WSM LESHIKA CONSULTING (PTY) LTD

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Jacana Environmentals cc

Preliminary Overview of Water Supply Options for the Proposed Duel Coal Mine, Makhado Municipality, Limpopo Province

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PRELIMINARY OVERVIEW OF THE WATER SUPPLY OPTIONS FOR THE PROPOSED DUEL COAL MINE

WATER RESOURCES

03

PRELIMINARY OVERVIEW OF WATER SUPPLY OPTIONS FOR THE PROPOSED DUEL COAL MINE, MAKHADO MUNICIPALITY, LIMPOPO PROVINCE

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ABSTRACT

The Duel Coal Project is currently in the process of conducting the Environmental Impact Assessment and Management Plan for the Mining right application, as well as to compile the Integrated Water Use License (IWULA).

The project water requirement has been conservatively estimated as 1 860m^3/day.

This preliminary study has identified the following potential water sources to meet this demand, i.e.

- Dzanani wastewater in combination with either Rambali Irrigation water Loss Recovery or Tshipise Fault Wellfield
- Makhado waste water
- Musina waste water
- Nzhelele irrigation buy out
- Vondo Dam Transfer

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1 INTRODUCTION

The Duel Coal Project is currently in the process of conducting the Environmental Impact Assessment and Management Plan for the Mining right application, as well as to compile the Integrated Water Use License (IWULA).

The proposed mine is an open pit and underground project with a 24-year lifespan producing 2.4 Mtpa ROM product in year 1-14, increasing to 3.6Mtpa from year 14 to 24.

Water in the northern parts of the Limpopo Province is scarce and there is strong competition between various water users for the limited water resources. Because of this, the availability of water for supply to the mine is considered one of the major risks to the project meeting its production deadlines.

This report therefore focuses on evaluating options available to the Duel Project to meet the water requirements and will discusses the risks and cost implications of these options.

2 AIM OF THE STUDY

The objectives of this bulk water supply investigation are to:

- Confirm water requirement by setting up a water balance
- Identify all possible water resources options within a 50 km radius that individually or conjunctively will meet the Duel Coal project water requirements;
- From published data and information determine the likely water availability from these options, assess the risks associated with each option, identify potentially affected parties and evaluate the cost implications;
- Evaluate the merits of each of the possible options and identify a short list of the most favourable water supply options that will be progressed to more detailed analysis.
- Develop the scope of works for the more detailed investigation of the most favourable water supply options.

3 WATER BALANCE

The total water usage for the project is expected to vary between 1225m^3/day and 2150m^3/day. Inflows into the mine are expected to vary between 650m^3/day and 2000m^3/day. The external water requirement is expected to peak at about 1550m^3/day. The preliminary water balance is shown in table 3.1 below.

Considering the high level of certainty (98%) required for the mine water supply a safety factor of 1.2 has been applied to the volume required from outside resources (1 550 m^3/day) to give a volume of 1860m^3/day or 0.679 Mm^3 / annum.

The options or combination of options considered in this study therefore all need to deliver at least 1860m^3/day of raw water to the Duel Project.

Table 3.1: Water Balance Summary for the Duel Project

Description	Unit	Year																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
On-Mine Water Inflow																									
Local Groundwater	m³/day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit Dewatering	0	0	750	2 000	1 200	1 800	900	800	900	1 250	750	700	650	700	750	700	600	800	750	700	700	650	650	650	650
Total Inflows	**m³/day**	**0**	**750**	**2 000**	**1 200**	**1 800**	**900**	**800**	**900**	**1 250**	**750**	**700**	**650**	**700**	**750**	**700**	**600**	**800**	**750**	**700**	**700**	**650**	**650**	**650**	**650**
Water Demand																									
Dust Suppression	m³/day	-164	-590	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790	-790
CHPP	m³/day	-164	-590	-790	-790	-790	-790	-790	-790	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	-1 180	65
Water to Water Treatment Plant	m³/day	-75	-90	-90	-90	-90	-90	-90	-90	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120
Washbay and Washdown Water	m³/day	-20	-25	-25	-25	-25	-25	-25	-25	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-10
Evaporation	m³/day	0	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30
Construction Water	m³/day	-800	-750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflows	**m³/day**	**-1 223**	**-2 075**	**-1 725**	**-1 725**	**-1 725**	**-1 725**	**-1 725**	**-1 725**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-2 150**	**-885**
Make-up Water Required from Outside Sources																	Max Demand								
Outside Make Requirment	m³/day	-1 223	-1 325	275	-525	75	-825	-925	-825	-900	-1 400	-1 450	-1 500	-1 450	-1 400	-1 450	-1 550	-1 350	-1 400	-1 450	-1 450	-1 500	-1 500	-1 500	-235
Rouded Balance+10% Contingency	**m³/day**	**-1 345**	**-1 458**	**303**	**-578**	**83**	**-908**	**-1 018**	**-908**	**-990**	**-1 540**	**-1 595**	**-1 650**	**-1 595**	**-1 540**	**-1 595**	**-1 705**	**-1 485**	**-1 540**	**-1 595**	**-1 595**	**-1 650**	**-1 650**	**-1 650**	**-259**

4 POSSIBLE WATER SUPPLY OPTIONS

4.1 Regional Overview

The Soutpansberg mountain range and the Highveld escarpment are major topographical features that greatly influence the viability of water supply options to meet the water demand of the Duel project.

The Soutpansberg is located immediately north of Makhado town and lies on a west – east axis stretching from Vivo in the west to beyond Thohoyandou in the east (see Figure 4.1). The Soutpansberg rises from a base elevation of roughly 625m above mean sea level at the mine site to a high point in excess of 1 600m above mean sea level. The Soutpansberg therefore greatly influences climate (see Figure 4.2), possible pipeline routes, pumping head and road access.

The escarpment between the Highveld and Lowveld follows a line northward between Haenertsburg near Tzaneen to Elim near Makhado from where the escarpment follows the Soutpansberg beyond Thohoyandou. The elevation difference between the Lowveld and Highveld is approximately 400m.

The prevailing rain producing winds are north – westerly and therefore a rain shadow occurs on the northern side of the Soutpansberg. The mean annual rainfall in the areas north of the Soutpansberg is less than 440mm and therefore surface water runoff from the area and ground water recharge is relatively low. The average annual rainfall in the higher levels of the eastern Soutpansberg is between 800 mm and 1 000 mm. Improved runoff therefore occurs from catchments that rise in the Soutpansberg.

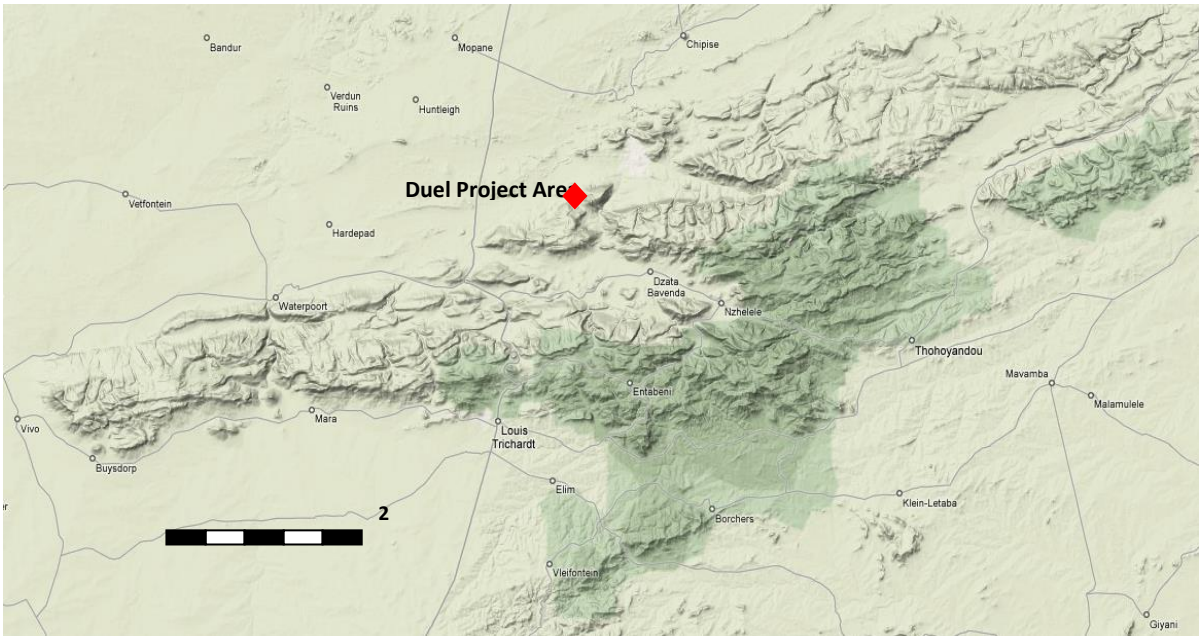

Figure 4.1: General Topography of the Study Area

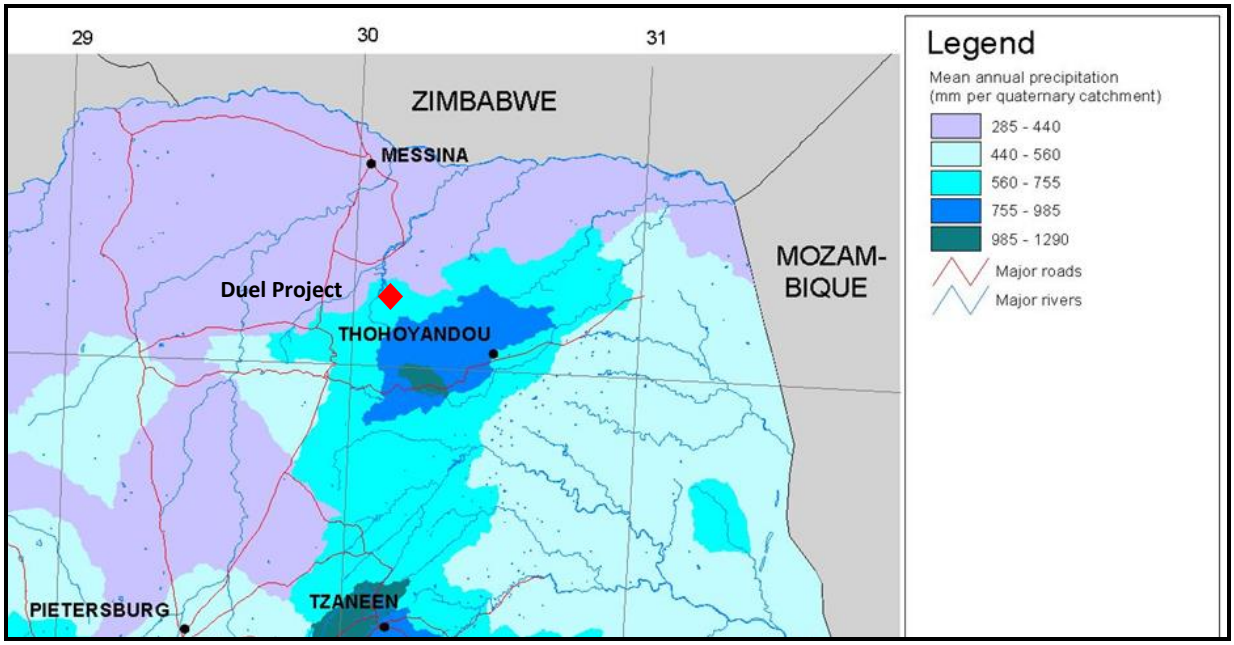

Figure 4.2: Mean Annual Precipitation of the Study Area

The region has experienced extensive urban, rural and irrigation development. In view of the relatively low rainfall experienced in the area and the seasonal nature of the runoff in the river's major capital works, in terms of the construction of dams and wellfields, have been undertaken in order to supply adequate bulk water infrastructure to meet the water demand. Below are extracts from DWS: Directorate National Water Resources Planning compiled 23 February 2006:

Groundwater: If the recently registered groundwater use (WARMS) is compared to the average annual recharge, it becomes evident that in general the groundwater potential in many of the WMAs is currently vastly under-utilized. There are many opportunities to establish small scale irrigation (i.e. community gardens) from groundwater sources and this aspect should be explored in all areas.

The Sand catchment (A7): The Sand catchment is a dry catchment with very limited surface water resources. However, it has exceptional groundwater resources, which have been fully and possibly over-exploited in certain areas. No surplus water is available for allocation.

The Nzhelele catchment (A80A-G): The catchment is clearly stressed, and this is due to over-allocation and/or over-development of the irrigation sector. No surplus water is available for allocation.

The Nwanedi catchment (A80H,J): The water resources of the catchment are limited and are in deficit. This is due to over-allocation or over-development by the irrigation sector. No surplus water is available for allocation.

Luvuvhu catchment (A91): In the Luvuvhu catchment water availability exceeds the water requirements by 37 million m^3/a. This water is available from the Nandoni Dam, but this dam was built to supply the growth in urban and industrial demands in Thohoyandou and Makhado, potentially releasing water from the Vondo Dam for other use. The quantity required for this was not accounted for during the ISP. There is furthermore some uncertainty

as to the impact of the ecological Reserve on the yield of the Nandoni Dam and this could influence the water balance figures. The KNP is situated at the bottom of this catchment and they are very sensitive about the impacts of Nandoni Dam on the flow in the river. The ISP recommended therefore that a more detailed analysis be carried out as a priority to determine the available resource more accurately. As part of this exercise, a comprehensive Reserve needs to be determined. This work will have to be done before making allocations from the surplus yield.

Mutale catchment (A92): The Mutale sub-catchment is in balance. No surplus water is available for allocation.

Groot Letaba catchment (B81): The Groot Letaba catchment water balance indicates that there is a deficit in the catchment. There is no surplus water available.

Klein Letaba catchment (B82): The Klein Letaba catchment water balance indicates that there is a deficit in the catchment. There is no surplus water available.

Obtaining approval to further develop the limited water resources therefore poses a significant challenge.

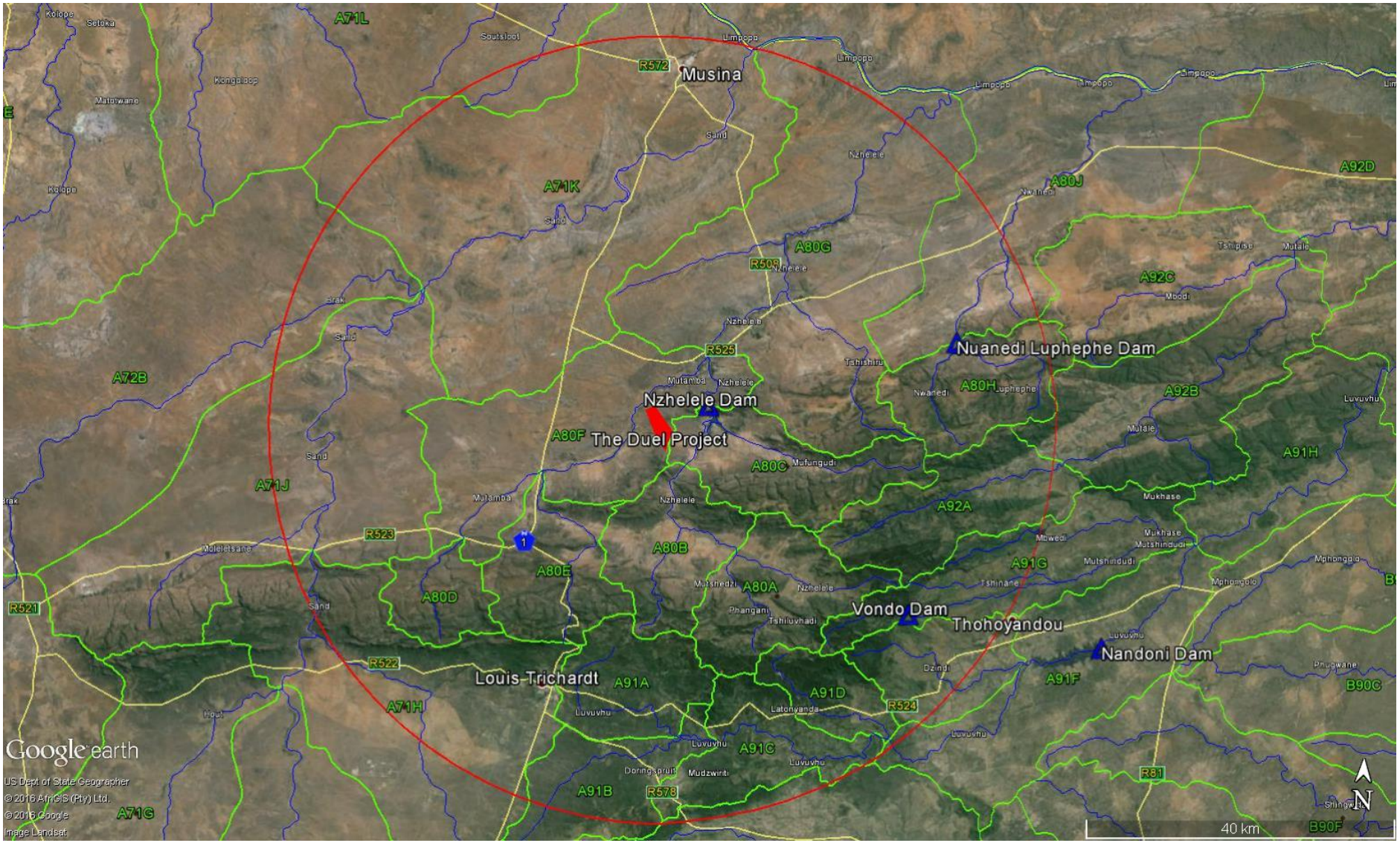

Figure 4.3: Quarternary Catchments

4.2 Identification of Options

In view of the limited water resources available in the region, options to meet the water requirements of the Duel Project would need to consider all possible available water, including efficient use of already exploited resources (e.g. water conservation and reuse of treated effluent), purchasing existing water rights, obtaining approval to utilise currently under-utilized water and development of limited available new surface and ground water resources options.

Options further than 50 km from the project area have not been considered at this stage and include options involving the sourcing of water from the Nandoni Dam. More than 30 possible water supply options have been identified in a radius of about 50 km from the Duel Project site of which the 10 most suitable options are listed in Table 4.1 below (also see Figures 4.4) and include:

- Implementing water conservation (reducing losses on the irrigation canals)
- Buy out of irrigation rights
- New ground water development
- Treated effluent re-use
- New surface water resources development

The other 20 options have been excluded due to the intense competition for the water, long pipe routes and excessive pumping heads. They are almost all on the southern side of the Soutpansberg Mountains.

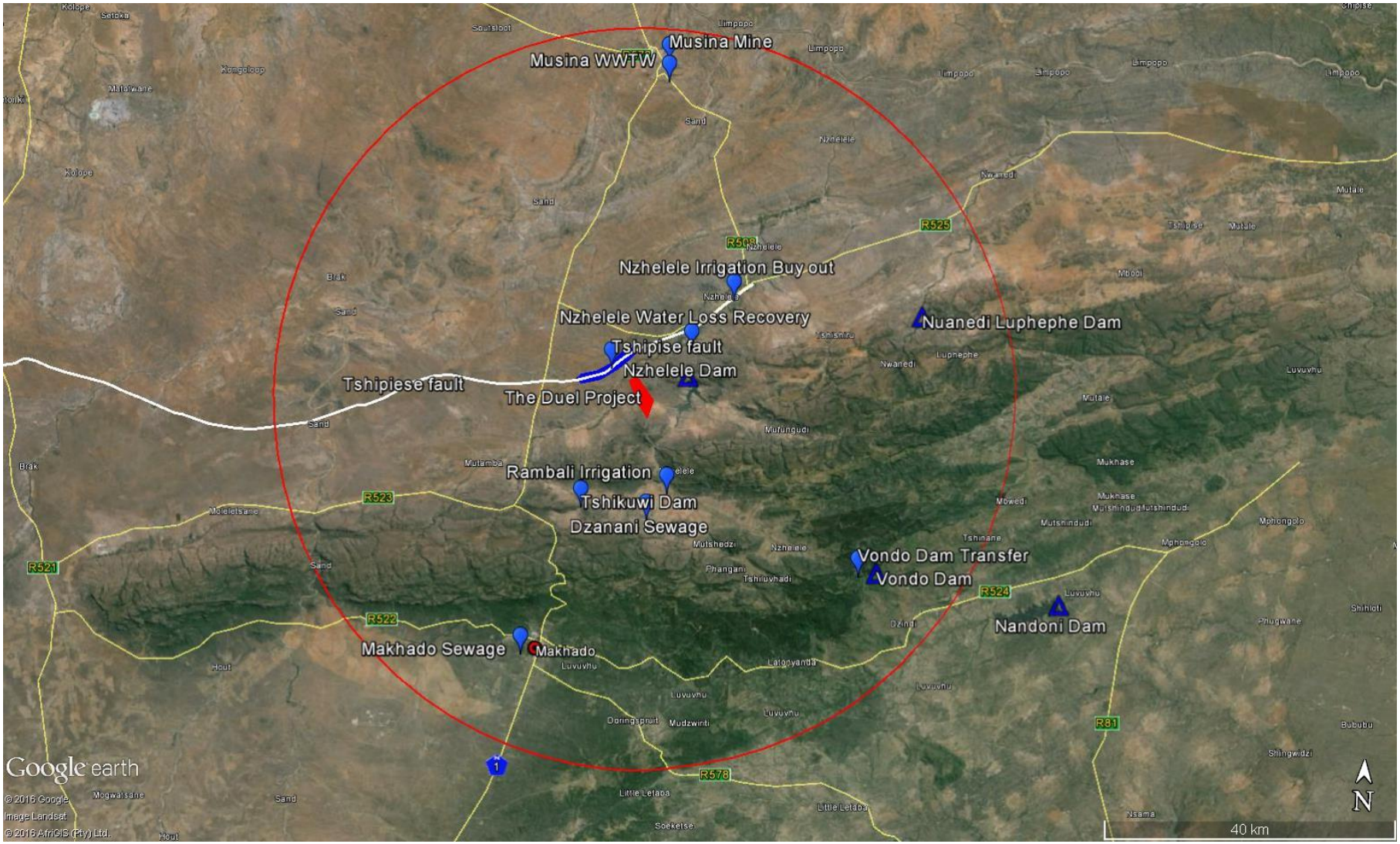

Figure 4.4: Bulk Water Supply Options

Table 4.1: List of Possible Water Supply Options

Option	Water Source	Water Supplied		Current Water Users	Issues
		Mm^3/annum	m^3/day		
Nzhelele Government Water Scheme - Water Loss Recovery	Nzhelele dam	0.679	1 860	Environment	- shortage of domestic water in the area - irrigation allocations severely cut - over allocation from Nzhelele dam - environmental reserve
Nzhelele irrigation buy out (164ha)	Nzhelele dam	0.679	1 860	Irrigation (164ha)	- need to buy irrigation water rights from farmers - compensate for allocation and higher assured yield - social impacts - food security
Dzanani wastewater	Wastewater	0.347	950	Informal irrigation / environment	- operation and maintenance of treatment works - available volume to increase as Dzanani town grows
Rambali irrigation scheme water loss recovery	Nzhelele river	0.282	770	Environment	- shortage of domestic water in the area - irrigation allocations severely cut - over allocation from Nzhelele river - environmental reserve
Tshipise Wellfield	Groundwater Tshipise Fault	0.365	1 000	Cattle, Game and domestic use for farms and lodges	- on private land - servitude registration - licensing - compensation

					- Impact of dewatering from mines
Makhado wastewater	Wastewater	0.679	1 860	Recharge of Makhado wellfield, irrigation of municipal gardens & golf course	- impact on Makhado town wellfield - difficult pipe route - excessive static pumping head (420m)
Musina wastewater	Wastewater	0.679	1 860	Golf course, environment	- long pipe distance (more than 50 km) - High pumping head (300m)
Abandoned Musina mine workings	Groundwater inflows and Limpopo flood flow	0.679	1 860	Backup for municipality	- long pipe distance (more than 50 km) - High pumping head (300m)
Tshikuwi Dam	Surface water	2.592	7 100	Environment and irrigation	- long lead time - possible impact on downstream users
Transfer from Vondo Dam	Vondo Dam	0.679	1 860	Domestic and irrigation	- Need buy-in from DWS - Shortage of domestic water along route - Long pipeline

4.3 Discussion of Options

4.4.1 Nzhelele Government Water Scheme Water Loss Recovery

The Nzhelele Government Irrigation Scheme draws its water from the Nzhelele dam. Water is released from the dam and captured in a weir some 3 km north and downstream of the Nzhelele dam (about 5km along the river). The water is then abstracted from the weir into a bulk water canal system, comprising of a main canal and 6 branch canals, which are used to convey the water to the irrigators. The total length of the canal system is 63 km which includes 61 syphons with a total length of about 10 km. The canal system was built in 1966.

Information available indicates that significant losses occur from the canal system. Losses occur as a result of:

- River losses – losses (seepage and evapotranspiration) that occur when water is released from the dam and flows down the river channel to the weir. These losses have been calculated to be at least 5% of the water released. This accounts for about 0.794 Mm^3/annum or 2 175 m^3/day.

  These losses can be significantly reduced if the water is transferred to the weir by means of a pipeline. A 3.6 km 1100 mm pipe will be required.

- Canal losses - In canal design, provision is made for a combined infiltration (or seepage) and evaporation loss rate of 1.9 litre/s per 1 000 m2 for concrete lined canals (DWA canal design guide). Assuming the main canal to have a 3.6 m^2 wetted concrete area per m length, the loss over 1 000 m of canal length is as follows:

  Loss = 1.9 * 3 600/1 000 = 1.9 * 3.6 = 6.84 l/s per km

  Taking the application period (conservatively) to be 10 months at 12h/day for 20 days a month, the total loss is as follows:

  0.00684 m^3/s * 10 * 12 *20 * 3600 = 59 097 m^3 per km length of main canal. For the 63 km of the main canal this amounts to 3.723 Mm^3/annum or 10 200 m^3/day.

  To save this water it would be required to replace the canals with pipelines. Total length to be replaced to save 1860 m^3/day would thus be about 12kms with pipe sizes varying from 1 100mm to 300mm.

  Canals chocked with sediment and algae cause water slugs passing down the canal to overflow with significant water losses. Regular maintenance to remove silt and algae is required.

Photo 4: Main canal close to overflowing

4.4.2 Nzhelele Irrigation Buy Out Option

The Nzhelele Dam, located on the Nzhelele River some 13 km east north east of the Duel Project, has a gross capacity of 51.2 Mm^3. The dam is used to irrigate citrus and other crops downstream of the dam. Irrigators have an allocation of 8 440 m^3/ha/annum.

Water rights purchased from farmers along the Nzhelele River would make water available for use on the Duel Project. To obtain 0.679 Mm^3/annum (1 860 m^3/day) at a high level of assurance the mine would need to purchase about 153 ha of scheduled irrigation.

(0.679 / 70) * 100 = 0.970 Mm^3/annum (only receive 70% of scheduled water)

(0.970 / 70) * 100 = 1.386 Mm^3/annum (only 70% of the water will be at 98% assurance)

1.386 / 8 440 = 164 ha)

This would impact on job opportunities and have other socio-economic consequences and requires further investigation. The cost of purchasing irrigation water rights in this area is likely to amount to about R150 000.00 /ha.

The water available from the scheme would be pumped to Duel Project through a 160 mm diameter pipeline from the dam. The maximum static head amounts to about 80 m and the pipeline length would be about 18 km.

4.4.3 Dzanani Wastewater

The Dzanani wastewater treatment works presently has an inflow of about 950m^3/day from sewage in the town and waste water from the Rhodes Food Group Dzanani factory. As the village supplying the waste water is a nodal development point, a significant increase in the

wastewater inflow is expected in the future. The mine should further consider housing their staff at this town as it is relatively close to the mine area and would help to increase the growth in the town thus producing more effluent available for mine use.

To obtain maximum benefit from this waste water it is recommended that the existing oxidation ponds (high evaporation losses) be replaced by a package plant. To get treated wastewater to the Duel Project will require a pipeline of about 16 km and a pump station to get over the mountain (150m head).

Photo 5: Flow at Dzanani sewage treatment works

4.4.4 Rabali Irrigation scheme Water Loss Recovery

The Rambali irrigation scheme in the upper Nzhelele valley currently flood irrigates 90 ha of cash crops. Water is obtained from the upper Nzhelele canal system. These canals are poorly maintained, and high losses occur (see photo 6). Irrigation efficiency is also very low.

Photo 6: Poorly maintained canals

It has been determined that if the canal is replaced with a pipeline (3.5km) and the flood irrigation replaced with sprinklers a water saving of at least 0.282 Mm^3/annum (770 m^3/day)

can be realised. The water saved could be pumped to the Duel Project over about 20kms at a head of about 150m.

4.4.5 Tshipise Fault Groundwater Development

Some kilometres north of the Duel Project area, a potential for groundwater development exists along the Tshipise fault. This fault is known to have high yielding boreholes. It is thought that about 0.365 Mm^3/annum (1 000 m^3/day) could be abstracted from a catchment area of about 8000ha (see figure 4.4). The impact of other mines and irrigation will however need to be evaluated

The farms covering the catchment area would either need to be purchased or permission to utilise the water obtained from the land owners and servitudes registered. To develop this wellfield would require developing about 10 production boreholes along the Tshipise fault and pumping the water via a pipeline to the Duel Project area. The total pipeline length would be about 35kms.

4.4.6 Makhado Wastewater

Wastewater from Makhado is treated in a wastewater plant located adjacent and south of Makhado. The treated wastewater is discharged to the upper reaches of the Dorps River catchment. The existing Makhado wellfield is in this area.

Available information suggests that the volume of wastewater delivered to the plant amounts to about 1.81 Mm^3/annum (5 000 m^3/day).

The treated wastewater could be pumped in a 300 mm diameter pipeline from Makhado treatment works to the Duel Project along the N1 traversing the high Soutpansberg mountains with the maximum static head being 450 m. The total pipeline length is about 50 kms.

4.4.7 Musina Wastewater

Wastewater from Musina is treated in a wastewater plant located adjacent and to the south east of the town. The treated wastewater is used to irrigate the golf course, with the remainder returning to the streams.

Available information suggests that the volume of wastewater delivered to the plant amounts to about 1.10 Mm^3/annum (3 000 m^3/day).

The treated wastewater would be pumped in a pipeline from Musina treatment works to the Duel Project along the N1 over a distance of about 70km with the static head being 150m.

4.4.8 Abandoned Musina Mine Workings

The old abandoned Messina Copper Mine has now filled with water. The mine is estimated to have 0.650 Mm^3 stored to 250 m below ground level. The water yield from the inflows into the mine has been estimated as 2 160 m^3/day (ref WSM Leshika Consulting report for the Messina Municipality, 1995)

This water can be pumped out and taken to the Duel Project via a 70 km pipeline along the N1.

4.4.9 Proposed Tshikuwi Dam

The proposed Tshikuwi Dam is located north of the Soutpansberg on a tributary of the Mutamba River, which is a tributary of the Nzhelele River. The Tshikuwi Dam would be about 35 m high and have a capacity of 1.5 MAR i.e. 8.8 Mm^3 per annum. The yield of the dam, based on a 90% level of assurance, is estimated to be about 2.1 Mm^3 per annum (5 800 m^3/day). The impact of the dam on irrigation downstream of Nzhelele Dam would need to be investigated. The Tshikuwi Dam would also submerge cultivated drylands.

The Tshikuwi Dam option comprises a dam, pump station and bulk water pipeline. Water from the dam would be conveyed through a 350 mm pipeline to the Duel Project area over about 25 km.

4.4.10 Transfer of water from Vondo Dam

Vondo Dam supplies water for irrigation of tea and domestic use for Thohoyandou and surrounds. The newly constructed Nandoni dam is intended to replace a large part of the domestic supply from Vondo Dam potentially releasing water for other uses, up to 3,0Mm^3/annum. This available water could be utilised to supply the villages along the Nzhelele valley as well as the Duel Project.

The route crosses a ridge (altitude 1093) over the upper portion of the dam catchment area close to the dam position (some 4 km), making the pumping main very short. After the ridge the route descends sharply over some 2 km down to a valley. The valley has mild and gentle slopes for some 24 km until a final ridge (altitude 806) is crossed in the immediate proximity of the mine. Due to the steep decent after the pumping main, two pressure break tanks are required near the dam in the gravity system. From the second pressure break tank, another pressure break tank is required after some 24 km before the gravity system discharges to the Duel Project.

4.4 Estimated Costs of Options

Option	Water Supplied (m^3/day)	Est Capital Cost (Rmil)	Est Unit Reference Value (R/m^3)
Nzhelele Government Water Scheme Water Loss Recovery	1 860	135	9.0
Nzhelele irrigation buy out (164ha)	1 860	82	8.5
Dzanani wastewater	950	38	4.8
Rambali irrigation scheme water loss recovery	770	45	4.6
Tshipise Fault Wellfield	1 000	90	6.8
Makhado wastewater	1 860	210	11.5
Musina wastewater	1 860	240	12.0
Musina mine workings	1 860	290	14.5
Tshikuwi Dam	1 860	520	15.5
Vondo Dam Transfer	1 860	345	9.5

4.5 Evaluation of Possible Water Supply Options

The options identified which could supply the required volume include:

- Water Loss Recovery Nzhelele Dam
- Nzhelele Irrigation Buy-out
- Makhado Sewage
- Musina Sewage
- Old Musina Mine
- Tshikuwi Dam
- Vondo Dam Transfer

A combination of the other options would be required to meet the required volume, i.e.

- Dzanani Waste water in combination with Rabali Water Loss Recovery or Tshipise Wellfield

A preliminary assessment has been undertaken of the options and a scoring system was used to determine the relative merits of the options. The aspects briefly evaluated included cost, likelihood of obtaining the required water use permit (consent), environmental and social concerns, potential design and construction issues and overall risk of securing the required water on time. These aspects for each of the options were assigned a score value in the range

+ 4 to – 4. The sum of the scores of each aspect yielded the overall score for each option, with the highest positive score yielding the best option.

Details of the scores assigned to each option are given in Appendix B and the results of this assessment are given in Table 4.3 below.

The overall merit score ranges from 23 to -19. It is recommended that options having a score of equal to and better than - 1 should be considered for further detailed study.

Table 4.3: Possible Water Supply Options Merit Score

Option	Water Available (m^3/day)	Total Merit Score
Nzhelele Government Water Scheme Water Loss Recovery	1 860	-6
Nzhelele irrigation buy out (164ha)	1 860	-2
Dzanani wastewater	950	24
Rambali irrigation scheme water loss recovery	770	-2
Tshipise Fault Wellfield	1 000	3
Makhado wastewater	1 860	7
Musina wastewater	1 860	3
Musina mine workings	1 860	-4
Tshikuwi Dam	1 860	-23
Vondo Dam Transfer	1 860	-3

The preliminary assessment of the various water supply options suggests that the following possible water supply options to meet the water requirements of the Duel Project merit further consideration:

- Dzanani wastewater in combination with either Rambali Irrigation water Loss Recovery or Tshipise Fault Wellfield
- Makhado waste water
- Musina waste water
- Nzhelele irrigation buy out
- Vondo Dam Transfer

These options, will enable the Duel Project to meet its long-term bulk water demands

5. SCOPE OF WORK FOR FURTHER OPTION EVALUATION

Detailed investigations are required on the above selected options in order to:

- confirm water available from each source
- refine assessment of the risks associated with the development of the options
- refine estimates of costs of the possible scheme, environmental concerns and social aspects
- Provide sufficient information to allow negotiation with relevant parties and which would ultimately lead to a successful water use authorisation application.

The scope of work would include:

- obtain greater clarity in terms of total water demand and associated water quality requirements
- develop a detailed list of data and information needs
- hold discussions with identified key parties including relevant members of DWA, Vhembe District Municipality, relevant land owners and farmer associations of the Nzhelele irrigation area
- site visits to assist and allow reconnaissance level engineering, hydrogeological and environmental assessments.
- water demand estimation and calculation of anticipated future wastewater volumes from Dzanani.
- investigation and evaluation of water availability from the Tshipise Fault Wellfield
- investigation and evaluation of water availability from the Vondo Dam
- preliminary identification and evaluation of most favourable pipeline routes
- conceptual design of water supply scheme infrastructure and preliminary capital cost estimate
- economic analysis of each of the options
- identification of all the likely interested and affected parties for each of the options
- risk assessment of each of the options
- overall assessment of each of the options and identification of the most favourable possible water supply scheme

6. TIME FRAME FOR FURTHER OPTION EVALUATION

The technical aspects of evaluating the 5 identified options can be done within about 4 months. However, as the next phase of evaluation will include discussions and negotiations with various government departments and private individuals it could take more than a year to conclude and reach final approval.

7. RECOMMENDATIONS

From the results of this preliminary investigation, it is recommended that:

- more detailed investigations be undertaken of the 5 short listed possible water supply options as detailed in section 4.5
- interaction with DWA and the Vhembe District Municipality be undertaken with a matter of urgency, in view of the intense competition for the limited available water resources

8. RISKS

The following risks should be considered when evaluating the identified options:

- Climatic risk, i.e. the mine is in an arid area which is prone to severe droughts. It should therefore source its water from a few different sources and not rely on one alone. Sources such as sewage effluent would be the most reliable to mitigate climatic risk.
- Due to the shortage of domestic water in the area there is considerable competition for potable water. Poor quality groundwater or grey water should therefore be targeted.
- Access to unutilised water resources such as the Tshipise Fault could delay investigations. Discussions and negotiations with property owners should be initiated as soon as possible.
- The Water Use Authorisation process is difficult and tedious. DWA officials should be brought on board as early as possible to assist in expediting this process.
- Neighbouring villages' water supply and sanitation needs need to be addressed in conjunction with the mine water supply to avoid conflict.

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APPENDIX A

MERIT SCORES OF EACH OF THE PARAMETERS OF EACH OF THE WATER SUPPLY OPTIONS

Option	Economic Score	Consents	Environment	Social	Complexity	Overall Development Risk	Total Merit
Nzhelele Government Water Scheme - Water Loss Recovery	*0*	*-1*	*-3*	*-1*	*1*	*-2*	*-6*
Nzhelele irrigation buy out (113ha)	*2*	*-2*	*-1*	*0*	*0*	*-1*	*-2*
Dzanani wastewater	*4*	*4*	*4*	*4*	*4*	*4*	*24*
Rambali Irrigation Scheme Water Loss Recovery	*3*	*-3*	*3*	*-4*	*2*	*-3*	*-2*
Tshipise Wellfield	*1*	*0*	*-2*	*-2*	*3*	*3*	*3*
Makhado wastewater	*-1*	*2*	*2*	*3*	*-1*	*2*	*7*
Musina wastewater	*-2*	*3*	*1*	*2*	*-2*	*1*	*3*
Abandoned Musina mine workings	*-3*	*1*	*0*	*1*	*-3*	*0*	*-4*
Tshikuwi Dam	*-4*	*-4*	*-4*	*-3*	*-4*	*-4*	*-23*
Vondo Dam Transfer	*-3*	*-1*	*-1*	*4*	*-1*	*-1*	*-3*