from discard piles

The water quality of the water presently in the Mini-pit, confirms that the discard dumps and the existing spoils material are acid-generating.

The pH in 1990, when mining of the Mini-pit ceased, fluctuated between 1.5 and 8.0 as the existing void began to fill up with water (**Figure 4.2 (d)**). The pH settled down to an average value of 2.7 after 1991. Water seeping from the discard dumps decants into the existing void with the resultant low pH and high concentrations of the metals including manganese, aluminium and especially iron (**Table 4.2 (b)**). High concentrations of sulphate were also observed in the existing void water.

Figure 4.2 (d) Time series of pH in the existing void of the Mini-pit since mining ceased in 1990.

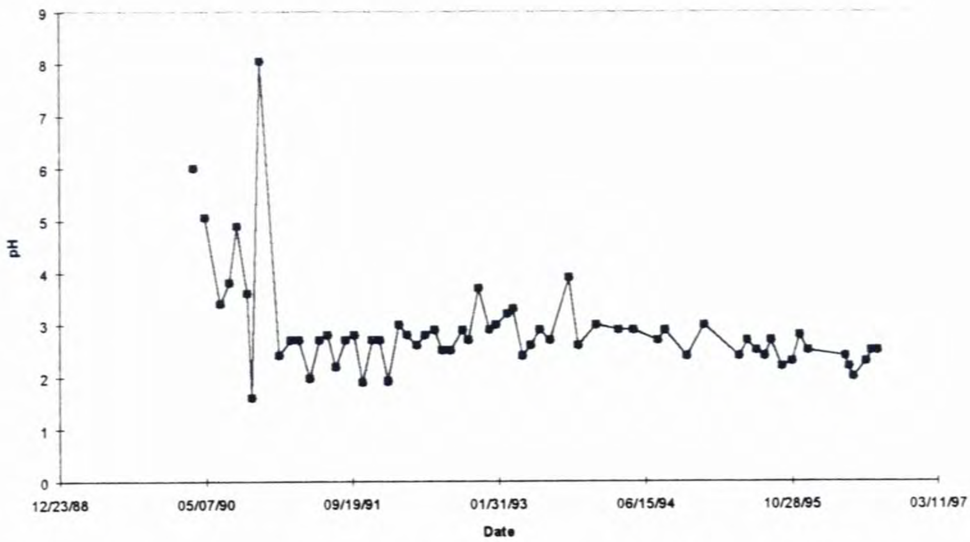


Figure 4.2 (e) Time series of Sulphate in the existing void of the Mini-pit since mining ceased in 1990.

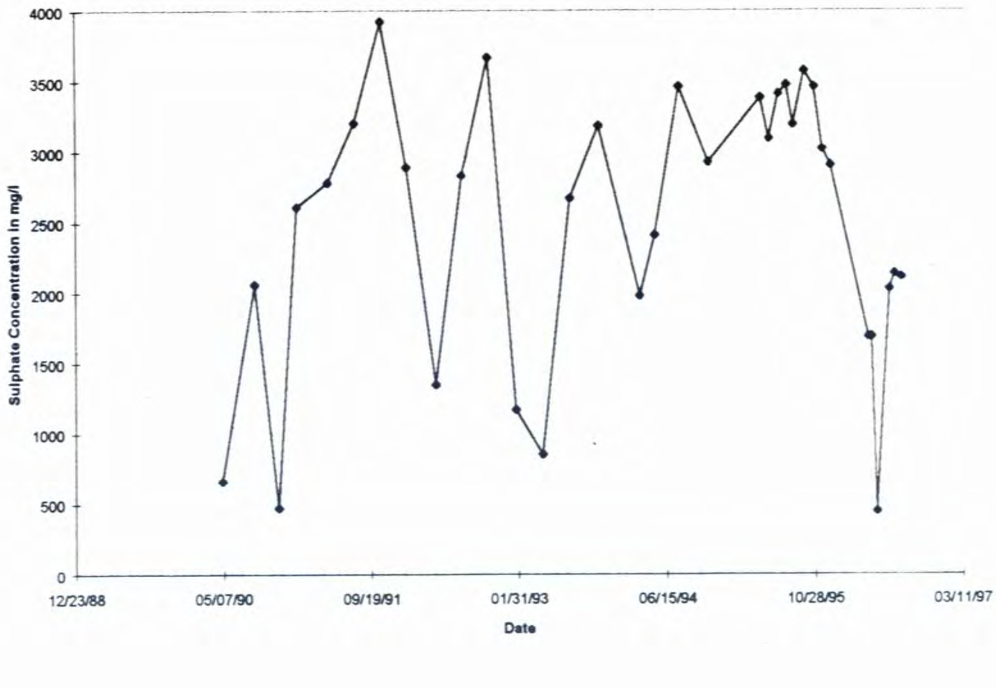


Table 4.2 (b) Water Quality Profile of water in the existing void of the #2 seam Mini-pit.

Water Quality	Water in the No 2 Seam Schoongezicht Mini-pit		
Variable (mg/ℓ)	5% tile	50% tile	95% tile
pH	1.9	2.7	5.0
Electrical Conductivity (mS/m)	137	387	481
Calcium, Ca	154	327	482
Magnesium, Mg	76	240	315
Sodium, Na	18	20	27
Potassium, K	1.4	5.5	52
Sulphate, SO_4	594	2806	3607
Chloride, Cl	2.4	20	76
Iron, Fe	5.3	119	279
Aluminium, Al	3	30	41
Manganese, Mn	18	36	46

From the results, it appears that the discard piles and spoils to the coal seams at Schoongezicht will be acid generating. It can thus be expected that the water entering the pit floor of the Mini-pit during mining will in effect be acid. It must be remembered that these conclusions are drawn based on a limited number of samples which may not be representative of the entire Minipit. Rapid dewatering of the pit will assist in preventing the acidification of water. Water stored or in contact for a prolonged period of time will be acidic.

4.3. Water-related impacts during mining

4.3.1. Surface Water (*Aide Memoire 5.2.8*)

The pit water model described in Section 4.1 was employed to simulate the Mini Pit water system over the length of the active mining period.

The historical rainfall record at the Witbank rain gauge was analysed to identify periods of dry, wet and average hydrological cycles. A 58 month moving average of rainfall was used to identify these cycles and simulations were conducted for the following three rainfall scenario's:

- **Worst case scenario**

A wet hydrological cycle (1 April 1986 to 31 January 1991) was used. The total depth of rain over the 58 month period was 3959 mm.

- **Probable scenario**

An average hydrological cycle (1 April 1972 to 31 January 1977) was used. The total depth of rain over the 58 month period was 3491 mm.

- **Best case scenario**

A dry hydrological cycle (1 April 1991 to 31 January 1996) was used. The total depth of rain over the 58 month period was 2623 mm.

The three rainfall scenario's were simulated to demonstrate the range of probable water volumes that may be generated during the mining operation. These are summarised in **Table 4.3 (a)** in terms of average monthly values for the different status types of the mining blocks. These averages are for the full 58 month period. The overall pit water balance is shown schematically in **Figures 4.3(a), 4.3(b)** and **4.3(c)** for the different rainfall scenarios. The groundwater entering the pit during the operational phase does not change as it is not influenced to a large extent by rainfall. The only part of the groundwater that is directly influenced by rainfall is the volume of water in the perched aquifer but this contributes a very small amount to the overall groundwater inflow volume - refer to **Table 3.3.2**. The surface areas of the different block status types varied over the life of the mine according to the mining plan and rehabilitation program (**Figures 4.1 (c) and 4.1 (d)**). Therefore due to the area of rehabilitated spoils increasing over the life of the mine, the average runoff volume from this status type is the largest. Similarly, the relative areas of the other status types will determine, together with the recharge rates, the relative magnitude of the average recharge volumes.

The variations in the monthly excess pit water generation rates over the life of the mine are shown in **Figures 4.3(d), 4.3(e)** and **4.3(f)**. The anticipated maximum monthly pump rates for each scenario are given in **Table 4.3(b)**.

The pit water generation is clearly seasonal and increases substantially in summer. Pit water generation in general will increase as mining progresses due to the increasing size of land disturbed in the process.

The amount of pit water generated is substantial and this water will have to be accommodated in the existing Landau Colliery water circuits.

Dewatering pumps will have to be sized to cater for the peak pit water generation rates. This may require further pit water modelling on a daily time-step.

Table 4.3 (a) Anticipated average water generation (m^3/month) during active Mini-pit mining

Water Element	Worst Case Scenario (Wet Cycle)	Probable Scenario (Medium Cycle)	Best Case Scenario (Dry Cycle)
	Average (m^3/month)	Average (m^3/month)	Average (m^3/month)
Recharge flows			
Rehabilitated spoils recharge (400 mm topsoil & vegetation)	1740	1641	1074
Topsoiled spoils (400 mm)	1669	1568	1003
Levelled Spoils	175	162	101
Unrehabilitated Spoils	2286	1979	1314
Sub-Total	**5870**	**5350**	**3492**
Groundwater flows	**2420**	**2420**	**2420**
Runoff flows			
Rehabilitated spoils	3124	1410	1588
Topsoiled spoils	585	750	740
Levelled Spoils	56	60	39
Unrehabilitated Spoils	623	707	184
Pre-stripped area	62	51	11
Pit floor	4746	4218	2865
Upslope catchment	1364	842	346
Sub-Total	**10 560**	**8 038**	**5773**
Total	**18 850**	**15 808**	**11 685**

Table 4.3 (b) Mini-pit water production for different hydrological scenarios.

	Best Case Scenario	**Probable Scenario**	**Worst Case Scenario**
Water Production			
Average annual pit water make (m^3/year)	92 001	132 244	145 544
Peak monthly pump rate (m^3/month)	22 030	43 686	40 198

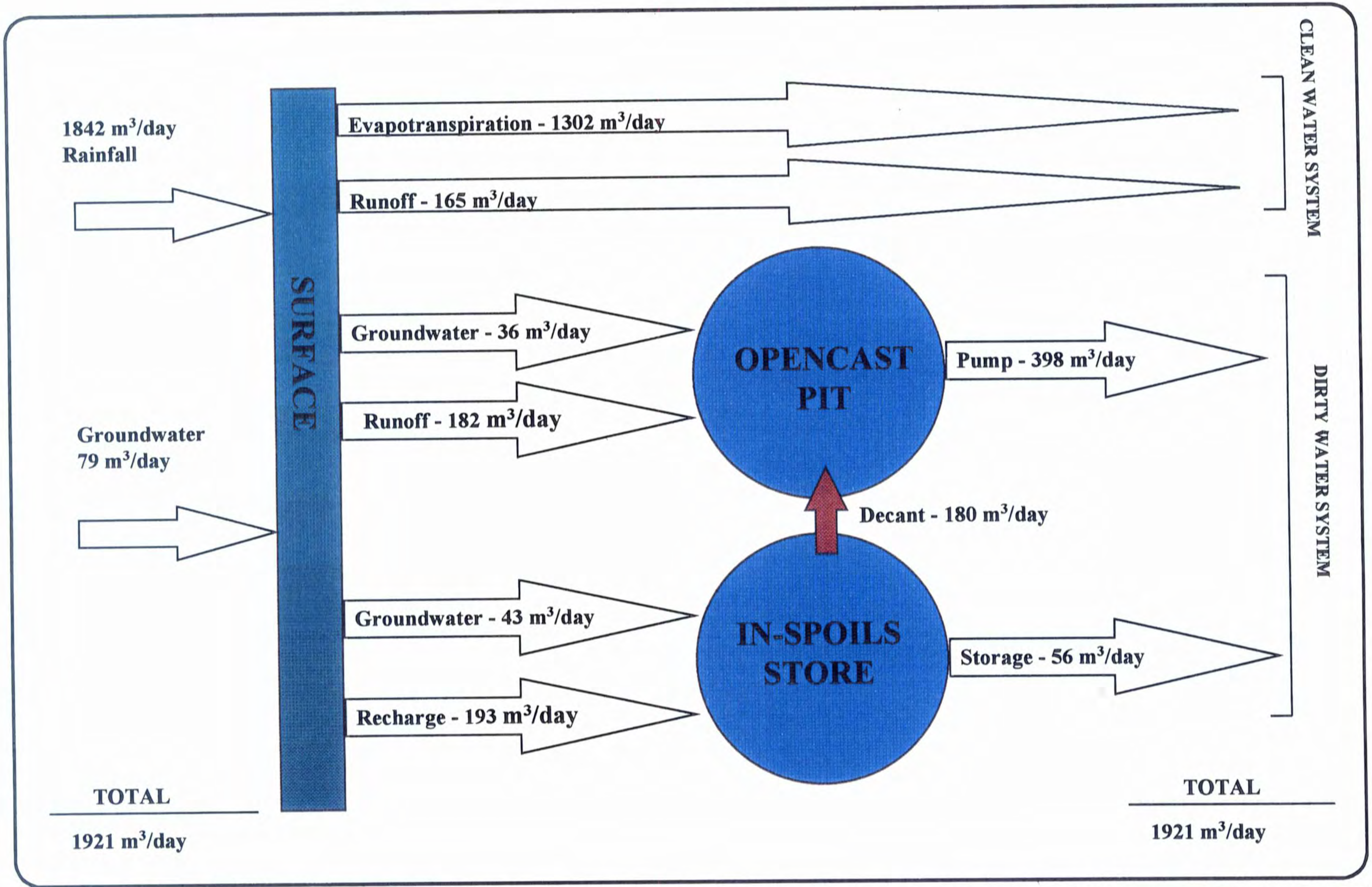


Figure 4.3(a) : Worst case scenario average water balance

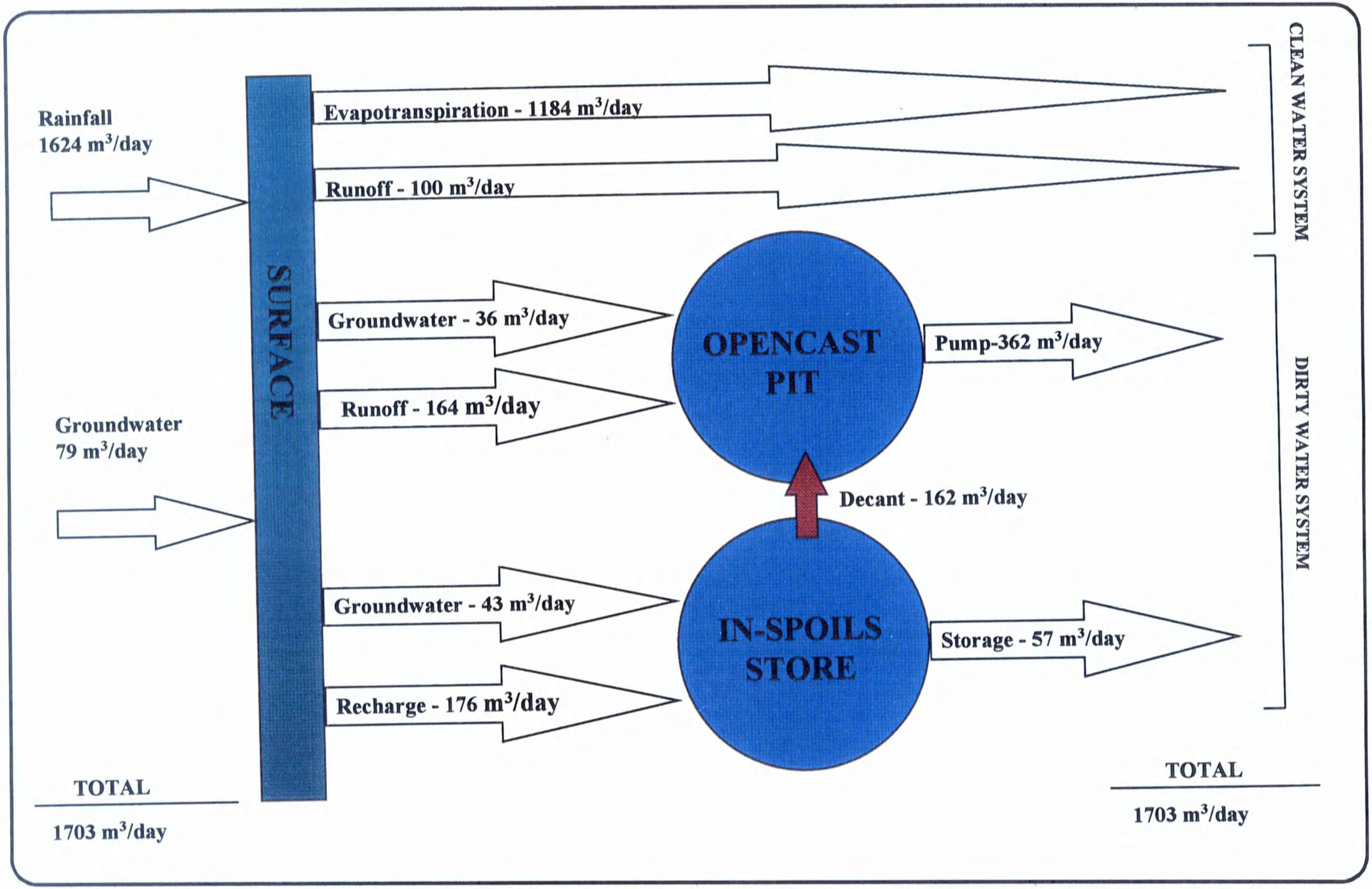


Figure 4.3(b) : Probable scenario average water balance

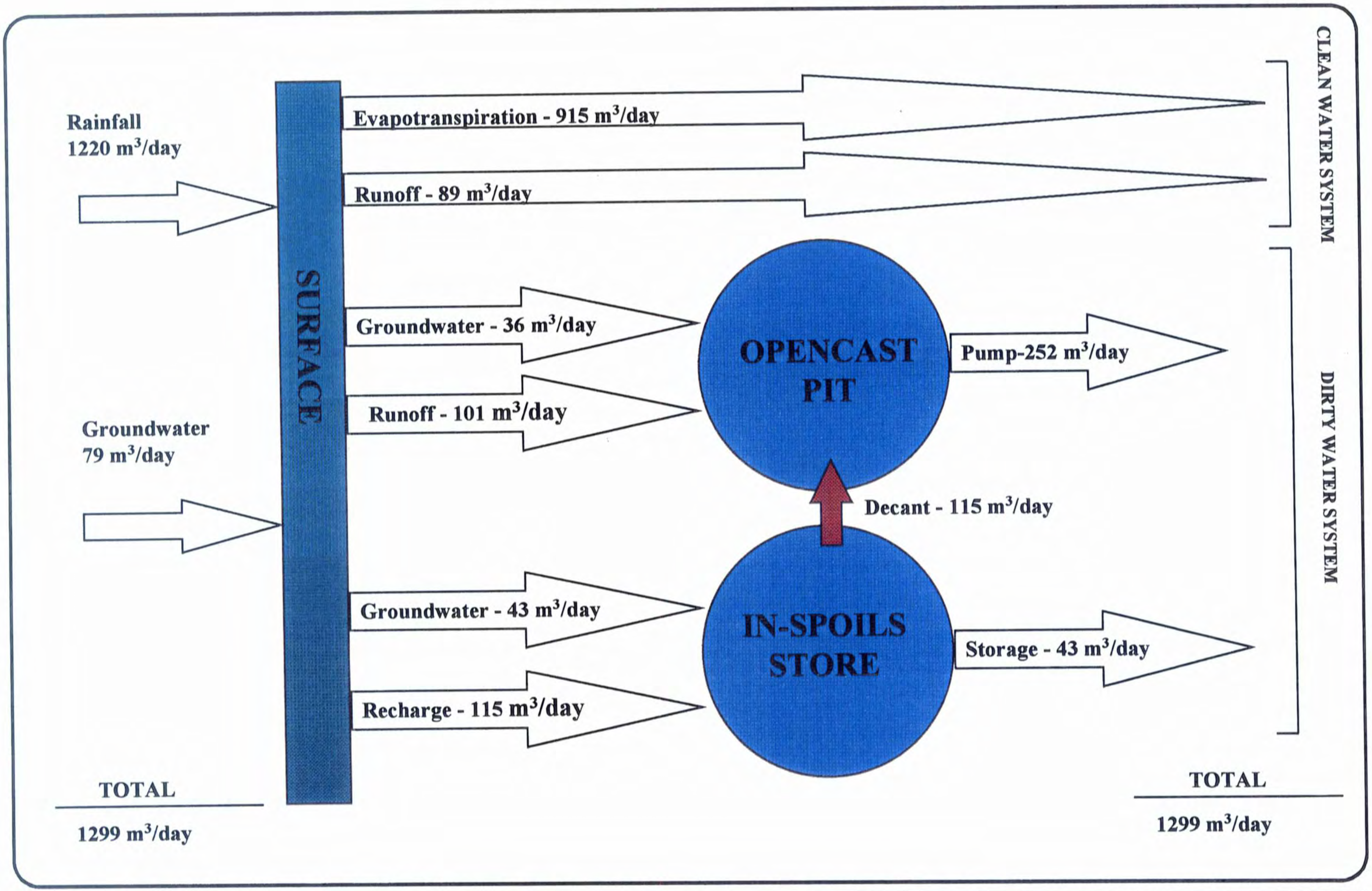


Figure 4.3(c) : Best case scenario average water balance

Figure 4.3 (d) : Schoongezicht No 2 Seam Mini-Pit Variation of Monthly Pit Water Generation over Life of Mine : Worst Case Scenario

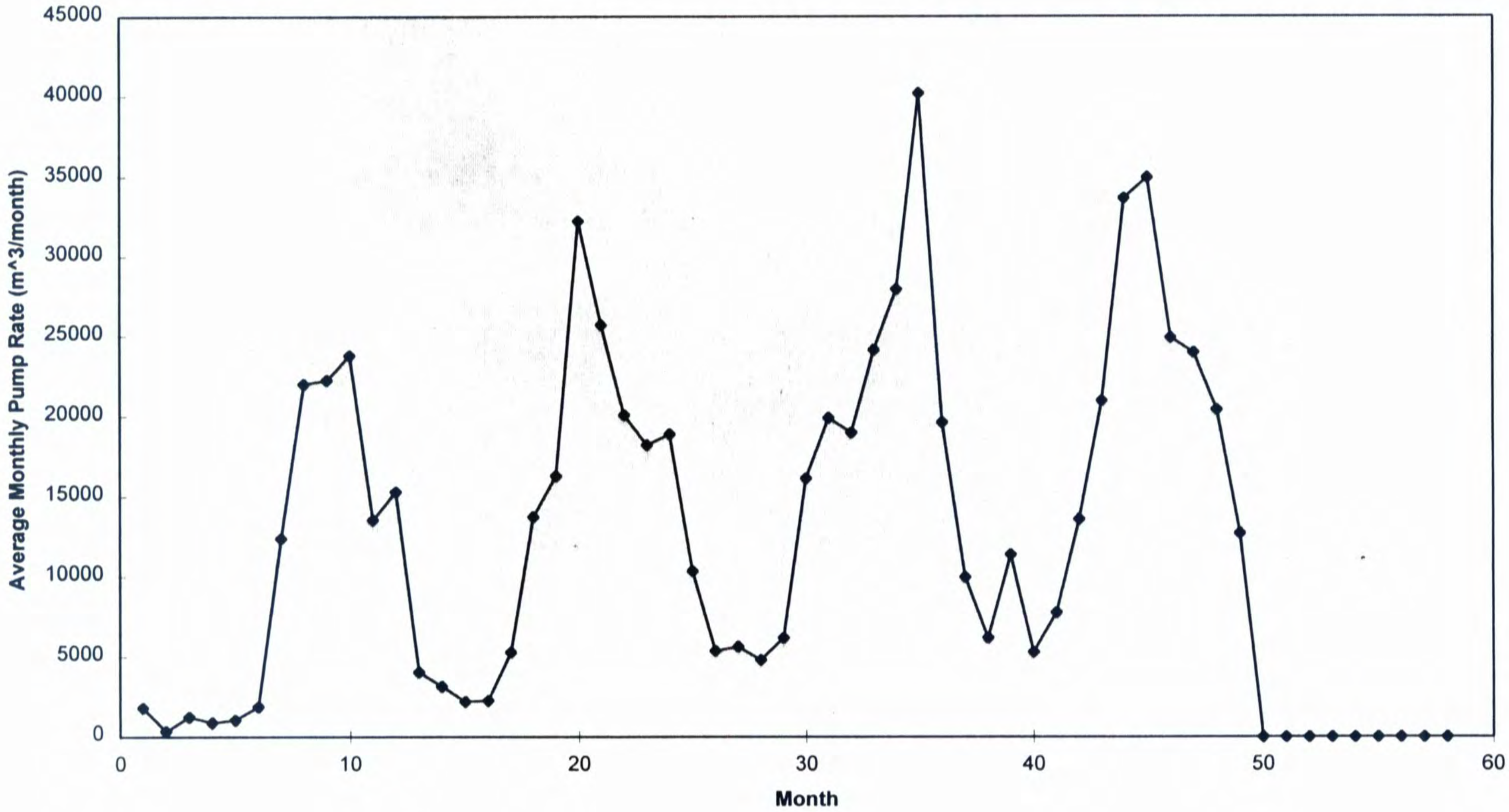


Figure 4.3 (e) : Schoongezicht No 2 Seam Mini-Pit Variation of Monthly Pit Water Generation over Life of Mine : Probable Scenario

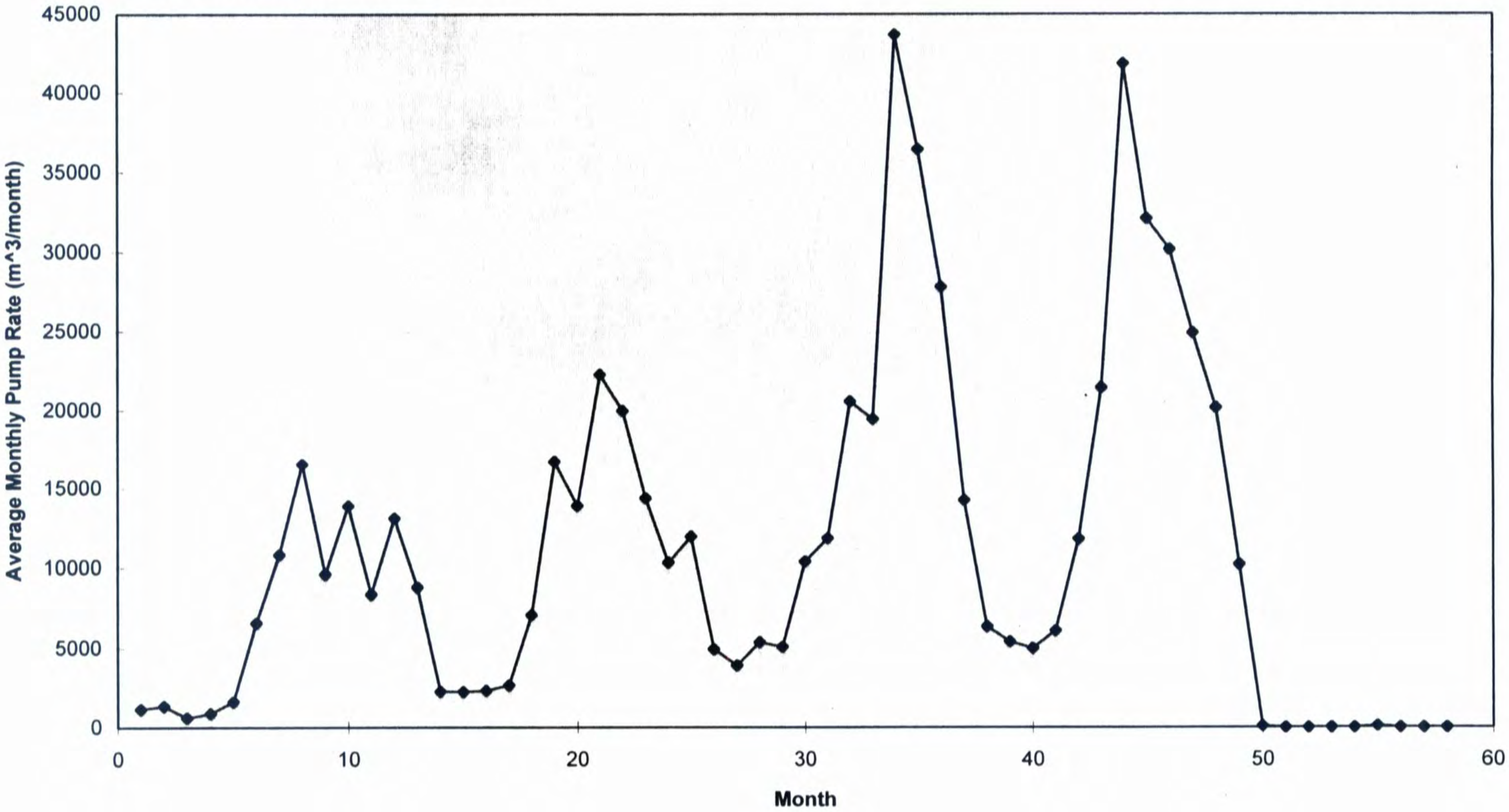
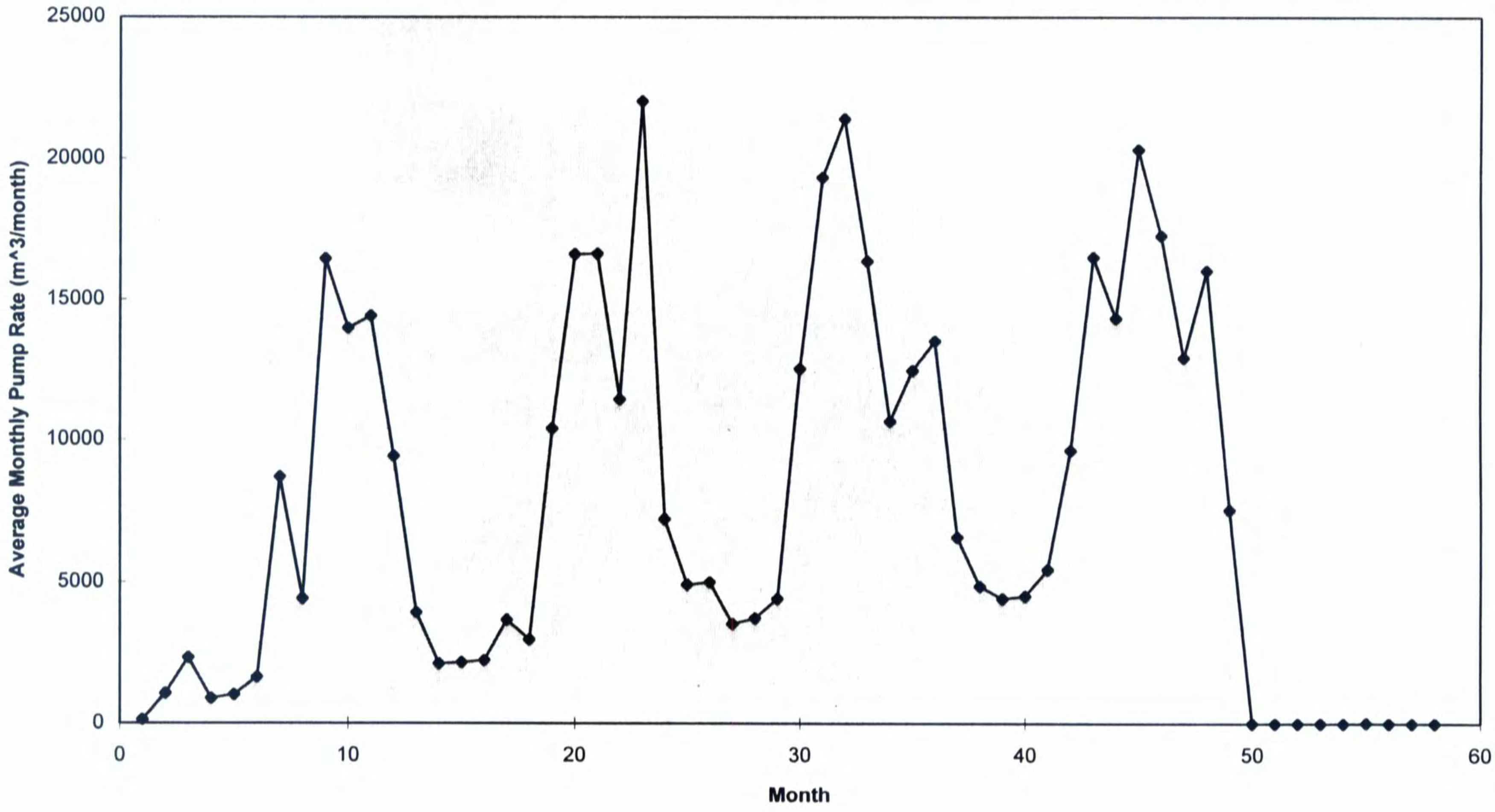


Figure 4.3 (f) : Schoongezicht No 2 Seam Mini-Pit Variation of Monthly Pit Water Generation over Life of Mine : Best Case Scenario



4.3.2. Groundwater flows (*Aide Memoire 5.2.9*)

During mining, operations at Schoongezicht No 2 seam Mini Pit will impact on the groundwater aquifers and will substantially modify the existing geohydrological condition.

The groundwater model predicts that the most significant impact during mining will be the dewatering of the surrounding area. The area of influence of this drawdown is limited to within 300m to 500m of the pit perimeter. This effect will be superimposed on the existing dewatering due to the old mine workings to the west and south of the Mini Pit. The water level in the old workings is estimated to be at an elevation of 1480 masl, which is below the floor of the Mini Pit. The effect of dewatering by the pit will thus have a negligible impact on the existing dewatering due to the old mine workings. Due to the absence of groundwater users in the area, this impact is not regarded as significant.

As pit workings will be kept essentially dry, there will be little seepage of polluted water from the workings to adjacent aquifers.

As the run-of-mine from the Mini Pit will be taken to the Navigation Coal Plant, there will be no discard dumps or slurry ponds on site. There will thus be no impacts on groundwater quality from such pollution sources.

4.4. Water-related impacts during the post-mining situation

4.4.1. Surface Water (*Aide Memoire 5.4*)

The effect of the Mini-Pit on the catchment yield after mining will be insignificant. The post-mining surface topography will be free draining (See **Figure 4.1(e)).** The surface runoff will be collected along a drainage line running east-west to the northern boundary of the rehabilitated pit. This surface water will be returned to the Schoongezichtspruit and the Townshipspruit.

The catchment area upslope of the rehabilitated pit is about 30 ha. The runoff from this area will run across the rehabilitated pit to the drainage line on the northern pit boundary. This runoff will have the following impacts on the rehabilitated pit.

- Increase recharge and hence production of polluted decant water from the pit.
- Increase the erosion potential along drainage lines before the vegetation cover has had time to establish.
- The east-west drainage line discharges at the decant point in the north-west corner of the pit. The surface runoff could become contaminated by the seepage water from the pit decant.
- Possible contamination of the upstream surface water while passing over the rehabilitated pit.

It is therefore proposed to permanently divert the upslope stormwater runoff around the rehabilitated pit. A post-mining analysis of the pit water balance showed that the pit will decant between 12 and 18 years after mining has ceased.

The decant flow from the pit after closure was determined using the entire 480 months of rainfall record available. The 25, 50 and 95 percentile estimated monthly decant flow volumes from the rehabilitated pit are given in **Table 4.4 (a).**

Table 4.4 (a) Estimated monthly decant flow volumes from the rehabilitated pit

Percentile	Decant Volume (m^3/month)
25	0
50	4 013
75	8 643
95	12 491

The small size of the post-mining decant flow, if allowed to take place, is a candidate for a passive treatment system.

4.4.2. Groundwater (*Aide Memoire 5.4*)

The anticipated post-mining impacts are as follows:

- Long-term impact on groundwater quality of polluted decant from the Mini Pit.
- Long-term impact on groundwater distribution caused by modification of natural hydraulic properties around and within the Mini Pit.

Polluted water decanting from the pit into the shallow subsurface and surface will report to the Brugspruit and result in a deterioration in water quality. This impact will contribute to the already high pollution load experienced in this water course and the impact is rated as significant.

Replacing the native sandstone, shale and coal with pit spoils subsequent to mining results in a change in the geohydrological properties of the Mini Pit. In general, the storage and permeability of the pit area will be increased. This will have the effect of flattening the piezometric surface around the pit perimeter and steepening of the groundwater surface just upstream of the pit. Both of these effects are limited to a small area and the absence of groundwater users implies that this impact is not significant.

5. ENVIRONMENTAL MANAGEMENT PROGRAMME (*Aide Memoire Part 6*)

5.1 Water-related management during the operational phase (*Aide Memoire 6.2.8 & 6.2.9*)

5.1.1. Upslope Stormwater management

The accepted best management guidelines related to the management of upslope stormwater, need to be implemented in the Mini pit operation. This will require the construction and maintenance of upslope stormwater diversion berms which are adequately sized to divert the 1 in 10 year storm. The upslope stormwater diversion berms will have to be relocated and reconstructed on an annual basis to restrict the size of the area from which runoff can enter the opencast pit workings via the high wall. It is proposed to construct new upslope stormwater diversion berms on an annual basis, just before the start of the rainy season. The stormwater will be diverted to the Townshipspruit and to the Schoongezichtspruit.

In general, the drainage of stormwater towards the pit should be minimised by minimising stormwater runoff from the access roads and ramp to the pit. The rehabilitated part of the pit will also be shaped to drain away from the mine workings.

5.1.2. Management of flood waters

In the event of excessive rain, exceeding the 1 in 10 year recurrence interval, large volumes of water will accumulate in the pit floor. The risk of interrupting mining operations therefore exists and emergency and standby pumping equipment must be available on the Landau Colliery Complex to deal with these situations. A risk assessment of the probability of excessive high rainfall events can be conducted to select appropriate sizes of dewatering pumps. This will require modelling of the pit using a daily time step model. It would probably be adequate to simply analyse the 1 in 5 year, 1 in 10 year , 1 in 20 year and 1 in 50 year 24 hour rainfall event and to estimate the probable generation of pit water at different time horizons during the mining of the Mini pit.

Permission should also be obtained from the Department of Water Affairs and Forestry to release the excess pit water during flood events, if it complies to the interim water quality guidelines developed for the Klipspruit Catchment. The pH and conductivity could practically be used to assess the achievement of these guidelines on an ongoing operational basis. It is therefore proposed to release excess flood water from the pit to the Townshipspruit and Schoongezichtspruit if the water quality complies with the following guidelines:

pH	6 – 9
Conductivity	< 120 mS/m

Pumping plant of adequate capacity must be available to rapidly dewater the pit during flood conditions and to prevent the further deterioration of the pit water. Longer contact times between the flood waters and the pit floor and spoils material will result in gradual deterioration of the water quality. This may reduce the volume of flood water which can be discharged to the public stream.

5.1.3. Mine Scheduling and operations

Mining operations will be conducted to allow the levelling topsoiling and vegetation of the spoils as rapidly as possible. The first row of spoils heaps behind the operating cut will remain unrehabilitated, until access can be gained for shaping and rehabilitation. The second row of spoils heaps can be shaped, topsoiled and vegetated as soon as is practically possible. Rehabilitation will be conducted in accordance with the rehabilitation and revegetation plan compiled for the Mini-pit. It is proposed to replace subsoil where available, and to place a topsoil cover on the rehabilitated Mini-pit of acceptable thickness.

The progress with surface rehabilitation will be monitored on an ongoing basis by the environmental manager of Amcoal Colliery to ensure the proper and timeous implementation of the rehabilitation guidelines, specifically in terms of contouring, topsoil placing, addition of fertilisers and establishment of vegetative cover.

5.1.4. Surface topography

It is essential to reconstruct a post-mining topography which will allow the pit surface to be free draining. The existing box cut will be filled and rehabilitated by the end of the first year of mining. Before the rehabilitation of the existing box cut, it will contribute surface water to the pit floor and mine workings.

5.1.5. Excess Pit Water

The water accumulating in the pit will be collected along the lowest elevation floor contour, which runs across the western portion of the pit. The pit will be dewatered as rapidly as is practically possible to prevent the further acidification of the water. The excess pit water will be pumped to the Schoongezicht polluted water dam, from where it will be introduced into the mine water circuits. This water will therefore be re-used in the plant water circuits.

It must be realised that the pit water will form an integral part of the overall Landau Colliery water system. This water will replace the water currently pumped from the Seam 4 Mini-pit and will partially replace the make-up water from Kleinkopje Colliery. Separate negotiations are already underway to obtain a consent from the Department of Water Affairs and Forestry for the release of excess Kleinkopje water to the Klipspruit Catchment.

5.1.6. Water monitoring

The following minimum pit water and surface water monitoring should be conducted during the operational phase of the mine:

- water quality and flow pumped from the Mini-pit to the Schoongezicht polluted water dam

- water pumped from the pit and discharged to the public stream during flood conditions.

- boreholes should be installed around the Mini-pit to monitor groundwater levels and quality.

This monitoring will, as a minimum, involve water quality and water flow measurement in accordance with the permit granted by the Department of Water Affairs and Forestry. Regular monitoring of pH and conductivity will have to be conducted and this will be supplemented by a more complete water quality analysis including pH, acidity/alkalinity, calcium, magnesium, sodium, potassium, sulphate, chloride, fluoride, aluminium (dissolved), iron (dissolved) and manganese (dissolved). Monitoring of the surface streams surrounding the Mini-pit, including Townshipspruit and Schoongezichtspruit, needs to continue in terms of the current surface water monitoring on the Colliery Complex.

Groundwater monitoring of all the indicated geohydrological monitoring boreholes (EMP01 - EMP06), refer to **Figure 3.3.2,** will also have to be conducted. This will form an integral part of the extensive colliery groundwater monitoring system. Groundwater level and water quality should be monitored on a quarterly basis. The same water quality variables recommended for the surface water monitoring system apply to the groundwater. Attention will have to be given to the possible drawdown of the groundwater surrounding the pit. This will give an indirect indication of the amount of groundwater flowing towards the Mini-pit during its operational life.

5.1.7. Summary of management recommendations during the operational phase

Table 5.1 (a) Recommendations for the operational phase of the Schoongezicht Mini-pit.

Variable	Management
Upslope Stormwater management	• Construct and maintain upslope diversion berms adequately sized to divert the 1 in 10 year storm. These berms will have to be relocated and reconstructed on an annual basis (just before the rainy season) to restrict the size of the area from which runoff can enter the opencast workings.
	• Minimise drainage of stormwater from access roads and ramps towards the pit.
	• Shape rehabilitated part of pit to drain away from the mine workings.
Management of flood waters	• Have emergency and standby pumping equipment available to deal with excessive rain, exceeding the 1 in 10 year recurrence interval.
	• A risk assessment of the probability of excessive high rainfall could be conducted using a daily time step model in order to select appropriate sizes of dewatering pumps.

Table 5.1 (a) continued Recommendations for the operational phase of the Schoongezicht Mini-pit.

Variable	Management
Management of flood waters (contd)	• Get permission from the Department of Water Affairs and Forestry to releases excess flood water during storm events if it complies to the interim water quality guidelines for the Klipspruit catchment.
	• Pumping plant of adequate capacity must be available to rapidly dewater the pit during flood conditions.
Mine Scheduling and operations	• Levelling, topsoiling and vegetation of the spoils will be conducted as rapidly as possible.
	• Subsoil will be replaced where available as well as a topsoil cover.
	• The surface rehabilitation will be monitored on an ongoing basis by the environmental manager of Amcoal collieries to ensure timeous and proper implementation of rehabilitation guidelines.
Surface Topography	• Post-mining topography must be free-draining.
	• The existing box cut will be filled and rehabilitated by the end of the first year of mining.
Excess Pit Water	• Pump excess pit water from the lowest elevation floor contour to the Schoongezicht polluted water dam.
Water Monitoring	• Monitor water quality and flow pumped from the Mini-pit to the Schoongezicht polluted water dam.
	• Monitor water pumped from the pit and discharged to the public stream during flood conditions.
	• Monitor groundwater quality and levels in boreholes which should be installed around the Mini-pit.
	• Continue to monitor surface streams - Schoongezichtspruit and Townshipspruit.
	• Groundwater monitoring of present geohydrological boreholes (EMP01 - EMP06) should continue. Groundwater level and water quality to be monitored on a quarterly basis.
	• Attention should be given to the possible drawdown of the groundwater surrounding the pit.