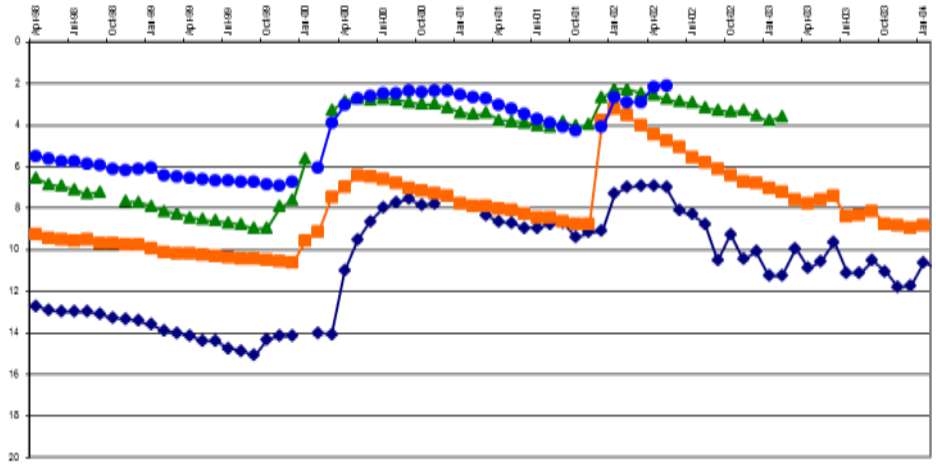
LIMPOPO REGION

1st QUARTERLY STATUS REPORT ON GROUNDWATER LEVEL TRENDS 2013 – 2014



H VERSTER

DIRECTORATE
WATER REGULATION AND USE

JUNE 2013

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SUMMARY

This is the 1st quarterly status report on monitoring and groundwater levels in the Limpopo for the 2013-2014 year. Groundwater level trends over the past quarter, the past rainy season and the past year is presented and discussed.

The impact of the past season`s rainfall on groundwater levels varies in magnitude as well as spatially. Recharge generally took place early in the season with levels starting to decline over the second half of the wet season with 42% of the stations monitored recording lower groundwater levels at the end of the rainy season compared to the situation midway through. After the wet season, higher water levels than before the wet season were recorded at 79% of the stations

The overall trend in groundwater levels is still a declining one, as has been the case for some time now. Comparison with historic long-term trends indicate this is a normal cycle that may continue for quite a number of years before the next major recharge event ending the cycle. Current water levels reflects a good situation and are generally still well above the worst recorded. It must be borne in mind that this trend cannot continue indefinitely before problems will arise, and it cannot be predicted how long this trend may continue before the next major recharge event occurs. The effect of global warming on climate adds to the uncertainty.

Groundwater is a valuable resource that can sustain the livelihood of a large number of people if scientifically assessed, developed and managed. The unseen nature of the resource prevents the identification of current or future problems that may exist or be expected, at a glance. This unfortunately led to poor understanding, misconceptions, mistrust, mismanagement and ultimately to failure. The management of groundwater by groundwater specialists is essential.

1. BACKGROUND

Groundwater level data is currently collected and evaluated quarterly from 190 monitoring stations on the water level monitoring network distributed over the Limpopo Province. A further 65 stations are quarterly visited and water level data collected for 6 different projects. An additional 41 water level monitoring stations are visited and data collected twice a year on the Kruger National Park project. A total of 255 stations are thus monitored for water level on a quarterly interval and 41 on a half-year interval (MAP1)

The quarterly report on groundwater status is compiled from the data collected at 188 stations on the monitoring network. The data from 2 stations monitored in the town of Bela-bela within the Crocodile west-Marico Water Management Area is not included in the quarterly report.

Monitoring projects differ both in purpose and time frames and findings are reported at the conclusion of each project.

The number of stations, for both the network as well as projects, may vary from time to time due to loss of stations due to boreholes collapsing, invasion by tree roots, vandalism, flood damage and installation of pumping equipment by municipalities, other service providers or private individuals etc.

Groundwater level data for this report was collected during May 2013. All water level values used are that on the 1st of each month in question and taken at 12H00 in the case of electronic data. Where electronic data is not available the hand measurement taken during the site visit is used.

2. GROUNDWATER LEVELS

2.1 GROUNDWATER LEVEL TREND; FEBRUARY TO MAY 2013 (MAP 2)

Feb 13 to May 13

total	190	Stations
less A2 drainage	188	Stations

With Data			176	Stations	94%

Down			75	Stations	42.6%
Up			98	Stations	55.7%
no change			3	Stations	1.7%
No data			12	Stations	
			188		

12 Stations do not have data values for both dates, mostly due to inaccessibility in February because of flood damage to roads and bridges.

176 Of the stations visited (94%) have data for both dates with 98 Stations (55.7%) indicating higher groundwater levels and 75 (42.6%) indicating a decline in groundwater level over the quarter. This is mostly due to very good recharge early in the season, especially in the eastern and northern parts of the Province (MAP 3). This resulted in fast rising water levels reaching in cases abnormal high levels, followed by a dry latter part with water draining naturally out of the aquifers towards normal (GRAPHS 1-3) Despite the decline since February, the levels at a considerable number of stations are still higher than at the start of the season and even compared to the previous year.

2.2 GROUNDWATER LEVEL TREND; PAST WET SEASON (MAP 4)

Past wet season

total	190	Stations
less A2 drainage	188	Stations

With Data			182	Stations	97%

Down			38		20.9%
Up			144		79.1%
no change			0		0.0%
No data			6		
			188		

6 Stations do not have data values for both dates, 2 vandalised, and 1 gate locked, 3 too wet to access.

182 Stations have data for both dates (97%). 144 (79.1%) of these have higher water levels after the wet season with an average rise of 1.77m, indicating fairly widespread recharge this past season.

38 Stations (20.9%) still have lower water levels. The average is only 24cm if 3 stations severely impacted by pumping are not included.

2.3 GROUNDWATER LEVEL TREND; MAY 2012 TO MAY 2013 (MAP5)

May 12 to May 13

total	190	Stations
less A2 drainage	188	Stations

With Data			174	Stations	93%

Down			61		35.1%
Up			113		64.9%
Same			0		0.0%
No data			14		
			188		

14 Stations do not have data values for the whole year

The majority of stations 113, (64.9%) have higher water levels than the corresponding time last year with an average rise of 1.9m.

Lower water levels were recorded at 61 (35.1%) of the stations. The lower water levels occur mostly in the southern and extreme western part of the Province. The average is 0.4m lower.

3. GROUNDWATER LEVEL RESPONSE TO SEASONAL RECHARGE

The localities of the stations used are indicated on **(MAP 6)**

3.1. SHORT-TERM (1 YEAR)

GRAPHS 1-3 are examples of the groundwater level response to the past season's rainfall, the difference in magnitude and rate of subsequent outflow.

3.1.1 GROUNDWATER LEVEL TREND AT STATION A4NABOOM-VAALWATER (GRAPH1)

The water level already started to rise by end of November 2012, reaching a peak by 1 February 2013. A relative dry second part of the season followed with normal outflow from the system. The result is a 1.7 m lower water level by the end of the rainy season compared to midway through in February. The water level has stabilised by March with the level in May almost the same as the corresponding time last year. The current water level at 10.33m is 3m higher than when monitoring first started het in 2009 with the average level for the past 4 years being 10.5m.

3.1.2 GROUNDWATER LEVEL TREND AT STATION A6 MAASSTROOM (GRAPH 2)

Water level at this station has been relatively stable since 2007, varying between 11.5 to 12m below collar. A rise in water level is indicated from the last week in December 2012, reaching a peak of 9.7m by the second week in February 2013, since when it started to decline again. The water level is still declining and has not stabilised yet. The average water level at this station the past 5 years is 11.85m with the current level at 10.5m.

3.1.3 GROUNDWATER LEVEL TREND AT STATION A7KLEIN BOLAYI (GRAPH 3)

The water level at Klein Bolayi has declined by almost 4m over the past 2 years to just over 10m below collar. The average water level over the past 6 years was 7.06m. The level rose dramatically since January 2013 to reach a record 1.5m below collar. The level has declined since then but at 2.3 m is currently still well above the average for this station.

3.2. MEDIUM-TERM (7 TO 8 YEARS)

3.2.1 GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE A8 DRAINAGE (GRAPH 4)

The past season response in similar to that discussed in 3.1 above. Normal seasonal fluctuations can be noted with the medium-term trend over the past 7 years a rather stable condition displaying no clear decline or rise.

3.2.2 GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE A9 DRAINAGE (GRAPH 5)

On graph 5 a steady decline in groundwater level is clear. Some seasonal fluctuations can be noted for A9Tshivongweni and A9Tswera in a previous season or two. A rise in water levels occurred at all stations this past season with the rise at A9Tswera extreme after which it started to decline sharply again. Water levels A9Tswera and A9Tshivongweni fully recovered the loss since 2006 but not so at the other two stations. The declining trend continues.

3.2.3 GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE B8 DRAINAGE (GRAPH 6)

This graph displays a more pronounced steady decline over a period of 7 years with very little fluctuation seasonally at most stations. In contrast to some of the stations discussed above, the past season`s recharge had little impact in this area and the trend stays a decline.

3.2.4 GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE B9 DRAINAGE (GRAPH 7)

The trend is also a constant declining one since May 2006, even at B9Mukhomi where some seasonal recharge is evident for most years. Despite a water level rise of 2.7m in February to May 2013, the current level is still 3m lower than in 2006. The trend is still a declining one as well.

3.3 LONG-TERM (38 YEARS)

Historically, groundwater level monitoring was mostly concentrated around the towns along the N1, especially Mokopane and Polokwane due to large-scale abstraction by the Municipalities. Some scattered monitoring was also done in a few areas with large-scale irrigation. Some of these stations have water level data available for a period of up to 40 years. Extension of the network to cover the whole Province started in 2005 and is still in progress to some extent. Data for the majority of the current monitoring network is only from 2005-2006. The period represented by the short to medium-term graphs discussed above. This short to medium-term trends indicated may give raise to unnecessary concern due to the apparent constant decline in groundwater levels. The long-term trend at station A7N0525Tweefontein (GRAPH 8) is included to give a better perspective.

3.3.1 GROUNDWATER LEVEL TREND AT STATION A7N0525 TWEEFONTEIN (GRAPH 8)

The effect of abstraction can be clearly seen for the first part of the graph up to mid-1985 where after large-scale abstraction was discontinued here. The trend from there on until 2000 represent a declining one similar to the trend currently displayed by the graphs discussed above. Groundwater recharge took place in 2000-2001, groundwater levels recovered and then started to decline again. The inset map represent the period from 2006 onward depicting the same period discussed in 3.2 above and corresponds well. The current declining trend has actually started in 2000 already. Despite this, looking at the long-term, the current water level is still representing a healthy situation. The good correlation in trend for the past 6-7 years between the new stations and this one suggest that if projected back, the same could be said for the current situation generally.

4. IMPACTS OF ABSTRACTION ON GROUNDWATER LEVELS

4.1 GROUNDWATER LEVEL TREND AT STATION A7BEAULE (GRAPH 9)

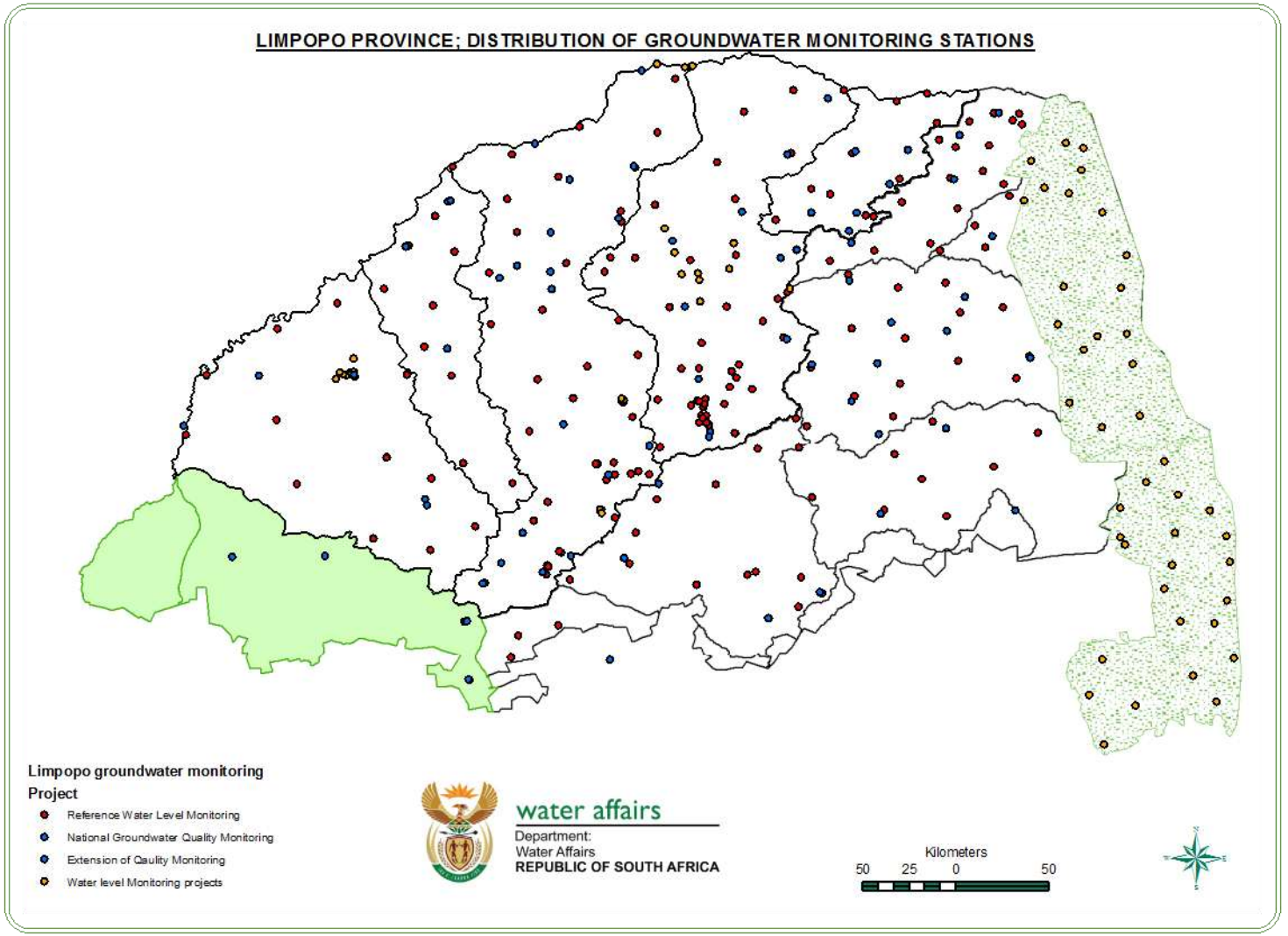
The initial trend represent the familiar slow decline noted at most stations. The increase in the rate of decline since the start of nearby abstraction is clear to see. The increase of depth of drawdown during pumping cycles can also be seen. The abstraction taking place in this area has without a doubt a large impact on the groundwater level.

4.2 GROUNDWATER LEVEL TREND AT STATION A6KROMHOEK 2 (GRAPH 10)

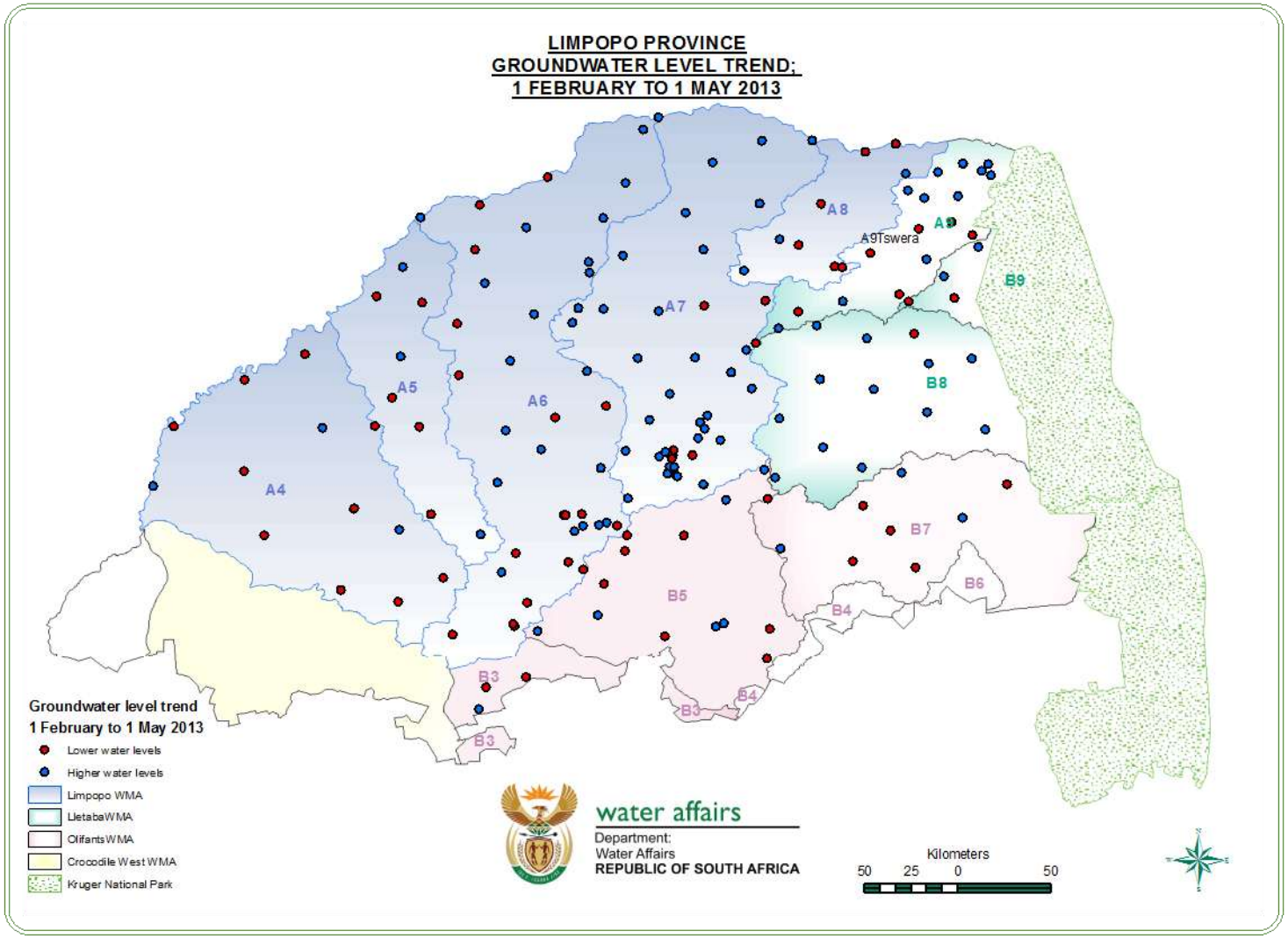
This graph needs no explanation. The drastic decline in water level since the start of abstraction in the area is very clear. It seems that the level has somewhat stabilized between 32 and 34 m the past year. Unfortunately no information on the abstraction rates or volumes is available to enable any meaningful conclusion on this.

5. IMPORTANCE OF GROUNDWATER MANAGEMENT

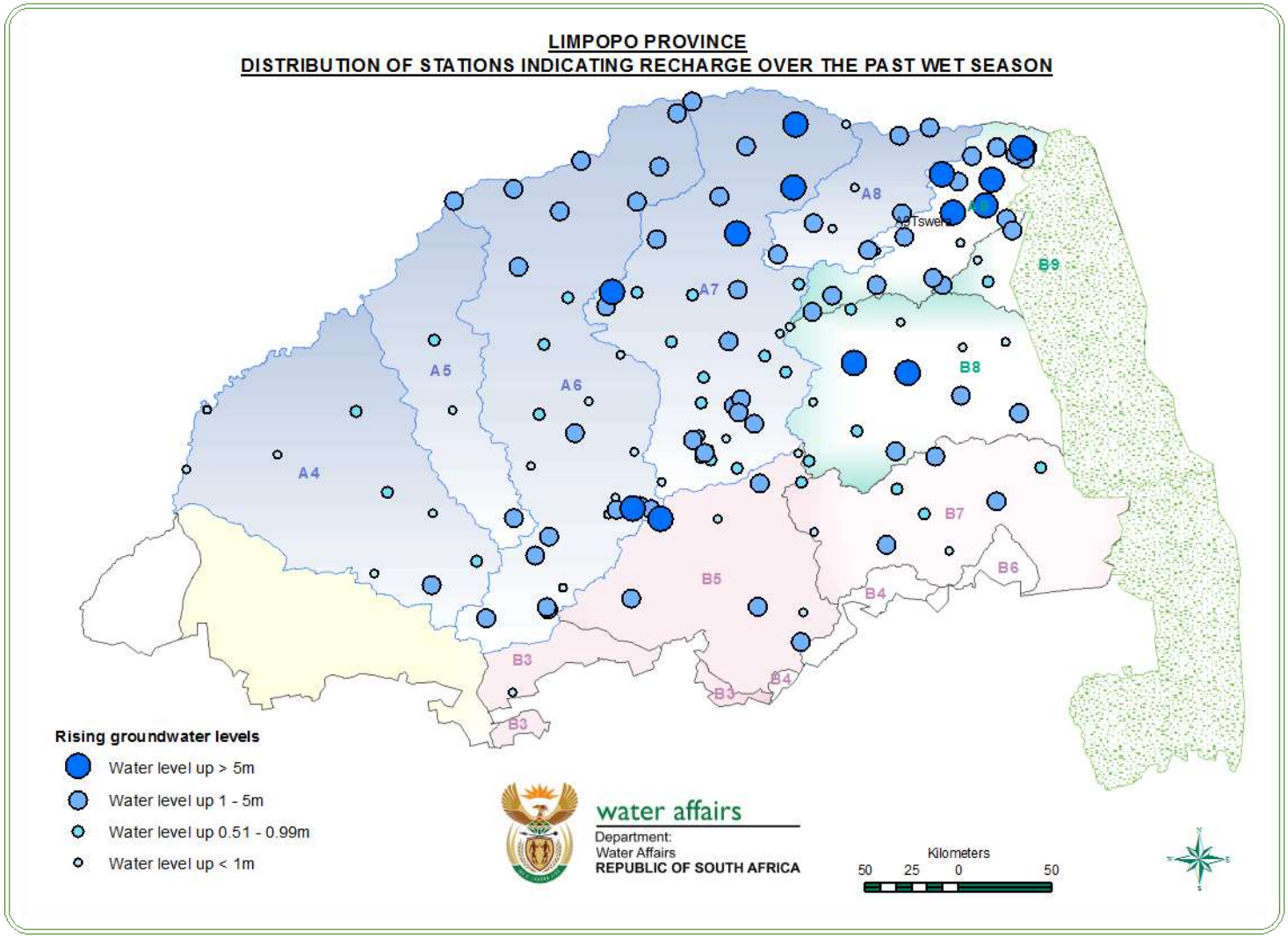
The above 2 graphs illustrates the effects of abstraction. If abstraction rates, volumes and water level trends are not monitored it is impossible to know how the source is reacting to abstraction and whether it can be sustained. Sound aquifer management is of utmost importance if groundwater is to be utilized sustainably.


LIMPOPO PROVINCE; DISTRIBUTION OF GROUNDWATER MONITORING STATIONS
Limpopo groundwater monitoring
Project
Reference Water Level Monitoring
National Groundwater Quality Monitoring
Extension of Qaulity Monitoring
Water level Monitoring projects
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

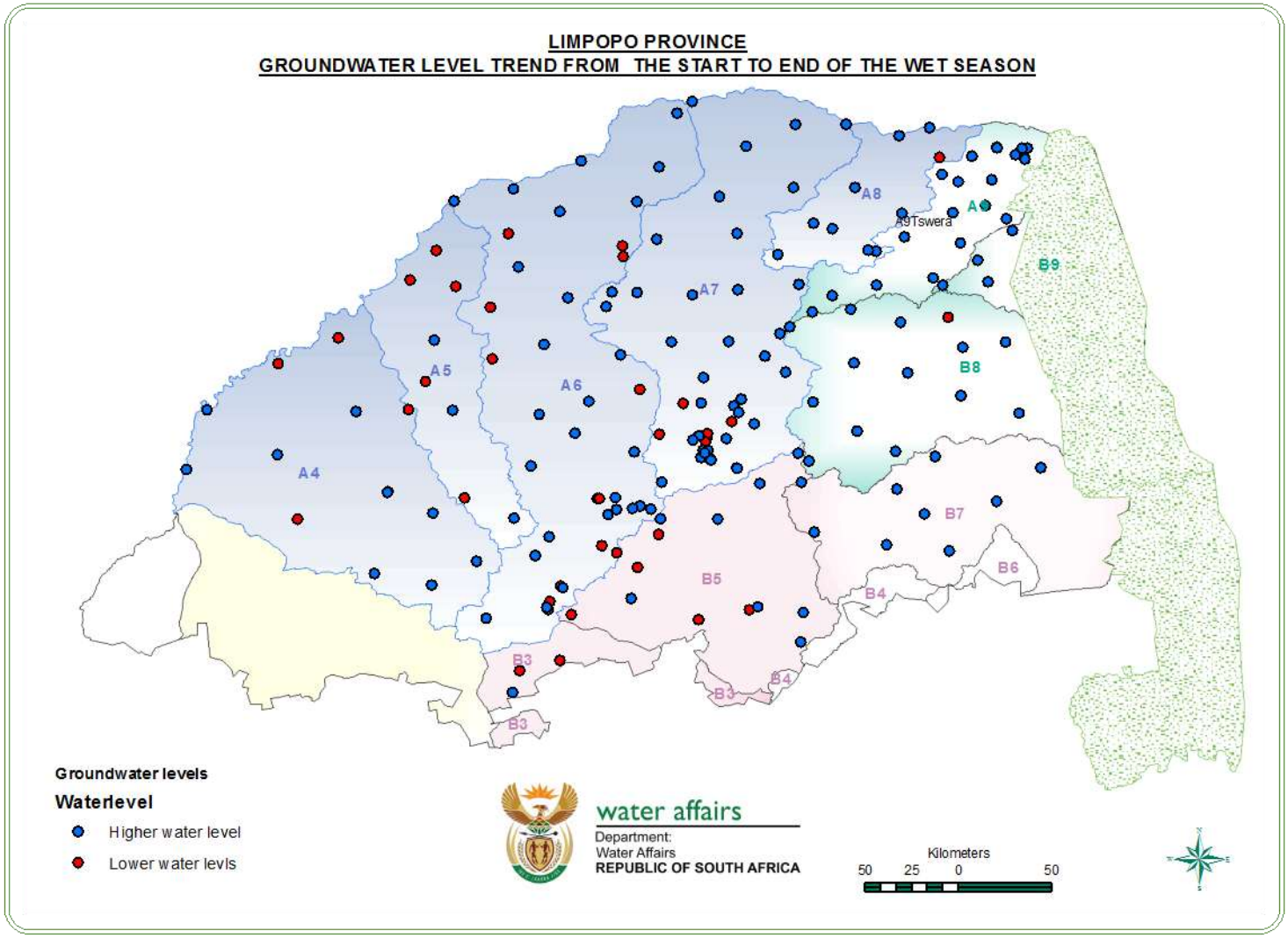
MAP 1


LIMPOPO PROVINCE
GROUNDWATER LEVEL TREND;
1 FEBRUARY TO 1 MAY 2013
A8
A9
A9Tswera
B9
A7
B8
A5
A6
A4
B7
B6
B5
B4
B3
B4
B3
B3
Groundwater level trend
1 February to 1 May 2013
Lower water levels
Higher water levels
Limpopo WMA
LletabaWMA
OlifantsWMA
Crocodile West WMA
Kruger National Park
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

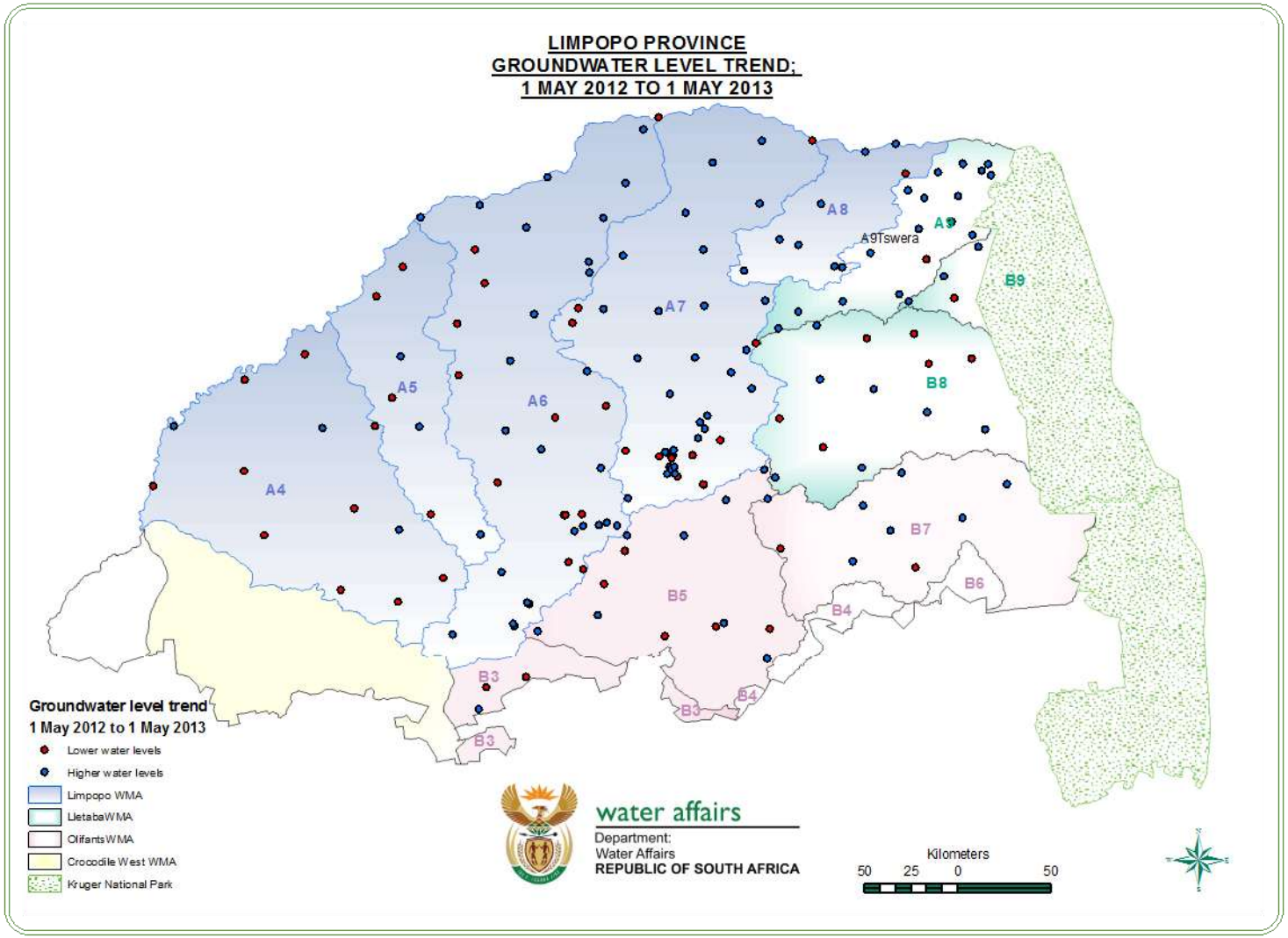
MAP 2


LIMPOPO PROVINCE
DISTRIBUTION OF STATIONS INDICATING RECHARGE OVER THE PAST WET SEASON
A8
A7
A5
A6
A4
B9
B8
B7
B6
B5
B4
B3
B3
B4
B3
B3
Rising groundwater levels
Water level up > 5m
Water level up 1 - 5m
Water level up 0.51 - 0.99m
Water level up < 1m
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

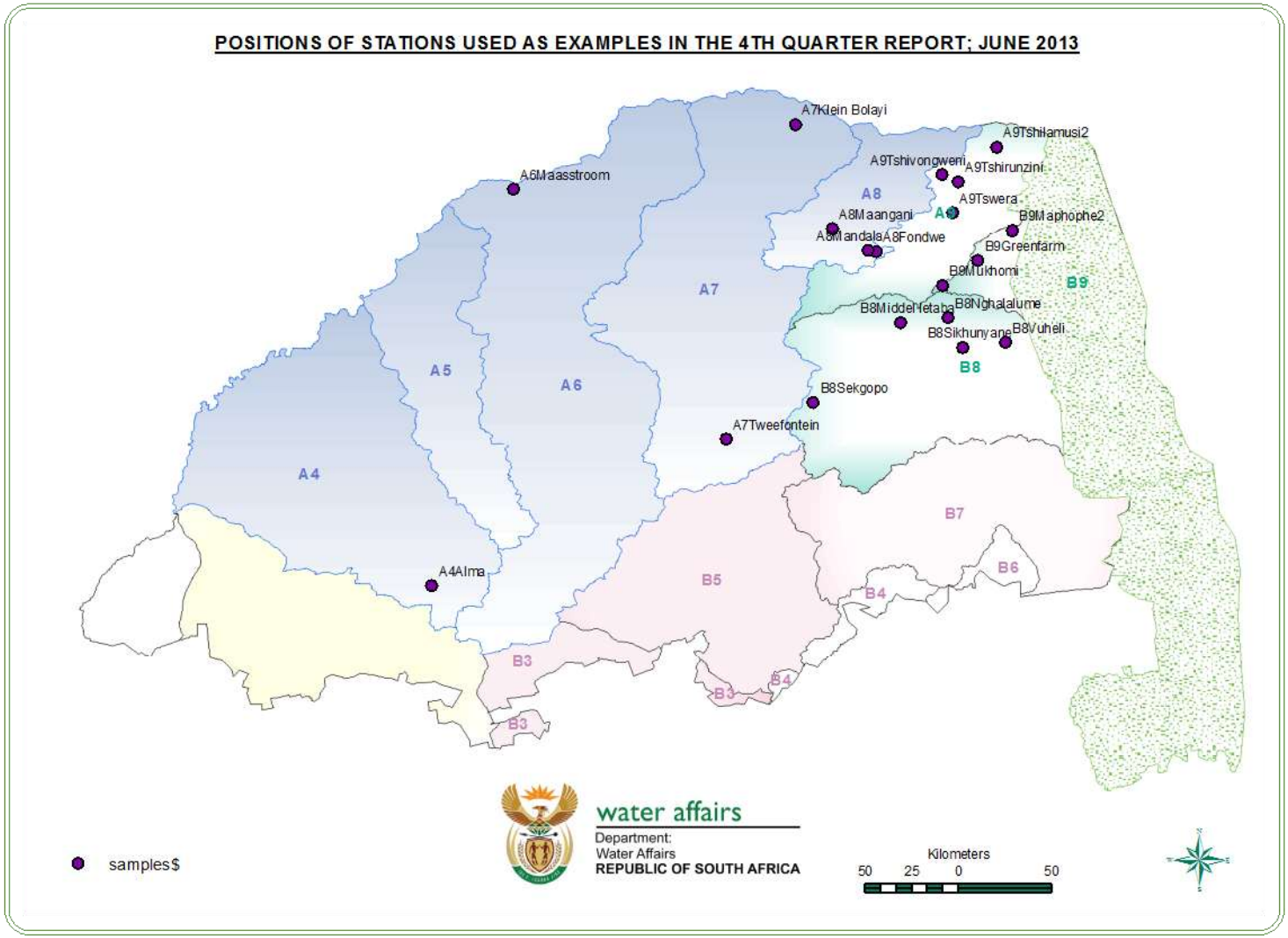
MAP 3


LIMPOPO PROVINCE
GROUNDWATER LEVEL TREND FROM THE START TO END OF THE WET SEASON
A8
A9Tswera
A9
B9
A7
A5
A6
B8
A4
B7
B6
B5
B4
B3
B4
B3
B3
Groundwater levels
Waterlevel
Higher water level
Lower water levls
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

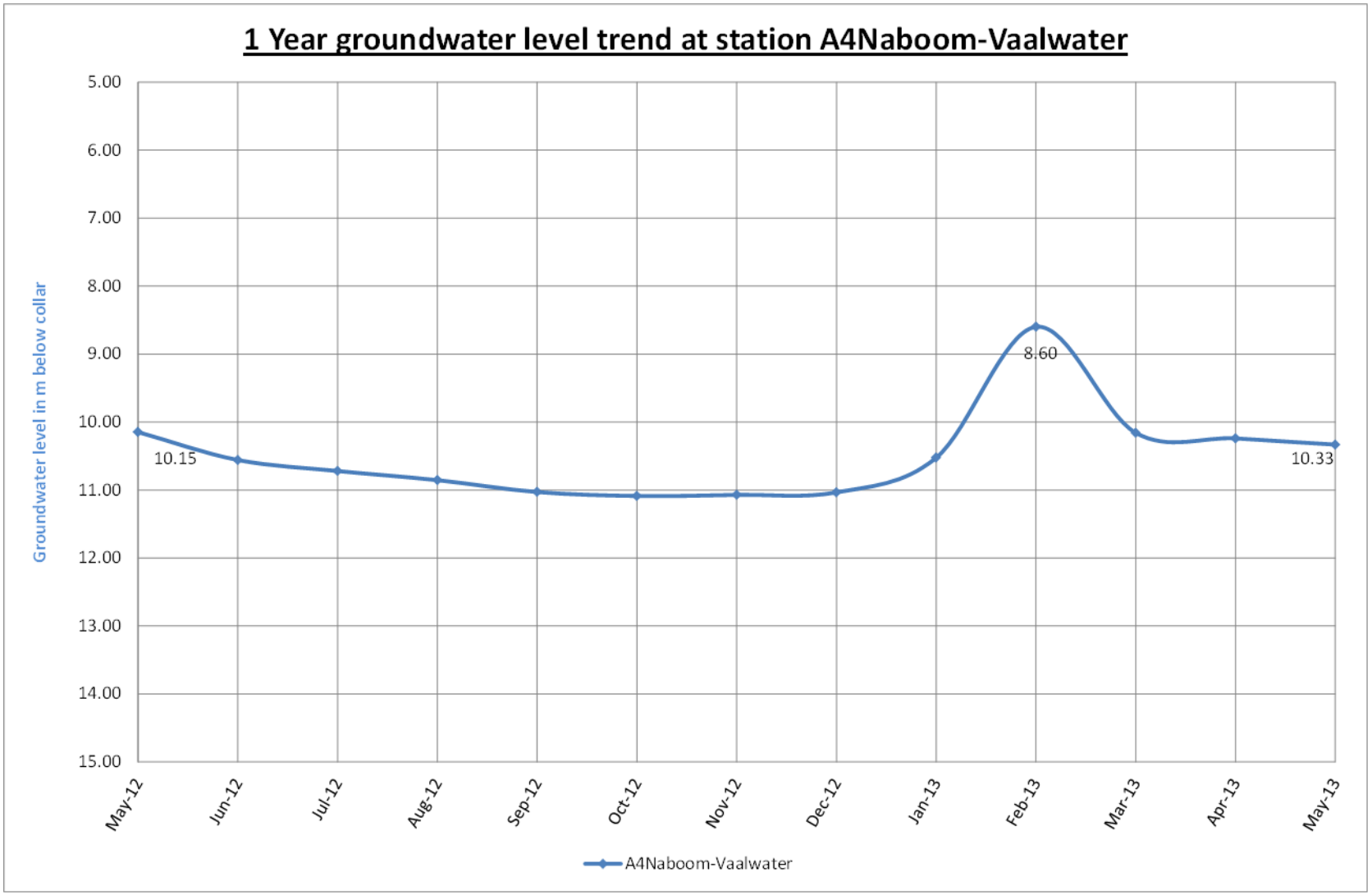
MAP 4


LIMPOPO PROVINCE
GROUNDWATER LEVEL TREND;
1 MAY 2012 TO 1 MAY 2013
A8
A9
A9Tswera
B9
A7
B8
A5
A6
A4
B7
B6
B5
B4
B3
B4
B3
B3
Groundwater level trend
1 May 2012 to 1 May 2013
Lower water levels
Higher water levels
Limpopo WMA
LletabaWMA
OlifantsWMA
Crocodile West WMA
Kruger National Park
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

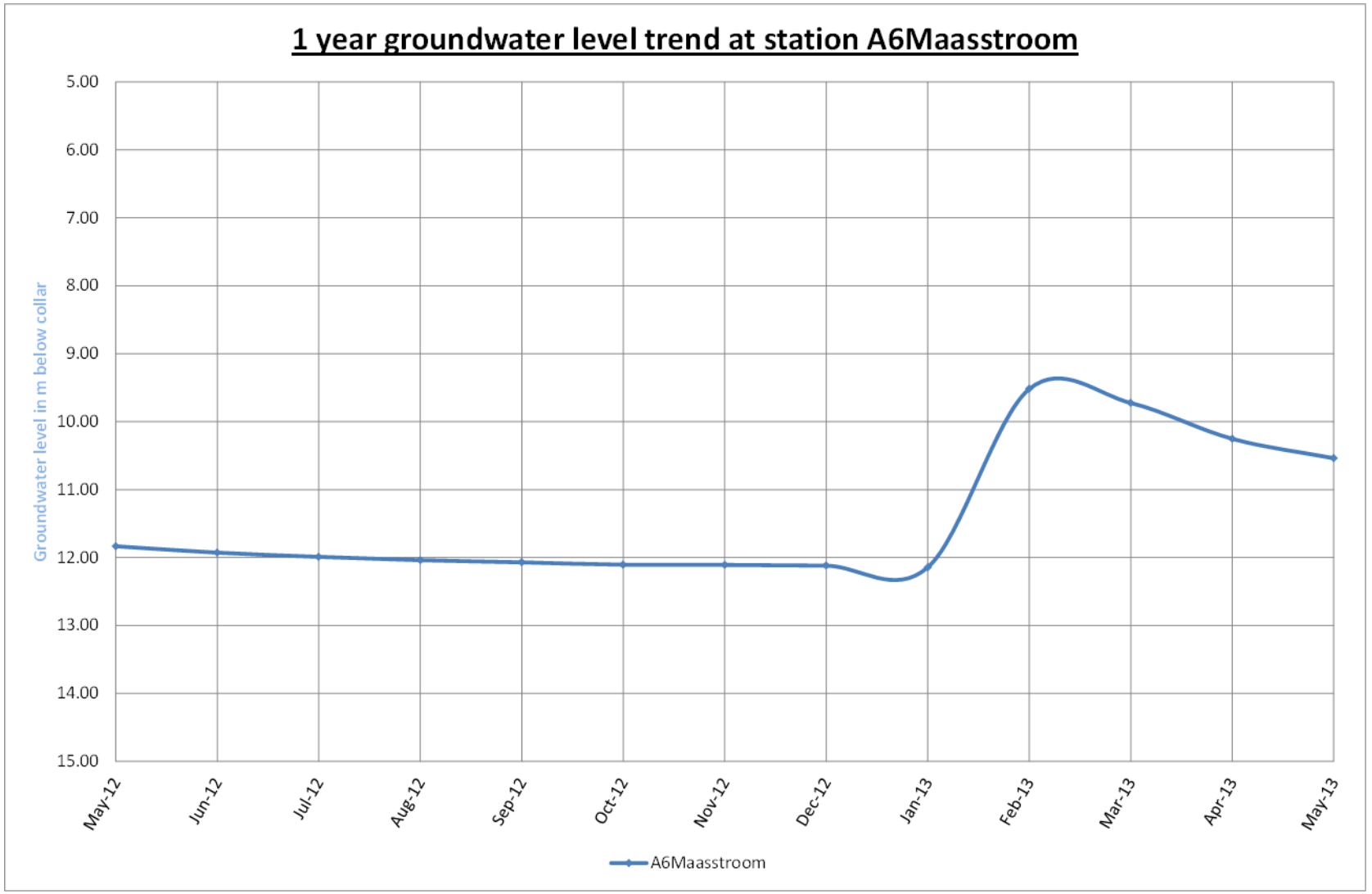
MAP 5


POSITIONS OF STATIONS USED AS EXAMPLES IN THE 4TH QUARTER REPORT; JUNE 2013
A7Klein Bolayi
A9Tshilamusi2
A9Tshivongweni
A9Tshirunzini
A6Maasstroom
A8
A9Tswera
A8Maangani
A9
B9Maphophe2
A8MandalaA8Fondwe
B9Greenfarm
B9Mukhomi
A7
B9
B8Middelvlei
B8Nghalalume
B8Sikhunyane
B8Vuheli
A5
A6
B8
B8Sekgopo
A7Tweefontein
A4
B7
A4Alma
B5
B6
B4
B3
B4
B3
B3
samples$
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA
Kilometers
50 25 0 50

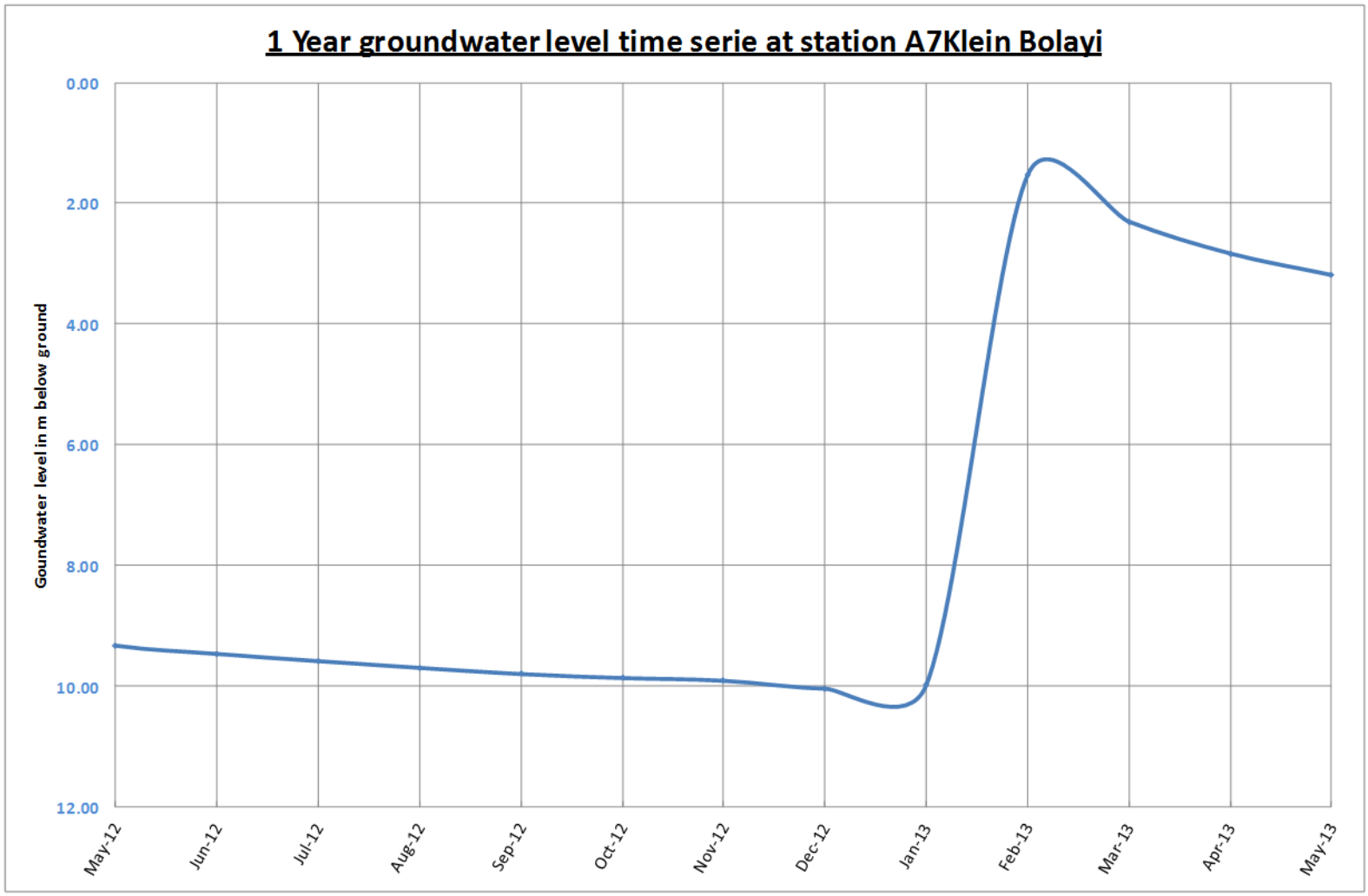
MAP 6


1 Year groundwater level trend at station A4Naboom-Vaalwater
Groundwater level in m below collar
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
10.15
8.60
10.33
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
A4Naboom-Vaalwater

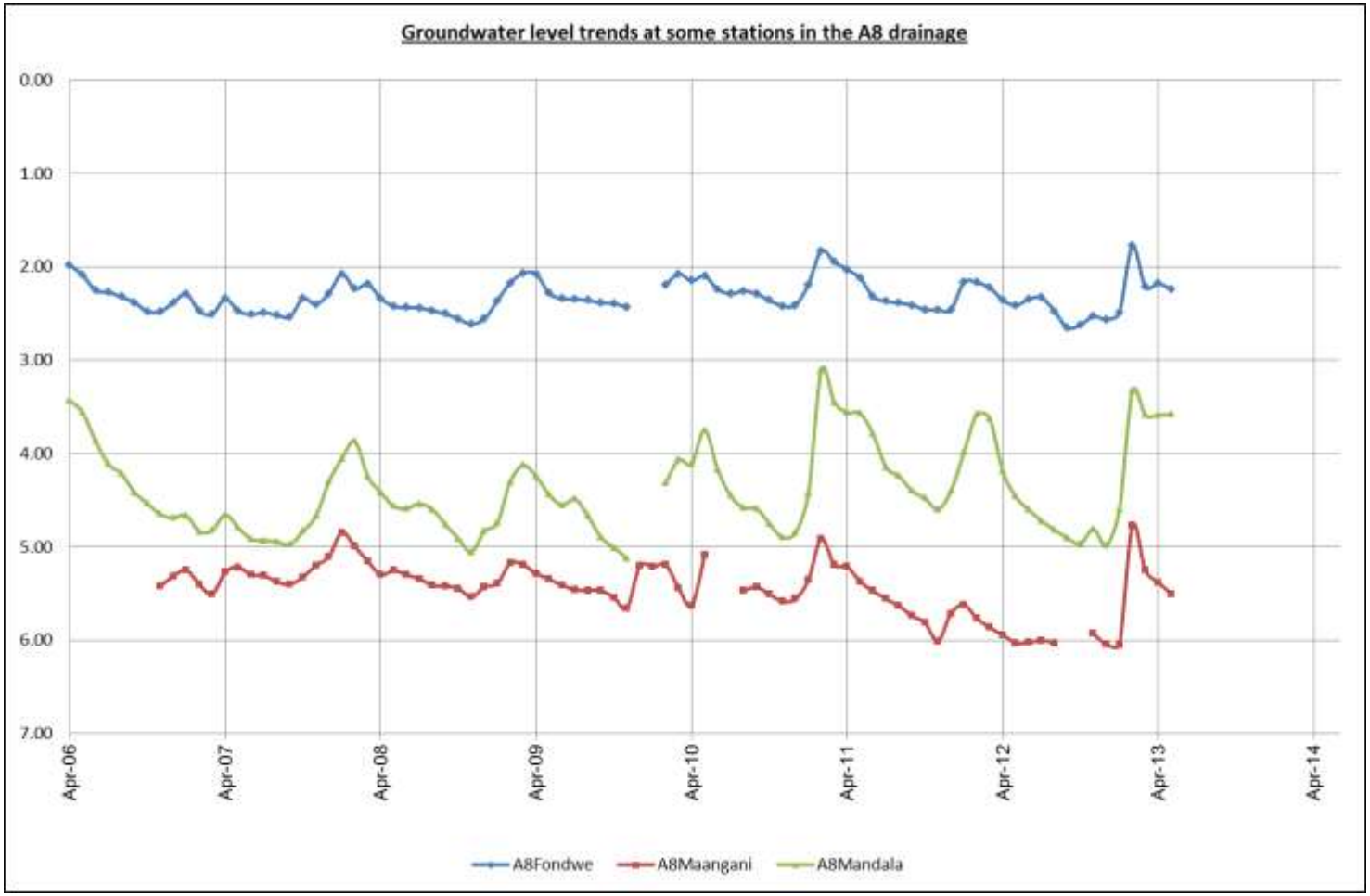
GRAPH 1


1 year groundwater level trend at station A6Maasstroom
Groundwater level in m below collar
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
A6Maasstroom

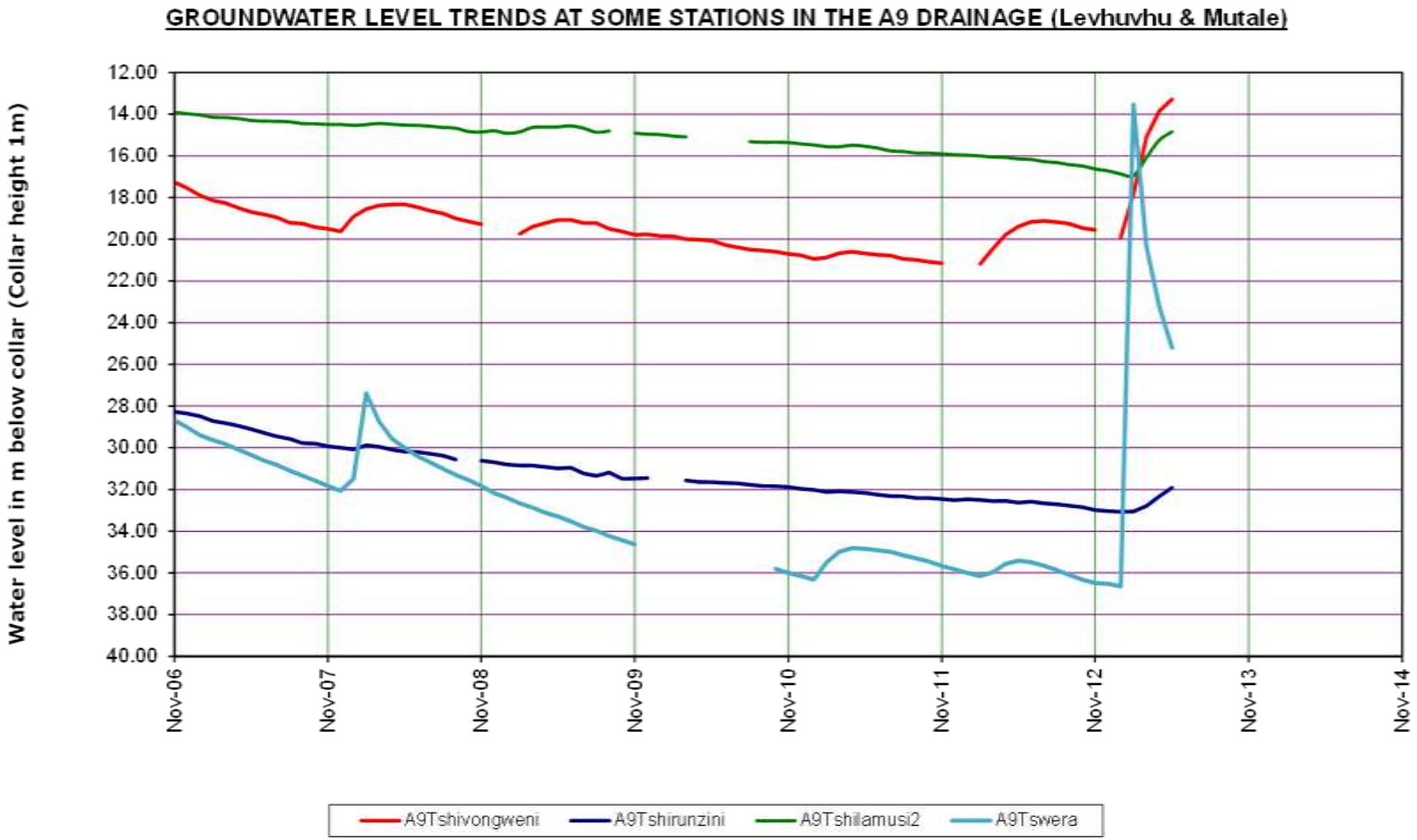
GRAPH 2


1 Year groundwater level time serie at station A7Klein Bolayi
Goundwater level in m below ground
0.00
2.00
4.00
6.00
8.00
10.00
12.00
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13

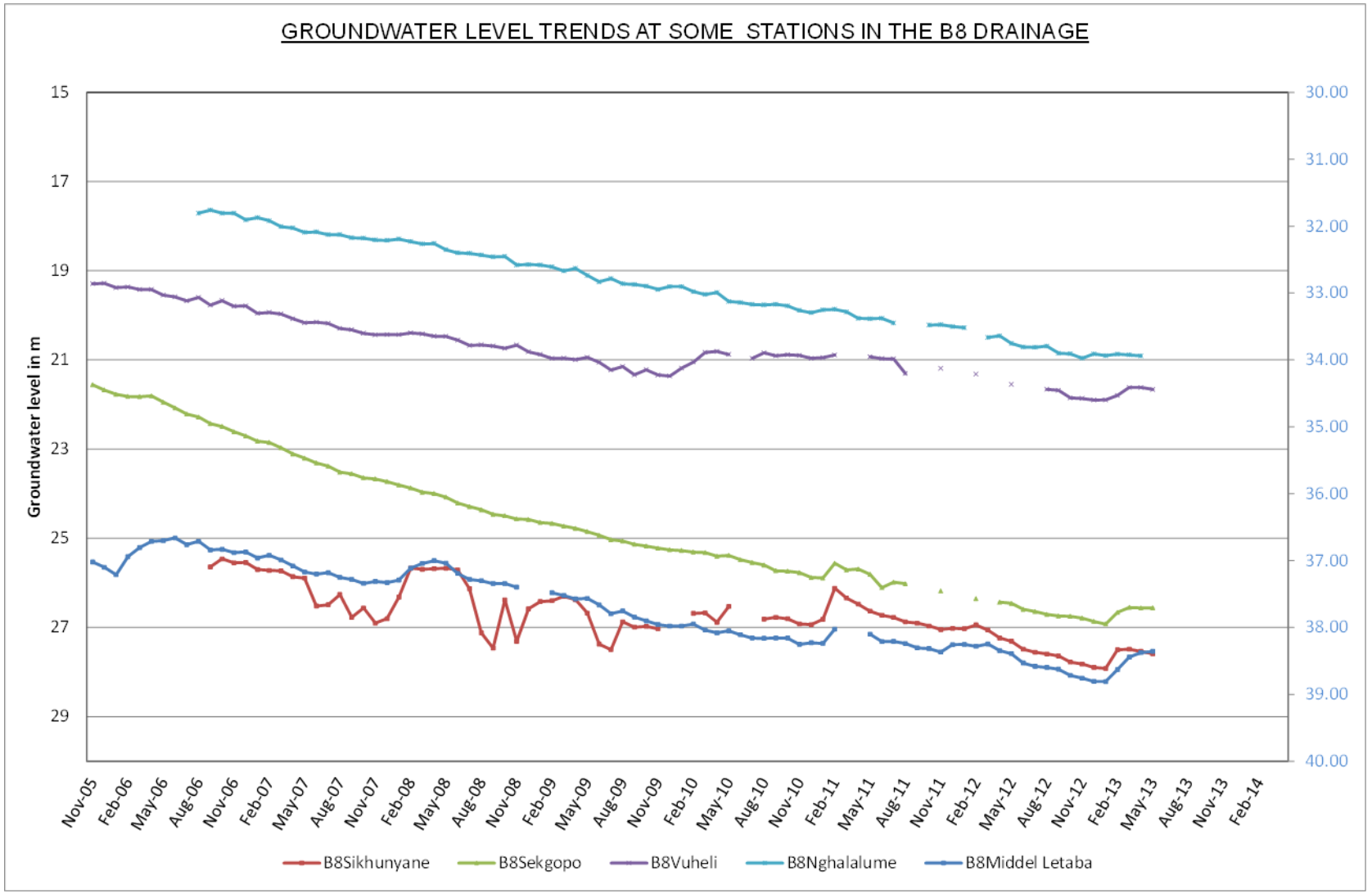
GRAP 3


Groundwater level trends at some stations in the A8 drainage
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
A8Fondwe
A8Maangani
A8Mandala

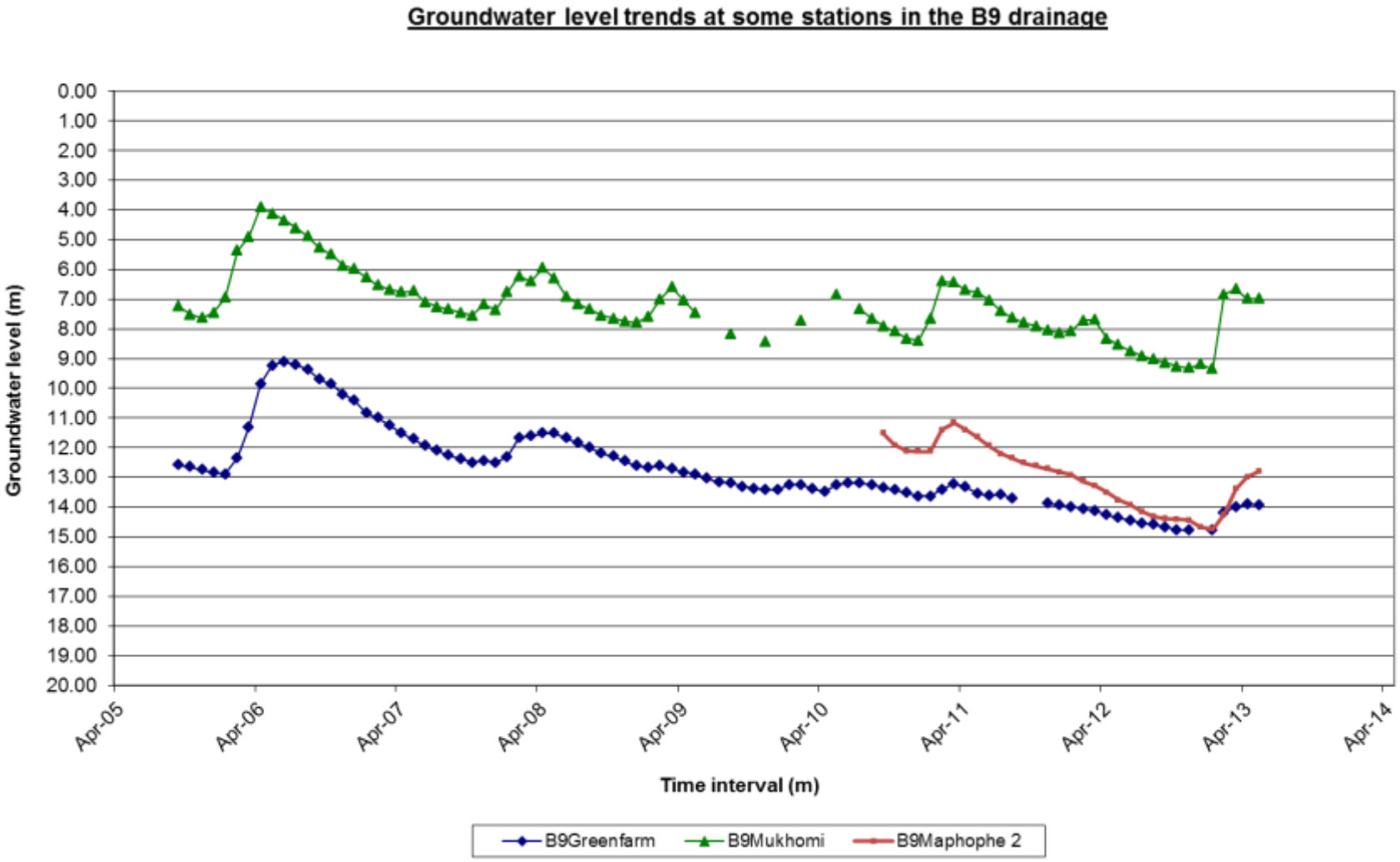
GRAPH 4


GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE A9 DRAINAGE (Levhuvhu & Mutale)
Water level in m below collar (Collar height 1m)
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
30.00
32.00
34.00
36.00
38.00
40.00
Nov-06
Nov-07
Nov-08
Nov-09
Nov-10
Nov-11
Nov-12
Nov-13
Nov-14
A9Tshivongweni
A9Tshirunzini
A9Tshilamusi2
A9Tswera

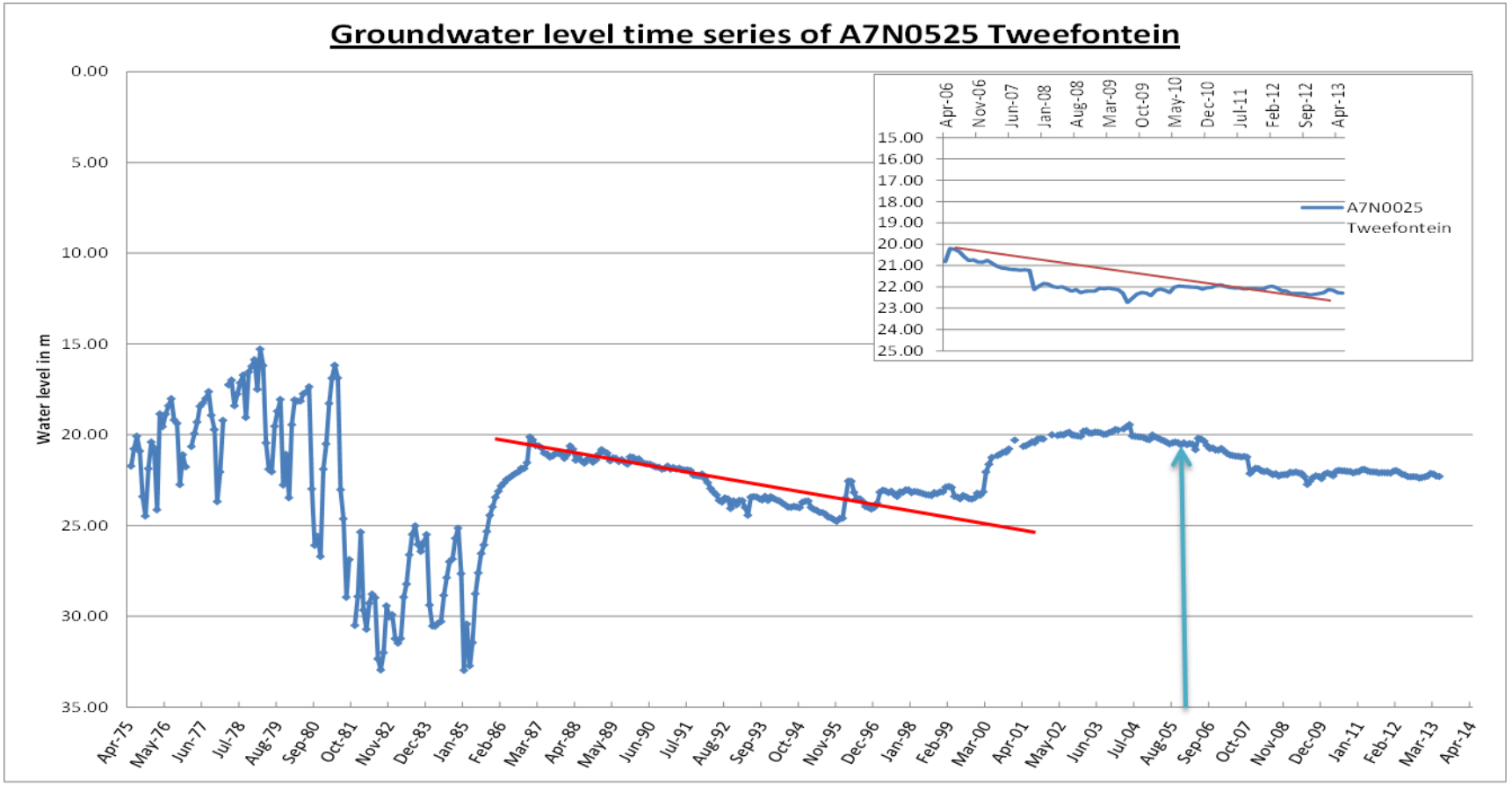
GRAPH 5


GROUNDWATER LEVEL TRENDS AT SOME STATIONS IN THE B8 DRAINAGE
Groundwater level in m
15
17
19
21
23
25
27
29
30.00
31.00
32.00
33.00
34.00
35.00
36.00
37.00
38.00
39.00
40.00
Nov-05
Feb-06
May-06
Aug-06
Nov-06
Feb-07
May-07
Aug-07
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
B8Sikhunyane
B8Sekgopo
B8Vuheli
B8Nghalalume
B8Middel Letaba

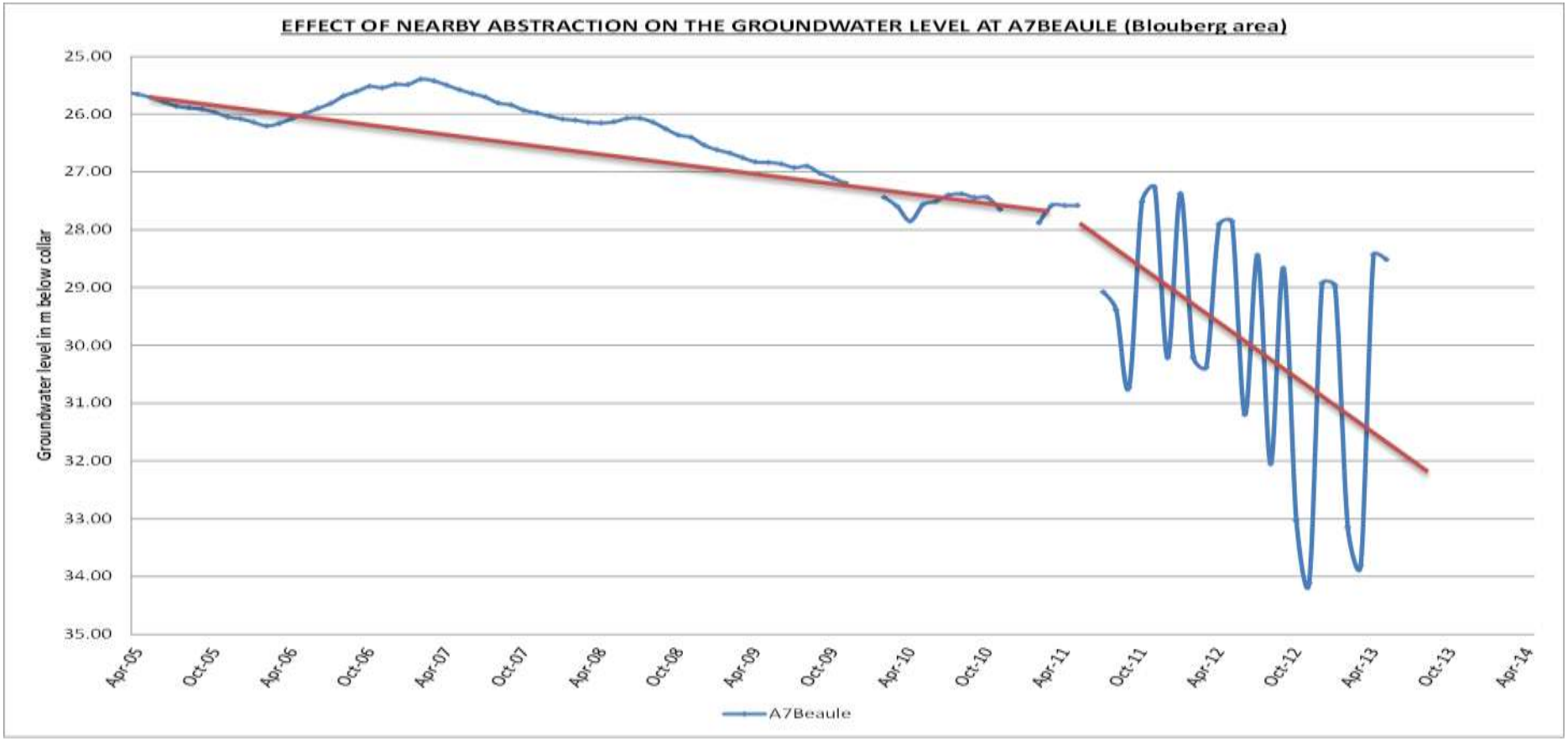
GRAPH 6


Groundwater level trends at some stations in the B9 drainage
Groundwater level (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Time interval (m)
B9Greenfarm
B9Mukhomi
B9Maphophe 2

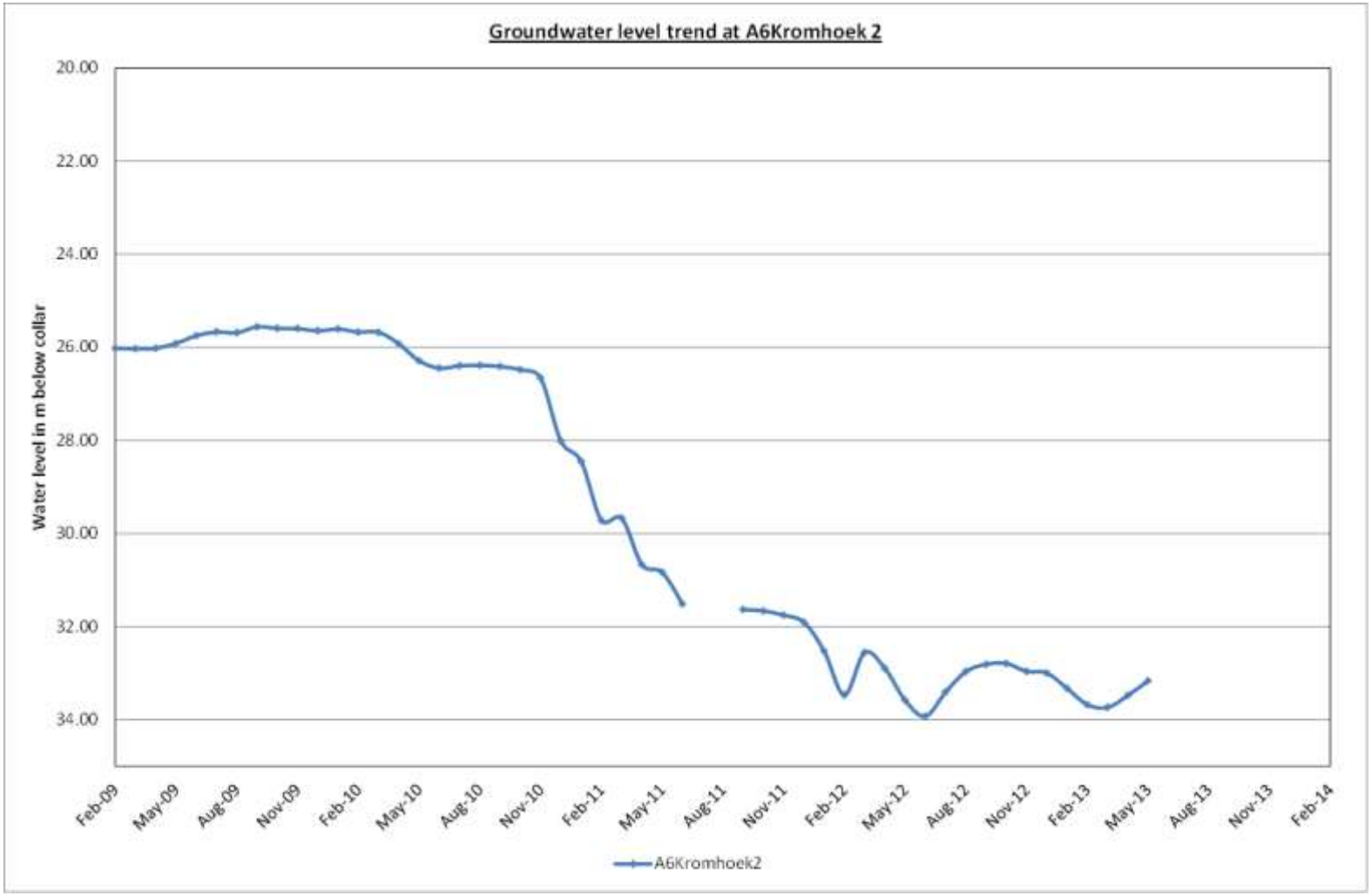
GRAPH 7


Groundwater level time series of A7N0525 Tweefontein
Water level in m
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Apr-75
May-76
Jun-77
Jul-78
Aug-79
Sep-80
Oct-81
Nov-82
Dec-83
Jan-85
Feb-86
Mar-87
Apr-88
May-89
Jun-90
Jul-91
Aug-92
Sep-93
Oct-94
Nov-95
Dec-96
Jan-98
Feb-99
Mar-00
Apr-01
May-02
Jun-03
Jul-04
Aug-05
Sep-06
Oct-07
Nov-08
Dec-09
Jan-11
Feb-12
Mar-13
Apr-14
Apr-06
Nov-06
Jun-07
Jan-08
Aug-08
Mar-09
Oct-09
May-10
Dec-10
Jul-11
Feb-12
Sep-12
Apr-13
15.00
16.00
17.00
18.00
19.00
20.00
21.00
22.00
23.00
24.00
25.00
A7N0025
Tweefontein

GRAPH 8


EFFECT OF NEARBY ABSTRACTION ON THE GROUNDWATER LEVEL AT A7BEAULE (Blouberg area)
Groundwater level in m below collar
25.00
26.00
27.00
28.00
29.00
30.00
31.00
32.00
33.00
34.00
35.00
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
A7Beaule

GRPAH 9


Groundwater level trend at A6Kromhoek 2
Water level in m below collar
20.00
22.00
24.00
26.00
28.00
30.00
32.00
34.00
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
A6Kromhoek2

GRAPH 10

STATION DETAIL			Water level difference in m		
Long	Lat	Name	FEB 13-MAY 13	NOV 12 - MAY 13	MAY 12 - MAY 13
28.11508	-24.54152	A4Alma	-0.746	1.004	-0.595
26.93093	-23.98176	A4Cumberland	0.146	0.030	-0.026
27.74936	-23.70069	A4Lephalale	0.141	0.543	0.055
27.03042	-23.69252	A4Matlabas-Limpopo	-0.039	0.081	0.012
27.46778	-24.22124	A4Matlabas-Mamba	-0.154	-0.095	-0.441
27.36998	-23.91008	A4Matlabas-Mokolo	-0.041	0.015	-0.140
27.66471	-23.34401	A4Mokolo end	-0.162	-0.041	-0.294
27.90429	-24.09054	A4Mokolo Poer se loop	-0.927	0.126	-0.328
27.90166	-24.09262	A4Mokolo Poer se loop2	-2.260	0.566	
28.33295	-24.42621	A4Naboom-Vaalwater	-1.734	0.739	-0.185
27.83912	-24.48514	A4Rhenosterpoort	-0.815	0.163	-0.689
27.37360	-23.46799	A4Stockpoort	-0.054	-0.060	-0.092
28.12093	-24.19335	A4Vaalwater	0.088	0.092	0.242
28.12796	-23.35499	A5Kitty	0.18	0.64	0.64
27.89113	-23.27390	A5Ongerep 2			
28.08613	-23.55500	A5Setateng	-0.12	-0.51	-0.51
28.00321	-23.69129	A5SouthEast Lephalale	-0.17	-0.35	-0.35
28.01120	-23.06397	A5Tom Burke	-0.18	-0.36	-0.36
28.51381	-24.21668	A5Upper Lephalale	0.39	2.91	2.91
28.21757	-23.69476	A5Visgat	-0.01	0.31	0.31
28.27439	-24.11917	A5Western Lephalale	-0.32	-0.74	-0.74
29.10782	-22.68464	A6Alldays	0.02	1.87	1.68
28.40044	-23.19579	A6Baltimore	-0.20	-0.41	-0.80
28.92577	-24.12256	A6Blinkwater	-0.11	-0.10	-0.20
28.91721	-24.12270	A6Blinkwater2	-0.13	-0.43	-0.80
29.21546	-22.51595	A6Bridgewater	1.50	2.53	2.26
28.73526	-22.73090	A6Cantebury	0.73	1.00	0.58
28.83799	-22.48714	A6Dardenellen	-1.41	2.00	1.24
29.17486	-24.17400	A6DeHoop	-8.71	3.85	2.15
28.74956	-24.55380	A6Du Toitkraal		0.04	-0.69
28.87556	-23.65110	A6Gilead2	-0.62	0.25	-0.27
28.74003	-24.54670	A6Grootvalley 2	-0.23	-0.30	9.57
28.79076	-24.68494	A6Klipput	0.00	-0.04	20.19
29.04107	-22.94940	A6Kromhoek	0.25	-0.18	0.01
29.03789	-22.89776	A6Kromhoek 2	0.48	-0.26	0.67
28.51089	-22.62244	A6Maasstroom	-1.02	1.57	1.30
29.00397	-24.11741	A6Mahwelereng	0.00	0.14	-0.45
28.40882	-23.44556	A6Marken road	-0.08	-0.12	-0.45
28.23185	-23.09429	A6Marnitz	-0.19	-0.15	
29.09528	-23.89543	A6Mashashane	0.15	0.25	0.14
28.59611	-23.96501	A6Mmotlane	0.06	0.09	-0.04
29.00974	-24.17560	A6Mokopane dorp	0.52	1.12	1.01
28.96855	-24.20010	A6MokopaneNyl	0.00	0.08	0.16
28.63518	-23.71375	A6Nelly	0.16	0.55	0.16
28.48749	-22.83852	A6Norfolk	-0.16	-0.41	-0.80
28.37916	-24.70111	A6Nylstroom2	-1.43	2.18	0.42
28.67178	-24.64930	A6Nylsvley1	-0.66	1.13	0.42
28.67854	-24.65930	A6Nylsvley2	-0.83	0.77	0.04
28.67854	-24.65930	A6Nylsvley3	-1.24	1.09	0.19
28.67854	-24.65930	A6Nylsvley4		0.90	0.02
28.68152	-24.61550	A6Nylsvley5			
28.68733	-24.62050	A6Nylsvley6			
28.68733	-24.62050	A6Nylsvley7		-0.29	
29.08672	-24.17070	A6Planknek2	7.68	13.41	12.09
29.30144	-22.25584	A6Pontdrift	0.89	2.91	2.76
29.12097	-23.59459	A6Rapitsi	-0.31	-0.12	-0.32
28.68399	-24.30740	A6Rykdom	-1.03	1.03	
28.77387	-23.14953	A6Sekhung	0.49	0.96	0.68
28.65835	-23.37624	A6Steilloop	0.20	0.89	0.40

28.53477	-22.99993	A6Tolwe	1.16	1.42	-0.73
28.61579	-24.39920	A6Upper Sterk 2	0.68	1.31	4.17
28.80758	-23.80539	A6Vlakfontein	0.68	1.85	0.88
28.93879	-24.35032	A6Volspruit	-0.40	-0.73	-1.79
29.12403	-24.15880	A6Weenen	1.88	1.56	1.02
28.22368	-22.68123	A6Zwartwater	0.21	1.04	0.65
28.13855	-22.92164	A6Zwartwater2	0.02	-0.04	-0.27
30.11889	-22.30987	A7Antonvilla	0.48	0.11	-0.03
29.79917	-23.32334	A7Bandolierkop	8.39	0.05	9.93
28.98720	-23.12150	A7Beaule	0.24	5.59	-0.24
29.27445	-23.36340	A7Boomzien	0.23	0.71	0.3954
29.45157	-23.88920	A7Boordepot	1.09	0.87	0.87
29.37553	-23.13561	A7Buysdorp	0.76	0.59	0.11
29.10820	-23.12437	A7Dikgomong	2.32	0.58	2.71
29.44812	-23.80799	A7Doornbult 2	-0.12	-0.06	0.072
29.43837	-23.84730	A7Doornkraal	-0.36	-0.04	-0.07
29.44412	-23.83300	A7Doornkraal 2	-1.52	-1.16	-1.26
29.21614	-23.81176	A7Doornpruit	0.36	-0.20	-0.07
29.82634	-23.50970	A7Eistleben	0.48	0.97	0.03
29.02878	-23.42621	A7Ga-Manhlodi	3.46	0.26	2.99
29.33158	-23.66153	A7Ga-Matmanyane	9.05	-0.23	
29.72625	-23.43173	A7Ga-phasha	4.73	0.88	6.88
29.22748	-24.04168	A7Geyser	0.57	0.45	0.03
29.37500	-22.19860	A7Greefswald	0.32	1.22	-0.07
29.42947	-23.53646	A7Kalkgat	0.72	0.71	0.10
29.87459	-22.31084	A7Klein Bolayi	0.95	6.73	0.19347
29.20344	-22.86683	A7Langjan	2.54	1.39	2.93
29.89070	-23.08469	A7Ledig	-0.51	0.51	61.91
29.55139	-23.36065	A7Legkraal	0.60	1.16	0.05
29.41792	-23.65942	A7Makibelo		0.99	
29.59566	-23.11044	A7Mara	-1.99	2.74	1.69
29.59230	-23.97537	A7Matjeskraal	0.26	0.59	-0.11
29.58990	-23.97427	A7Matjieskraal2	0.27	0.28	-0.11
29.86376	-22.61559	A7Mopane	0.70	5.78	0.08
29.40771	-23.81791	A7Palmietgat	1.29	0.66	1.20
29.56596	-23.74998	A7Papkuil	1.44	-5.13	1.48
29.41861	-23.82030	A7Pelgrimshoop 2	-0.07	-0.28	-0.07
29.61102	-23.64137	A7Roodewal	0.11	1.55	0.95
29.50589	-22.65974	A7Sandbrak	1.18	2.01	0.90
29.67412	-23.76016	A7Sebayeng	0.37	2.26	-0.04
28.95889	-23.19189	A7Sekiding 2	0.24	2.22	-0.234
29.37878	-23.83892	A7Seshego	0.32	1.05	-0.073
29.41739	-23.92290	A7Sterkloop Farm	0.18	0.65	0.40
29.42789	-23.88790	A7Sterkloop Pump	0.01	0.26	0.413
29.53941	-23.83240	A7Tweefontein	-0.16	0.06	-0.09
29.46545	-23.93544	A7Uniepark	0.25	0.88	-0.16
29.63585	-22.41584	A7Venetia Road	1.01	2.36	0.32
29.45344	-23.92280	A7Waterland	-0.02	0.59	0.43
29.59205	-22.83820	A7Waterpoort	1.05	9.30	0.56
29.43503	-23.90120	A7Westernburg	-0.02	1.16	0.66
29.57551	-23.67360	A7Zandrivierspoort 2	0.12	1.13	0.90
29.59846	-23.70542	A7Zandrivierspoort 3	1.82	1.82	2.29
29.78856	-22.94022	A8Aintree	2.20	3.43	2.81
30.26360	-22.92410	A8Fondwe	-0.47	0.29	0.18
30.05234	-22.81509	A8Maangani	-0.73	0.43	0.52
30.57008	-22.47003	A8Mabvete	0.13	-0.07	-0.22
30.22570	-22.91880	A8Mandala	-0.24	1.23	0.89
30.38886	-22.74094	A8Mavhode		1.51	
29.96088	-22.78889	A8Mudimeli	1.04	2.60	1.98
30.37452	-22.36452	A8Scrutton	-0.77	1.55	0.75
30.16060	-22.61640	A8Tshipise	-0.06	0.23	0.31
30.52230	-22.32617	A8Vrouwensbrom	-2.54	4.05	3.60

29.84556	-23.29078	A9Bandolierkop2	-0.152	0.165	-0.084
30.93740	-22.45660	A9Bileni	1.610	2.130	1.915
30.05142	-23.13907	A9Elim	-0.175	2.411	1.686
30.67031	-22.88436	A9Gondeni	0.670	0.484	-0.060
30.82308	-22.57881	A9Guyuni west	3.794	7.331	6.283
30.26623	-23.08848	A9Levhuvhu	0.879	4.337	2.166
29.95510	-23.21843	A9Mailaskop	0.835	1.463	0.588
30.72660	-22.46380	A9Makavhini	0.702	1.241	1.007
30.89370	-22.76670	A9Mhinga	-0.155	1.177	1.148
30.99426	-22.42471	A9Pafuri Gate		3.620	
30.53884	-23.05410	A9Phaphazela	-0.445	1.714	1.238
30.39991	-22.85428	A9Tshidzivhe	-5.416	4.997	2.103
30.98251	-22.47762	A9Tshikondeni	1.535	1.975	1.721
30.96880	-22.42490	A9Tshikuya1	1.469	5.077	4.914
30.96870	-22.42490	A9Tshikuya2	0.225	3.229	3.012
30.84740	-22.42290	A9Tshilamusi1	1.272	2.164	1.624
30.84680	-22.42090	A9Tshilamusi2	1.394	2.030	1.484
30.66050	-22.58740	A9Tshirunzini	1.168	1.414	0.963
30.58120	-22.55160	A9Tshivongweni	4.544	6.267	6.100
30.63414	-22.73744	A9Tswera	-11.685	11.272	10.203
30.79233	-22.70289	A9Vhurivhuri	-5.175	6.472	5.582
28.50623	-25.06145	B3Dekuil 2	0.153	0.297	0.127
28.54093	-24.95602	B3Settlers	-2.256	-3.031	-0.137
28.54093	-24.95602	B3Settlers 2	-0.406	-0.694	-1.383
28.73503	-24.90635	B3Tuinplaas	-2.050	-1.920	-1.233
29.08025	-24.60710	B5Byzonderheid 2	1.063	2.321	4.122
29.49841	-24.22186	B5Chuene	-0.079	0.182	0.579
29.70159	-24.04886	B5Dithlopaneng	0.425	1.517	1.078
29.01072	-24.38490	B5Doelen 2	-0.236	-0.496	-1.203
29.40535	-24.70891	B5Elandskraal	-0.378	-0.120	-0.372
29.69125	-24.64631	B5Maololo	0.680	1.055	0.008
29.91249	-24.67381	B5Marulaneng	-0.422	0.135	-0.329
29.65162	-24.66141	B5Mmatsekele	0.054	-0.001	-0.606
29.21231	-24.29572	B5Modderfontein	-0.036	-0.118	-3.505
29.90000	-24.81667	B5Nebo	-0.104	2.508	0.749
29.22194	-24.22028	B5Portugal	-4.259	7.090	3.043
29.11131	-24.45600	B5Wildebeestpan 2	-0.189	-0.215	-0.030
30.49702	-24.19696	B7Bismarck2	-0.177	0.625	0.479
30.36440	-24.07633	B7Julesburg2	-0.037	0.702	0.175
30.84531	-24.13615	B7Mica	0.442	1.102	2.826
31.05970	-23.97240	B7Namakgale	-0.291	0.616	0.490
30.31462	-24.34613	B7Penge	-2.634	2.660	2.697
30.54982	-23.91828	B7Rubbervale	1.128	3.572	2.572
30.61731	-24.37586	B7The Willows2	-0.199	0.447	-0.557
29.96515	-24.28484	B7Tshebeng	0.428	0.441	-0.079
29.88690	-23.90289	B7Veekraal	0.033	0.371	0.390
29.90250	-24.04346	B7Wolkberg	-0.378	0.871	0.589
30.14028	-23.20531	B8Chavani	0.815	0.815	0.756
30.41597	-23.51347	B8Femane	5.422	5.422	4.520
29.93923	-23.94055	B8Haenertsburg	0.865	0.865	0.442
30.35806	-23.89336	B8Letsitele	1.720	1.720	0.903
30.15652	-23.46550	B8Lwamondokop	6.863	6.863	4.809
30.39170	-23.73420	B8Mamitwa			
31.01740	-23.60020	B8Mbaula			
30.38180	-23.26800	B8Middel letaba	0.131	0.131	-0.347
30.67340	-23.62390	B8Mphagani	3.334	3.334	2.461
29.93040	-23.36904	B8Muumoni			
30.61137	-23.24507	B8Nghalalume	-0.043	-0.043	-0.628
30.95463	-23.70830	B8Nyageleni	1.261	1.261	0.860
29.95910	-23.65490	B8Sekgopo	0.127	0.127	-0.305
30.68188	-23.38954	B8Sikhunyane	0.318	0.318	-0.556
30.17093	-23.79483	B8Tzaneen	0.601	0.601	-0.048

30.88949	-23.36434	B8Vuheli	0.067	0.067	-0.477
30.75457	-22.96745	B9Greenfarm	0.259	0.002	0.435
30.80470	-23.07210	B9Halahala	-0.033	0.853	-0.280
30.92169	-22.82390	B9Maphophe2	1.448	2.332	0.972
30.58518	-23.08865	B9Mukhomi	-0.149	1.650	1.546

TABLE 1