GLSCRP
GIYANI LOCAL SCALE CLIMATE RESILIENCE PROGRAMME

WATER RESEARCH COMMISSION

AGRICULTURAL COOPERATIVES

NHLAMBETO PRIMARY COOPERATIVE

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GIYANI LOCAL SCALE CLIMATE RESILIENCE PROGRAMME

Technical designs for Local Multiple Use Systems.

Nhlambeto Primary Agricultural Cooperative water supply

March 2023

Acknowledgements

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March 2023

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The Giyani Local Scale Climate Resilience Programme (GLSCRP)

The Giyani Local Scale Climate Resilience Programme (GLSCRP) aims to develop and implement activities that will research, develop and demonstrate climate adaptive responses and solutions for optimising water utilisation in drought-stricken areas. The programme will focus on the Greater Giyani Municipal area within the Mopani district and aims to impact an estimated 5000 beneficiaries over a three-year period in terms of water utilisation, improved water mix, and socio-economic opportunities as responses to climate adaptation. A 2019 WRC study on droughts and adaptation strategies has highlighted risks to reduced productivity, livelihoods and food security, and an increase in vector and water-borne diseases in communities such as Giyani. Ultimately, climate change impacts on water resources in the Giyani area cannot be underestimated.

The programme has three key areas that will support for improving local scale adaptation and resilience in Giyani. They are:

1) a strengthened enabling environment whereby local authorities, institutions, communities, traditional authorities and market players are mobilised to improve climate resilience and water utilisation;

2) improved energy, ground and surface water solutions developed with communities to optimise and diversify water sources;

3) activities that support livelihoods and local economic development opportunities.

The programme will cover a spectrum of rural and rural residential areas in Giyani, working closely with the Mopani District Municipality and the Greater Giyani Local Municipality. Implementation partners include Tsogang Water and Sanitation as the lead on water projects and infrastructure; Association for Water and Rural Development (AWARD) in support of capacity development and stakeholder engagement, University of the Western Cape (UWC) as the water and energy technical partner and the WRC's TTO Enterprise Development arm on social enterprise development supporting local economic development projects.

About this Technical Design document

This technical Design document consist of a summary of all 5 sites of the Agricultural Cooperative project. Technical designs for the infrastructure interventions are also outline in this technical design document.

Who is the Technical Design document for?

This technical design document is meant for the Agriculture Cooperative members, Department of Agriculture and the Mopani District Municipality as the Water Service Authority.

What does the Technical Design document contain?

In this technical design document, we share important information on the type of innervations each project site received. We also share the technical designs for the infrastructure that was installed at each project site.

How to use the Technical Design Document?

The Agriculture Cooperative members will use the document for maintenance. The Department of Agriculture and the District Municipality will use the document to provide support to the agriculture cooperative in terms procuring more infrastructure and also to have in-depth knowledge of off grid water and alternative water source.

Technical Designs for Agricultural Cooperative

The feasibility and design of the systems at each pilot site was refined in more detail based on the following aspects:

1. The original feasibility study conducted in WRC project No. C2020.2021-00718 (Jovanovic et al., 2021)
2. More specific coordinates, elevations measured at key points during the field campaign on 14-19 May 2022; further discussions with stakeholders that took place during the same field campaign
3. Technical information (static rest water levels and required pressure heads; water requirements pipeline layout, pipe diameter, installation and size of tanks; installation of booster pumps to secure enough water pressure is delivered)

The main method for the refinement of MUS technical design at pilot sites was the adapted Toolbox for Solar Powered Irrigation Systems (SPIS) (GIZ and FAO, 2021) and field measurements. Further refinement is possible once equipment specification and availability on the market from suppliers and manufacturers is known, as well as specific borehole characteristics and pumping tests. In particular, for the drinking water sources, the final work designs will consider the water treatment plant packages and the need for pressure booster pumps for water delivery to the distribution and storage systems. It should be noted that, for all sites, water meters will have to be installed at the point of abstraction and at the point of use, so that the efficiency of the distribution system can be assessed during performance evaluation, e.g. leakages and losses of water.

The following table describe the description and intervention for each agricultural cooperative projects:

Agricultural Co-operative	Interventions
Nhlambeto Multi-purpose Primary Cooperative	1. ***Hybrid Solar System installed:*** *This innovation integrates grid-supply with solar power for the purposes of powering local groundwater supply systems. The innovation provides relief from grid load shedding and allows for cheaper access to water for rural villages.*
	2. ***Security of Hybrid Solar System installed:*** *Theft and vandalism can be problematic. The project installed palisade fencing, barbed fencing and alarm systems to protect investments.*
	3. ***Water Storage installed:*** *Water storage provides both pressure for driving reticulated water as well as continued supply when the solar powered pumps are not functioning.*
	4. ***Borehole testing, equipping and skills development:*** *All boreholes where tested for water quality and equipped with a suitable pump for the system. In all cases beneficiaries where trained to understand water quality monitoring procedures.*

	5. ***Drip irrigation system installed:*** *In this project 1 hectare of drip irrigation was installed to improve water use efficiency and support food production by the co-operative*

Table 1: Macena Primary Agricultural Cooperative Water Supply project sites and GLSCRP intervention

1 Nhlambeto Primary Agricultural Cooperative intervention summary

BACKGROUND

The Nhlambeto farm is the only site with mixed water use for drinking water and agriculture. The village is quite large, however the system is being designed for water supply to a population of 1,000 people (a fraction of the population of Dzumeri), amounting at 25 m3 d-1 or 9,125 m3 a-1. The water requirement for agriculture was estimated to be 33.9 m3 d-1 at its peak equivalent to 12,373.5 m-3 a-1. The total water requirement is therefore 58.9 m3 d-1 or 21,863.5 m3 a-1. Nhlambeto farm is also the only site that abstracts water from the Molototsi River sand bed. Nhlambeto farm is a cooperative and the total is about 5 ha, although less than 25% is under cultivation. The farm abstracts water directly from the sand banks by digging a sump that collapses over time. There is no bulk water supply and the villagers collect water by digging improvised holes in the river sand. Due to the multiple use, the site presents a conflict of interest between the users, and the emerging farmer at Nhlambeto has been recently asked to stop farming because the groundwater level in the sand banks drops during abstraction for agriculture compelling the community to dig deeper for drinking water supply.

INTERVENTION CONTENT

The was a need to install a more permanent structure for abstraction from the river sand banks, about 4 m deep (estimated depth of the sand river bed) to allow the utilization of a thicker portion of the sand aquifer sufficient to supply both the farm and the community with water. Occasional river flows will recharge the sand aquifer. Water will be abstracted with a solar-powered groundwater pump. The water quality in the sand aquifer is excellent, with exception of elevated Al and Fe concentrations, the origin of which will have to be investigated. Abstracted water will be conveyed with a 75 mm pipe to a steel tank installed on the high-lying western portion of the farm, about 270 m from the abstraction point. From here, it can be distributed to the farm for agricultural use through a main line. It will be desirable to supply and install a distribution network of dripper lines to the farm. Another main line will feed into a water treatment plant for supply of drinking water. The requirements for booster pressure pumps and solar panels at the water storage and distribution points of both main lines need to be investigated, depending on the supplier/manufacturers of the system.

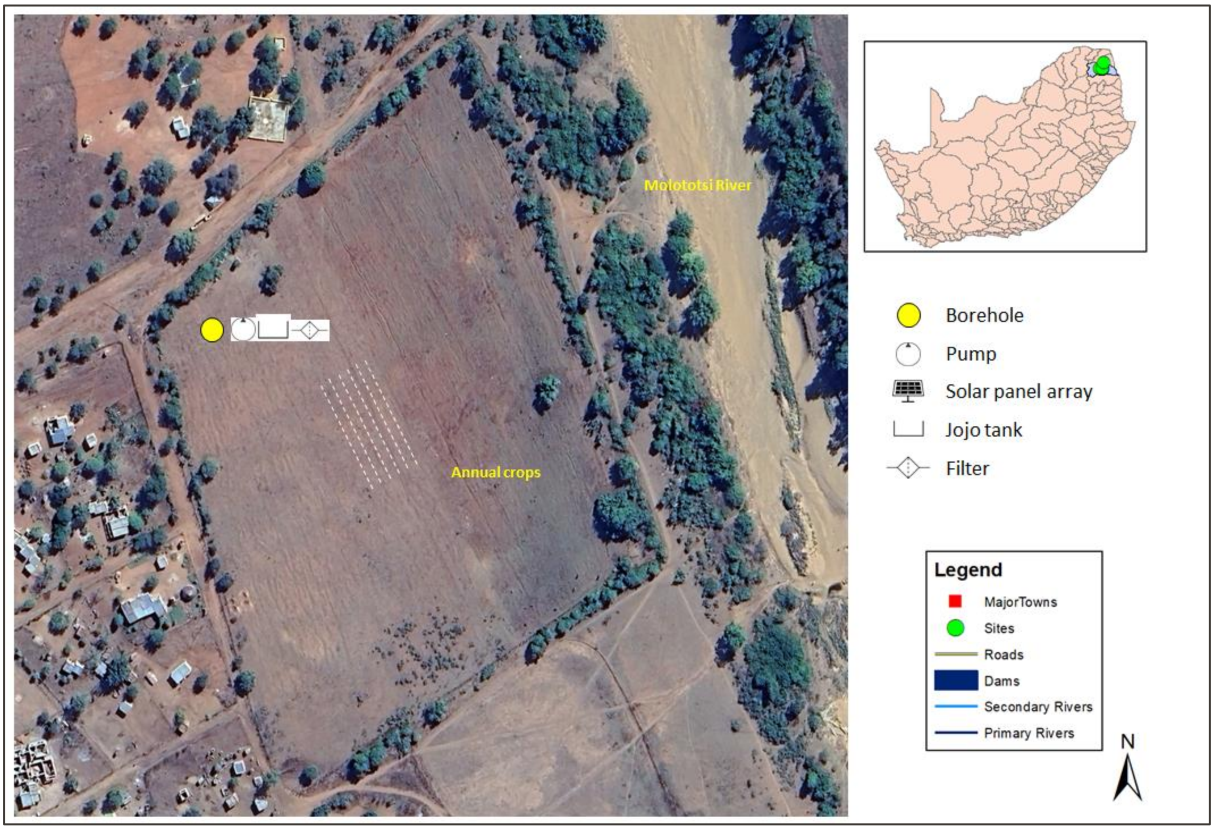


Figure 4: *Final installation design of solar powered groundwater pumps for irrigation and drinking water supply at Nhlambeto Primary Agricultural Cooperative (background is Google Earth image)*

Water source quality for the GLSCRP Project sites

The need was to install a solar-powered groundwater pump for agricultural water use at borehole No. 2. In addition, a pressure booster pump was installed to deliver water from the reservoir to the fields at enough pressure for sprinkler irrigation, usually operating at 2-3 bars. Providing additional distribution pipes and drip-irrigation lines is desirable, so that a water distribution network can be established from the water tank across the farm. The pump and accompanying solar panels array will be installed at borehole No. 2 (elevation is 447 m) that will pump water to the concrete reservoir (elevation is 457 m). The groundwater quality is fit for agriculture with elevated NO_3, which can be seen as an additional supplement of nutrients. Water treatment is therefore not required, however an ordinary filter for agricultural water will be required.

Groundwater samples were collected during a field campaign on 26-31 October 2022 and collection of the samples is a continuous process in all the water sources. The samples were collected at the water sources according to standard procedures in 0.25 L plastic bottles, for chemical analyses in the laboratory. Water sources at all 9 pilot sites were sampled, except at Matsotsosela where borehole H14-0025 dried up and the pump at the currently operating borehole H14-1724 could not be started. The samples were kept in a cooler box with ice bricks, and sent to the Central Analytical Facility (CAF) of Stellenbosch University for laboratory analyses. The following physical and chemical parameters were analysed:

- Physical parameters: electrical conductivity (EC), total dissolved solids (TDS) and colour (Hazen)
- pH and total organic carbon (TOC)
- Anions: F, Cl, SO_4, NO_2, NO_3, Br
- Cations: Li, Na, Ca, Mg, K, NH_4
- Heavy metals: Al, Mn, Fe, Cu, Cd, Zn

All the results are presented in the tables below and they were compared to the South African National Standard SANS 241 of 2015 to determine the water quality fitness for domestic use. The figures in red in the tables indicates values of determinants that are not within the SANS 241 thresholds. For comparative purposes, the analyses of samples collected in the previous sampling campaign on 14-19 May 2022 are shown in the tables.

Although the pH values were within the range of drinking water quality standards for all sites, high salinity levels (Electrical Conductivity EC and Total Dissolved Solids TDS) were recorded at Mbhedle, A hi tirheni Mqekwa and Duvadzi, mainly due to elevated Na and Cl. High NO_3 levels were recorded at Mbhedle, Mayephu, Mzilela (borehole H14-0022), A hi tirheni Mqekwa and Muyexe, above the legally required standard for drinking water quality (<48.7 Mg L^{-1} NO_3). The borehole at Mbhedle also displayed elevated NO_2 (6.698 mg/L). Total Organic Carbon (TOC) levels were within the standard drinking water quality range.

In comparison with the previous sampling campaign in May 2022, the elevated salinity values at Mbhedle, A hi tirheni Mqekwa farm and Duvadzi farm were confirmed. The elevated NO_3 at Mbhedle, Mayephu (borehole H14-1815), Mzilela, A hi tirheni Mqekwa and Muyexe were also confirmed due to the proximity of villages (draining water from villages). The spike of 205 mg L-1 NO3 concentration at borehole H14-1815 in Mayephu was confirmed due to the vicinity of an animal kraal. By far the best water quality source is the water retained in the sand alluvial aquifer of the Molototsi River (Nhlambeto farm at Dzumeri). This confirms previous results from the previous sampling campaign in May 2022. All parameters were within the standard limits, including colour. In general, the findings confirmed the need for groundwater treatment at sources for drinking water purpose. For agricultural purposes, water quality is fit to marginally fit for water use. The risk of salinization should be monitored at all sites.

Water Sources for the GLSCRP project sites

Village	Site	Water requirements		Source of water	Coordinates		Duration	Purpose
		($m^3 d^{-1}$)	($m^3 a^{-1}$)		Latitude	Longitude		
Mbhedle	Village population = 1230	30.8*	11242	Borehole in village, not recorded	-	-	3 years	**Drinking water.** No bulk water supply, villagers have to walk up to 0.7 km to collect water. Site proposed by community members.
Mayephu	Village population = 1940	48.5*	17702.5	Borehole No. H14-1815	-23.589623°	30.778480°	3 years	**Drinking water.** Emergency intervention linked to bulk water supply. Borehole and reservoir are established.
				Borehole No. H14-1818	-	-		
Mzilela	Village population = 1150	28.8*	14162	Borehole in village	-23.592869°	30.17120°	3 years	**Drinking water.** Bulk water supply is seldom available due to water shortage (once per month).
Matsotsosela	Village population = 2300	57.5*	20987.5	Borehole No. H14-0026	-23.60106°	30.829530°	3 years	**Drinking water.** No bulk water supply. Boreholes are established. Diesel expenses subsidized by local government are extremely high. Community operator is very committed.
				Borehole No. H14-0025	-23.600749°	30.825683°		
Dzumeri	Nhlambeto farm	58.9**	21863.5	Non-perennial river sand	-23.561512°	30.701696°	3 years	**Drinking water + emerging farm.** Emerging farmer was recently asked to stop farming by other water users due to drop in groundwater level.
Dzumeri	Ngamba farm	33.9	12373.5	Borehole not numbered	-23.591533°	30.706566°	3 years	**Emerging farm.** Pressure head is too low with the current pumping system.
Dzumeri (Daniel Ravalela)	A hi tirheni Mqekwa farm	33.9	12373.5	Borehole No. H14-1699	-23.57025°	30.65841°	3 years	**Emerging farm.** Well established. Electricity bills are very high.
				Borehole No. H14-1700	-23.57094°	30.65878°		
Loloka	Duvadzi farm	33.9	12373.5	Borehole No. H14-1703	-23.56712°	30.81966°	3 years	**Emerging farm.** Well established. Groundwater can also be abstracted from adjacent non-perennial river sand.
Muyexe	Muyexe community project	33.9	12373.5	Borehole not numbered	-23.187820°	30.911963°	3 years	**Emerging farm.** Rehabilitation of cooperative by Limpopo Department of Agriculture is planned.

Table 2: GLSCRP Water Source for project sites

Groundwater sample analyses for all water sources

Analysis	Mbhedle	Mayephu H14-1815	Mzilela H14-0022	Nhlambeto farm	Ngamba farm	A hi tirheni Mqekwa farm H14-1700	Duvadzi farm H14-1702	Muyexe farm		SANS 241
EC (µS/cm) (25°C)	2455	1586	1096	196	1533	2683	3556	1053		≤ 1700
pH (25°C)	7.53	7.06	7.07	7.92	7.01	7.21	7.36	7.54		≥ 5 and ≤ 9.7
TDS (ppm) @ 25°C	1228	793	548	98	767	1342	1778	527		≤ 1200
Colour (Hazen)	0.3	0.0	0.0	6.3	0.0	0.0	0.0	0.0		< 15
F (mg/L)	0.439	0.435	0.205	0.141	0.452	0.443	0.678	0.232		≤ 1.5
Cl (mg/L)	472.705	128.466	117.984	6.497	277.122	668.842	1026.835	62.029		≤ 300
SO_4 (mg/L)	44.114	71.668	29.832	3.544	28.093	46.311	83.111	24.966		≤ 500 (health) ≤ 250 (aesthetic)
PO_4 (mg/L)	n.d	n.d	n.d	Below calibration standard	Below calibration standard	n.d	Below calibration standard	Below calibration standard		-
NO_2 (mg/L)	6.698	n.d	n.d	n.d	n.d	n.d	n.d	n.d		≤ 2.96
Br (mg/L)	1.264	0.627	0.448	Below calibration standard	0.609	1.387	2.611	0.313		-
NO_3 (mg/L)	62.825	204.651	100.388	4.542	24.799	73.812	27.22	74.728		≤ 48.7
Li (mg/L)	0.025	0.012	0.003	n.d.	0.009	0.026	0.018	Below calibration standard		-
Na (mg/L)	359.952	77.172	72.004	12.883	153.405	242.848	338.291	46.093		≤ 200
NH_4 (mg/L)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		≤ 1.5
K (mg/L)	11.663	1.269	1.435	1.926	2.393	2.771	11.425	0.583		-
Mg (mg/L)	90.863	101.797	53.733	3.617	74.068	129.812	182.351	71.137		-
Ca (mg/L)	81.935	135.446	67.533	9.435	87.14	164.636	176.275	63.648		-

Table 3: Results of the laboratory analyses of groundwater samples collected from all water sources at the pilot sites on 26-31 October 202

Analysis	Mbhedle	Mayephu H14-1816	Mayephu H14-1815	Mzilela	Matsotsosela	Nhlambeto farm	Ngamba farm	A hi tirheni Mqekwa farm H14-1700	Duvadzi farm H14-1702	Muyexe farm		SANS 241
EC (µS/cm) (25°C)	2500	1286	1566	1046	2032	279.7	2691	2672	1941	1045		≤ 1700
pH (25°C)	7.286	7.171	6.958	7.928	7.335	7.275	6.857	7.16	7.569	7.768		≥ 5 and ≤ 9.7
TDS (ppm) @ 25°C	1336	523	1016	1250	783	140	643	971	1346	523		≤ 1200
Colour (Hazen)	1.7	1.4	0	0.1	3.3	69.5	1.7	0	0.2	0		< 15
F (mg/L)	0.592	0.598	0.582	0.300	0.968	0.14	0.547	0.596	1.017	0.321		≤ 1.5
Cl (mg/L)	475.706	110.216	125.116	87.419	319.65	16.741	678.633	632.826	463.861	61.275		≤ 300
SO_4 (mg/L)	44.819	46.085	74.881	31.299	34.524	4.674	36.347	46.188	40.470	24.318		≤ 500 (health) ≤ 250 (aesthetic)
PO_4 (mg/L)	n.d	<LCS	n.d	n.d	n.d	<LCS	n.d	n.d	n.d	n.d		-
NO_2 (mg/L)	n.d	.	n.d	n.d	.	n.d	.	n.d	n.d	n.d		≤ 2.96
Br (mg/L)	1.303	0.420	0.634	0.427	0.913	0.069	1.408	1.506	1.411	0.302		-
NO_3 (mg/L)	73.867	32.588	212.745	77.846	34.99	0.531	31.269	68.950	9.428	70.932		≤ 48.7
Na (mg/L)	357.126	69.707	77.438	47.791	335.407	20.154	240.526	217.145	211.894	49.142		≤ 200
NH_4 (mg/L)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		≤ 1.5
K (mg/L)	12.138	2.937	1.984	2.289	4.057	3.797	6.909	6.048	9.253	1.407		-
Mg (mg/L)	93.167	84.701	100.099	85.141	64.826	8.600	133.473	137.232	89.329	79.151		-
Ca (mg/L)	85.097	100.382	137.242	52.957	71.867	20.666	161.796	174.406	93.887	66.138		-
TOC [mg/l]	16.519	15.347	15.533	9.214	15.663	6.629	16.181	15.674	8.467	8.889		≤ 10

Table 4: Results of the laboratory analyses of groundwater samples collected from all water sources at the pilot sites on 15-16 May 2022

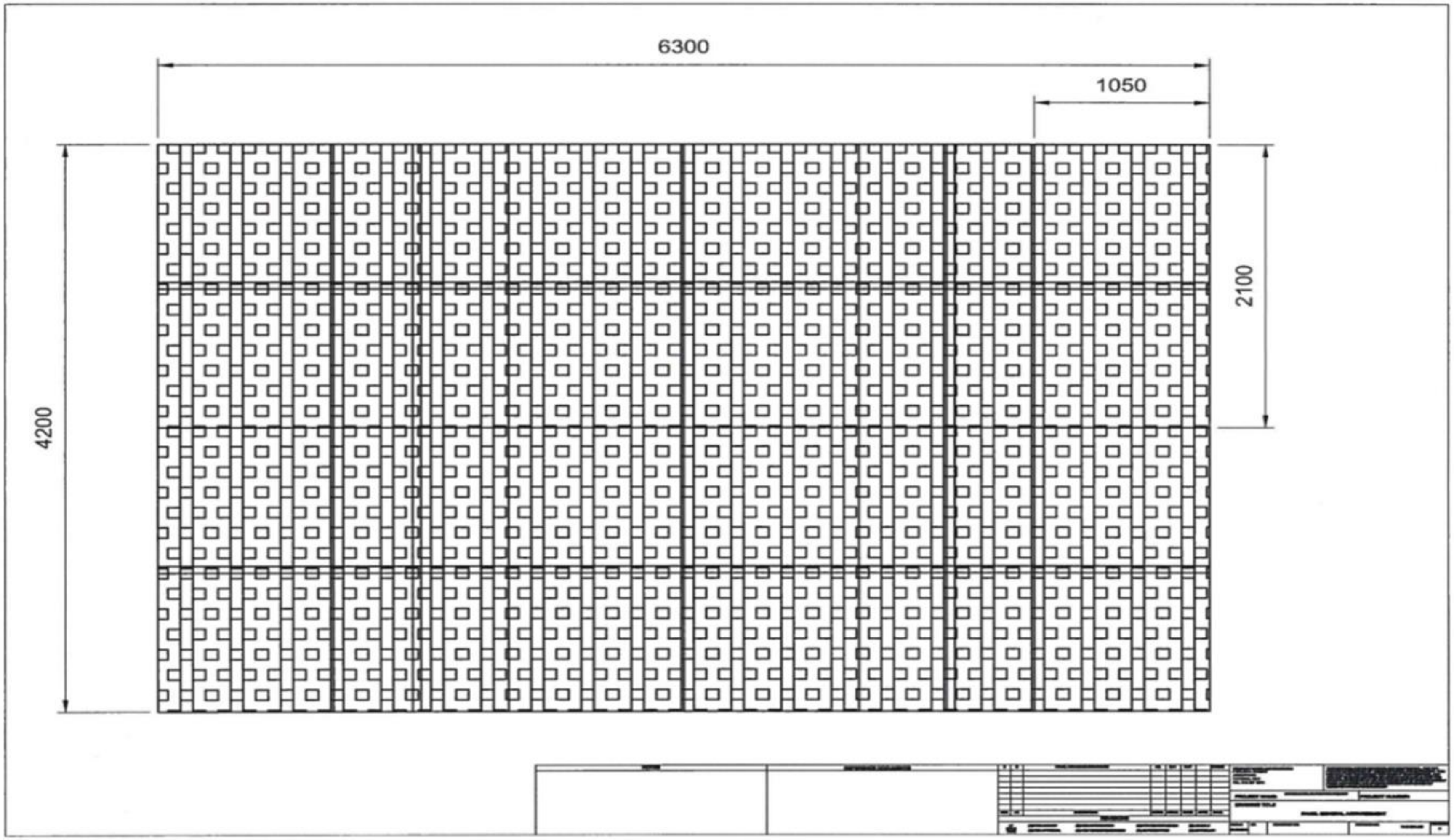
Analysis	Nhlambeto farm	Ngamba farm	A hi tirheni Mqekwa farm AHM6	Duvadzi farm H14-1702	Muyexe farm		SANS 241
EC (µS/cm) (25°C)	770	3044	991.8	2136	1054		≤ 1700
pH (25°C)	7.144	6.528	7.588	7.288	6.954		≥ 5 and ≤ 9.7
TDS (ppm) @ 25°C	385	1522	495.9	1068	527		≤ 1200
Colour (Hazen)	6.4	0	0	2.8	0.5		< 15
F (mg/L)	0.132	0.574	0.791	1.061	0.356		≤ 1.5
Cl (mg/L)	114.612	876.824	24.54	525.214	66.463		≤ 300
SO_4 (mg/L)	13.826	45.924	10.852	55.364	24.882		≤ 500 (health) ≤ 250 (aesthetic)
PO_4 (mg/L)	n.d	n.d	n.d	Below calibration standard	Below calibration standard		-
NO_2 (mg/L)	n.d	n.d	n.d	n.d	n.d		≤ 2.96
Br (mg/L)	0.297	1.639	0.17	1.466	0.346		-
NO_3 (mg/L)	2.106	60.464	2.368	16.16	69.526		≤ 48.7
Na (mg/L)	77.242	275.105	138.067	244.152	55.269		≤ 200
NH_4 (mg/L)	Below calibration standard	n.d	n.d	n.d	n.d		≤ 1.5
K (mg/L)	6.335	11.475	4.998	10.261	1.069		-
Mg (mg/L)	17.697	145.058	33.308	98.492	73.848		-
Ca (mg/L)	45.39	166.91	47.096	95.499	63.524		-
TOC [mg/l]	8.76	13.94	13.89	13.77	12.60		≤ 10
Al (µg/L)	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ		≤ 300
Mn (µg/L)	262.25	115.14	241.80	24.32	<LOQ		≤ 400 (health)

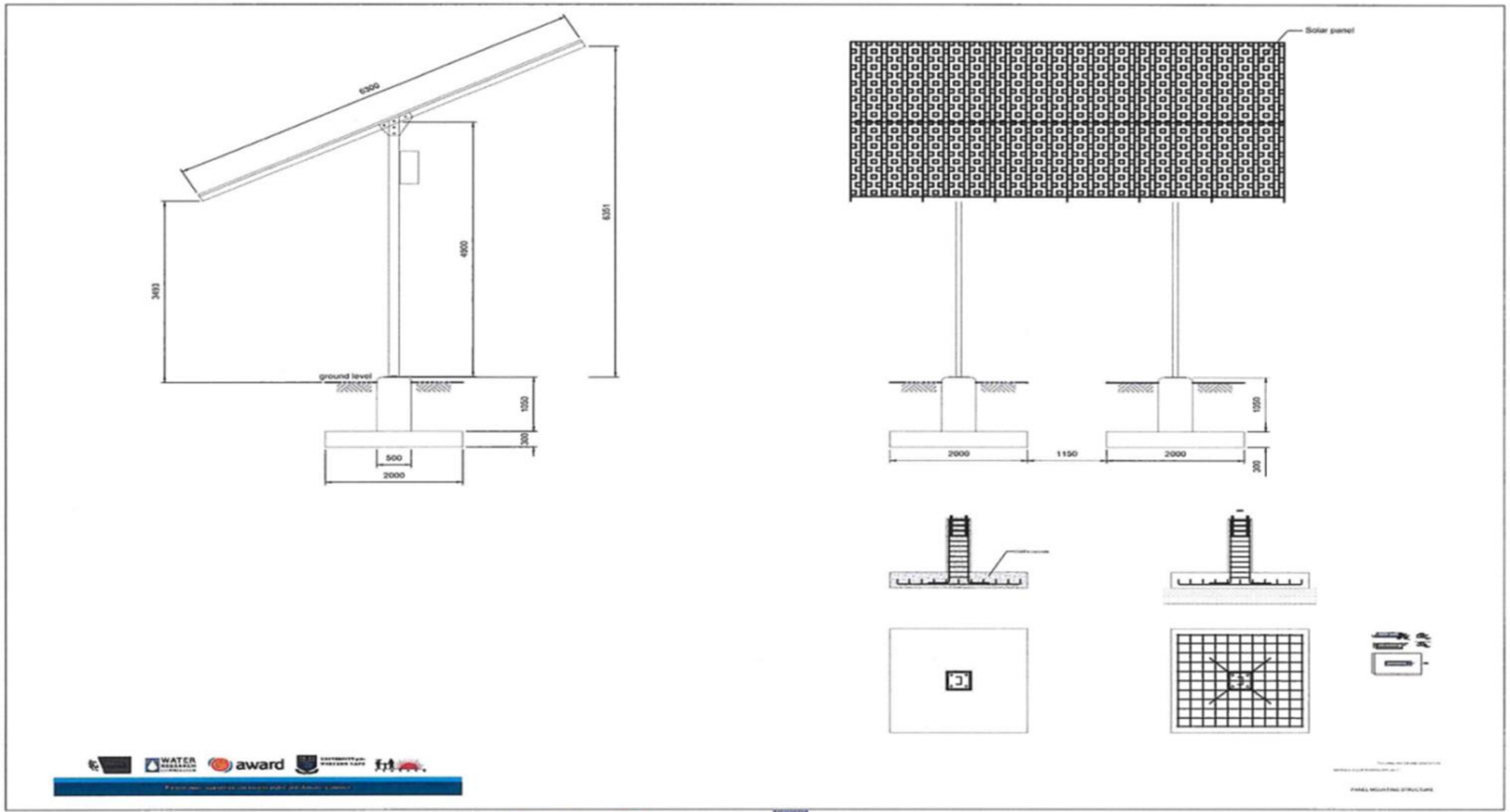
Analysis	Nhlambeto farm	Ngamba farm	A hi tirheni Mqekwa farm AHM6	Duvadzi farm H14-1702	Muyexe farm		SANS 241
							≤ 100 (aesthetic)
Fe (µg/L)	2.98	1.91	3.84	2.68	3.31		≤ 2000 (health) ≤ 300 (aesthetic)
Cu (µg/L)	0.75	1.49	1.65	<LOQ	<LOQ		≤ 2000
Cd (µg/L)	<LOQ	0.09	<LOQ	<LOQ	<LOQ		≤ 3
Zn (µg/L)	1.14	2.07	3.67	0.30	30.44		≤ 5000
As (µg/L)	<LOQ	<LOQ	<LOQ	0.20	7.00		≤ 10

Table 5: Results of the laboratory analyses of groundwater samples collected from all water sources at the pilot sites on 4-8 September 2023.

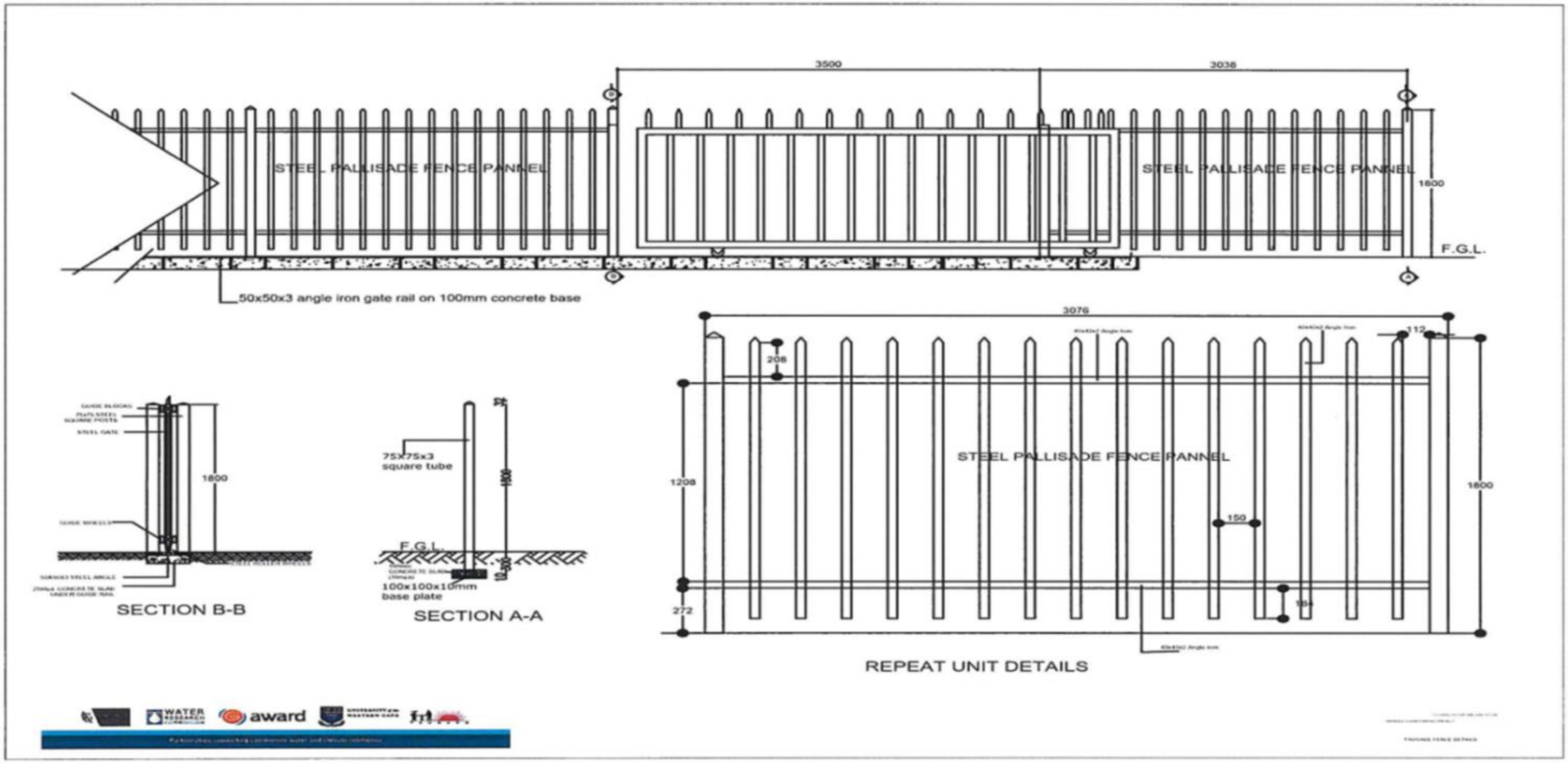
Agricultural Cooperative Water Supply Drawings:

1. Hybrid Solar System

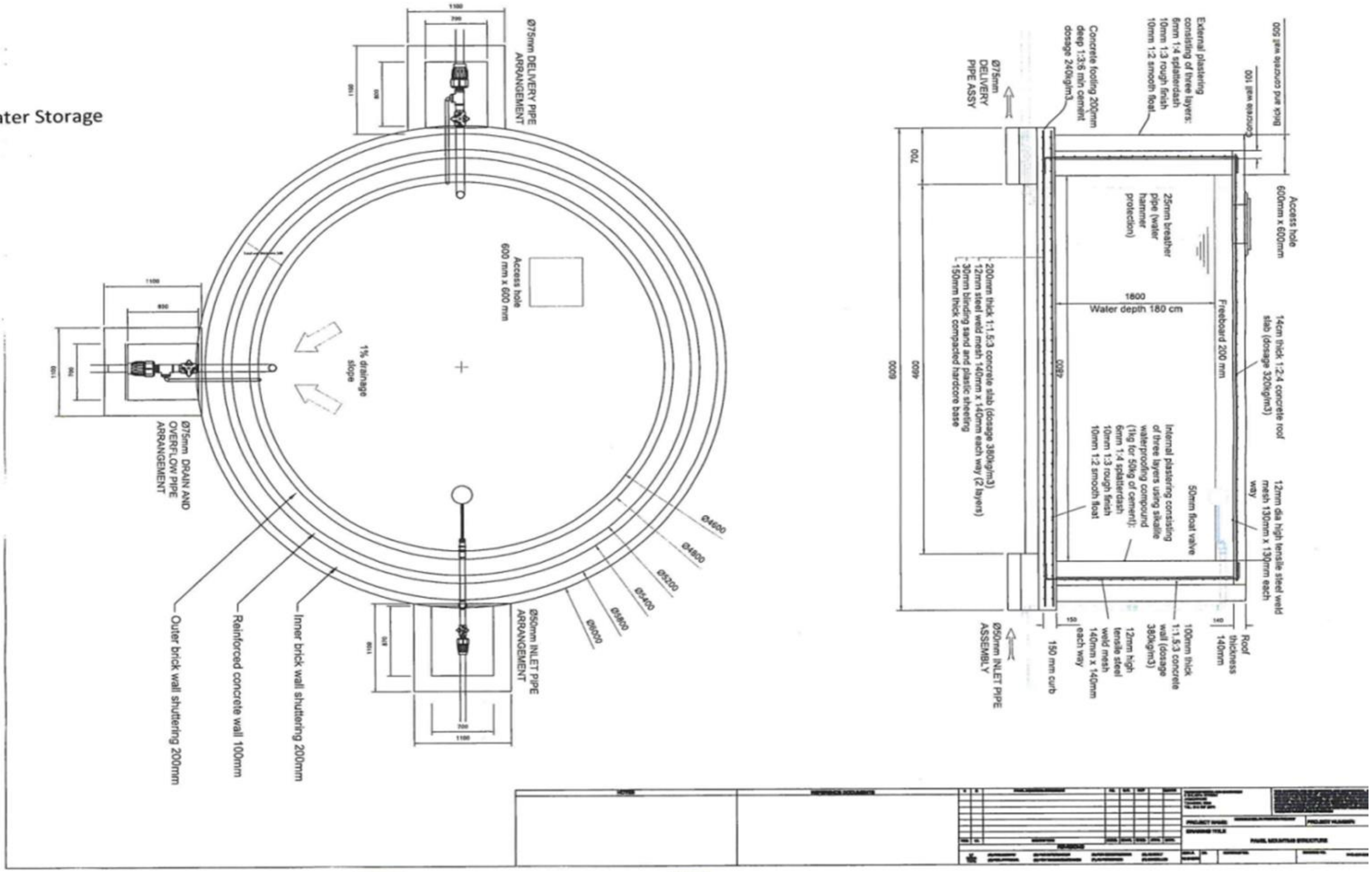



6300
6351
4900
3493
ground level
1050
300
500
2000
Solar panel
1150

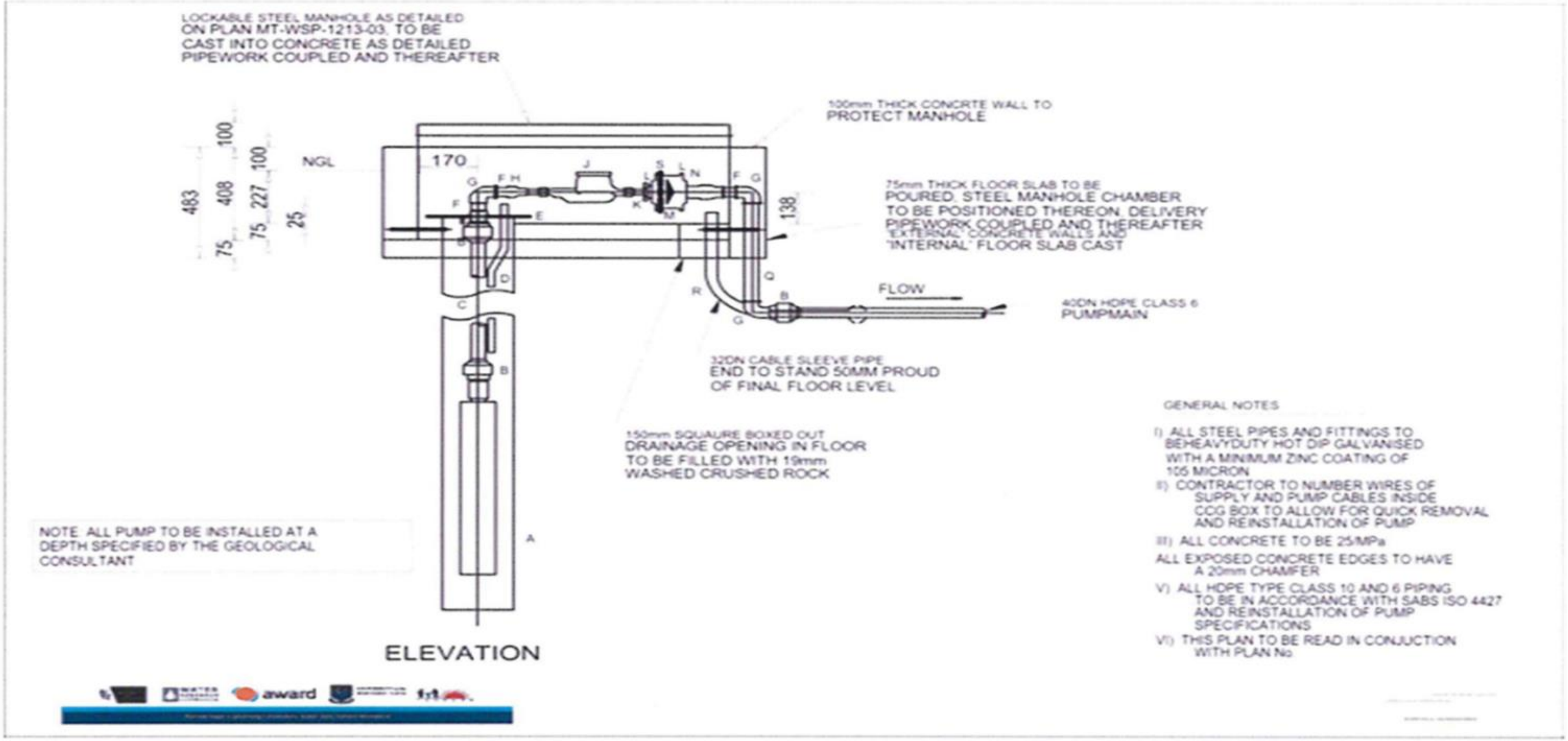
2. Fencing (Storage and Solar)



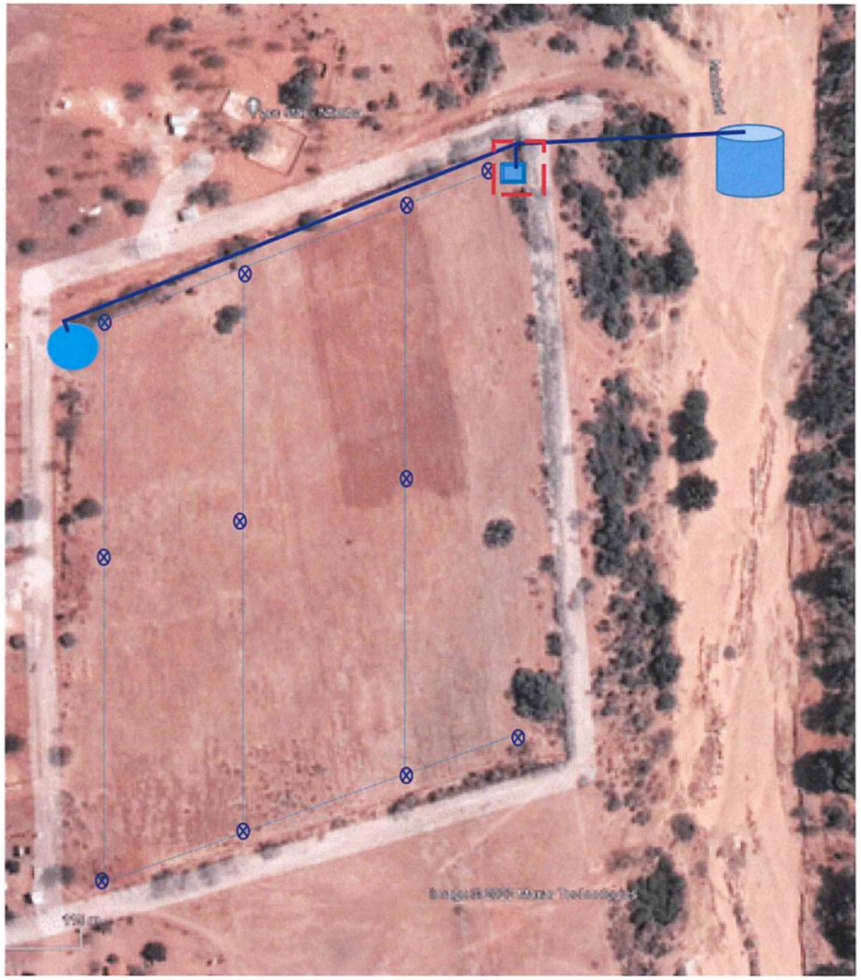
3. Water Storage



4. Borehole testing/ Equipping



5. Drip irrigation layout



Legend:

⬭	Storage	▪	Borehole	⊗	Usage node	—	Rising main	—	Reticulation	▭	Solar

GLSCRP

GIYANI LOCAL SCALE CLIMATE RESILIENCE PROGRAMME

GLSCRP is a community advised and LED programme demonstrating climate adaptive responses and solutions for improved water utilisation in the Giyani Municipal area. It is a partnership programme funded by the Government of Flanders, led by the Water Research Commission with partners Tsogang Water and Sanitation (Tsogang), Association for Water and Rural Development (AWARD) and the University of the Western Cape (UWC). The Programme aims to develop, research and demonstrate, practical water-linked climate adaptation solutions at local, community and catchment scale for the benefit of 5000 Giyani community members in order to improve water utilisation, community resilience and local economic growth for local and women-led enterprises.