

# Groundwater Monitoring: Langebaan Road Aquifer Wellfield



**GROUNDWATER  
CONSULTANTS**

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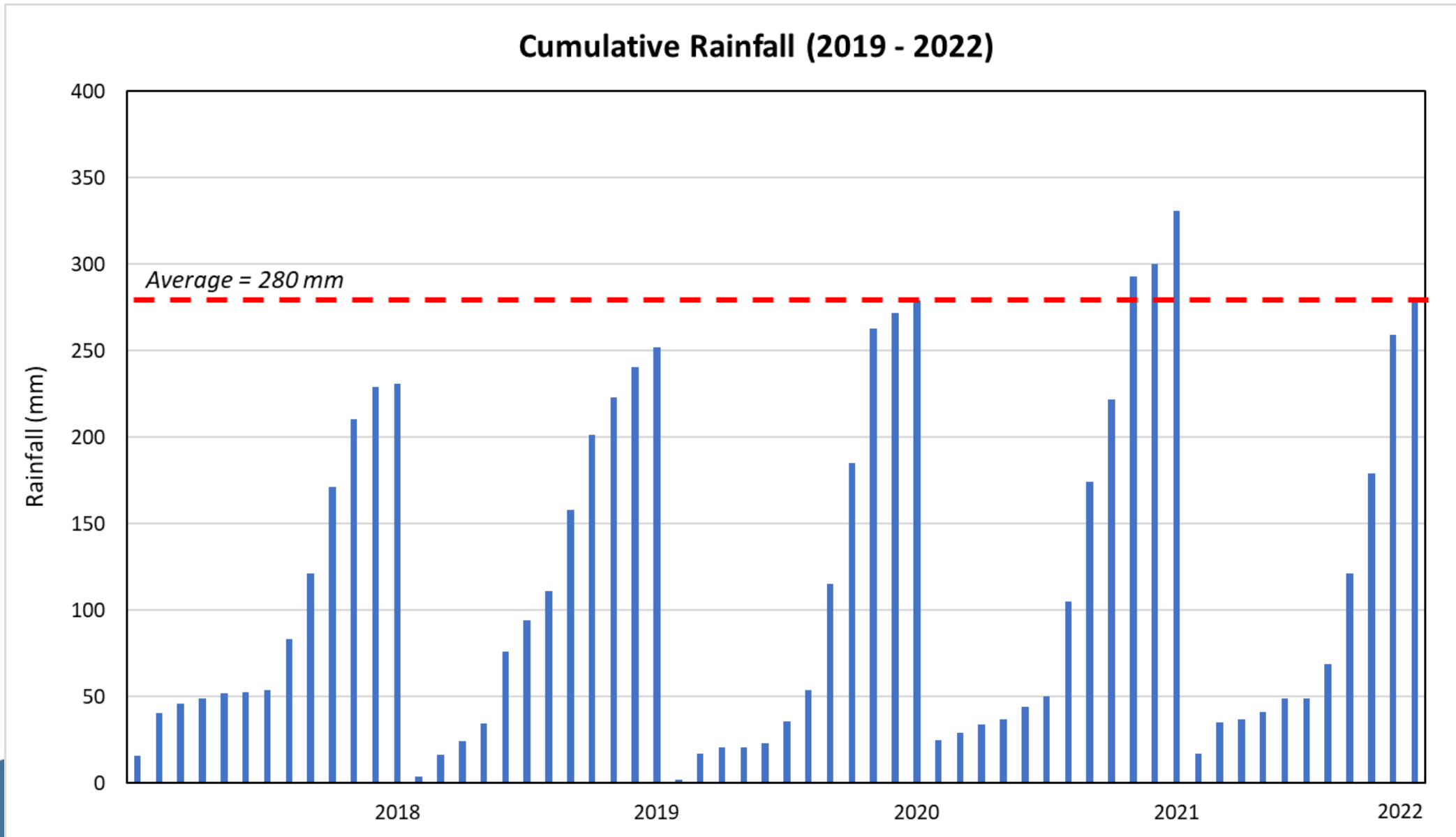
Aqeela Parker – Hydrogeologist

Martin von Fintel – GIS Specialist

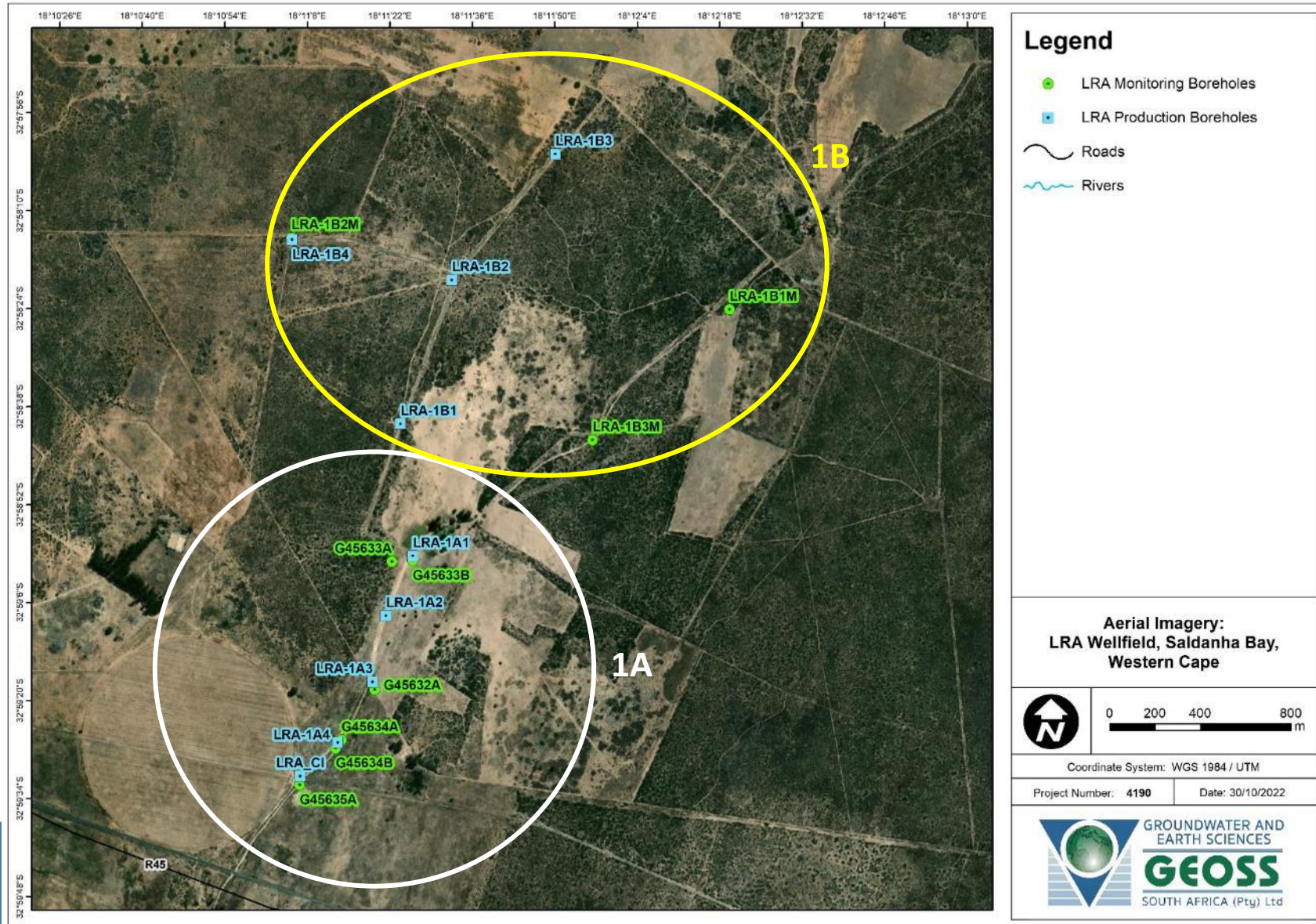
# Groundwater Monitoring Program Summary Schedule:

<u>2022</u>	<u>Item</u>	<u>2023</u>	<u>Item</u>
October	Quarterly report (groundwater levels, abstraction, chemistry and physical characteristics)	January	Quarterly report (groundwater levels, abstraction, chemistry and physical characteristics)
November	Monthly monitoring	February	<ul style="list-style-type: none"> <li>• Monthly monitoring</li> <li>• Bi-annual water use report</li> </ul>
December	<ul style="list-style-type: none"> <li>• Monthly monitoring</li> <li>• Annual internal audit</li> <li>• Annual monitoring report</li> </ul>	March	Monthly monitoring
<p>WUL Start → 22 February 2019</p> <p>WUL Valid → 22 February 2039</p>		April	Quarterly report (groundwater levels, abstraction, chemistry and physical characteristics)
		May	Monthly monitoring
		June	Monthly monitoring

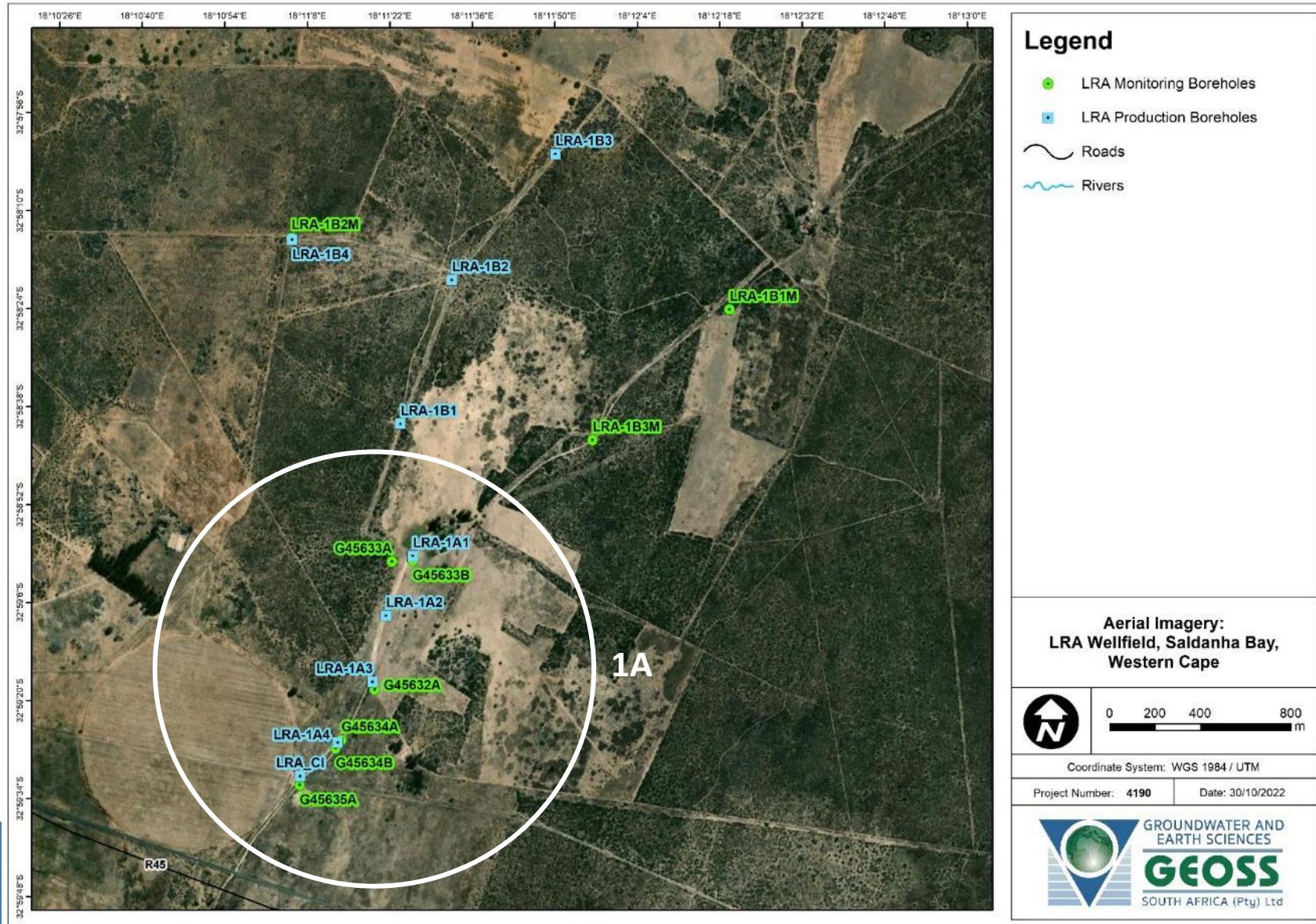
# Historical rainfall for the study area



# Groundwater Monitoring



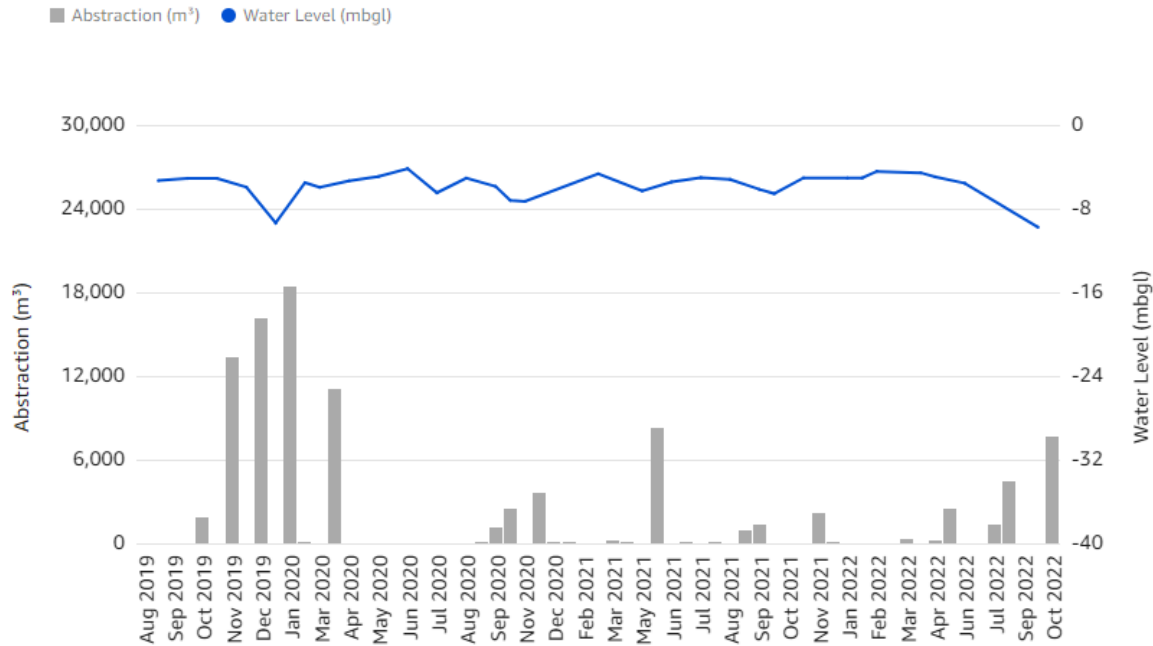
# Groundwater Monitoring (LRA-1A)



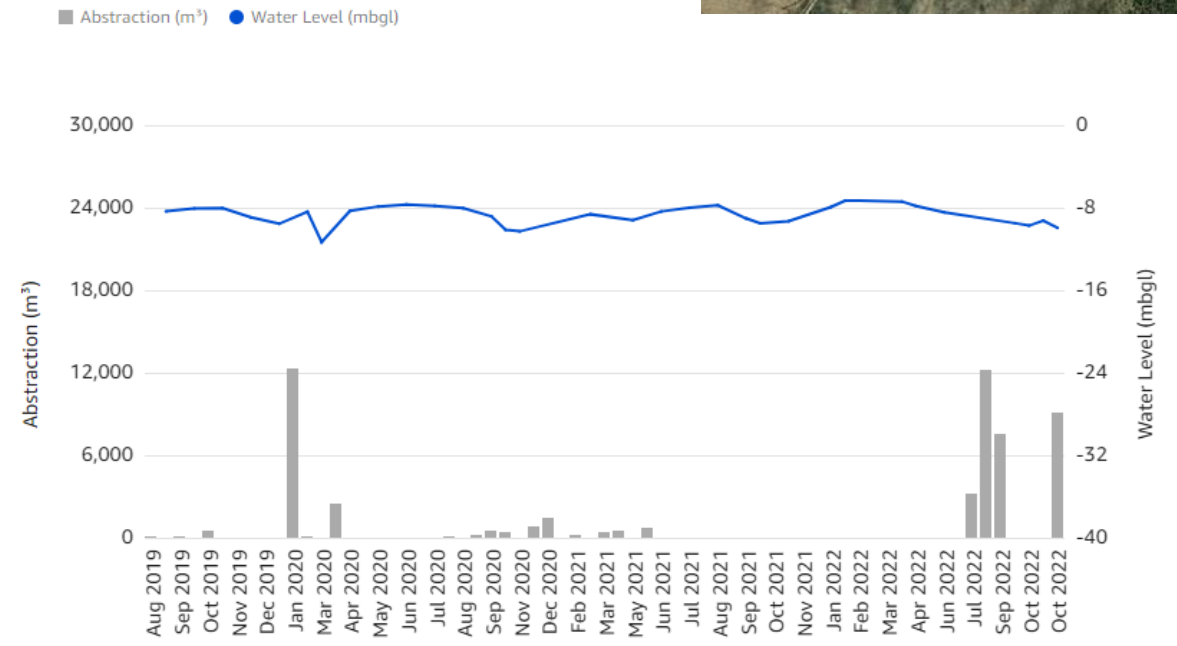
# Groundwater Monitoring: Production Boreholes Langebaan Road Wellfield (1A)



LRA-1A1 Water Level (mbgl) & Abstraction (m³)



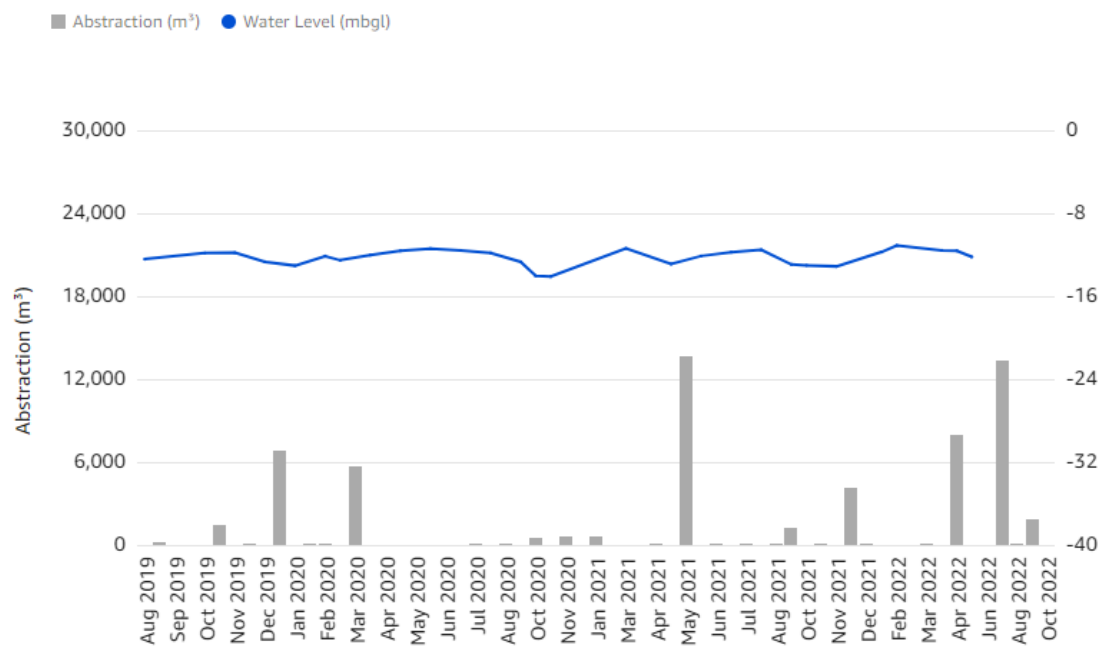
LRA-1A2 Water Level (mbgl) & Abstraction (m³)



# Groundwater Monitoring: Production Boreholes Langebaan Road Wellfield (1A)

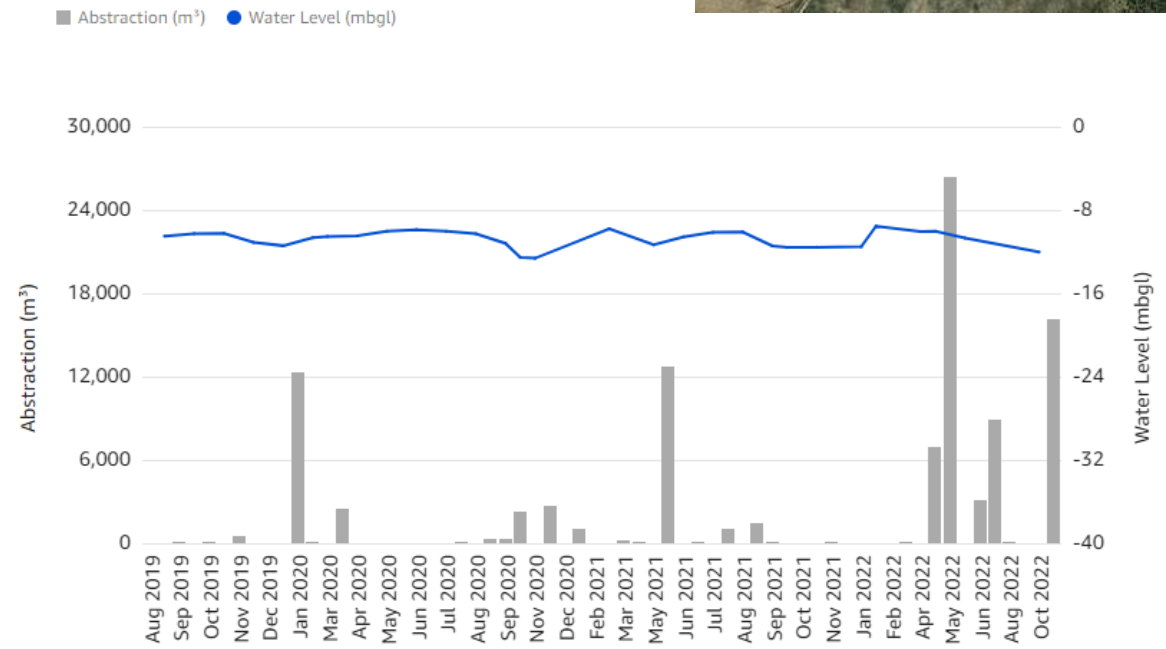


LRA-1A3 Water Level (mbgl) & Abstraction (m³)



*\*LRA-1A3 - The water level could not be measured IN Oct due to no observation pipe*

LRA-1A4 Water Level (mbgl) & Abstraction (m³)

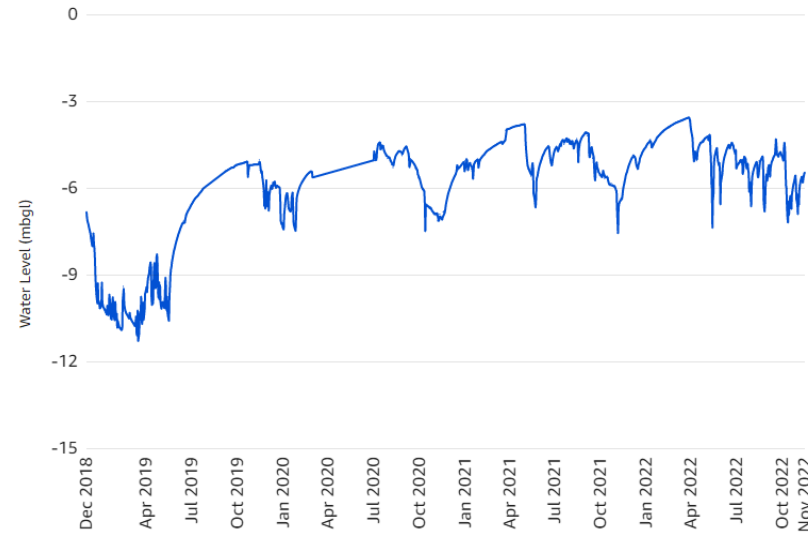


# Groundwater Monitoring: Monitoring Boreholes Langebaan Road Wellfield (1A)

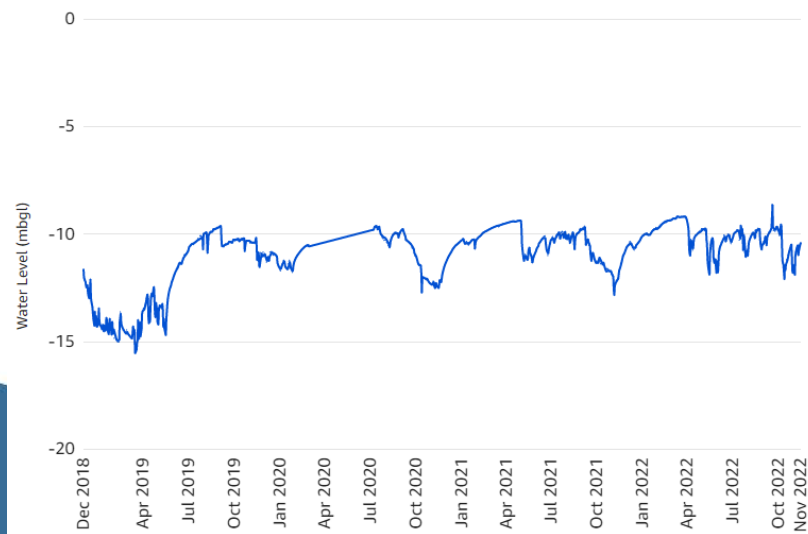
G45632A Water Level (mbgl)



G45633A Water Level (mbgl)



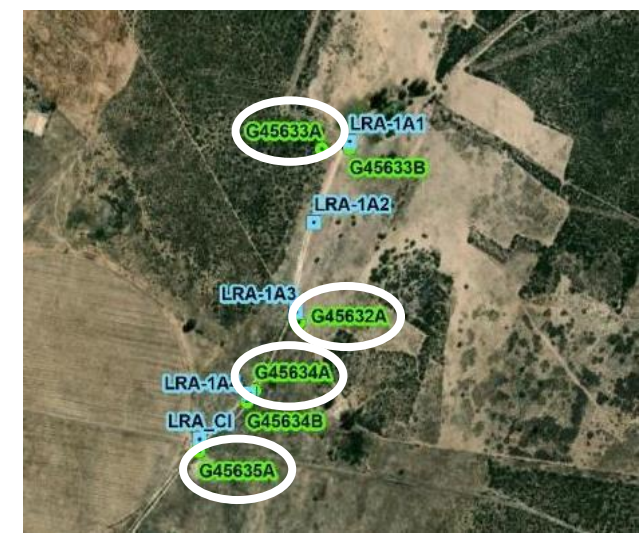
G45634A Water Level (mbgl)



G45635A Water Level (mbgl)



Lower Aquifer Boreholes

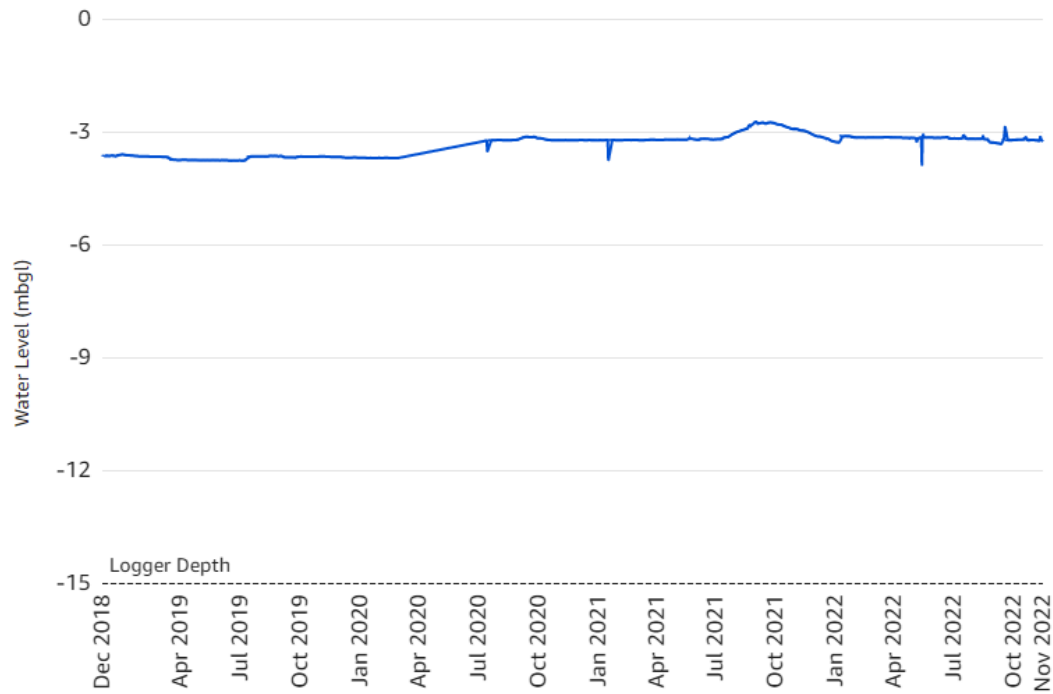




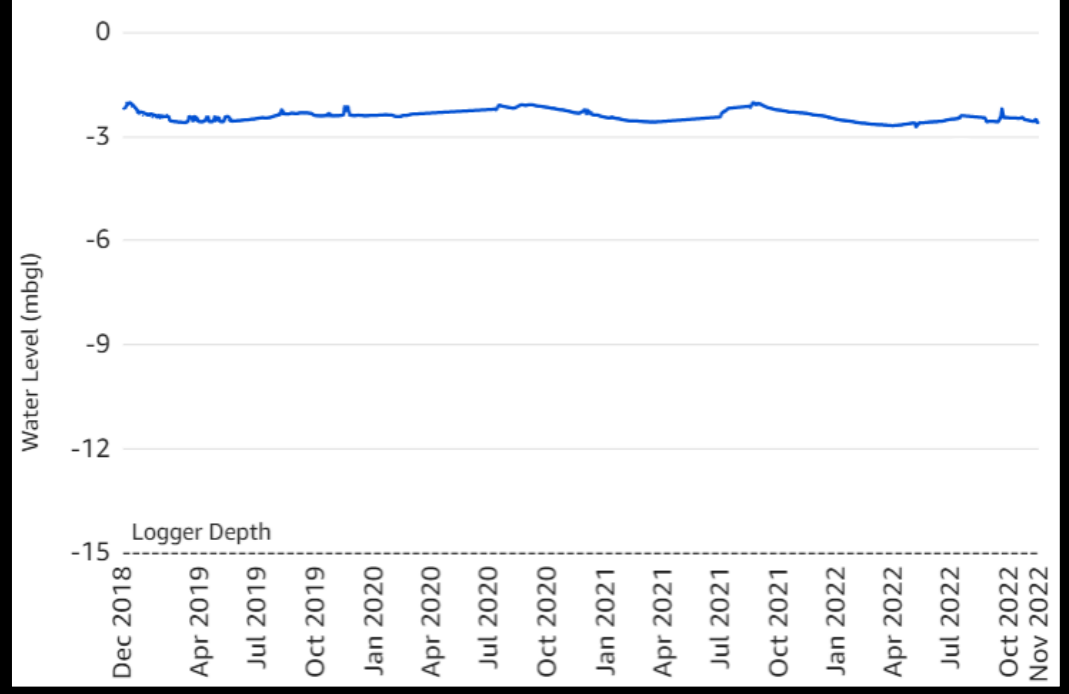
# Groundwater Monitoring: Monitoring Boreholes Langebaan Road Wellfield (1A)

## Upper Aquifer Boreholes

G45633B Water Level (mbgl)

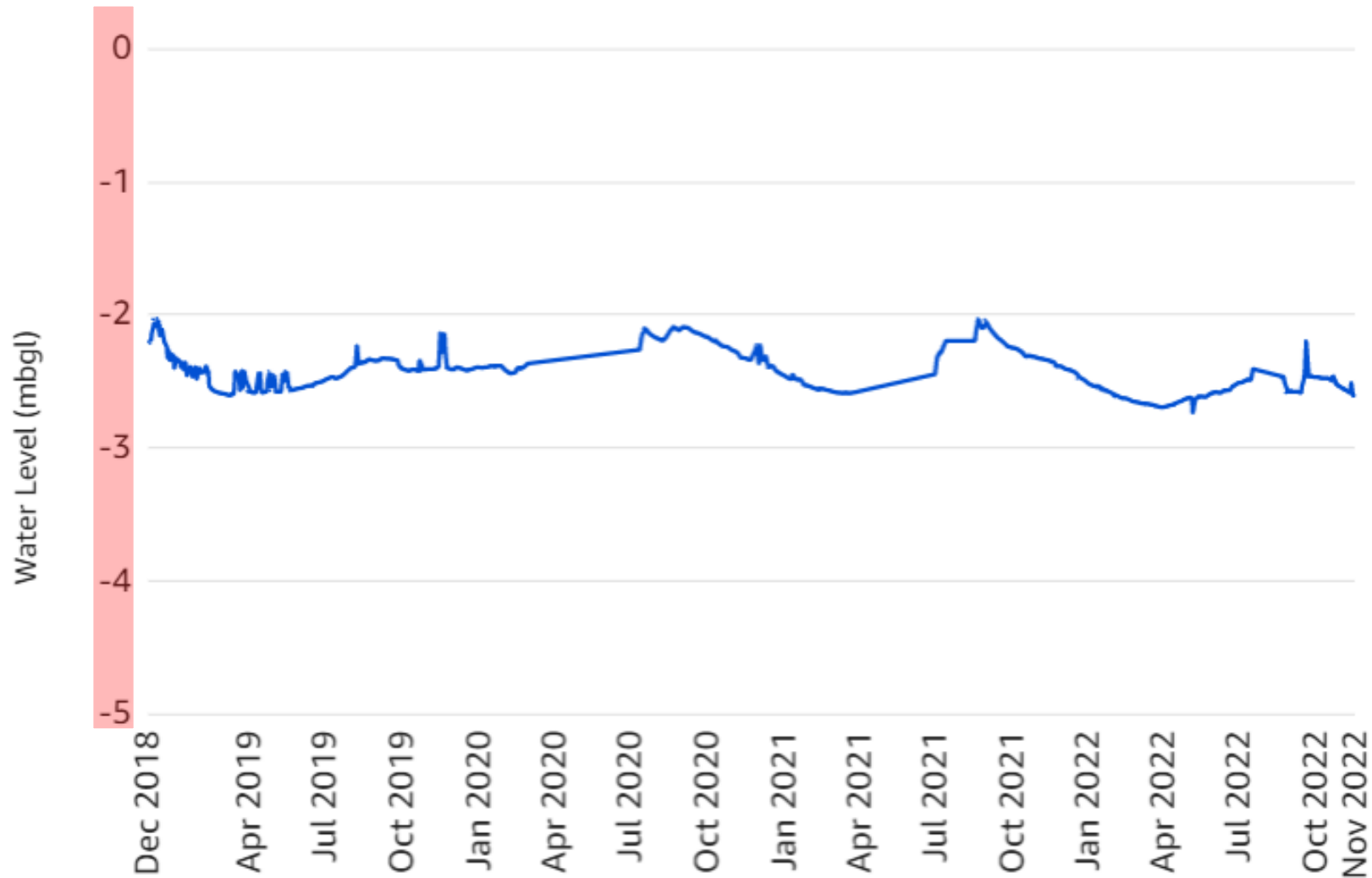


G45634B Water Level (mbgl)

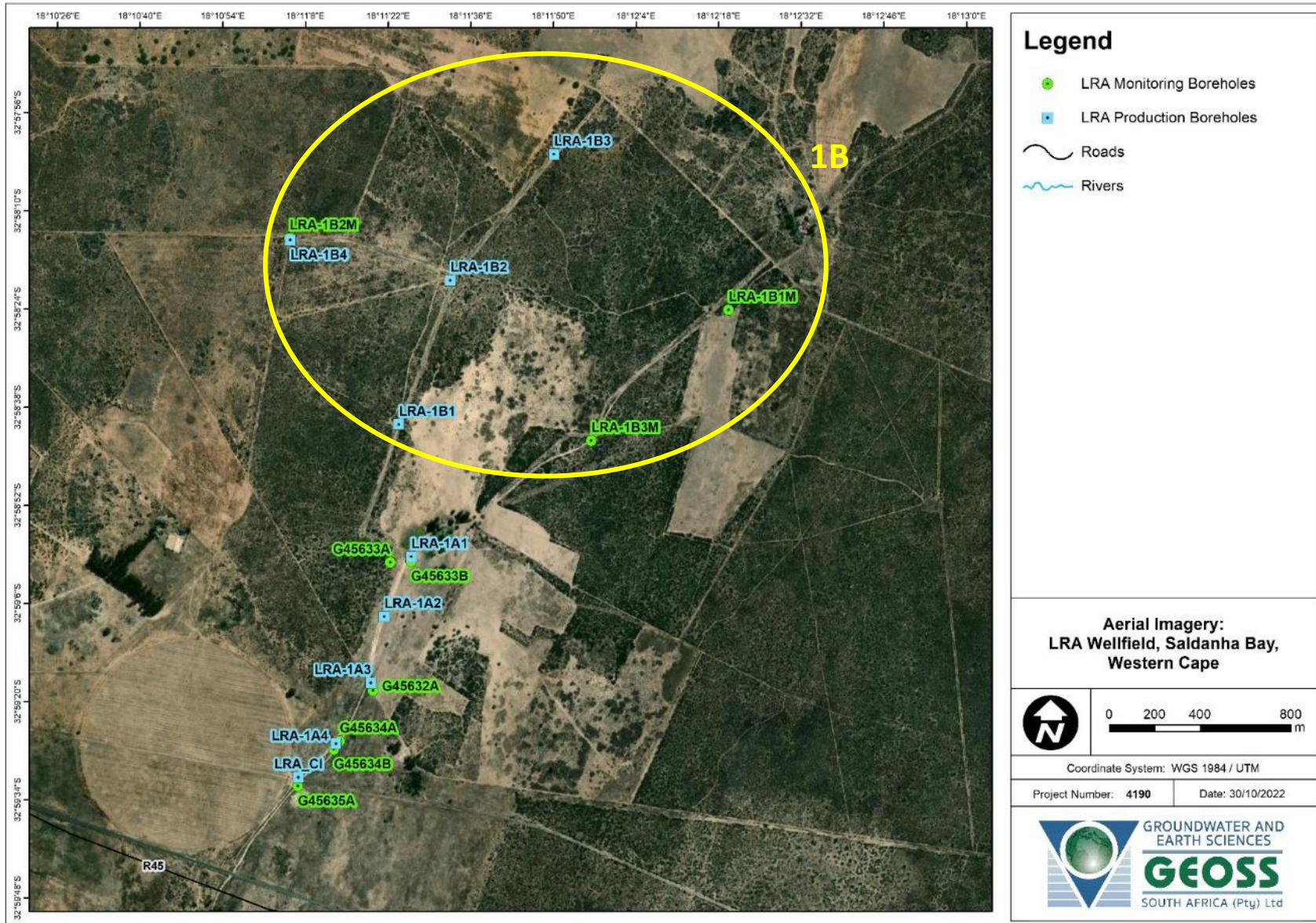


# Groundwater Monitoring: Monitoring Boreholes Langebaan Road Wellfield (1A)

## G45634B Water Level (mbgl)



# Groundwater Monitoring (LRA-1B)



# Groundwater Monitoring: Production Boreholes Langebaan Road Wellfield (1B)



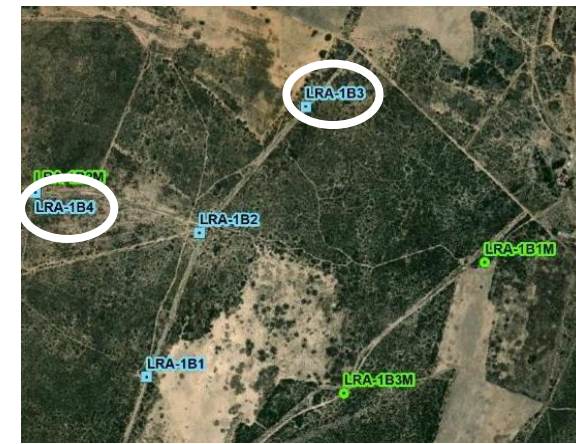
LRA-1B1 Water Level (mbgl) & Abstraction (m³)



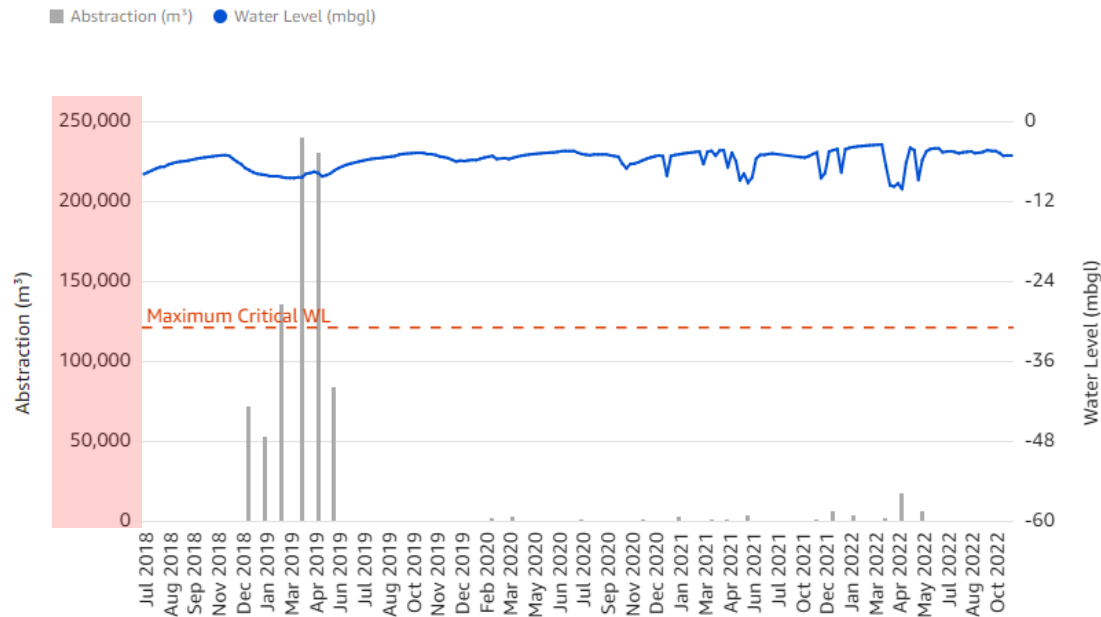
LRA-1B2 Water Level (mbgl) & Abstraction (m³)



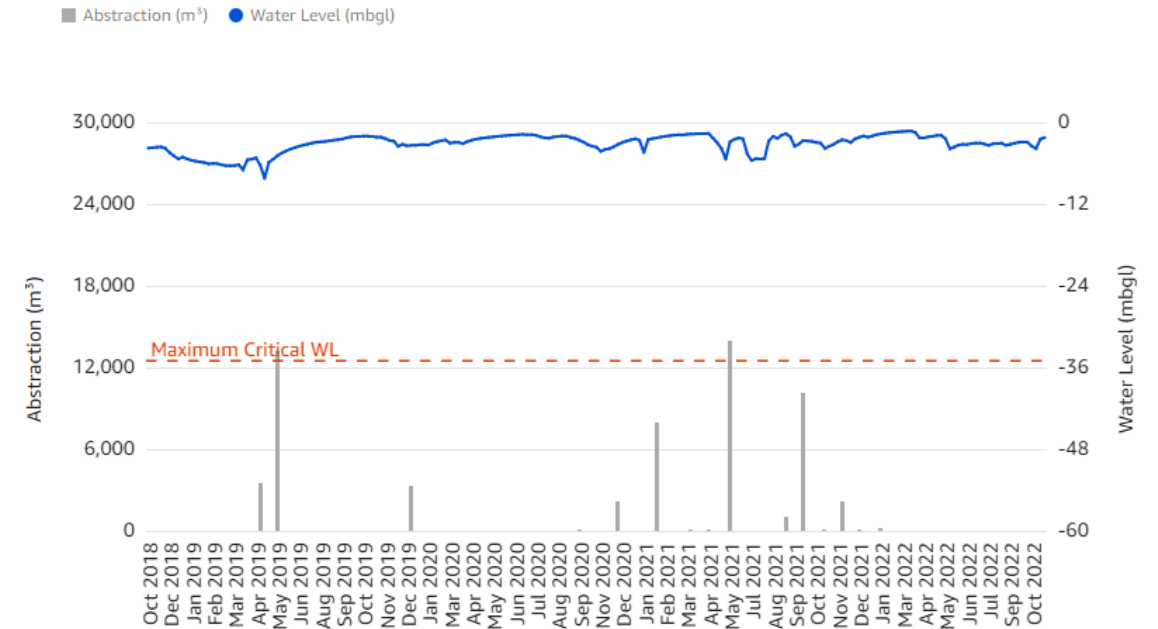
# Groundwater Monitoring: Production Boreholes Langebaan Road Wellfield (1B)



LRA-1B3 Water Level (mbgl) & Abstraction (m<sup>3</sup>)



LRA-1B4 Water Level (mbgl) & Abstraction (m<sup>3</sup>)

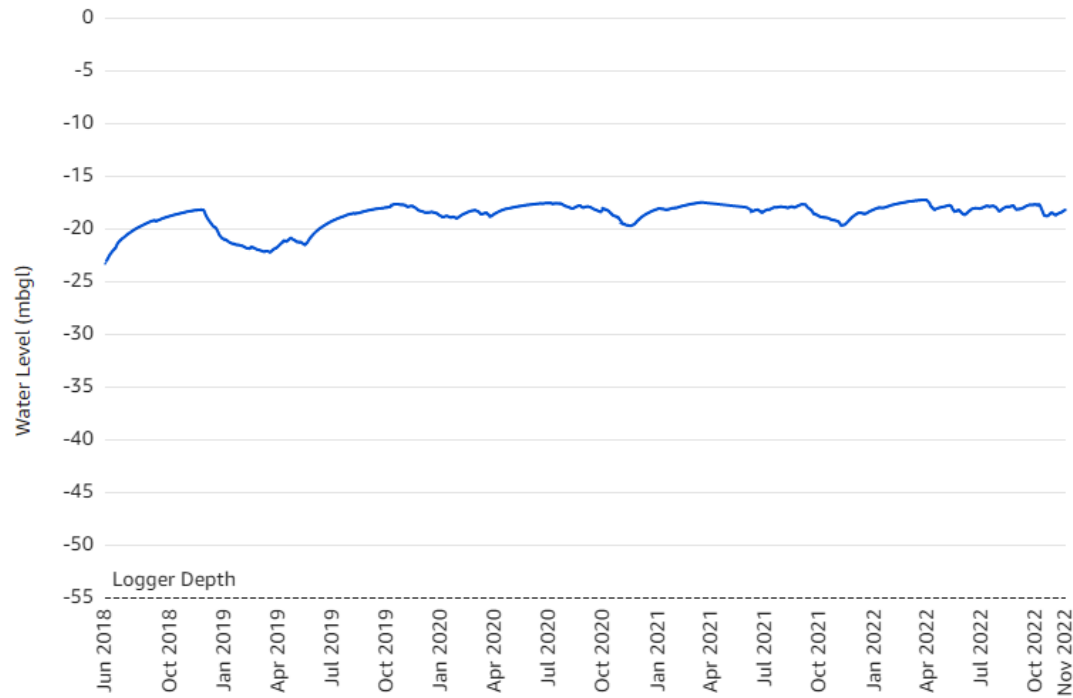


# Groundwater Monitoring: Monitoring Boreholes Langebaan Road Wellfield (1B)

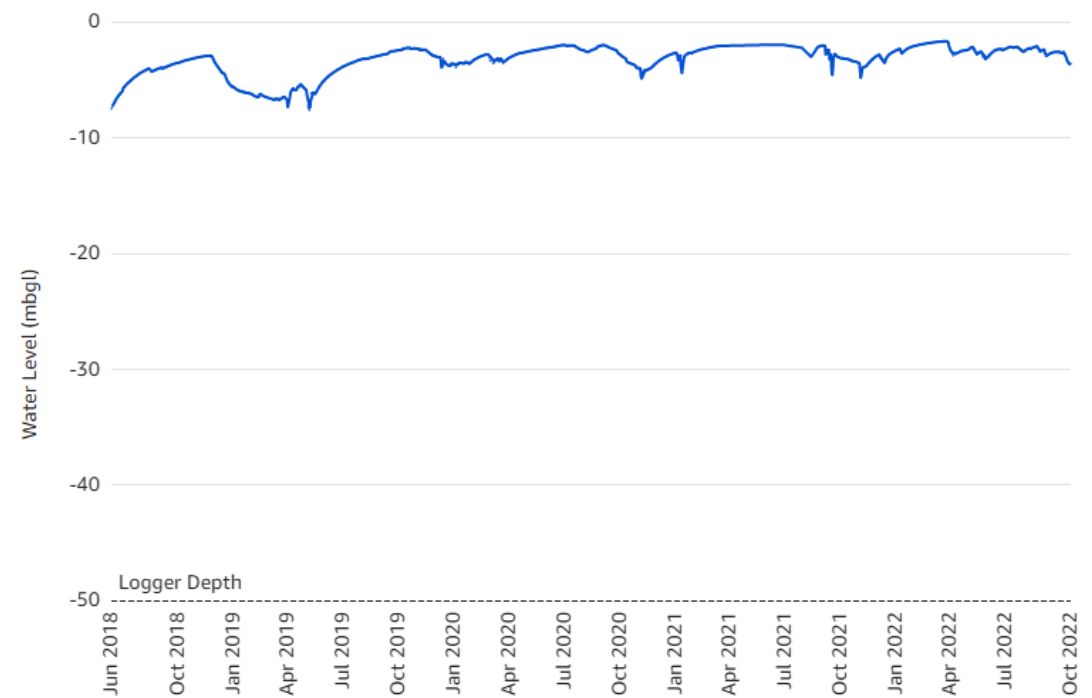
## Lower Aquifer Boreholes



LRA-1B1M Water Level (mbgl)



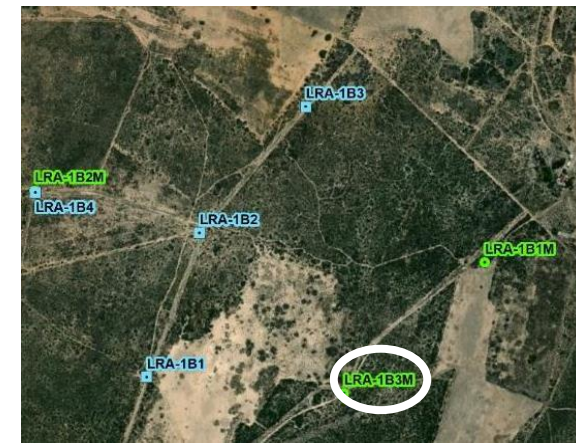
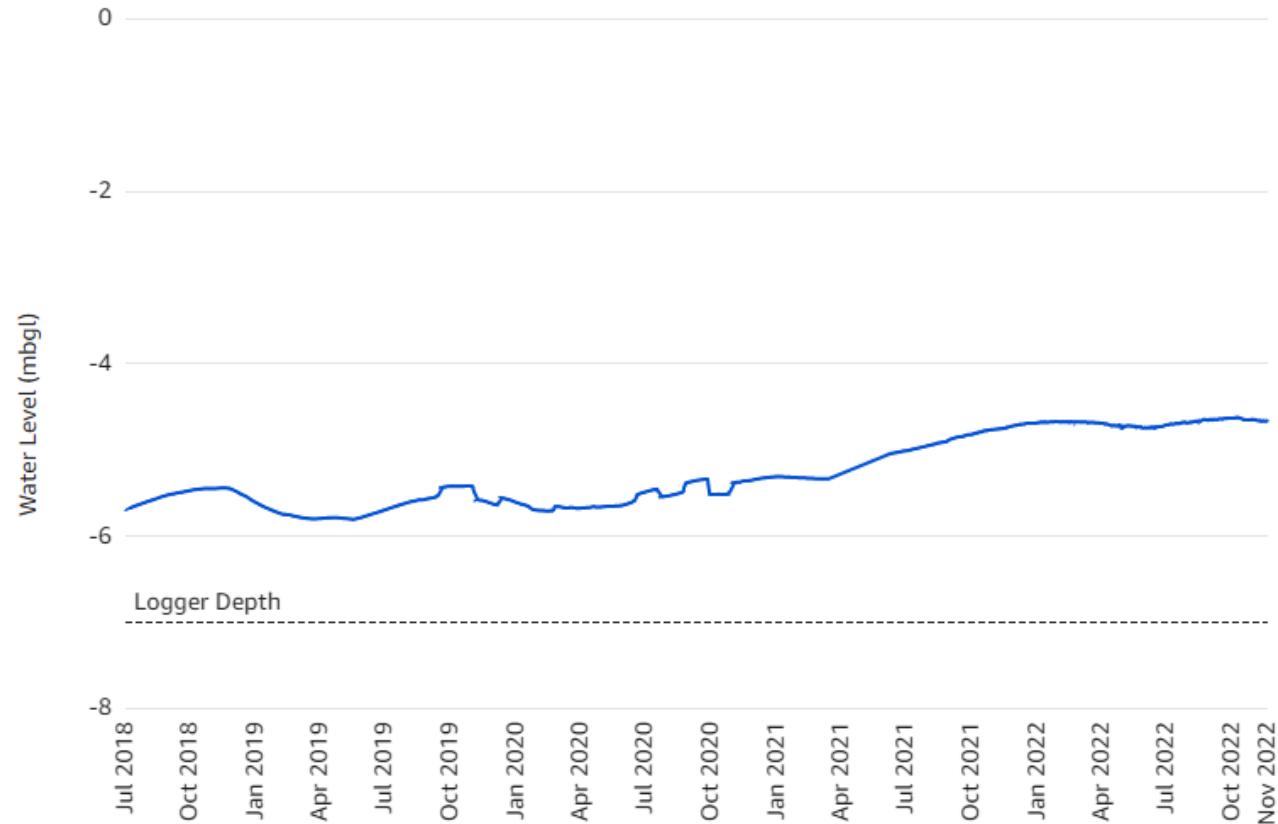
LRA-1B2M Water Level (mbgl)



# Groundwater Monitoring: Monitoring Boreholes Langebaan Road Wellfield (1B)

Upper Aquifer  
Borehole

LRA-1B3M Water Level (mbgl)



# Groundwater Quantity & Quality



# Groundwater Monitoring - Abstraction:

Year	Total	
	M <sup>3</sup>	% of WUL
2018	1 741 620.20	60%
2019	1 247 552.38	43%
2020	108 502.74	4%
2021	150 107.33	5%
2022 (YTD)	185 808	6%

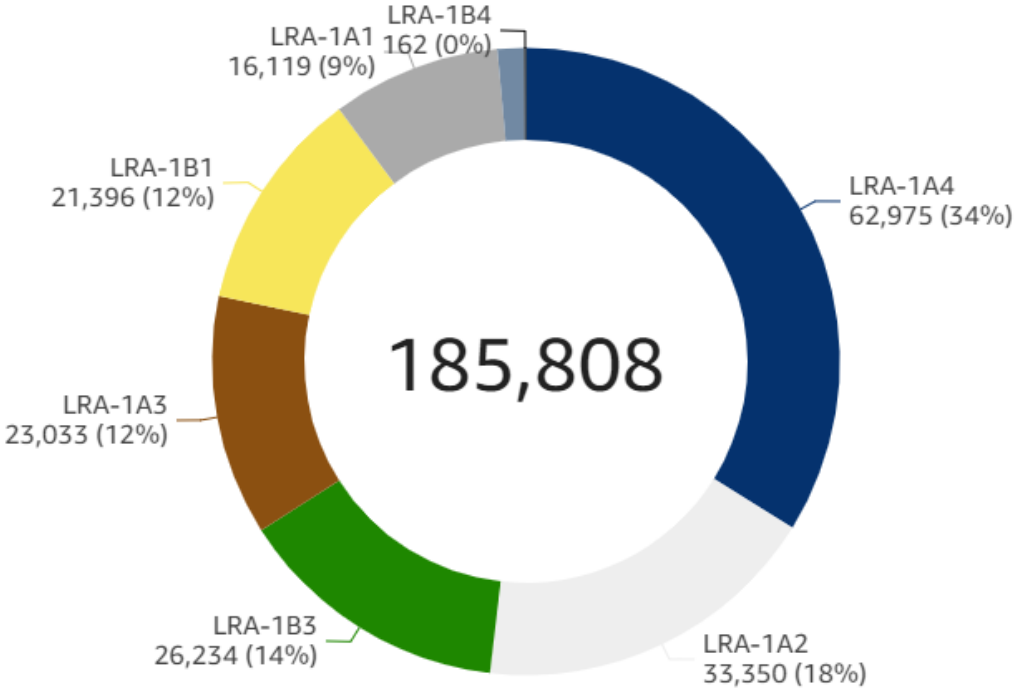
Annual licensed volume: 2 922 000 m<sup>3</sup>/annum



# Groundwater Monitoring - Abstraction:

2022

**Abstraction (m<sup>3</sup>)**  
2022-01-01 to 2022-11-30



# Groundwater Monitoring: Water Quality

Acute Health	Aesthetic	Chronic health	Operational	Acceptable
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Analyses	LRA-1A1	LRA-1A2	LRA-1A3	LRA-1A4	SANS 241-1:2015
pH (at 25 °C)	7.64	7.7	7.7	7.8	≥5 - ≤9.7 Operational
Conductivity (mS/m) (at 25 °C)	69.60	66.0	63.9	63.9	≤170 Aesthetic
Sodium (mg/L as Na)	70.30	63	61	66	≤200 Aesthetic
Potassium (mg/L as K)	1.40	2	1	2	N/A
Magnesium (mg/L as Mg)	6.30	4	5	5	N/A
Calcium (mg/L as Ca)	44.50	38	40	38	N/A
Chloride (mg/L as Cl)	144.00	115.00	108.00	104.00	≤300 Aesthetic
Sulphate (mg/L as SO4)	26.20	19.60	13.20	4.70	≤250 Aesthetic ≤500 Acute Health
Nitrate & Nitrite Nitrogen (mg/L as N)	0.38	0.49	0.36	0.39	≤12 Acute Health
Nitrate Nitrogen (mg/L as N)	<0.2	<0.2	<0.2	<0.2	≤11 Acute Health
Nitrite Nitrogen (mg/L as N)	0.42	0.53	0.46	0.46	≤0.9 Acute Health
Ammonia Nitrogen (mg/L as N)	<0.1	<0.1	<0.1	<0.1	≤1.5 Aesthetic
Total Alkalinity (mg/L as CaCO3)	115.00	98.1	112.0	129.0	N/A
Total Hardness (mg/L as CaCO3)	137.08	112.5	119.9	114.8	N/A
Fluoride (mg/L as F)	0.62	<0.5	<0.5	<0.5	≤1.5 Chronic Health
Total Chromium (mg/L as Cr)	<0.004	<0.004	<0.004	<0.004	≤0.05 Chronic Health
Manganese (mg/L as Mn)	<0.018	<0.018	<0.018	<0.018	≤0.1 Aesthetic ≤0.4 Chronic Health
Iron (mg/L as Fe)	0.21	0.024	0.033	0.021	≤0.3 Aesthetic ≤2 Chronic Health
Zinc (mg/L as Zn)	<0.01	0.070	0.020	<0.01	≤5 Aesthetic
Arsenic (mg/L as As)	<0.010	<0.010	<0.010	<0.010	≤0.01 Chronic Health
Charge balance %	-8.3	-5.6	-4.4	-3.7	≥-5 - ≤5 Acceptable

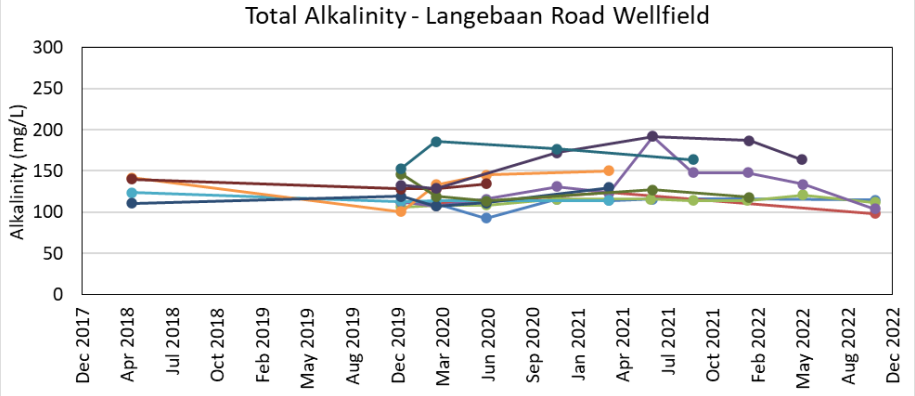
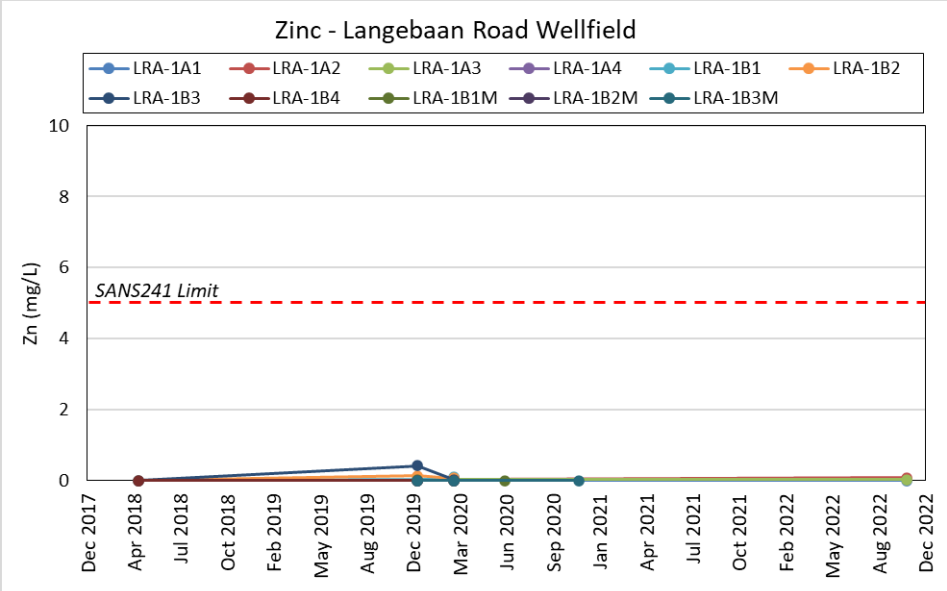
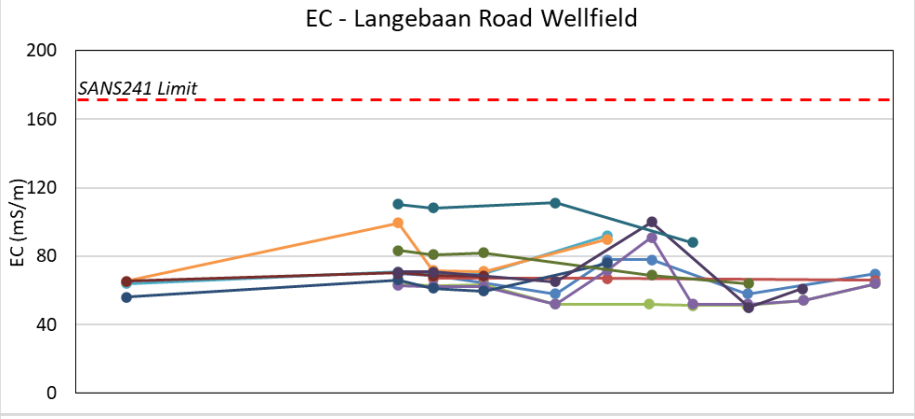
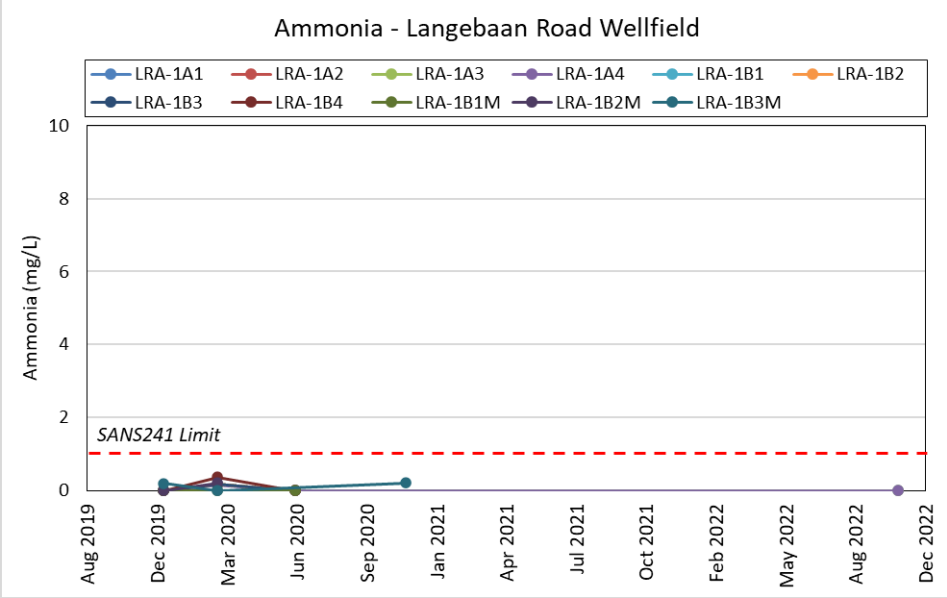
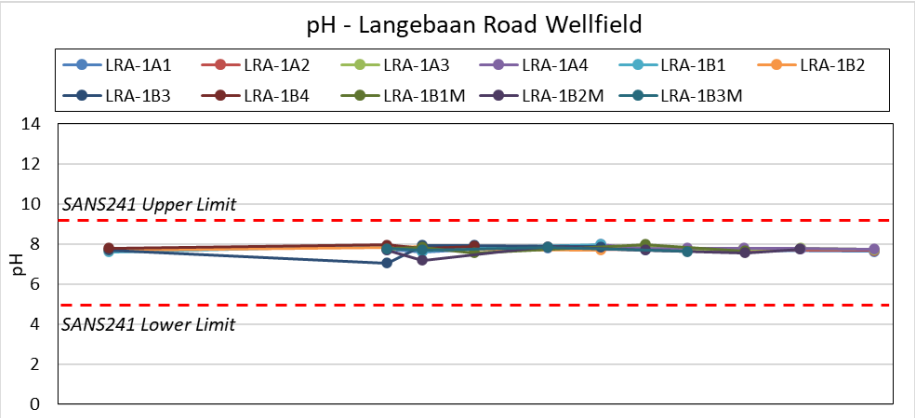
**Only LRA-1A production boreholes were sampled in October due to infrastructure issues at the LRA-1B wellfield**

# Groundwater Monitoring: Water Quality

Legend		
<b>Blue</b>	(Class 0)	Ideal water quality - suitable for lifetime use.
<b>Green</b>	(Class I)	Good water quality - suitable for use, rare instances of negative effects.
<b>Yellow</b>	(Class II)	Marginal water quality - conditionally acceptable. Negative effects may occur.
<b>Red</b>	(Class III)	Poor water quality - unsuitable for use without treatment. Chronic effects may occur.
<b>Purple</b>	(Class IV)	Dangerous water quality - totally unsuitable for use. Acute effects may occur.

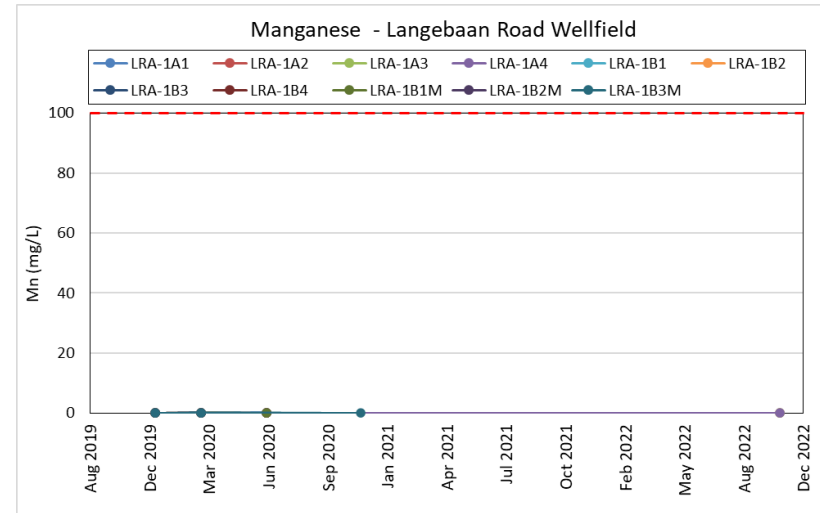
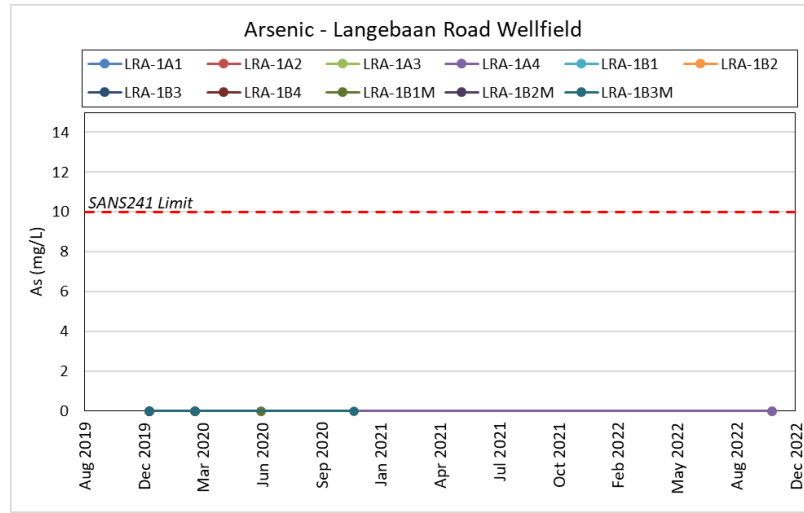
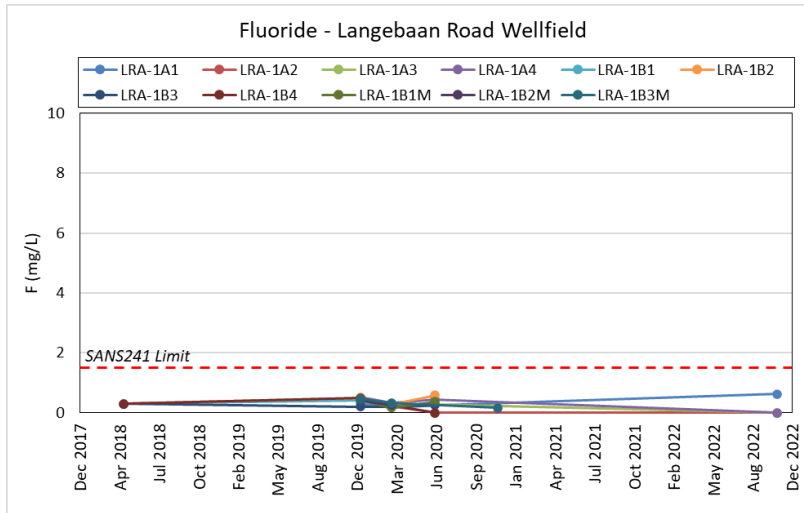
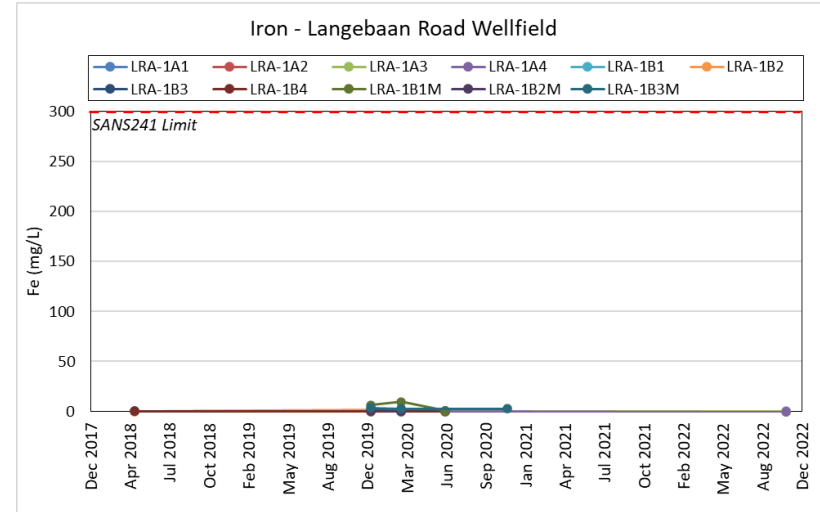
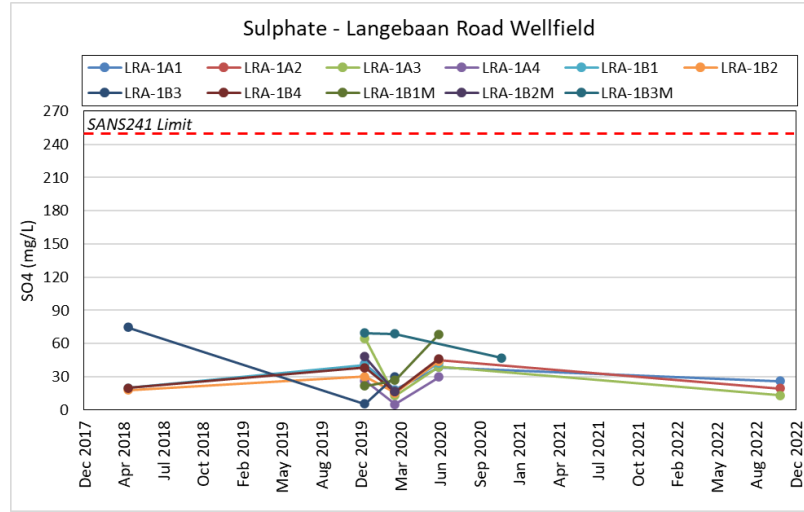
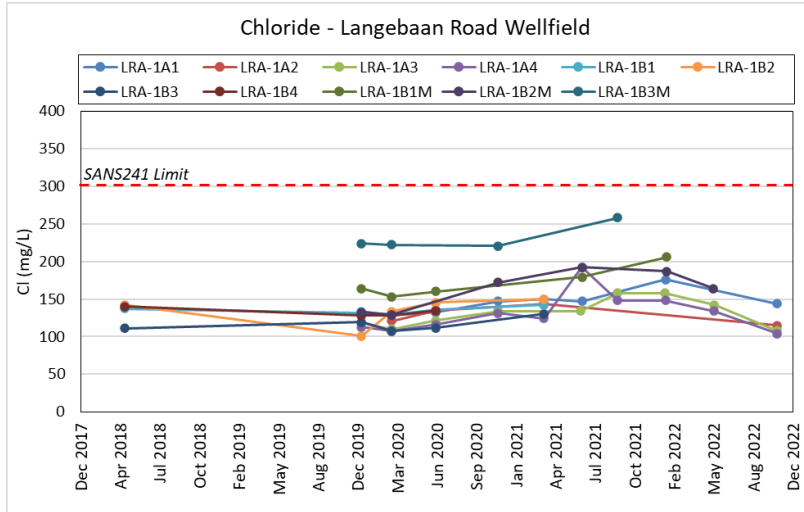
Sample Marked :	LRA-1A1	LRA-1A2	LRA-1A3	LRA-1A4	DWAf (1998) Drinking Water Assessment Guide				
					Class 0	Class I	Class II	Class III	Class IV
pH	7.6	7.7	7.7	7.8	5-9.5	4.5-5 & 9.5-10	4-4.5 & 10-10.5	3-4 & 10.5-11	< 3 & >11
Conductivity (mS/m)	69.6	66.0	63.9	63.9	<70	70-150	150-370	370-520	>520
	mg/L								
Sodium (as Na)	70	63	61	66	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	1	2	1	2	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	6	4	5	5	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	45	38	40	38	<80	80-150	150-300	>300	
Chloride (as Cl)	144.00	115.00	108.00	104.00	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO4)	26.20	19.60	13.20	4.70	<200	200-400	400-600	600-1000	>1000
Nitrate& Nitrite (as N)	0.38	0.49	0.36	0.39	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	0.62	<0.5	<0.5	<0.5	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	<0.018	<0.018	<0.018	<0.018	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	0.211	0.024	0.033	0.021	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Zinc (as Zn)	<0.01	0.070	0.020	<0.01	<20	>20			
Arsenic (as As)	<0.010	<0.010	<0.010	<0.010	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Hardness (as CaCO3)	137.080	112.54	119.86	114.77	<200	200-300	300-600	>600	

# Groundwater Chemistry Results:





# Groundwater Chemistry Results:



# Groundwater Monitoring: Water Quality (LRA-1A) Baseline Parameters

Borehole Name	LRA-1A1	LRA-1A1	LRA-1A2	LRA-1A2	LRA-1A3	LRA-1A3	LRA-1A4	LRA-1A4
Parameter	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (October 2022)	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (October 2022)	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (October 2022)	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (October 2022)
pH	7.73	7.64	7.78	7.7	7.74	7.7	7.78	7.8
EC	69.80	69.60	67	66	63.8	63.9	62.8	63.9
Ammonia (as N)	<0.15	<0.1	0.16	<0.1	<0.15	<0.1	<0.15	<0.1
Nitrate (NO <sub>3</sub> )	<0.5	<0.2	<1	<0.2	<0.5	<0.2	<0.5	<0.2
Nitrite (NO <sub>2</sub> )	<0.05	0.42	<0.05	0.53	<0.05	0.46	<0.05	0.46
Calcium (Ca)	49	44.5	49	44.5	46	40	46	38
Chloride (Cl)	133.6	144	121.04	115.0	118.23	108	112.6	104
Fluoride (F)	0.31	0.62	0.22	<0.5	0.48	<0.5	0.51	<0.5
Magnesium (Mg)	7	6.30	7	4	6	5	6	5
Potassium (K)	3	1.4	1	2	3	1	3	2
Sodium (Na)	69	70.30	66	63	62	61	62	66
Sulphate (SO <sub>4</sub> )	41.66	26.20	15.78	19.6	64.9	13.2	26.65	4.7
Zinc (Zn)	<0.01	<0.01	0.028	0.07	<0.008	0.02	0.011	<0.01
Iron (Fe)	0.39	0.21	0.27	0.024	0.04	0.033	0.03	0.021
Manganese (Mn)	<0.01	<0.018	0.01	<0.018	0.01	<0.018	0.01	<0.018
Chromium (Cr)	<0.004	<0.004	0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Arsenic (As)	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Alkalinity	111.90	115	112.1	98.1	106.2	112	123.1	129



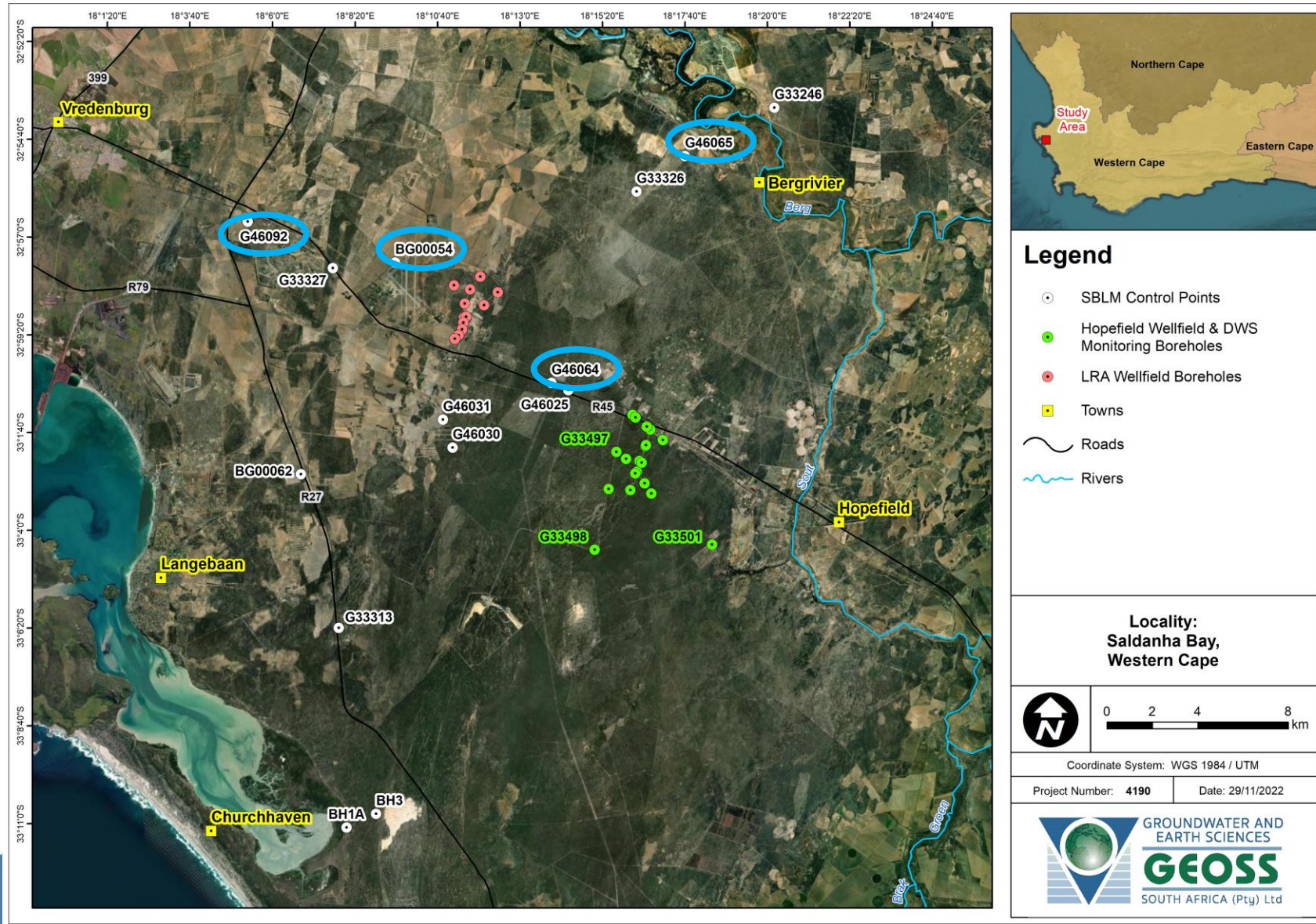
# Water Quality Baseline Parameters (LRA-1B)

Borehole Name	LRA-1B1	LRA-1B1	LRA-1B2	LRA-1B2	LRA-1B3	LRA-1B3	LRA-1B4	LRA-1B4
Parameter	Reference Value (mg/L) (April 2018)	Recorded Value (mg/L) (March 2021)	Reference Value (mg/L) (April 2018)	Recorded Value (mg/L) (March 2021)	Reference Value (mg/L) (April 2018)	Recorded Value (mg/L) (March 2021)	Reference Value (mg/L) (April 2018)	Recorded Value (mg/L) (March 2021)
pH	7.60	7.97	7.70	7.7	7.7	7.86	7.8	7.89
EC	73.08	92	79.4	90	63.82	76	68.1	68.2
Ammonia (as N)	<0.15	-	<0.15	-	<0.15	-	<0.15	-
Nitrate (NO <sub>3</sub> )	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Nitrite (NO <sub>2</sub> )	<0.1	-	<0.05	-	<0.05	-	<0.05	-
Calcium (Ca)	55.2	108	64.0	112.8	50.2	88	49.75	48
Chloride (Cl)	137	142	134.3	150	115.8	130	132.7	134.34
Fluoride (F)	0.30	-	0.41	-	0.24	-	0.35	-
Magnesium (Mg)	15.9	9.6	7.84	7.2	13.04	7.2	6.75	7
Potassium (K)	2.3	-	2.6	-	17.85	-	2.33	-
Sodium (Na)	69.0	-	80.75	-	47.5	-	67.75	-
Sulphate (SO <sub>4</sub> )	30.0	-	27	-	29.55	-	30.3	-
Zinc (Zn)	<0.025	-	<0.025	-	<0.025	-	<0.025	-
Iron (Fe)	0.45	-	0.70	-	0.34	-	0.13	-
Manganese (Mn)	0.01	-	0.05	-	0.01	-	0.01	-
Chromium (Cr)	0.006	-	0.011	-	<0.004	-	0.004	-
Arsenic (As)	<0.01	-	<0.01	-	<0.01	-	<0.01	-
Total Alkalinity	116	114	123.68	124	103.56	108	117	116.6

# Water Quality Baseline Parameters (LRA-1B)

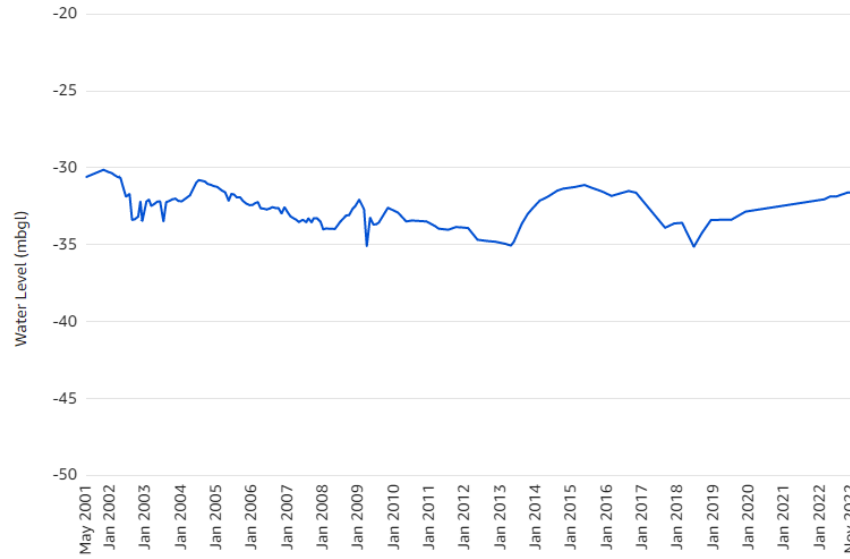
Borehole Name	LRA-1B1M	LRA-1B1M	LRA-1B2M	LRA-1B2M	LRA-1B3M	LRA-1B3M
Parameter	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (January 2022)	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (May 2022)	Reference Value (mg/L) (December 2019)	Recorded Value (mg/L) (September 2021)
pH	7.78	7.65	7.71	7.75	7.6	7.64
EC	75.82	64	69.6	61	104.5	88
Ammonia (as N)	<0.15	-	<0.15	-	0.19	-
Nitrate (NO <sub>3</sub> )	<1	-	<1	-	<1	-
Nitrite (NO <sub>2</sub> )	<0.05	-	<0.15	-	<0.05	-
Calcium (Ca)	79.68	92	82.2	70.4	79.8	91.2
Chloride (Cl)	172.4	206	162.8	164	231.2	258
Fluoride (F)	0.32	-	0.34	-	0.32	-
Magnesium (Mg)	16.5	27.84	15.65	12.24	11.4	5.52
Potassium (K)	2.7	-	3	-	3	-
Sodium (Na)	84	-	76	-	136	-
Sulphate (SO <sub>4</sub> )	39.0	-	32.32	-	61.73	-
Zinc (Zn)	0.009	-	<0.008	-	<0.008	-
Iron (Fe)	5.58	-	0.91	-	2.92	-
Manganese (Mn)	0.02	-	0.05	-	0.026	-
Chromium (Cr)	<0.004	-	<0.004	-	<0.004	-
Arsenic (As)	<0.01	-	<0.01	-	<0.01	-
Total Alkalinity	124.9	118	131.73	222	169.8	164

# Extended Groundwater Monitoring

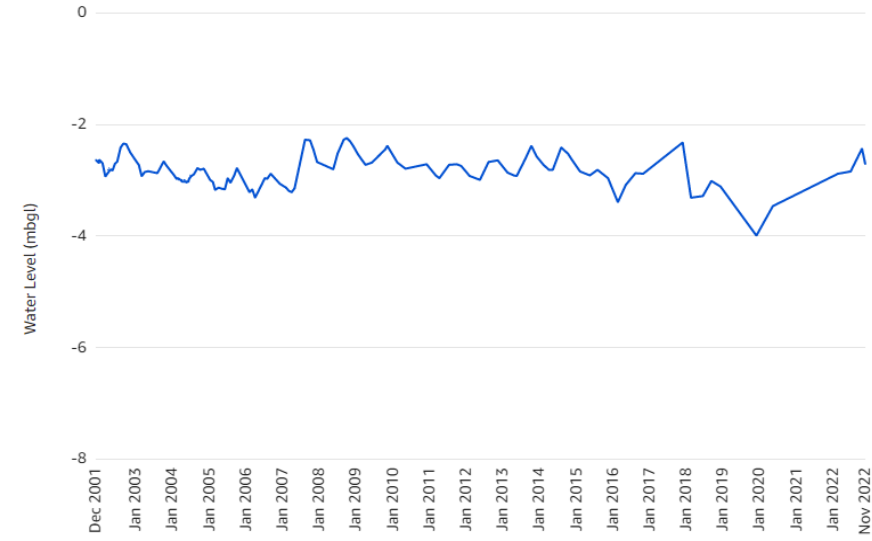


# Groundwater Monitoring: Extended Monitoring Boreholes

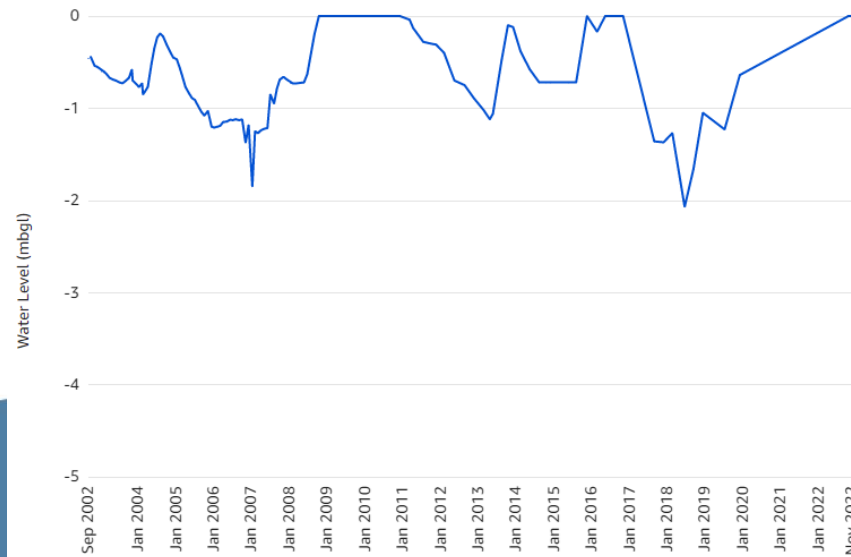
G46064 Water Level (mbgl)



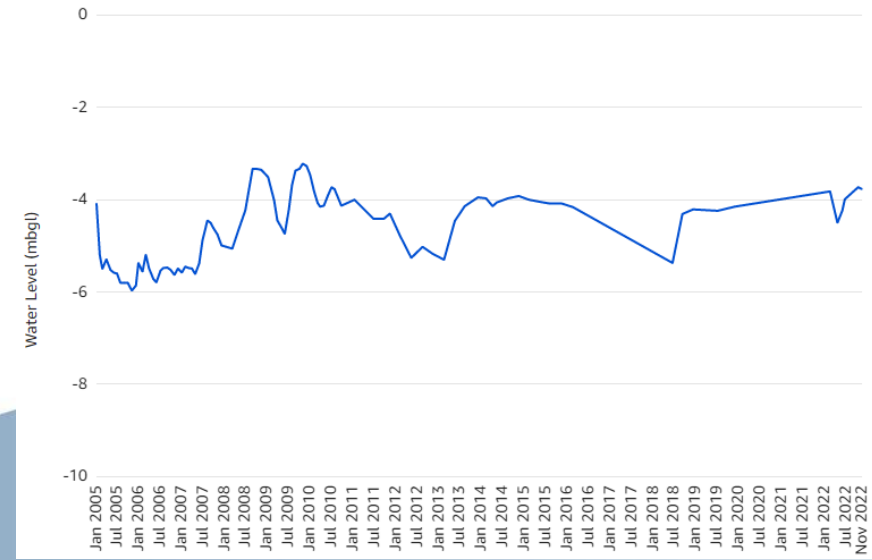
G46065 Water Level (mbgl)



G46092 Water Level (mbgl)

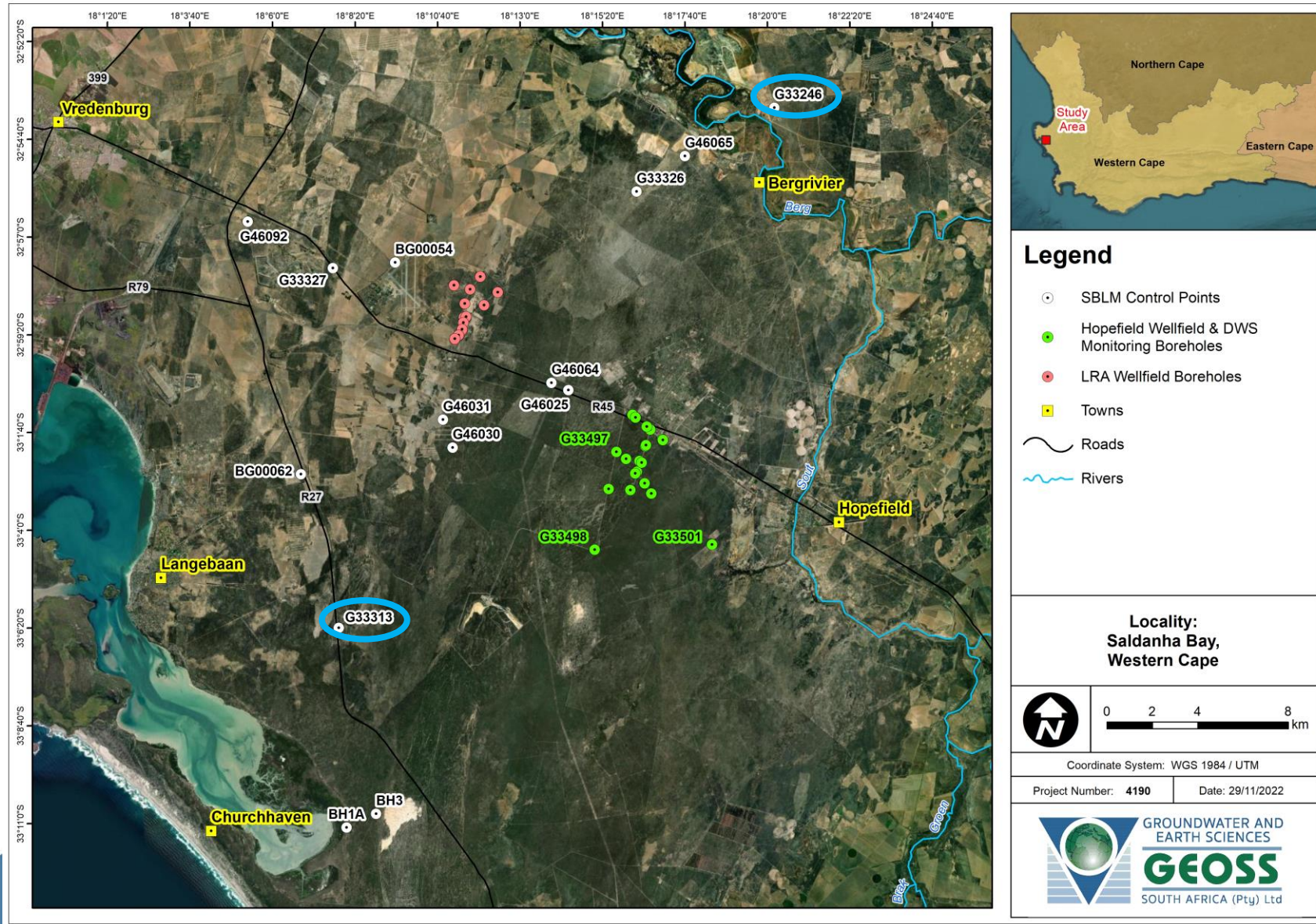


BG00054 Water Level (mbgl)



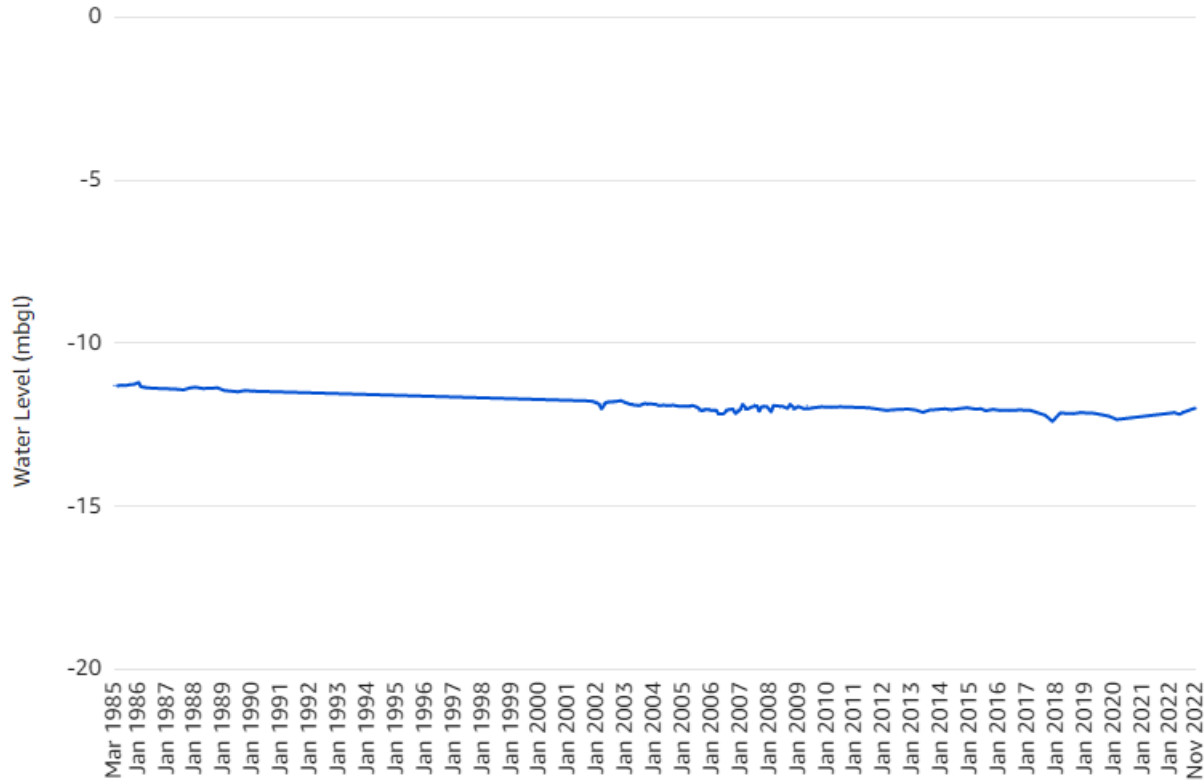
Lower Aquifer  
Boreholes

# Extended Groundwater Monitoring

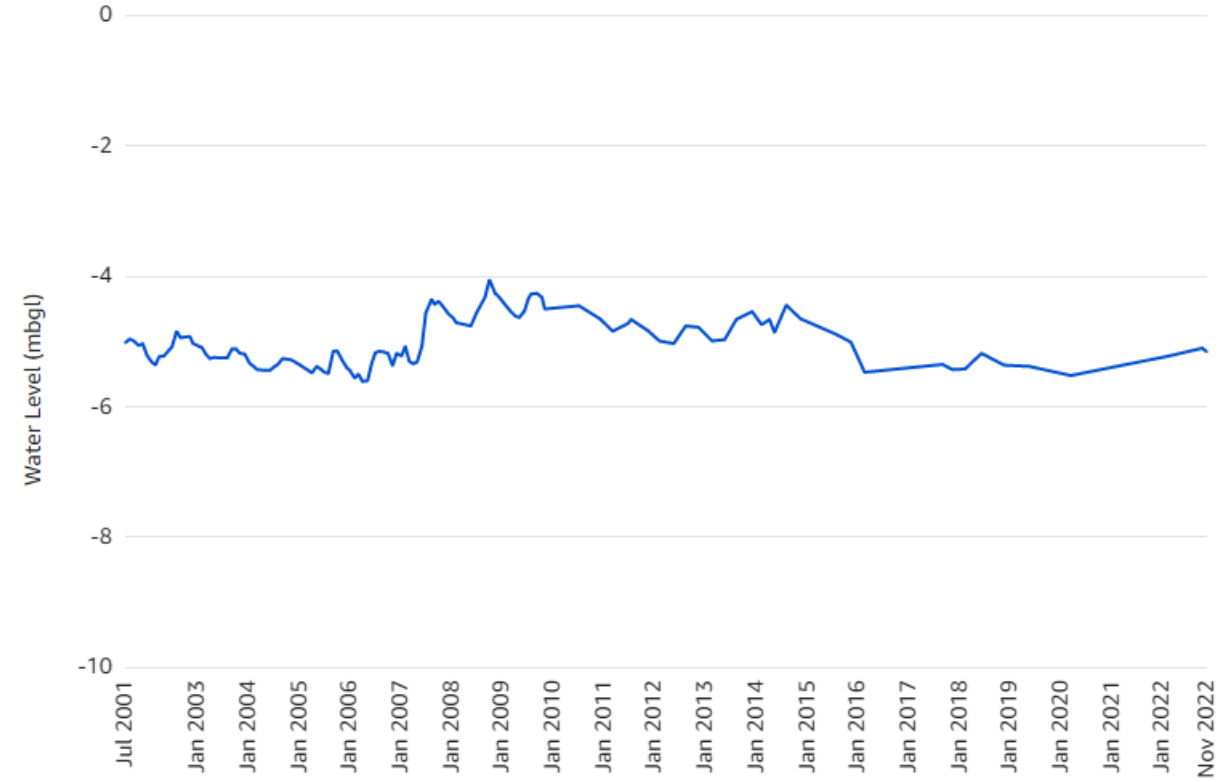


# Groundwater Monitoring: Extended Monitoring Boreholes

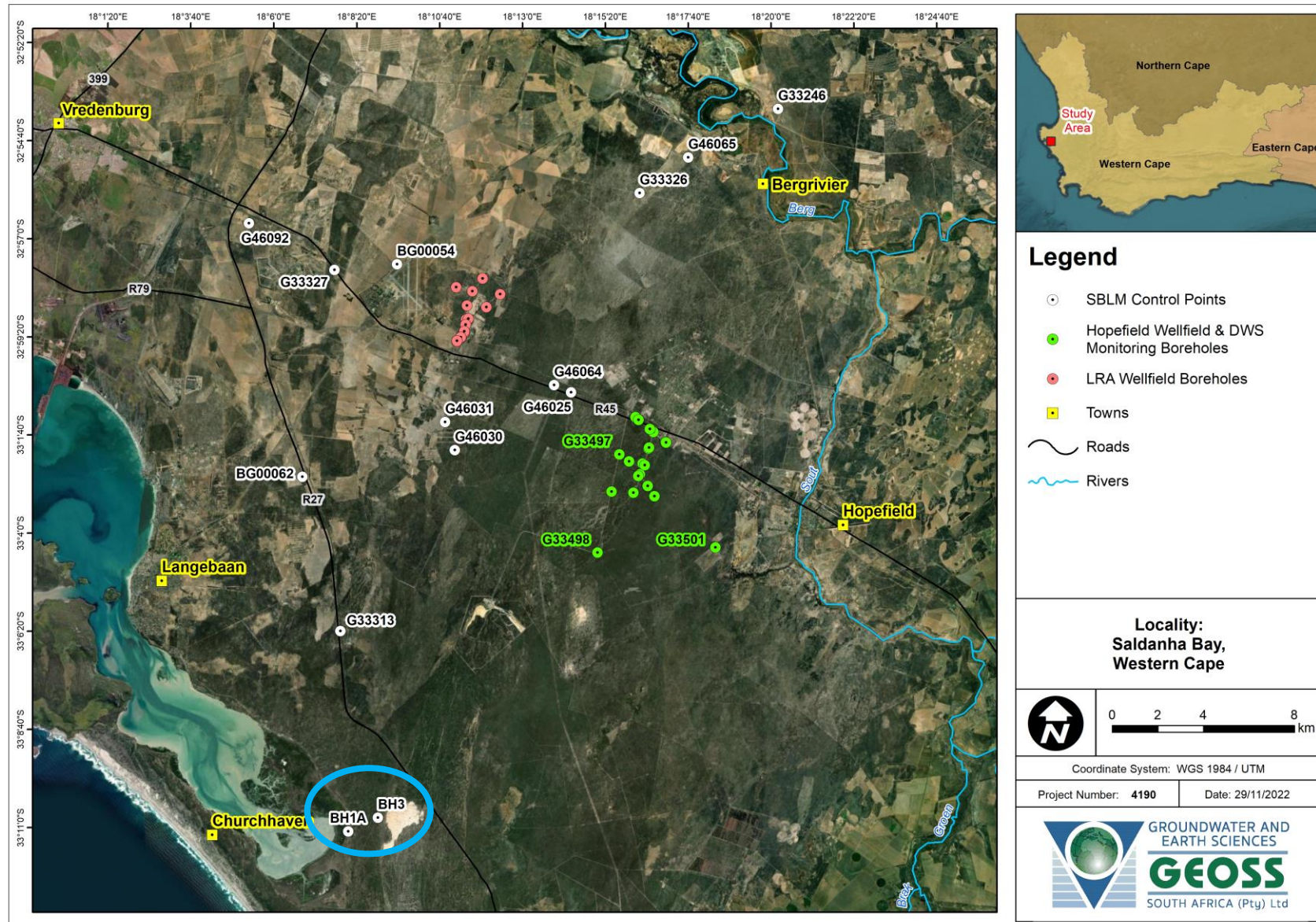
G33313 Water Level (mbgl)



G33246 Water Level (mbgl)

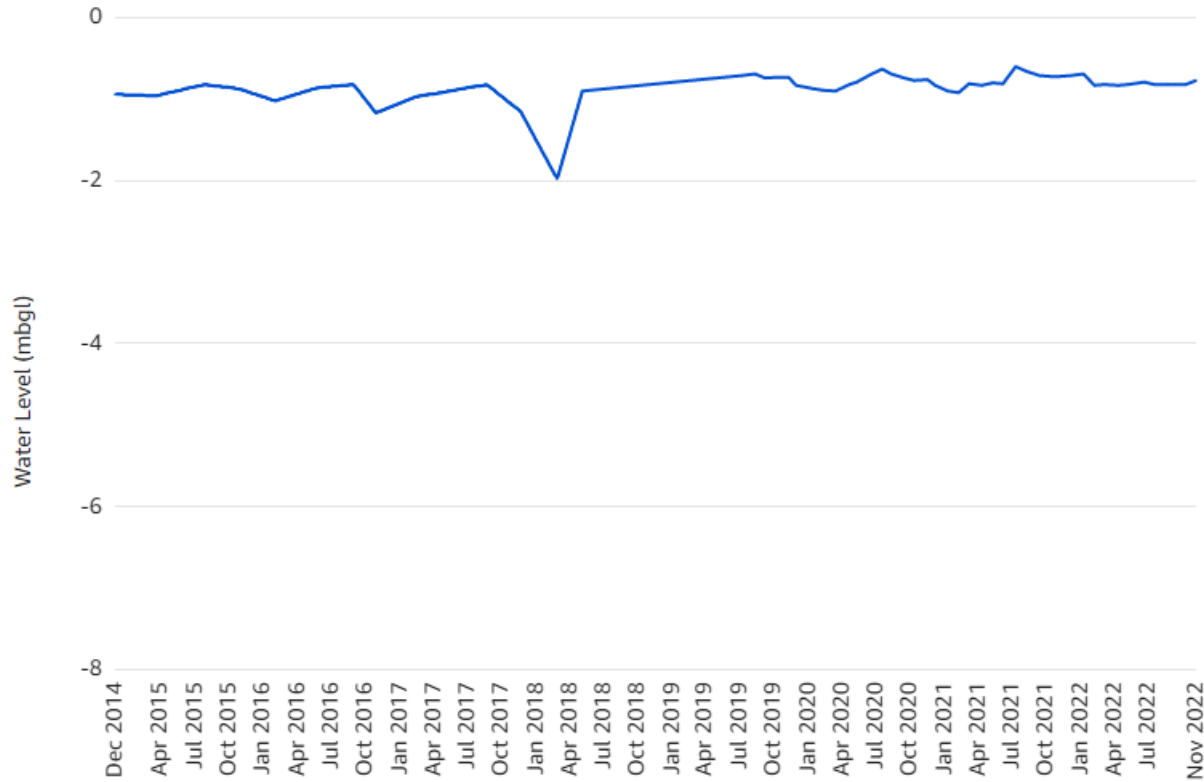


# Extended Groundwater Monitoring

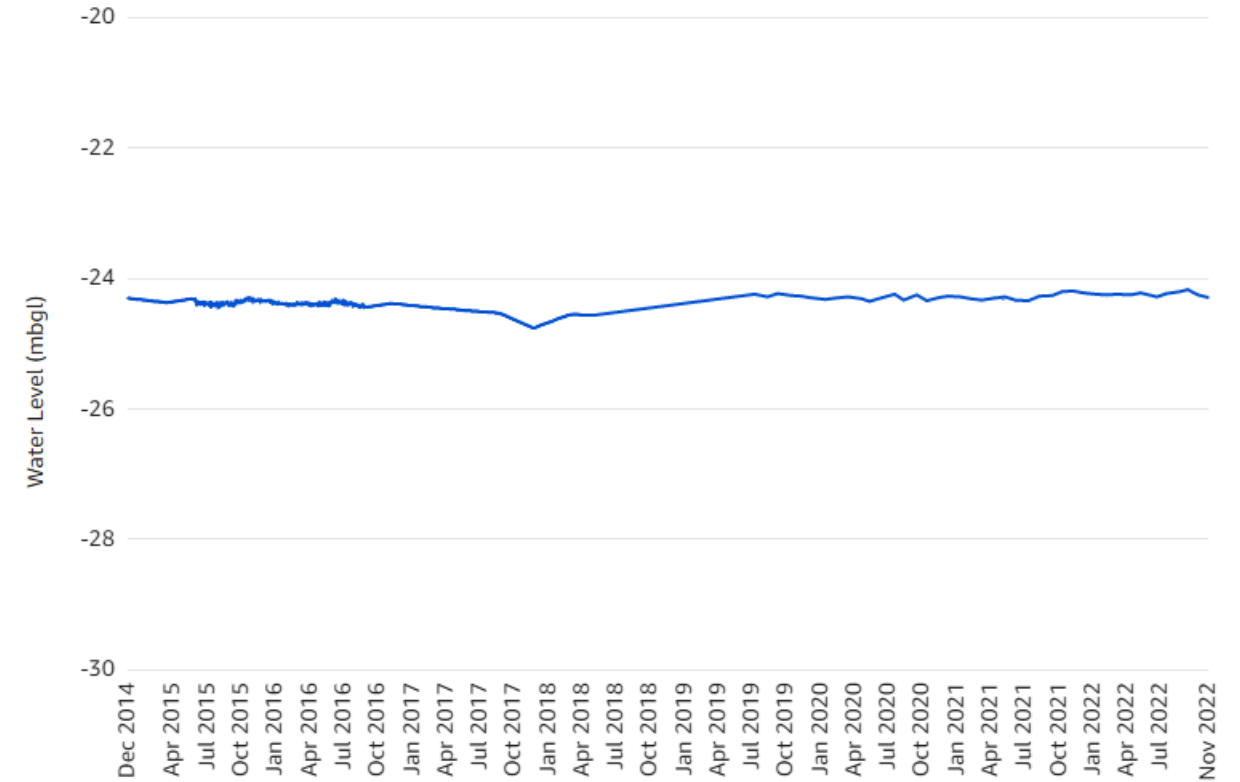


# Groundwater Monitoring: Extended Monitoring Boreholes

GBK01 Water Level (mbgl)



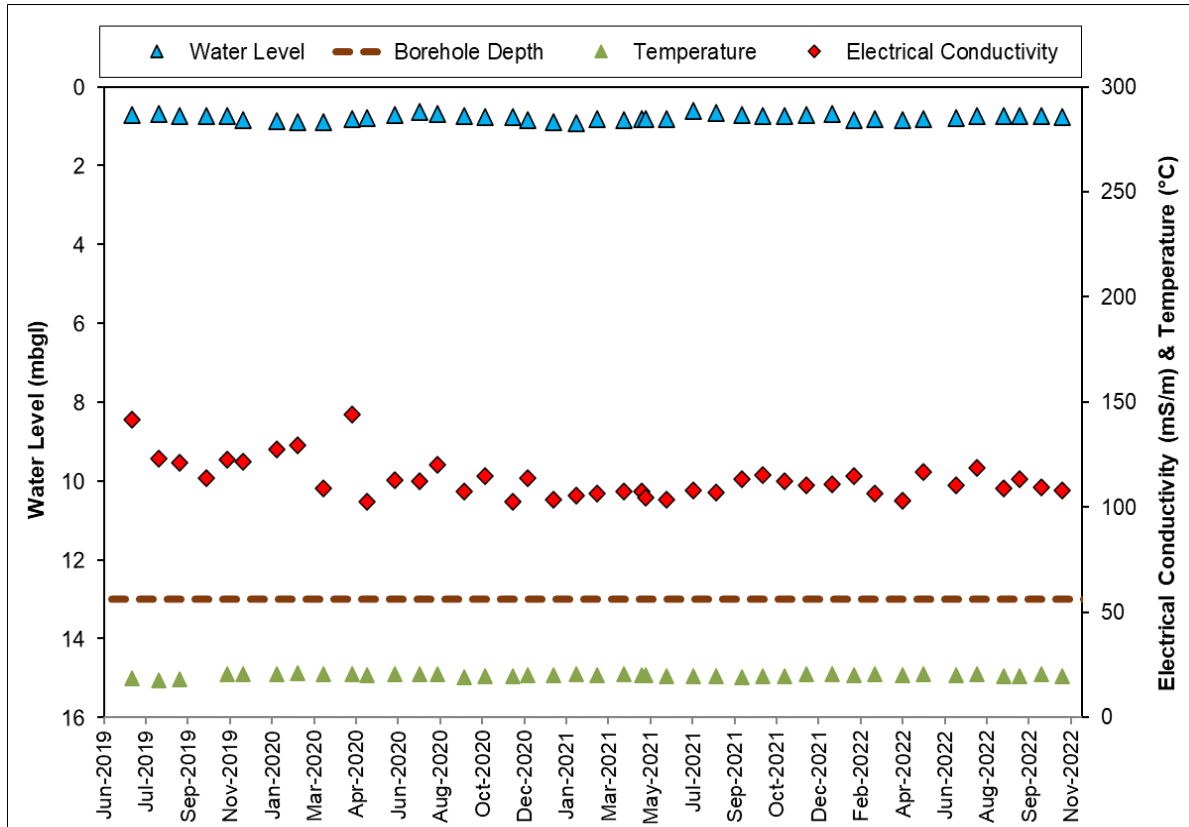
GBK03 Water Level (mbgl)



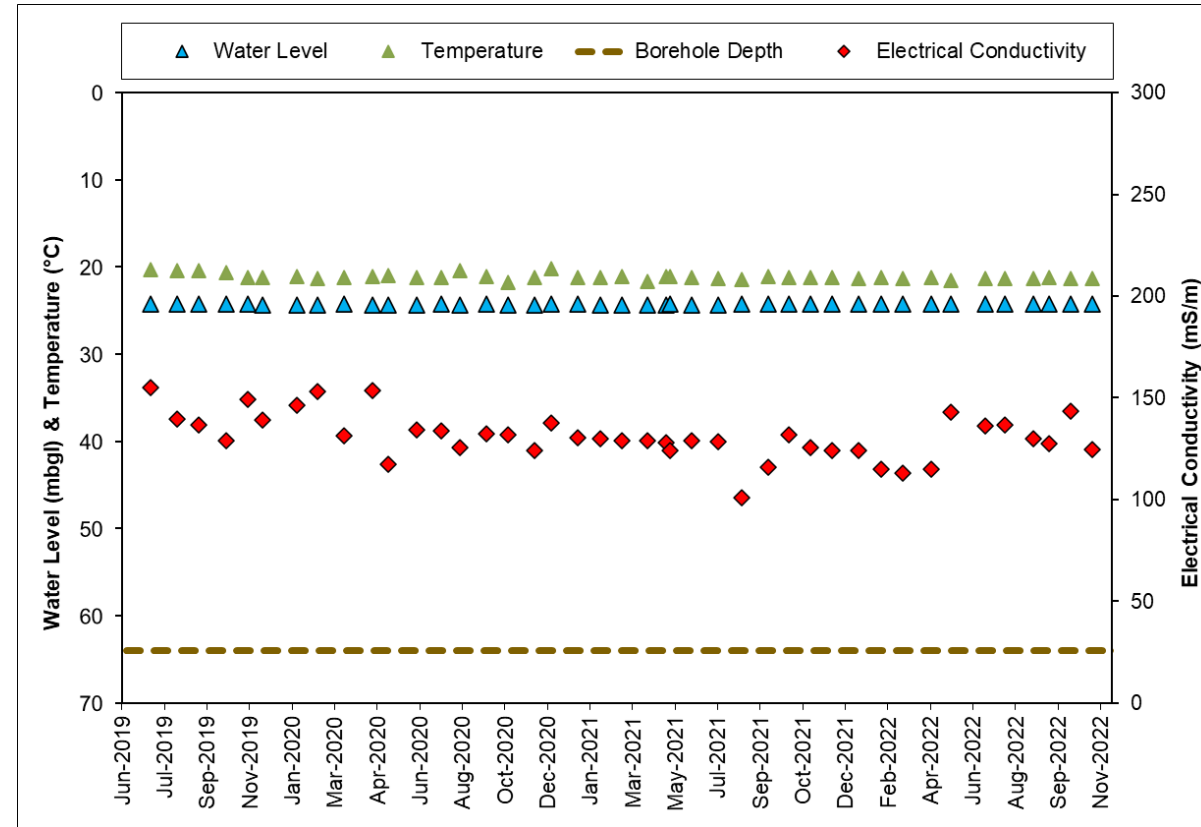


# Groundwater Quality: Geelbek Boreholes

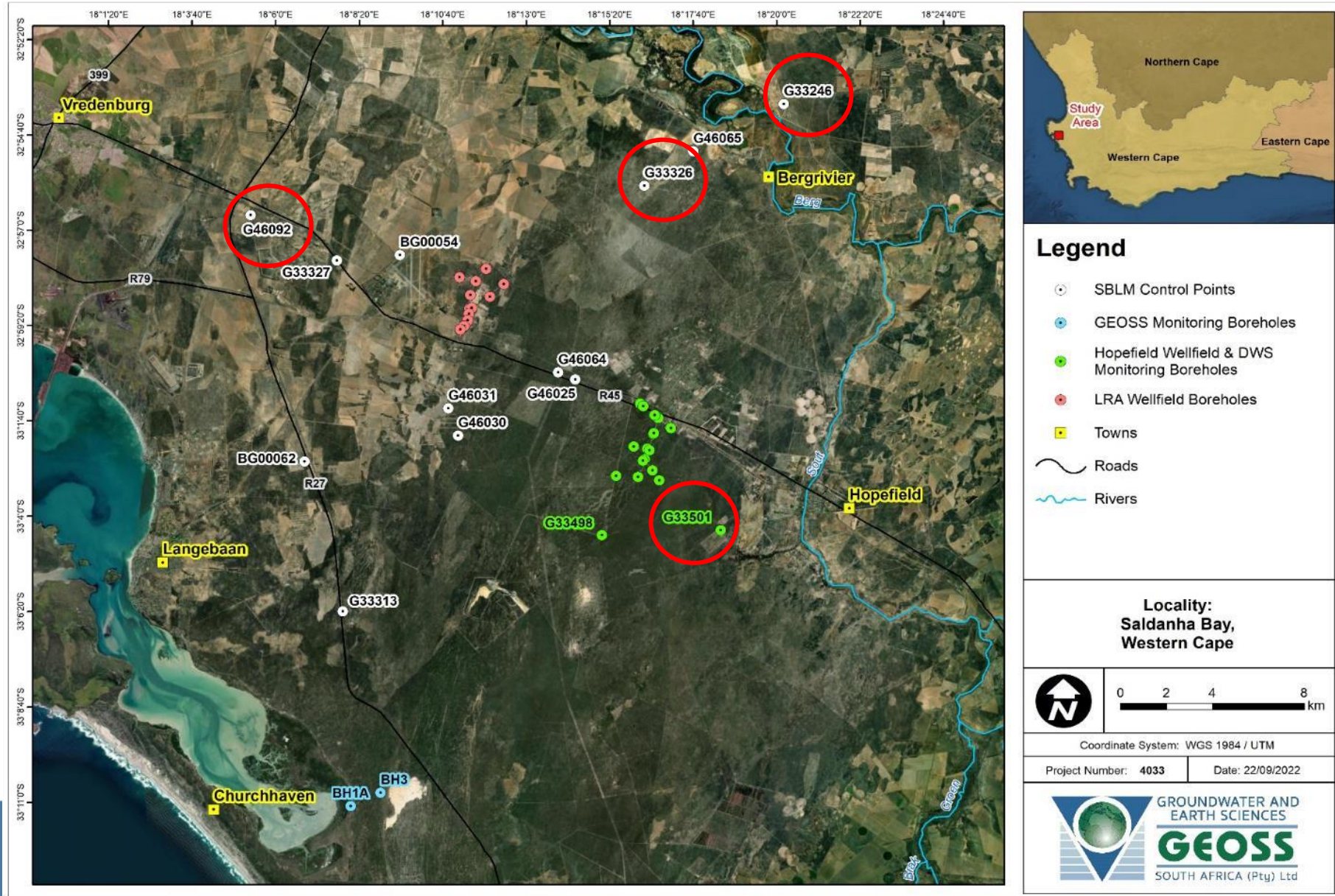
GBK01



GBK03



# Extended Groundwater Quality Monitoring

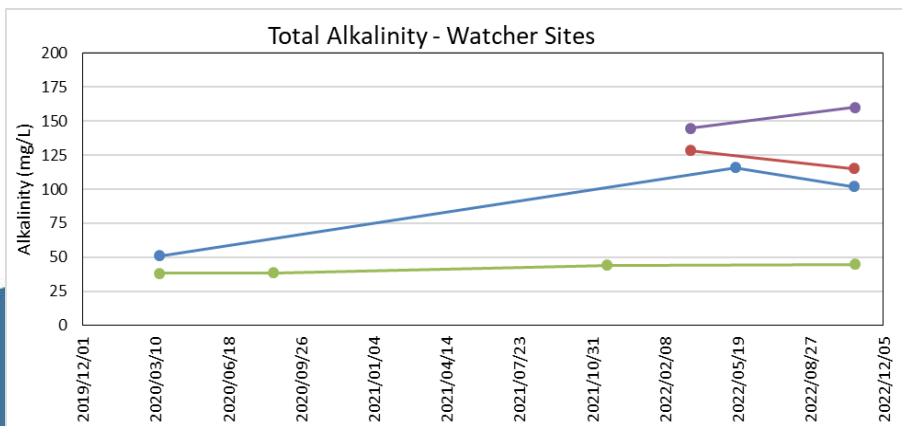
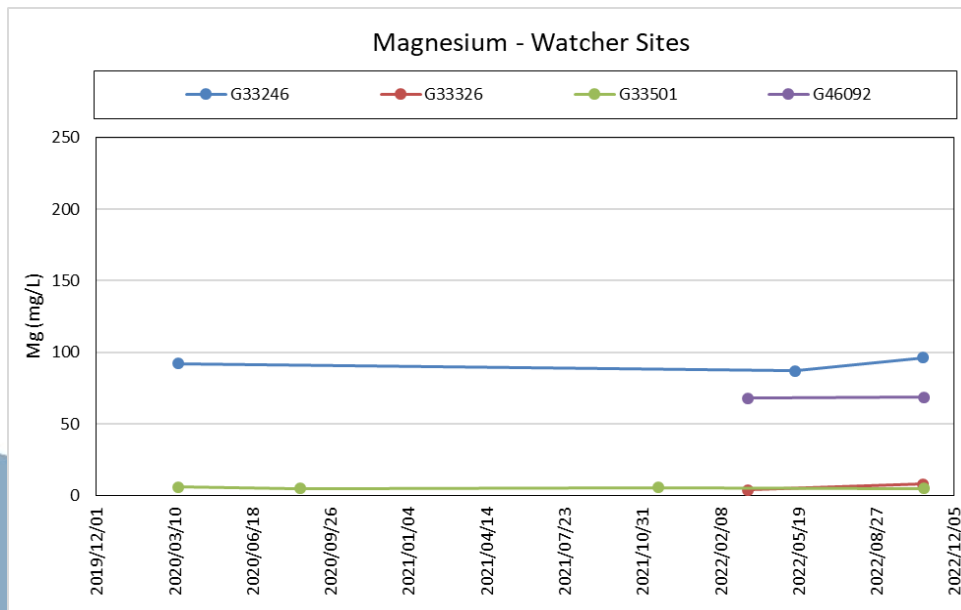
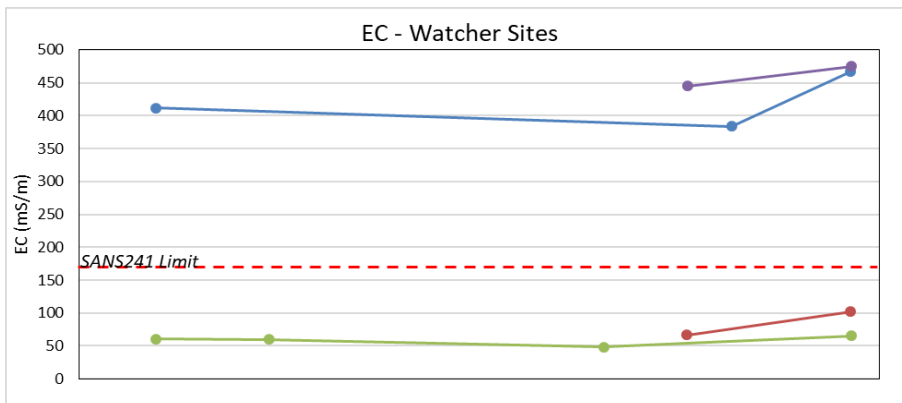
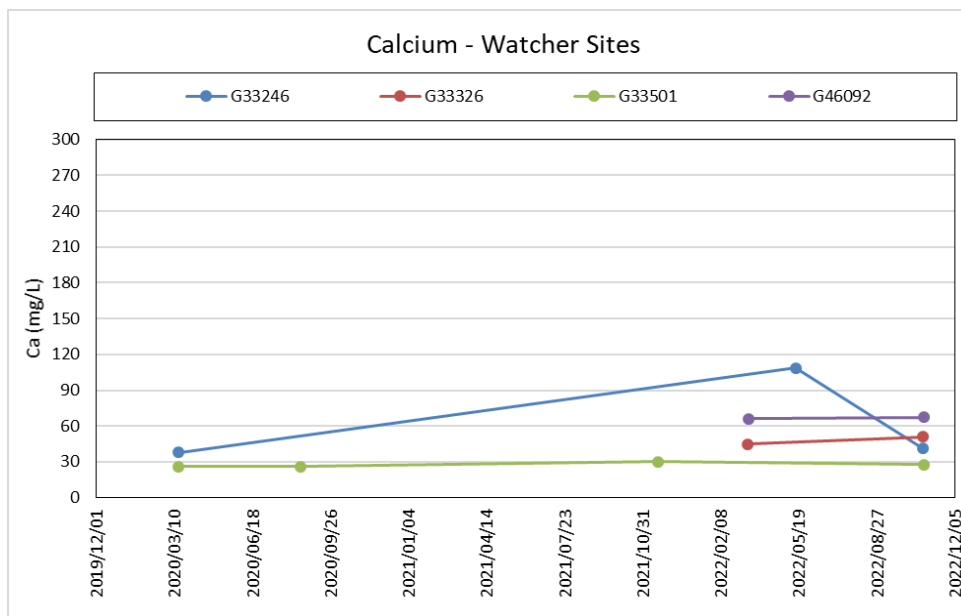
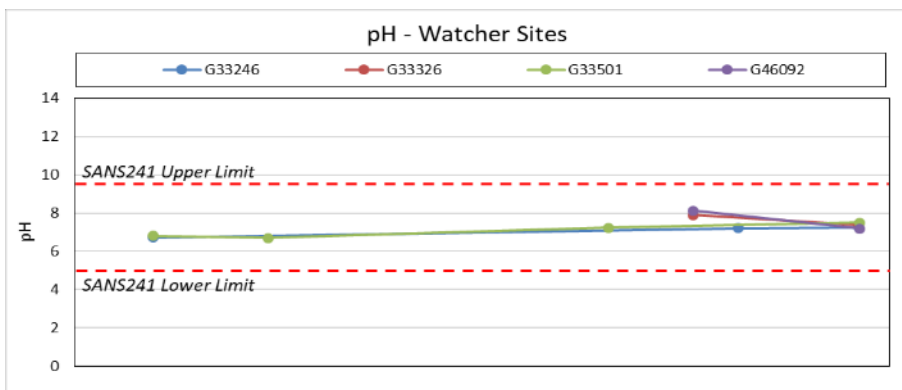


# Groundwater Monitoring Chemistry Results:

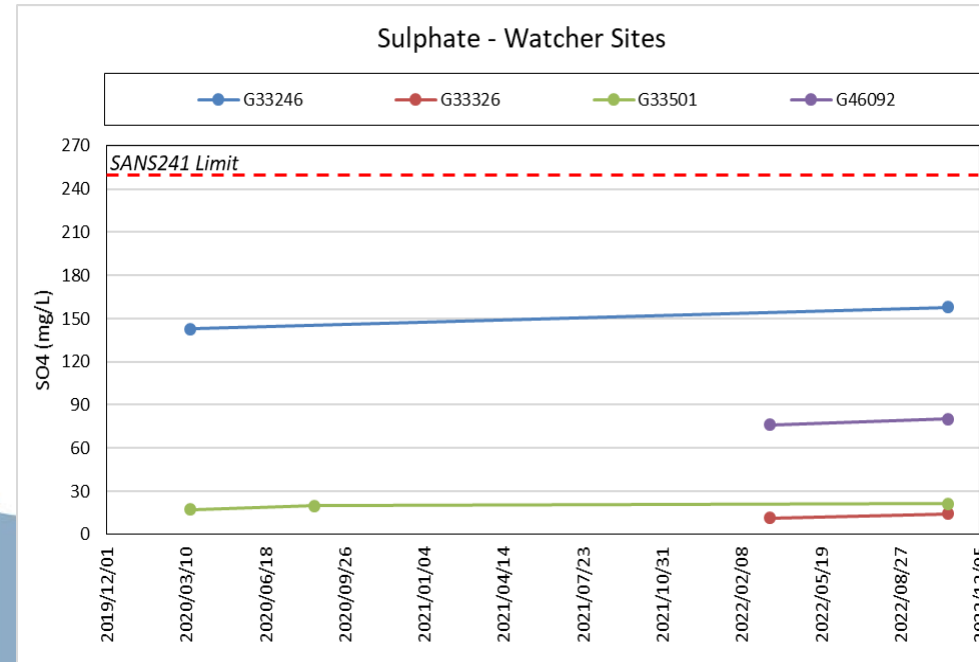
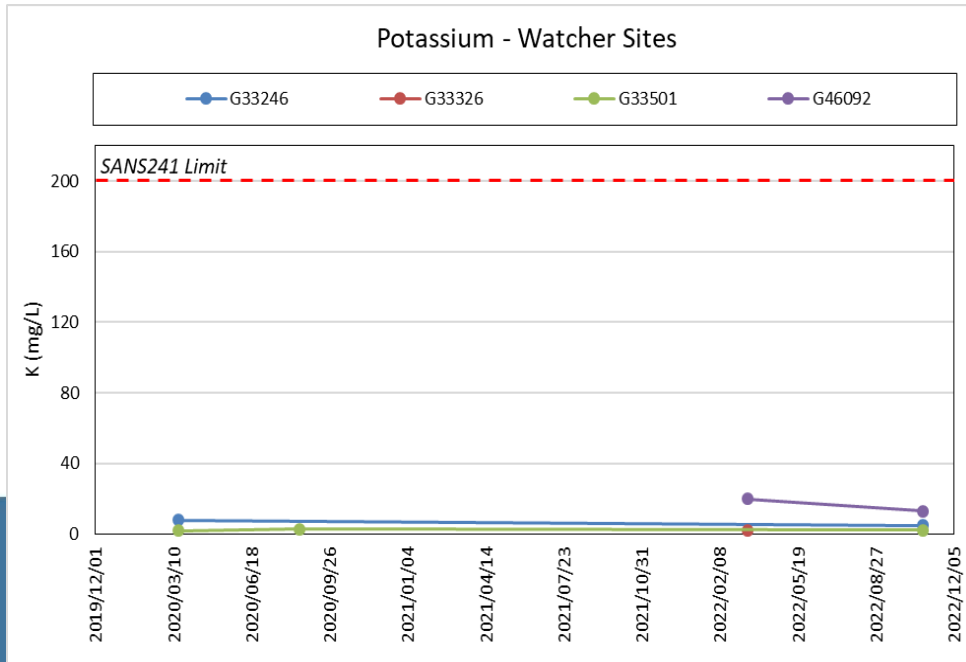
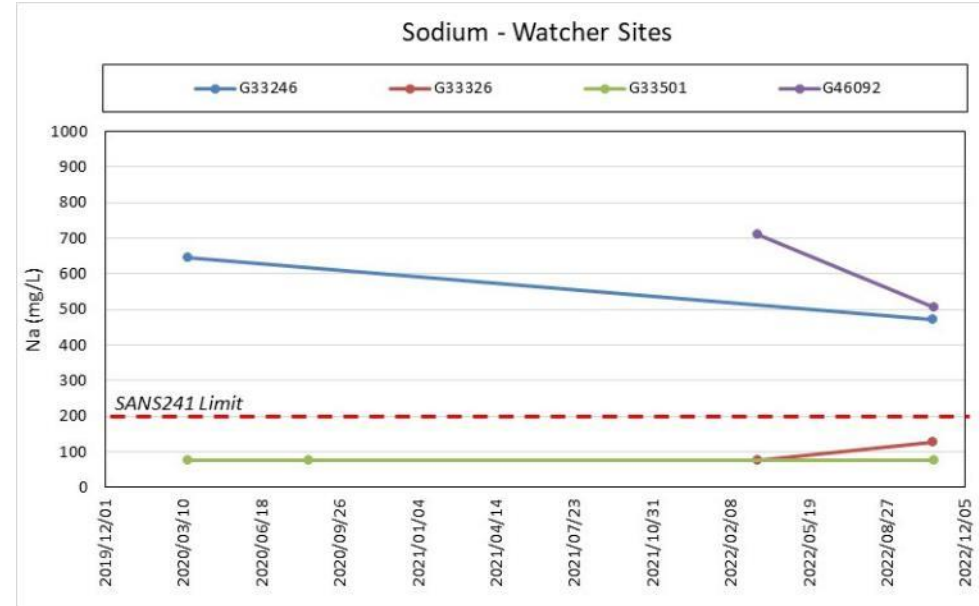
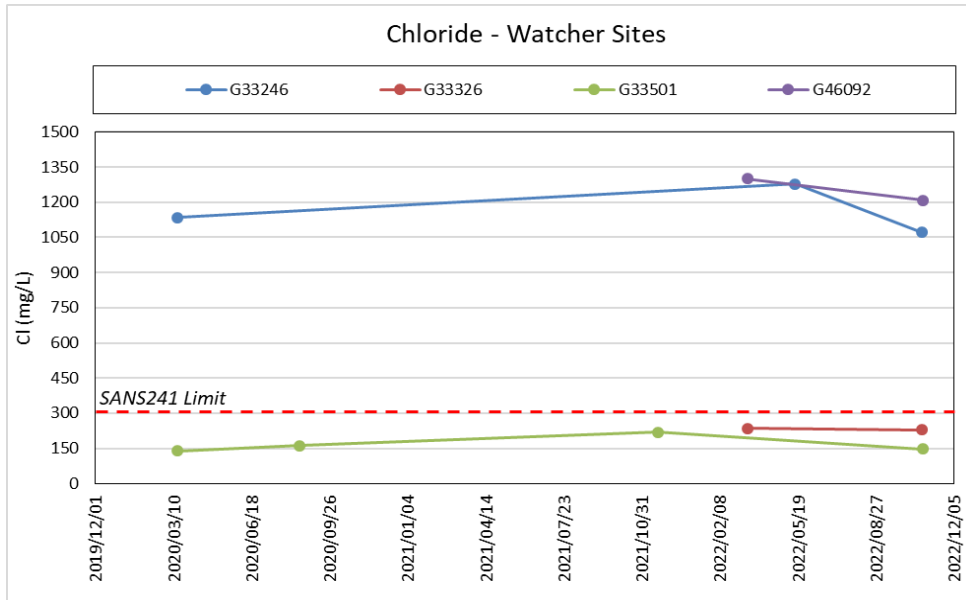
Acute Health	Aesthetic	Chronic health	Operational	Acceptable
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Analyses	G33246	G33326	G33501	G46092	SANS 241-1:2015
pH (at 25 °C)	7.26	7.4	7.5	7.2	≥5 - ≤9.7 Operational
Conductivity (mS/m) (at 25 °C)	467.00	102.0	65.4	475.0	≤170 Aesthetic
Sodium (mg/L as Na)	473.00	127	76	506	≤200 Aesthetic
Potassium (mg/L as K)	5.00	3	2	13	N/A
Magnesium (mg/L as Mg)	96.10	8	5	69	N/A
Calcium (mg/L as Ca)	41.20	51	28	67	N/A
Chloride (mg/L as Cl)	1071.00	229.00	147.00	1208.00	≤300 Aesthetic
Sulphate (mg/L as SO4)	158.00	14.50	21.30	80.40	≤250 Aesthetic ≤500 Acute Health
Nitrate & Nitrite Nitrogen (mg/L as N)	3.10	0.36	<20	0.46	≤12 Acute Health
Nitrate Nitrogen (mg/L as N)	0.70	<0.2	<0.2	<0.2	≤11 Acute Health
Nitrite Nitrogen (mg/L as N)	2.40	0.40	<0.2	0.49	≤0.9 Acute Health
Ammonia Nitrogen (mg/L as N)	1.50	0.30	<0.1	<0.1	≤1.5 Aesthetic
Total Alkalinity (mg/L as CaCO3)	102.00	115.0	44.7	160.0	N/A
Total Hardness (mg/L as CaCO3)	497.01	159.4	89.3	449.1	N/A
Fluoride (mg/L as F)	0.99	0.57	0.50	1.30	≤1.5 Chronic Health
Total Chromium (mg/L as Cr)	<0.004	<0.004	<0.004	<0.004	≤0.05 Chronic Health
Manganese (mg/L as Mn)	0.08	<0.018	<0.018	0.036	≤0.1 Aesthetic ≤0.4 Chronic Health
Iron (mg/L as Fe)	0.14	0.586	0.085	3.627	≤0.3 Aesthetic ≤2 Chronic Health
Zinc (mg/L as Zn)	<0.01	<0.01	<0.01	0.020	≤5 Aesthetic
Arsenic (mg/L as As)	<0.010	<0.010	<0.010	<0.010	≤0.01 Chronic Health
Charge balance %	-7.3	-1.6	-3.1	-10.6	≥-5 - ≤5 Acceptable

# Groundwater Monitoring Chemistry Results:



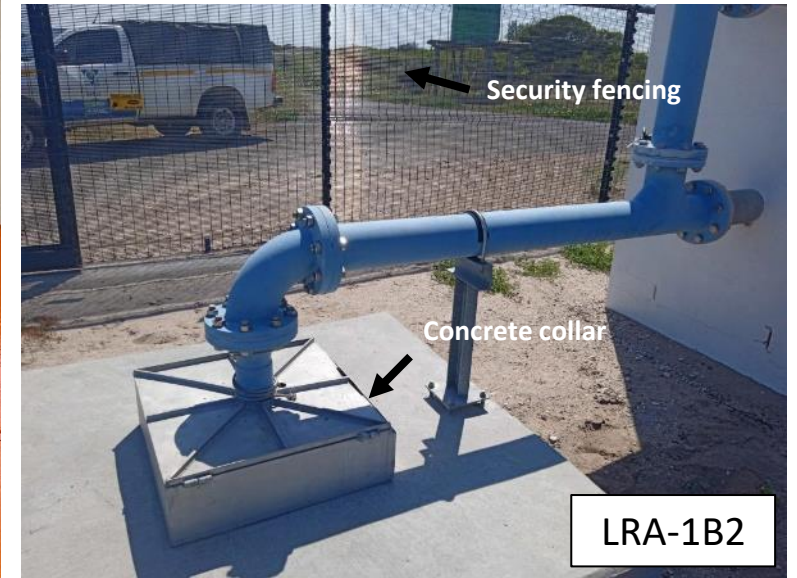
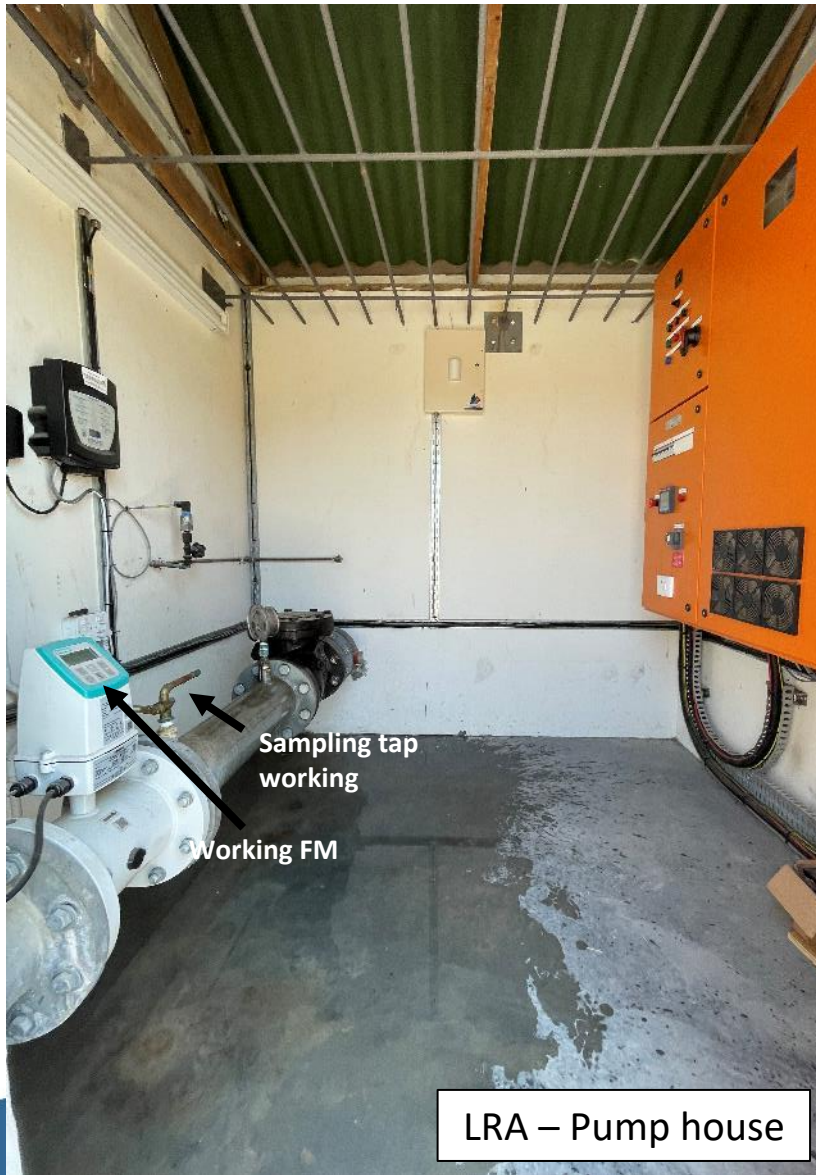
# Groundwater Monitoring Chemistry Results:



# Monitoring of borehole physical characteristics (visual inspection of wellfield boreholes)

- All production boreholes are protected with electrified security fencing.
- All boreholes are protected with concrete collars or lockable caps.
- Elevated concrete collars are installed around the standpipes.
- No ponding was observed or is possible next to any of the boreholes (no risk for contamination of the aquifer).
- All sampling taps are working at the production boreholes.
- All flow meters are working.
- Loggers in boreholes are working (DRC connection issues at LRA-1B1, LRA-1B2, and LRA-1B3)
- There is cattle farming around the boreholes with a small cattle feeding enclosure near LRA-1A4. However, no risk of contamination to lower aquifer.
- Production boreholes are in good condition.
- All monitoring boreholes aside from LRA-1B1M are in good condition (obstruction in borehole and rusted cap)

# Monitoring of borehole physical characteristics



# Conclusion

Based on the results of the current monitoring events, the following notes are made:

- No significant changes in water levels observed – all WLS above critical levels and boreholes are performing well.
- The abstraction volumes are all within the WUL-licensed volume.
- Baseline chemistry has been determined – no concerns at this time (LRA1A boreholes have been resampled)
- Groundwater quality fits within SANS241 and DWAF drinking water standards.
- A dashboard has been created for the LRA monitoring network and can be viewed with requested access (<http://bit.ly/3UaUKc5>)





# Thank you



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30 November 2022  
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# Questions?