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A: SOURCE DESCRIPTION

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Local Municipality:	ELUNDINI LM					
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B: TYPE OF INFORMATION

Information format:	Hard copy	X	Data Summary		Electronic Report	
	Specify Other:					
Report / Info Title:	ELUNDINI MUNICIPALITY MACLEAR & UGIE TOWNS					
Report Nr:	308195		Date:	Aug-07		
Author Details:	GP. Nel					
Author's Qualification:	Hydrogeologist	X	Govt Dept		Project Manager	
	Engineer		Technician		Other	
	Specify Other:					
Captured by:	VOSL	Date:	8/29/2007	Signed:		

C: GEOHYDROLOGICAL CATEGORIZATION

Project Type	Source development	X	Feasibility Study		Sanitation Study:	
	Specify Other:					

Reference Co-ordinate:	Latitude	Longitude
	31°13"00'	28°14"3.6'

	Yes	No	Complete	Incomplete
Lithological & Construction Logs		X		
Hydrocensus Data		X		
Pump Testing Data		X		
Chemical Water Analysis Data	X			
Geohydrological Data		X		
Spring Data		X		
Remote Sensing Data		X		
Map Data	X			

Comments: No coding info

Reviewed by: G. Nel Date: Signed:

7

ELUNDINI MUNICIPALITY -MACLEAR & UGIE TOWNS

GEOHYDROLOGICAL REPORT

PROPOSED NEW SITES & CLOSURE OF EXISTING SITES

Report No. 308195/2

FEBRUARY 2003

SRK Consulting
Engineers and Scientists

21

ELUNDINI MUNICIPALITY -MACLEAR & UGIE TOWNS

GEOHYDROLOGICAL REPORT
PROPOSED NEW SITES & CLOSURE OF EXISTING SITES

By:

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Report No. 308195/2

February 2003

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NELG\nelg

Report No 308195/2

February 2003

GEOHYDROLOGICAL INVESTIGATION

MACLEAR & UGIE

NEW AND EXISTING WASTE DISPOSAL SITES

1 INTRODUCTION

The existing waste disposal facilities at Ugie and Maclear are currently inadequate to serve the demand and are being investigated for closure. New sites therefore need to be identified for both towns. By law, the Department of Water Affairs and Forestry requires a geohydrological report as part of the closure of existing sites and the application for new sites.

UWP Consulting Engineers appointed SRK Consulting (SRK) in August 2002 to conduct a preliminary geohydrological investigation on the proposed candidate sites (see SRK Report 308195/1).

Following the ranking of the proposed sites, two new sites were identified, one in each town, as being the most likely sites for waste disposal by landfill. The two sites were indicated to and discussed with the Department of Water Affairs & Forestry (DWAF) on a site meeting that was held on 17 December 2003. It was agreed at the site meeting to proceed with the final geohydrological investigations on the new sites and the existing sites (for closure).

As per DWAF's minimum requirements (Minimum Requirements for Waste Disposal by Landfill, Second Edition 1998), all landfill sites that are closed after August 1990, when the legislation came into effect, must be permitted before they can be closed. The criteria used for the geohydrological investigation on existing sites are therefore very similar to what is required for new sites. The feasibility study is a minimum requirement on all GS (General waste, Small site).

As part of the geohydrological feasibility study, the following aspects will be discussed:

- Geology - description of the regional and local geology;
- Soils - general description on type, permeability, depth and volume available for cover material;
- Borehole census - census of boreholes around the site (within 1 km radius, depending on topography and drainage) with the view of recording ground water uses in the area;
- Groundwater - indication of minimum depth to groundwater, yield and probable flow direction. The importance of ground water needs to highlighted, as well as the importance of any aquifers in the vanity of the site, if any.

The proposed site and existing site in Ugie are discussed under section 2 and 3 and the Maclear sites under section 4 and 5. All evaluations and risk assessments are done based on geological, geohydrological and hydrological (limited) considerations. The evaluations are further based on, but not necessarily inclusive of, the guidelines that is specified in DWAF's Minimum Requirements for Waste Disposal by Landfill, Second edition 1998.

UGIE

2 PROPOSED NEW SITE

The proposed new site for Ugie is situated ~ 4 km outside Ugie, on the road to Mount Elton (See Figure 2, Appendix 1).

2.1 Geology

Ugie is situated on mudstone, shale and sandstone of the Molteno Formation, with dolerite intrusions in the form of dykes and sheets (sills). The Ugie area can be classified as having a minor aquifer system with moderate vulnerability (according to the Aquifer Classification of South Africa Map - DWAF), which means that economically viable groundwater is targeted along linear features such as dolerite dykes, faults and lineaments, as well as in fractured and weathered systems such as dolerite sheets and geological contacts. Several lineaments crosses the area and a prominent dolerite dyke can be seen to the east of the town.

2.2 Soils

The site is underlain by fractured and weathered shale, interbedded with mudstone. The average depth to bedrock is 1 - 1.5 m (see Table 2.2 - trial holes) with an additional 1-2 metres of fractured shale/sandstone. Two areas within the site have already been mined for fractured shale. The permeability, as tested by Controlab, with a 70% compaction ratio, is 4.06 x 10^{-3} cm/second, and therefore classifies as medium. Based on a visual and GIS-based estimate (no field measurements were done), the available volume cover material is ~ 50,000 m^3 (50,000 square metres and average thickness of weathered material = 1 m).

Table 2.2: Trial holes at Ugie's new site

Trial Hole No.	Latitude	Longitude	Soil profile
UGNH1	31° 13" 00'	28° 14" 03.8'	0 - 0.3 Topsoil 0.3 - 1.3 Sandy clay - weathered sandstone/shale 1.3 Sandstone / shale hard rock
UGNH2	31° 13" 13.5'	28° 14" 05'	0 - 0.3 Topsoil 0.3 - 0.9 Sandy clay - weathered sandstone/shale 0.9 Sandstone / shale hard rock
UGNH3	31° 13" 17.3'	28° 14" 07.7'	0 - 0.3 Topsoil 0.3 - 1.5 Sandy clay - weathered sandstone/shale 1.3 Sandstone / shale hard rock
UGNH4	31° 13" 15.1'	28° 14" 09.8'	0 - 0.3 Topsoil 0.3 - 1.2 Sandy clay - weathered sandstone/shale 1.2 Sandstone / shale hard rock
UGNH5 (Measured in the quarry sidewall)	31° 13" 13.1'	28° 14" 13.3'	0 - 0.3 Topsoil 0.3 - 1.3 Sandy clay - weathered sandstone/shale 1.3 - 2.1 Fractured shale / sandstone 2.1 Shale / sandstone hard rock
Note: The depth of the excavations was limited to the capabilities of the excavator used. The holes were stopped when the excavator failed to dig deeper (refusal)			

2.3 Borehole census & Geohydrology

- Existing groundwater use: One existing borehole and one spring were found in the vicinity of the proposed waste site. The borehole is being used for water supply to a private chicken abattoir and the spring for drinking. No information was available on the borehole (i.e. depth, abstraction rate, etc.). The distances from the site to the borehole and spring are ~ 400 m and ~ 450 m respectively. The town receives bulk water from the Wildebeesrivier.
- Groundwater flow: Due to the scarcity of information, the direction of groundwater flow could not be determined, but it most probably follows the surface drainage towards the Wildebeesrivier. Surface contours suggest that the site is situated on a water divide with surface (and groundwater?) flow to the northwest and southeast.
- Groundwater potential: Based on the mapped lineaments and dykes, the most feasible areas for groundwater exploration would be to the east of the town where a dolerite dyke intersects the Wildebeesrivier. The lineaments can also be targeted for groundwater development, but then in the lower lying areas of the town, near the Wildebeesrivier.
- Groundwater quality: Water samples of the borehole and spring were taken and analysed for background and investigative parameters (see Table 2.1.3).

Table 2.3: Water sample results of borehole and spring at Ugie's new site

Parameters	Borehole (Ter 1)	Spring (sample 2)	Comment
(Nitrate & Nitrite) as N	0.93	1.8	
Alkalinity	<10	<10	
Ammonia as N	0.08	0.04	
Boron as B	<0.001	<0.001	
Cadmium as Cd (µg/l)	9.0	8.8	Marginal water quality
Calcium as Ca	0.63	<0.5	
Chemical Oxygen Demand	21	<10	
Chloride as Cl	<4	<4	
Chromium as Cr (µg/l)	54	14	
Chromium as Cr6+ (mg/l)	0.01	0.02	
Conductivity	6.4	4.5	
Cyanide (free) as Cn (µg/l)	<8	<8	
Faecal coliforms (CFU/100ml)	24	43	Poor water quality
Lead as Pb (µg/l)	<30	<30	
Magnesium as Mg	1.9	1.8	
Mercury as Hg (µg/l)	<0.3	<0.3	
pH	5.72	5.74	
Phenolic Compounds (µg/l)	<40	<40	Class II - maximum allowable = 70
Potassium as K	1.8	1.4	
Sodium as Na	4.9	4.9	
Solids - dissolved	32	23	
Sulphate as SO4	<3	28	

2.4 Evaluation of possible Fatal flaws - Ugie's new site

Potential Flaws	
* 3 km from airstrip	N/A
* Below 1:50 year flood line	No
* Close to significant surface water bodies	No
* Unstable areas	No
* Sensitive areas (ecological & historical)	No
* Catchment areas for water resources	No
* Flat gradient, shallow or emerging ground water	No
* Areas of ground water recharge	No
* Areas adjacent to important aquifers	No
* Shallow bedrock with little soil cover	No (bedrock ± 1.5 m)
Notes: * Significant surface water bodies are seen to exclude seasonal springs * Evaluation based on geological / geohydrological and hydrological aspects	

2.5 Conclusions - Ugie proposed new site

- The proposed site is situated on a topographical high with drainage primarily to the north-west and south-east.
- The site is not situated on or near an important groundwater aquifer or areas that will be targeted for future ground water supply to Ugie.
- Groundwater is used in the vicinity of the site (one borehole and one spring) and care needs to be taken not to pollute these sources.
- Of concern is the current high Faecal contamination that exists in both the borehole and spring samples, making the water unfit for human consumption, even with once-off use.
- The soil cover and permeability seem adequate for the development of a small landfill site.

2.6 Recommendations - Ugie proposed new site

- Two monitoring boreholes must be drilled on either side of the proposed site to intersect the groundwater level, between the proposed site and the existing borehole and spring, approximately 30 m from the outside boundary of the proposed site. Once the site is in operation, these boreholes must be monitored bi-annually for the parameters as specified in Appendix 2.
- In addition to these parameters, Faecal Coliforms must also be included, as well as for any other substance that will be disposed of in significant concentrations (eg. iron, lead, copper, etc.).
- The water quality of the existing borehole and spring must be monitored bi-annually for the parameters as indicated above. The borehole must be properly purged and the sample taken as hygienically as possible.

3 UGIE EXISTING SITE

3.1 Geology

The geology is similar to that of the new site (see section 2.1 Geology).

3.2 Soils

The existing site has been mined to 70% of its capacity in terms of soil cover and excavatability. Based on a visual and GIS-based estimate (no field measurements were done), the remaining available volume cover material is ~ 5 100 m^3. The site is underlain by fractured and weathered shale. The average depth to bedrock is 0.8 m in the remaining open space. The permeability, as tested by Controlab, with a 70% compaction ratio, is 9.62 x 10^{-5} cm/second, and therefore classifies as low.

Table 3.2: Trial holes at Ugie's existing site

Trial Hole No.	Latitude	Longitude	Soil profile
UGEH1	31° 11"23.5'	28° 15" 10.8'	0 - 0.3 Topsoil 0.3 - 0.7 Sandy clay - weathered sandstone/shale
UGEH2	31° 11" 24.0'	28° 15" 13.7'	0 - 0.3 Topsoil 0.3 - 0.8 Sandy clay - weathered sandstone/shale
Note: The depth of the excavations was limited to the capabilities of the excavator used. The hole was stopped when the excavator failed to dig deeper (refusal)			

3.3 Borehole census and Geohydrology

- Existing groundwater use: No existing boreholes were found near the existing site. Indications of seasonal spring (change in vegetation) were found to the south-west of the existing landfill site, down gradient from the sewerage ponds. The spring was dry at the time of the investigation.
- Groundwater flow: No info. Surface drainage on the landfill site will be towards the north-east.
- Groundwater potential: Based on the topography and geology, the groundwater potential is considered low. If drilling in the vicinity of the existing site is considered, it would be in the valley below the site, ~ 300-400 m from the site.
- Groundwater quality: No water samples were taken since no boreholes or sustainable springs were found. The groundwater quality is however expected to be poor because of the landfill site itself and the sewerage ponds next to the landfill site.

3.4 Evaluation of possible Fatal flaws - Ugie's existing site

Potential Flaws	
* 3 km from airstrip	N/A
* Below 1:50 year flood line	No
* Close to significant surface water bodies	Yes, Wildebeesrivier
* Unstable areas	No
* Sensitive areas (ecological & historical)	No
* Catchment areas for water resources	Yes, Wildebeesrivier
* Flat gradient, shallow or emerging ground water	No
* Areas of ground water recharge	No
* Areas adjacent to important aquifers	No
* Shallow bedrock with little soil cover	Yes, little soil cover left
Notes: * Significant surface water bodies are seen to exclude seasonal springs * Evaluation based on geological / geohydrological and hydrological aspects	

3.5 Conclusions & Recommendations - Ugie existing site

- The existing site at Ugie has reached capacity and needs to be closed and rehabilitated.
- The sewerage ponds causes concern since seepage from them could enter the existing landfill site and cause the leaching-out of contaminants.
- The water quality of any seasonal springs that emerges within 200 m of the sewerage ponds and the existing landfill site needs to be monitored (especially after rain events). Parameters must include those as specified in Appendix 2.

MACLEAR

4 MACLEAR - PROPOSED NEW SITE

4.1 Geology

Maclear is situated on mudstone, shale and sandstone of the Molteno Formation, with dolerite intrusions in the form of dykes and sheets (sills). The proposed new site partially underlain by a dolerite sheet that crosses the site east-west (see Figure 1: Locality Map, Appendix 1).

4.2 Soils

The proposed site is partly underlain by a dolerite sheet imbedded between sedimentary layers of shale. The thickness of the dolerite sheet is on average 1.2 m with permeability 1.61 x 10^{-4} cm/sec, which is classified as low. The available volume of weathered dolerite in the open space between the road, the fence and the trees is ~ 2000 m^3.

Table 4.2: Trial holes at Maclear's existing site

Trial Hole No.	Latitude	Longitude	Soil profile
MACH1	31° 05" 34.3'	28° 21" 39.3'	0 - 0.2 Topsoil - weathered shale 0.2 - 1.5 Weathered dolerite 1.5 shale hard rock
MACH2	31° 05" 33.5'	28° 21"39'	0 - 0.2 Topsoil 0.2 - 0.9 weathered shale 0.9 shale hard rock
MACH3	31° 05" 33.3'	28° 21" 41'	0 - 0.2 Topsoil - weathered shale 0.2 shale hard rock
MACH4	31° 05" 33.7'	28° 21" 42.6'	0 - 0.3 Topsoil 0.3 - 0.7 weathered shale 0.7 - 1.7 weathered dolerite 1.7 shale hard rock
Note: The depth of the excavations was limited to the capabilities of the excavator used. The holes were stopped when the excavator failed to dig deeper (refusal)			

4.3 Geohydrology

The site is situated on the top side of a mountain and groundwater development is unlikely to take place within 2 km of the site. Springs can be expected to emerge from the horizontally layered sedimentary strata lower down. New evidence (trial holes) however suggests that spring forming as result of the dolerite sheet is unlikely to take place since the dolerite sheet is very thin in the area of the proposed new site. It is however expected that the springs would not be sustainable due to a lack of recharge (limited catchment).

A spring originates ~ 200-300 m down gradient from the site, but is unlikely to be influenced by the proposed site (from vertical seepage) due the low permeability of the shale and the thickness of the unsaturated zone. There are no known boreholes near the proposed site. No water samples were taken.

4.4 Evaluation of potential fatal flaws - Maclear new site

Potential Flaws	
* 3 km from airstrip	N/A
* Below 1:50 year flood line	No
* Close to significant surface water bodies	No
* Unstable areas	No
* Sensitive areas (ecological & historical)	N/A
* Catchment areas for water resources	No
* Flat gradient, shallow or emerging ground water	No
* Areas of ground water recharge	No
* Areas adjacent to important aquifers	No
* Shallow bedrock with little soil cover	In some areas
Notes: ▪ Significant surface water bodies are seen to exclude seasonal springs	

4.5 Conclusions

From the geohydrological investigation it is concluded that the proposed site at Maclear does not pose any significant threat to the groundwater resources on or near the site. The site is situated on top of a 140 m high mountain (estimated from surface contours, taken as height above river level) and hence groundwater development (boreholes) is unlikely. There are some springs near the site (~ 300 m) and their areas of recharge are not known, but they originate most likely from confined conditions caused by the near-horizontal bedding of the sedimentary layers (sandstone and shale) and will therefore not be affected by near surface conditions.

4.6 Recommendations

It is recommended that all springs down gradient from the proposed site and within 300 m of the proposed site be monitored on a bi-annual basis for the parameters as specified in Appendix 2, Table 13.1 and 13.2.

5 MACLEAR - EXISTING SITE

5.1 Geology & Geohydrology

The existing site is situated south-west of central town, along a dirt road and stretches across a valley. Surface run-off would be directly through the middle of the site. The "dump face" of the site is too wide and people start dumping their waste where the access road to the site joins the main road (~ 200 m from the site), which creates unnecessary risk of surface water contamination. Due to the topographical setting of the existing site, groundwater exploration is very unlikely to take place on or near the site, but seasonal springs can be expected higher up the mountain and will flow through or very close to the site.

5.2 Soils

The soil on and around the existing site comprise largely clayey material. The trial holes indicated clayey material up to a depth of 1.6 m and are estimated to go even deeper. In depth, the clay changes colour and become denser, forming a no-flow barrier in terms of vertical seepage. The permeability (on 77% compaction) of the clay tested 9.62 x 10^{-4} cm/sec, which can be classified as low.

Table 5.2: Trial holes at Maclear's existing site

Trial Hole No.	Latitude	Longitude	Soil profile
MACE1	31° 04" 35.4'	28° 20" 09'	0 - 0.5 Clay, dark brown, contain ~ 20% sand, moist 0.5 - 1.6 Clay, dark brown, more dense, less moist 1.6 Clay, yellow to brown, very dense
MACE2	31° 04" 37.7'	28° 20"08.5	0 - 0.9 Clay, dark brown, loose material (compost), moist 0.9 - 1.3 Clay, yellow to light brown, dense

Notes:

- The depth of the excavations was limited to the capabilities of the excavator used. The holes were stopped when the excavator failed to dig deeper (refusal).

5.3 Evaluation of potential fatal flaws - Maclear's existing site

Potential Flaws	
* 3 km from airstrip	N/A
* Below 1:50 year flood line	No
* Close to significant surface water bodies	No
* Unstable areas	No
* Sensitive areas (ecological & historical)	N/A
* Catchment areas for water resources	Yes, catchment for Mooiriver
* Flat gradient, shallow or emerging ground water	Possible after rain - emerging groundwater
* Areas of ground water recharge	No
* Areas adjacent to important aquifers	No
* Shallow bedrock with little soil cover	No
Notes:	
▪ Significant surface water bodies are seen to exclude seasonal springs	

5.4 Conclusions & Recommendations

From the geohydrological investigation it is concluded that the existing site is not suitable for waste disposal, mainly due the following:

- Contamination risk to seasonal springs,
- Flooding risk,
- Contamination risk to the Mooiriver,

5.5 Recommendation

It is recommended that the existing site be closed and that all material that could cause contamination to surface and groundwater (springs) be relocated to the new site. All natural drainage systems must be restored to their natural conditions to ensure that they are free of blockages and that rainwater and seasonal springs can flow unhindered.

IT IS RECOMMENDED THAT THIS REPORT BE SUBMITTED TO THE DEPARTMENT OF WATER AFFAIRS AND FORESTRY FOR COMMENTS AND APPROVAL.

GP NEL Pr Sci Nat
Principal Hydrogeologist

JU DU PLOOY Pr Sci Nat
Hydrogeologist

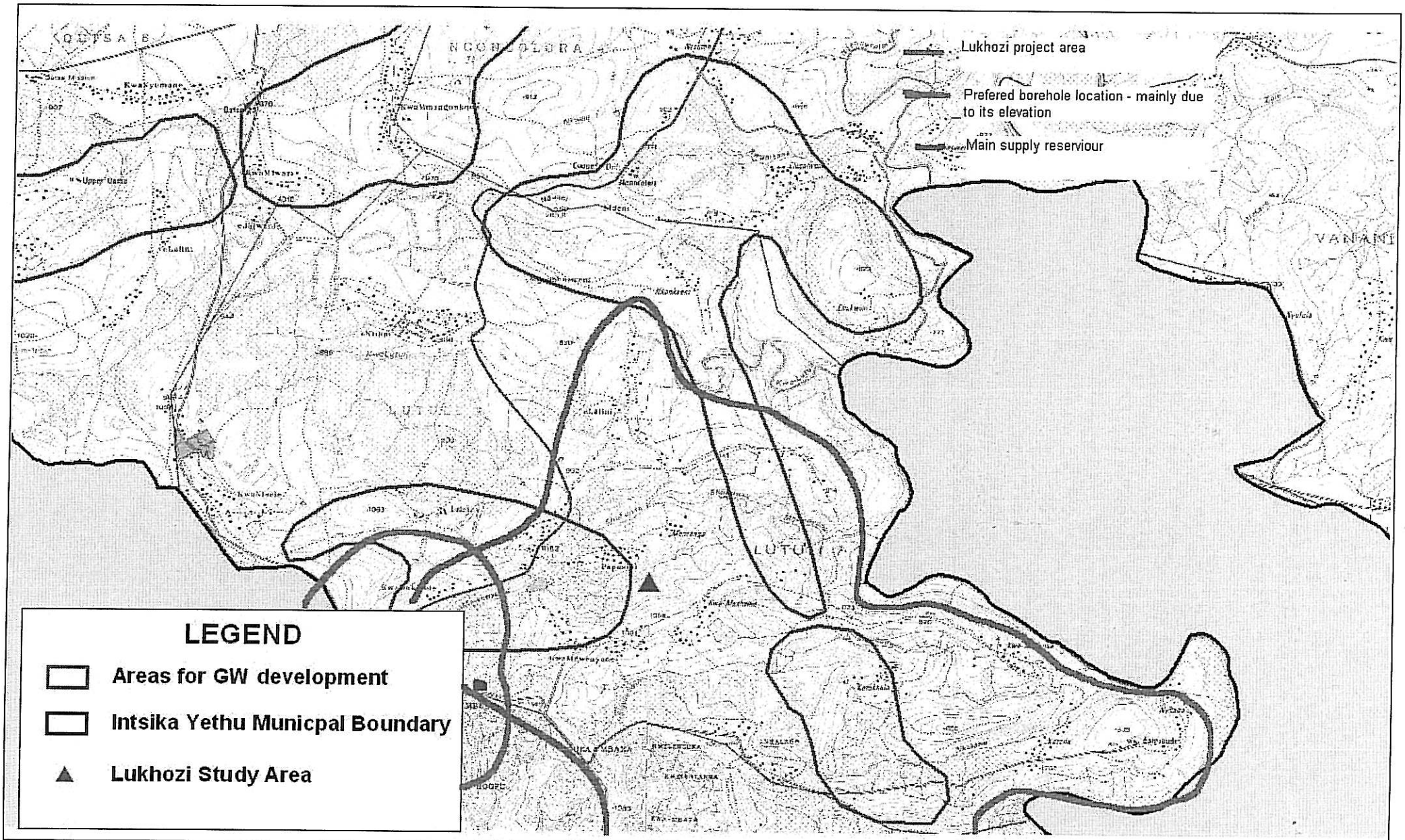
SRK CONSULTING

APPENDIX 1

FIGURE 1: MACLEAR MAP

FIGURE 2 : UGIE MAP

SRK Consulting
Engineers and Scientists

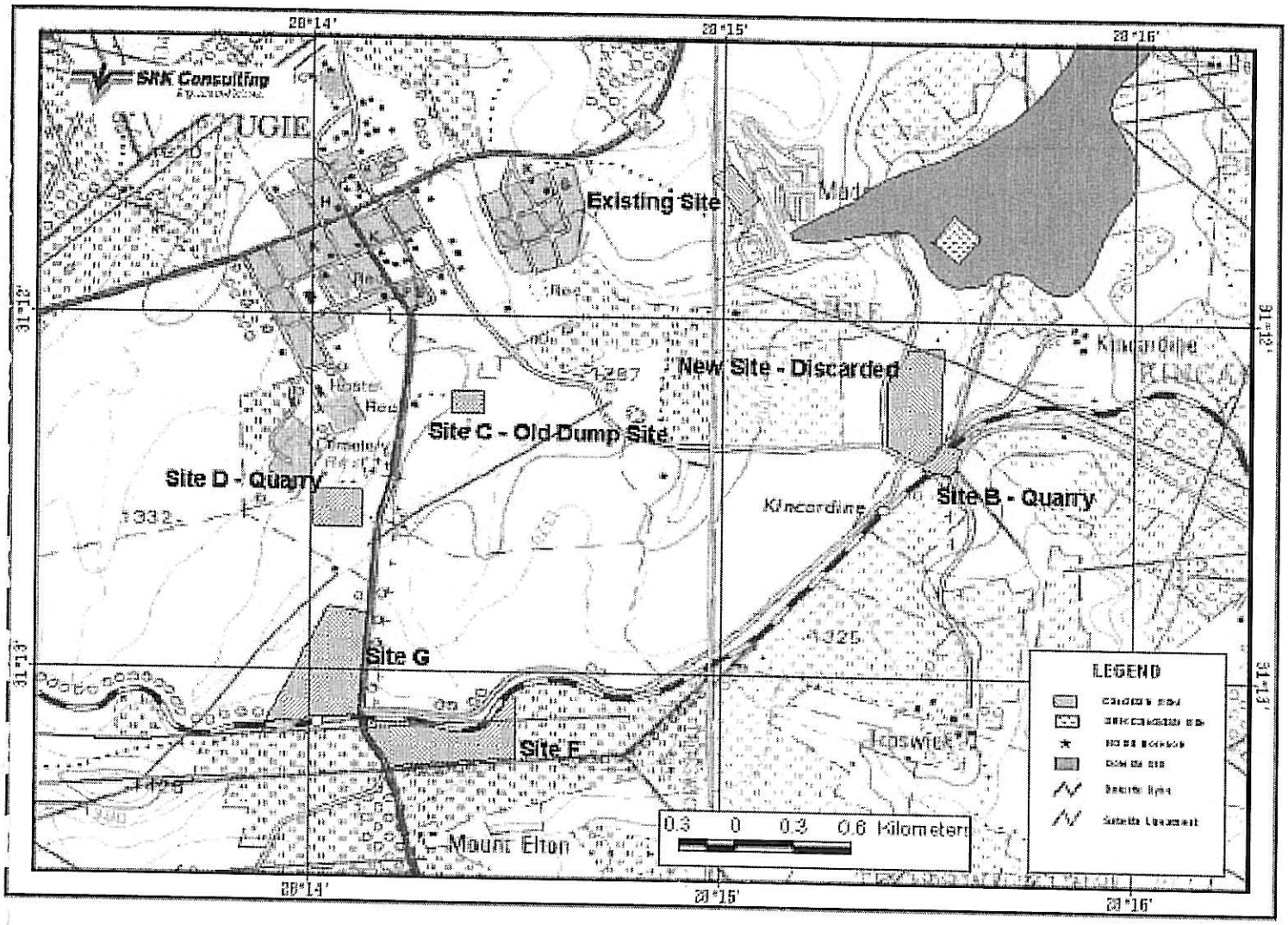


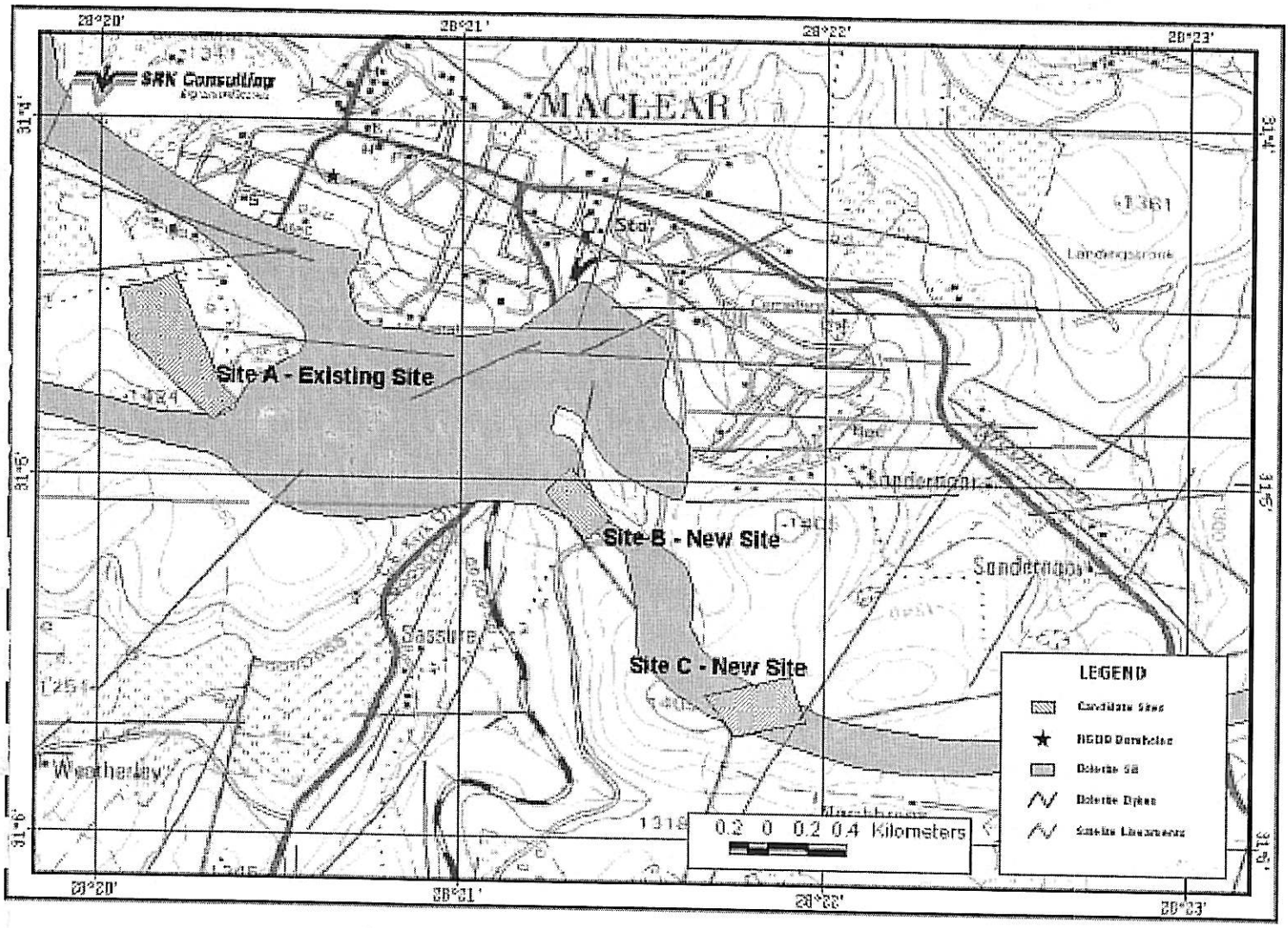
JOB NO.

INTSIKA YETHU LOCAL MUNICIPALITY

Potential Areas for Groundwater Development

FIG NO.
001
October 2003


SRK Consulting
Existing Site
New Site - Discarded
Site C - Old Dump Site
Site D - Quarry
Site B - Quarry
Site G
Site F
Mount Elton
Kilmacardine
LEGEND
0.3 0 0.3 0.6 Kilometers
28°14'
28°15'
28°16'
31°12'
31°13'


28°20'
28°21'
28°22'
28°23'
31°4'
31°5'
31°6'
SRK Consulting
MACLEAR
Site A - Existing Site
Site B - New Site
Site C - New Site
Sandernoot
Sandernoot
Sassuite
Weatherley
0.2 0 0.2 0.4 Kilometers
LEGEND
Candidate Sites
Diorite SB
Diorite Dykes

APPENDIX 2

CHEMICAL PARAMETERS
as part of the groundwater monitoring requirement (DWAF)

TABLE 13.1

Suggested Parameters for Background and Investigative Monitoring

Ammonia (NH_3 as N)	Electrical Conductivity (EC)
Alkalinity (Total Alkalinity)	Free and Saline Ammonia as N (NH_4-N)
Lead (Pb)	Magnesium (Mg)
Boron (B)	Mercury (Hg)
Cadmium (Cd)	Nitrate (as N) (NO_3-N)
Calcium (Ca)	pH
Chemical Oxygen Demand (COD)	Phenolic Compounds (Phen)
Chloride (Cl)	Potassium (K)
Chromium (Hexavalent) (Cr^{6+})	Sodium (Na)
Chromium (Total) (Cr)	Sulphate (SO_4)
Cyanide (CN)	Total Dissolved Solids (TDS)

TABLE 13.2

Suggested Parameters for Detection Monitoring

(a) **Bi-annually for:**	(b) **Annually for:**
Alkalinity (Total Alkalinity)	Calcium (Ca)
Ammonia (NH_3 - N)	Fluoride (F)
Chemical Oxygen Demand (COD)	Magnesium (Mg)
Chlorides (Cl)	Sodium (Na)
Electrical Conductivity (EC)	Sulphate (SO_4)
Nitrate (NO_3 - N)	
pH	
Potassium (K)	
Total Dissolved Solids (TDS)	

APPENDIX 3

Geotechnical

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CLIENT: SRK Consulting
P O Box 15739
BEACON BAY
5205

ATT : Mr G Nel

PROJECT: UGIE

DATE: 03-03-2003

REF: 23199

PERMEABILITY

SAMPLE No	699	MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION	Hole 1 New				
DESCRIPION	lt R O Sh + cly st	1791 / 15.2	1365	76.2	$4.06 * 10^{-3}$

REMARKS: FALLING HEAD

SAMPLE No	700 Existing	MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION	Hole 2				
DESCRIPION	dk Br Ss + cly s	2044 / 8.8	1487	72.7	$9.62 * 10^{-5}$

REMARKS: FALLING HEAD

SAMPLE No		MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION					
DESCRIPION					

REMARKS:

SAMPLE No		MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION					
DESCRIPION					

REMARKS:

DEGREE OF PERMEABILITY

	over	$1 X 10^{-1}$	-----	HIGH
$1 X 10^{-1}$	to	$1 X 10^{-3}$	-----	MEDIUM
$1 X 10^{-3}$	to	$1 X 10^{-5}$	-----	LOW
$1 X 10^{-5}$	to	$1 X 10^{-6}$	-----	VERY LOW
	less than	$1 X 10^{-7}$	-----	PRACTICALLY IMPERMEABLE

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CONTROLAB cc

CK 90/12841/23

CIVIL ENGINEERING MATERIALS AND GEOTECHNICAL LABORATORY

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Tel: (041) 461 1832
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Cape Town
Tel: (021) 469 9111
Fax: (021) 423 1079

CLIENT: SRK Consulting
P O Box 15739
BEACON BAY
5205

ATT : Mr G Nel

PROJECT: UGIE

DATE: 03-03-2003

REF: 23199

PERMEABILITY

SAMPLE No	699	MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION	Hole 1 New				
DESCRIPION	lt R O Sh + cly st	1791 / 15.2	1365	76.2	$4.06 * 10^{-3}$

REMARKS: FALLING HEAD

SAMPLE No	700 Existing	MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION	Hole 2				
DESCRIPION	dk Br Ss + cly s	2044 / 8.8	1487	72.7	$9.62 * 10^{-5}$

REMARKS: FALLING HEAD

SAMPLE No		MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION					
DESCRIPION					

REMARKS:

SAMPLE No		MOD A.A.S.H.T.O.	REMOULDED DRY DENSITY	PERCENT COMPACTION	PERMEABILITY cm / Second.
POSITION					
DESCRIPION					

REMARKS:

DEGREE OF PERMEABILITY

	over	$1 X 10^{-1}$	------	HIGH
$1 X 10^{-1}$	to	$1 X 10^{-3}$	------	MEDIUM
$1 X 10^{-3}$	to	$1 X 10^{-5}$	------	LOW
$1 X 10^{-5}$	to	$1 X 10^{-6}$	------	VERY LOW
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CLIENT: S R K Consulting
P O Box 15739
BEACON BAY
5205

ATT : Mr G Nel

PROJECT: MACLEAR

DATE: 03-03-2003
REF: 23199

FOUNDATION INDICATOR RESULT SUMMARY

SAMPLE NO:	698	701				
POSITION	MAC	MAC E1				
	TP 1	Existing Site				
DESCRIPTION:	lt R O Sh	lt R				
	+ cly s	sty s				
SIEVE ANALYSIS						
% PASSING 75 mm						
37.5 mm	100					
19 mm	92	100				
9.5 mm	82	99				
4.75 mm	73	98				
2.36 mm	65	94				
1.18 mm	58	87				
0.600 mm	54	82				
0.425 mm	52	78				
0.300 mm	51	76				
0.150 mm	48	70				
0.075 mm	46	65				
MECHANICAL ANALYSIS						
0.06 mm	35	50				
0.02 mm	24	35				
0.006 mm	19	25				
0.002 mm	15	18				
SOIL CONSTANTS						
LIQUID LIMIT	43	18				
PLASTICITY INDEX	16	5				
LINEAR SHRINKAGE	8.0	2.5				
C B R						
MOD AASHTO	1612	1958				
O.M.C. %	18.2	11.2				
CBR @ 100% COMPACTION	8	86				
CBR @ 98% COMPACTION	7	51				
CBR @ 95% COMPACTION	7	25				
CBR @ 93% COMPACTION	6	16				
CBR @ 90% COMPACTION	6	8				
% SWELL	0.00	1.41				

Checked by: R L W

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Fax: (021) 423 10

CLIENT: S R K Consulting
P O Box 15739
BEACON BAY
5205

ATT : Mr G Nel

PROJECT: MACLEAR

DATE: 03-03-2003
REF: 23199

FOUNDATION INDICATOR RESULT SUMMARY

SAMPLE NO:	698	701				
POSITION	MAC	MAC E1				
	TP 1	Existing Site				
DESCRIPTION:	lt R O Sh	lt R				
	+ cly s	sty s				
SIEVE ANALYSIS						
% PASSING 75 mm						
37.5 mm	100					
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MECHANICAL ANALYSIS						
0.06 mm	35	50				
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LINEAR SHRINKAGE	8.0	2.5				
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MOD AASHTO	1612	1958				
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CBR @ 100% COMPACTION	8	86				
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CBR @ 95% COMPACTION	7	25				
CBR @ 93% COMPACTION	6	16				
CBR @ 90% COMPACTION	6	8				
% SWELL	0.00	1.41				

Checked by: P L W

APPENDIX 4

Water Quality

Amatola Water - Amanzi - *Water is life*

Scientific Services Division

Nahoon Dam Complex
Nahoon Dam
Private Bag X2
East London

Tel No: (043) 7452081
Fax No: (043) 7451375
sservices@amatolawater.co.za
http://www.amatolawater.co.za

Certificate of Analysis

SRK Consulting
PO Box 15739
Beacon Bay
5205
043 - 748 1811
gnel@srk.co.za

Submitted By: Mr. Gert Nel
Date Received: 07 March, 2003
Date Reported:

Certificate No: SRK 2003/03/07

All samples were analysed according to approved "Standard Methods"
Chemical results in milligrams per litre (unless otherwise stated)

SAMPLE NO:	14371	14372
	SRK Consulting	SRK Consulting
SAMPLE DESCRIPTION:	TER 1 Order 9801 Borehole	Sample 2 Order 9801 Spring
SAMPLED DATE:	07/03/2003	07/03/2003
COMMENTS		
(Nitrate & Nitrite) as N	0.93	1.8
Alkalinity	<10	<10
Ammonia as N	0.08	0.04
Boron as B	<0.001	<0.001
Cadmium as Cd (µg/l)	9.0	8.8
Calcium as Ca	0.63	<0.5
Chemical Oxygen Demand	21	<10
Chloride as Cl	<4	<4
Chromium as Cr (µg/l)	54	14
Chromium as Cr6+ (mg/l)	0.01	0.02
Conductivity (mS/m)	6.4	4.5
Cyanide (free) as CN (µg/l)	<8	<8
Faecal coliforms count (CFU / 100ml)	24	43
Lead as Pb (µg/l)	<30	<30
Magnesium as Mg	1.9	1.8
Mercury as Hg (µg/l)	<0.3	<0.3
pH (pH units)	5.72	5.74
Phenolic Compounds (µg/l)	<40	<40
Potassium as K	1.8	1.4
Sodium as Na	4.9	4.9
Solids - dissolved	32	23
Sulphate as SO4	<3	28
Temperature (°C)	21.9	21.8

Steffen, Robertson and Kirsten (South Africa) (Pty) Ltd

Report Distribution Record

Report No. : 308195

Copy No. : 1

Name/Title	Company	Copy	Date	Authorised By
A. Chaloner	UWP Engineers	2	1 April 2003	G. Nel

Approval Signature :

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