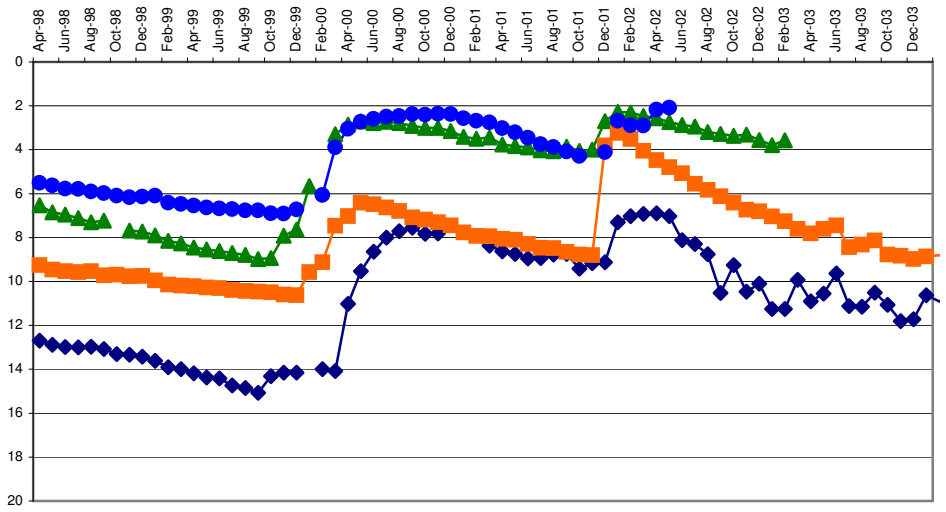
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
LIMPOPO REGION
WATER RESOURCE MANAGEMENT

STATUS REPORT ON MONITORING & GROUNDWATER LEVEL TRENDS NOVEMBER 2007 – NOVEMBER 2008



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DECEMBER 2008

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1) EXECUTIVE SUMMARY

Groundwater levels

Water level values for 1 November 2007, 1 May 2008 and 1 November 2008 were used for comparison in this report. Of the 183 stations listed for visiting this session only 8 could not be accessed, 5 of which were due to wet terrain after heavy rains, 3 of these are located in the Kruger National Park.

Comparison of water levels with the previous quarter: (August 2008 to November 2008)

- Stations visited = 175.
- Stations with data for both dates: = 171

	No of stations	% of stations	Average
Water level down more than 1 m	16	9.4%	-3.14 m
Water level down less than 1m	127	74.3%	-0.33 m
Higher water levels more than 1m	4	2.3%	2.08 m
Higher water levels less than 1m	22	12.8%	0.24 m
No difference in water level	2	1.2%	
Total	**134**	**100%**	

This period represent the situation midway to the end of the past dry season. It is normal for water levels to lower during the dry season, especially the latter part, and as is to be expected for this period, 143 (83.6%) of the 171 stations with data indicate lower water levels. The average decline for these stations is -0.64m over the past 3 months.
Of the 22 stations indicating higher water levels, the increase at only 4 of them is notable with an average of 2.08m. These stations are however all affected to some extend by nearby abstraction and does not reflect natural conditions. The previous water levels may probably reflect pumping levels. The rise at the remaining 22 stations is 0.2m average.

Comparison of water levels with the corresponding time last year: (November 2007 to November 2008)

Data for the whole year is available for 129 stations, of these, 81 (62.8%) indicates lower water levels while 48 (37.2%) indicate higher water levels. Overall an average decline of -0.41m was recorded. This is an indication of the lack in recharge the previous wet season in some areas as well as the limited recharge overall.

LIMPOPO WATER MANAGEMENT AREA:
Lephalale (A4), Mokolo (A5), Mogalakwena (A6), Sand (A7) and Nzhelele (A8) drainages

Water levels in general indicate a slow declining trend for the past ± 6 years despite some varying seasonal recharge. This is interpreted as part of a normal long-term cycle of lesser and major recharge periods and mostly does not raise serious concern at this stage. Comparison with long-term data at some stations indicate that levels are mostly still above the worst recorded as well as long-term averages.
There are some local exceptions.

- A6 Drainage: The water level at A6N0082 Klipput has been declining steeply since March 2002 and reached the maximum depth to water level recorded in November 1995 again by January

2007. The current level is 1.2m below the worst recorded and still declining. The graph is attached as (**ANNEXURE 1**). The area is characterized by large scale irrigation.

- A7 Drainage: Quite a few boreholes in this drainage indicate rather steep declines. Most concern is raised by the water level trends in some boreholes around Polokwane that indicate above normal to very serious declines. An example is station A7N0586 located at the Municipal well field on Doornkraal. The water level dropped by 16.8m since January 2007 and is currently 7.7m below the worst recorded in 1994. The graph is attached as (**ANNEXURE 2).**
- A8Drainage: Water levels in this drainage are relatively stable and no points of real concern could be identified.

Local conditions can vary over short distances and may escape detection due to the low density of the network.

LEVHUVHU-LETABA WATER MANAGEMENT AREA:
Levhuvhu (A9), Letaba (B8) and Shingwedzi (B9) drainages

No long-term data is yet available for any of these drainages but most water levels indicate a slow decline over the past 2-4 years. The decline is more widely noticeable in the A9 Drainage. Boreholes in the Muswodi – Klein Tshipise area tend to indicate faster rates of decline. The decline in this area varies from 3.5 to 4.5 m over the past 3 years (**ANNEXURE 3).** Only the Sekgopo area that lowered by 3m the past 3 years indicates a relative fast decline in the B8 Drainage (**ANNEXURE 4).** Due to a lack of long-term data, the real threshold of concern can not be quantified but short-term correspondence with other areas with long-term data indicates the possibility that no serious concern exists at this point in time. Again, local conditions may differ over short distances and may not be noticed.

OLIFANTS WATER MANAGEMENT AREA:

So far not many stations have been established in this WMA and are widely separated in some cases. The short-term trend of slowly declining water levels is predomionant here as well. Some good correlation with stations in this area can be found with stations in adjoining areas and the same conclusions are thus made with the regard to the general state of affairs on the longer term. As with the other areas, exceptions do occur. Much has been said about the situation in the Settlers-Tuinplaas area in previous reports. Suffice to note that the current water levels are still a matter of concern (**ANNEXURE 5).** Water levels in the Mica and The Willows areas are also decling at a faster rate than the general trend overall and declined by almost 7m the past 2 years (**ANNEXURE 6)**

IN GENERAL:

Despite a general slow decline in water levels, the situation, compared to historical records, is still favorable. Except for the Settlers-Tuinplaas area that raises concern for some years now, no specific area of concern could be identified at this stage. As is highlighted by the attached annexure, there are some localities that need to be investigated and closely monitored.

The monitoring network is not designed to monitor local aquifer conditions, but the general situation over a whole catchment or WMA. It is however virtually impossible to find completely un-impacted areas and the combined effects of water use in an area is usually reflected. The Areas characterized by more rapidly declining trends than elsewhere may represent areas of greater impact. The stations located inside the Kruger National Park established 18 months to 1 year ago, is considered to be the least impacted and can probably be regarded as natural conditions. The same slow decline is generally seen here as well. These stations were visited in May and again in November 2008. The average water

level decline for the 31 stations with data for this period is -0.26m. Stations outside the Park reveal that the 124 stations with data for both dates indicate an average decline of -0.93m from May to November. The average decline outside the Park is around 0.6m greater than in the Park where natural conditions prevail.

Despite the current network being focused on ambient conditions as far as possible, some of the old stations are located near well fields or points of abstraction. New abstraction boreholes are sometimes drilled and equipped in the vicinity of existing monitoring stations which then alter the type of behavior monitored. In such cases local aquifer response is monitored and can local anomalies be detected. An example is the Doornkraal well field mentioned above.

Aquifer monitoring and management is the responsibility of the user or service provider. Adherence to this is of utmost importance to ensure sustainable use.

Monitoring network

Extension of the monitoring network is still ongoing but has been hampered some by instrument shortages the past 3 months.

Summary:

Current stations		Planned stations					
Active stations(including new)	**New; No data yet**	**New boreholes drilled but not equipped yet**	**Still to be drilled**	**Project station to include**	**Possible old existing holes to be used**	**Total**	**Total sites to monitor (before gap filling)**
193	10	4	4	4	7	19	212
(34 in KNP)	Included in column 1				(Sekhukhune area)		

The position of current and planned stations is depicted in **MAP 1**.

Other monitoring:

Tshitale project	**Taaibosch project**	**Matlala project**	**National Groundwater Quality project**
4 stations	16 stations	25 stations	55 stations

Of the new stations 7 still have to be registered on the National database. The Kruger Park stations also still have to be registered but old reports need to be studied for the information.

Field verification of possible boreholes for inclusion in the National Groundwater Quality network has been completed for the areas where government or communal equipped boreholes can be used and 27 sites were visited and verified. Planning of a sampling program to test the suitability of the selected sites is underway and would be completed by end of December.

Extension of the rainfall recorder network was halted until a suitable solution to vandalism can be found but service of the remaining stations continues.

2) STATUS OF MONITORING NETWORK

The Limpopo Province's Groundwater Level Monitoring Network currently consists of 193 active monitoring stations, including 34 in the KNP **(Map 1)**

175 Stations were visited during November 2008. 8 Stations could not be access for various reasons and 10 are new with no time series data yet. 19 Additional new stations are currently planned of which 4 are already drilled but not yet equipped. Of the 7 sites planned by using old existing boreholes in the Sekhukhune area, 4 suitable boreholes have been verified. The 3 remaining will probably need to be drilled new. 4 Holes still need to be drilled in the A4 drainage. 4 Project boreholes are planned to be included in the network at a later stage. Some network gaps identified will be addressed next year. Problems with access to the site A5N0001 is still experienced due to new owner which is difficult to contact.
7 of the newly drilled boreholes still have to be registered on the National database

No progress on the phase 2 upgrading of existing stations.

The following project stations are monitored, 25 at Matlala, 4 at Tshitale and 16 at Taaibosch (Monitored by Head Office). **(Map 2)**

Regional and Head Office jointly service a total of 55 stations for the National Groundwater Quality Program in the Limpopo Province. **(Map 3)**

27 possible new sites for the Groundwater Quality Monitoring Network has been visited and verified. A sampling program in the areas of these sites is currently being planned. Sampling will commence as soon as new instrumentation is delivered next year.

3) DATA COLLECTION, EVALUATION AND REPORTING

Data was collected during November 2008 with the value for 1 November representing the end of the current dry season. Comparisons were drawn between 1 November 2007, (Corresponding period the previous year) 1 May 2008 (Beginning of the dry season) and 1 November 2008 (End of the current dry season) **(Maps 4 & 5)**

4) LIMPOPO WATER MANAGEMENT AREA.

The area consists of secondary drainage areas A4, A5, A6, A7 and A8.

4.1 A4 Drainage Area. (Matlabas, Mokolo Rivers)

There are now 7 newly equipped stations in this drainage but no time series data is available yet. 1 Borehole has been drilled but not equipped yet and another 4 still need to be drilled.

4.2 A5 Drainage Area. (Lephalala River)

There are 6 active stations. 1 New borehole drilled must still be equipped. Station A5N0001, as well as 3 additional project boreholes around it, could still not be equipped yet due to access problems and instrument shortages. Water levels in this drainage are very stable with very little fluctuation but the slow decline as noticed everywhere.
(GRAPHS 1-4)

4.3 A6 Drainage Area. (Nile, Sterk, Mogalakwena & Dorps Rivers)

There are 39 monitoring stations in this drainage.
Levels started to decline since the onset of the dry season and are evident at most stations. **(GRAPH 5)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)
Data for 36 stations is available. 34 Stations (94.5 %) have lower levels and 2 stations (5.5%) indicate higher water levels. Overall an average decline of -1.02m was recorded for the period. **(GRAPHS 6 & 8)**

November 2007 to November 2008
Data for the whole year is available for 35 stations. 15 Stations (42.9%) indicate lower water levels than November last year and 20 stations (57.1%) indicate a rise in water levels. An overall rise of 0.7m was recorded over the past year **(GRAPH 7 & 8)**

Current average water levels are slightly lower than the long-term average values but are 3.3m higher than the maximum average recorded, **(GRAPH 9)**

4.4 A7 Drainage Area. (Sand, Blood, Diep, Hout, Dwars & Brak Rivers)

There are 38 monitoring stations in this drainage.
Trends are similar to that of the A6 drainage with little recharge the past wet season and general declines since the dry season. **(GRAPH 10)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)
Data is available for 35 stations of which 3 stations (8.6%) indicate higher water levels, while 32 stations (91.4%) indicate lower water levels, average -0.87m. Overall a decline of -0.77m was recorded over this period **(GRAPHS 11&13).**

November 2007 to November 2008

Data is available for 33 stations, 24 (72.7%) Indicate lower water levels, average -0.97m. 9 Stations (27.3%) indicate higher water levels, average 0.84m. Overall a decline of -0.48m was recorded for the period **(GRAPHS 12&13)**.

Current average water levels are lower than the long-term average but 1.7m above the lowest average recorded **(GRAPH 14).**

4.5 A8 Drainage Area ((Nwanedzi, Nzhelele Rivers)

11 Stations are monitored in this area but as for the previous reports, the data for the artesian station was not used as it is still overflowing.

As noted for above mentioned drainages, a slight initial rise the past wet season followed by a decline again at all stations. **(GRAPH 15)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

7 Stations indicate declining water levels with an average of -0.45m and 1 slightly higher **(GRAPHS 16 & 18)**.

November 2007 to November 2008
8 Stations indicate lower water levels, average -0.32m, and 1 a higher water level **(GRAPHS 17 & 18)**.

An overall an average decline of -0.15m was recorded over the past year **(GRAPH 18)**

5) LEVHUVHU-LETABA WATER MANAGEMENT AREA.

The area consists of secondary drainage areas A9, B8 & B9.

5.1 A9 Drainage Area. (Mutale, Levhuvhu Rivers)

This drainage has 18 monitoring stations.

The general slow declining trend is also evident as in the other drainages **(GRAPH 19).**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

Data is available for all 18 stations of which 17 indicate lower water levels; average -1.06m (**GRAPHS 20&22)**.

November 2007 to November 2008)
12 Stations (66.7%) indicate lower water levels, average -0.86m and 6 stations indicate higher water levels, average 0.43m **(GRAPHS 21&22)**.

Overall an average decline of 0.43m was recorded over the area the past year.

5.2 B8 Drainage Area. (Groot, Middel & Klein Letaba Rivers)

14 Stations are monitored in this drainage.

A general slow decline over the past year is indicated **(GRAPH 23).**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

Data is available for all 14 stations and 13 stations indicate lower water levels, average -0.67m **(GRAPHS 24&26)**

November 2007 to November 2008
10 Stations indicate lower water levels, average -0.35m, with 3 slightly higher (**GRAPHS 25&26)**

Overall a decline of -0.14m was recorded since the corresponding time last year.

5.3 B9 Drainage Area. (Shingwidzi, Mphongolo Rivers)

All levels declining since the dry season **(GRAPH 27)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

Water levels at all stations indicate a decline, average -0.94m **(GRAPHS 28 & 30).**

November 2007 to November 2008
3 Stations have lower water levels than the corresponding time last year, average -0.24m **(GRAPHS 29&30)**

6) OLIFANTS WATER MANAGEMENT AREA.

The part of this Water Management Area within the Limpopo Province mostly consists of the B3, B5 & B7 secondary drainage areas.

6.1 B3 Drainage Area. (Elands, Gotwane Rivers (Springbok flats area)

3 Stations are monitored in this area.

In opposite to other areas, water levels started to rise after February but very little at B3N0022 **(GRAPH 31)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

All stations indicate higher levels **(GRAPH 32)**

November 2007 to November 2008
All Stations indicate higher water levels (**GRAPH 33)**

Despite the rising water levels at B3N0001 and B3N0012, the current water levels are still far below long-term average and is a reason for concern for some years now (**GRAPH 34)**

6.2 B5 Drainage Area. (Olifants, Nkumpi Rivers)

7 Stations are monitored in this drainage.

As in most other drainages, an initial rise in water levels followed by a decline **(GRAPH 35)**

Comparison with previous levels:

May 2008 to November 2008 (beginning to end of the dry season)

6 Stations indicate lower water levels and 1 slightly higher; the level at B5N0055 reflects direct pumping effects of a new production borehole and was not used in calculations. The average decline at the other 5 stations is -1.7m. This figure is higher than for other drainages but is due to 2 stations being located on the dolomites and characterized by relative large short-term fluctuations **(GRAPHS 36&38)**

November 2007 to November 2008
Varying behavior between stations; **GRAPHS 37&38)**

Current average water levels are above the long-term averages as well as the lowest average recorded **(GRAPH 39)**

6.3 B7 Drainage Area (Olifants, Selati, Klaserie, Makhutswi Rivers)

8 Stations are monitored in this drainage.

Very little fluctuation except the slow decline the past year **(GRAPH 40)**

Comparison with previous levels:

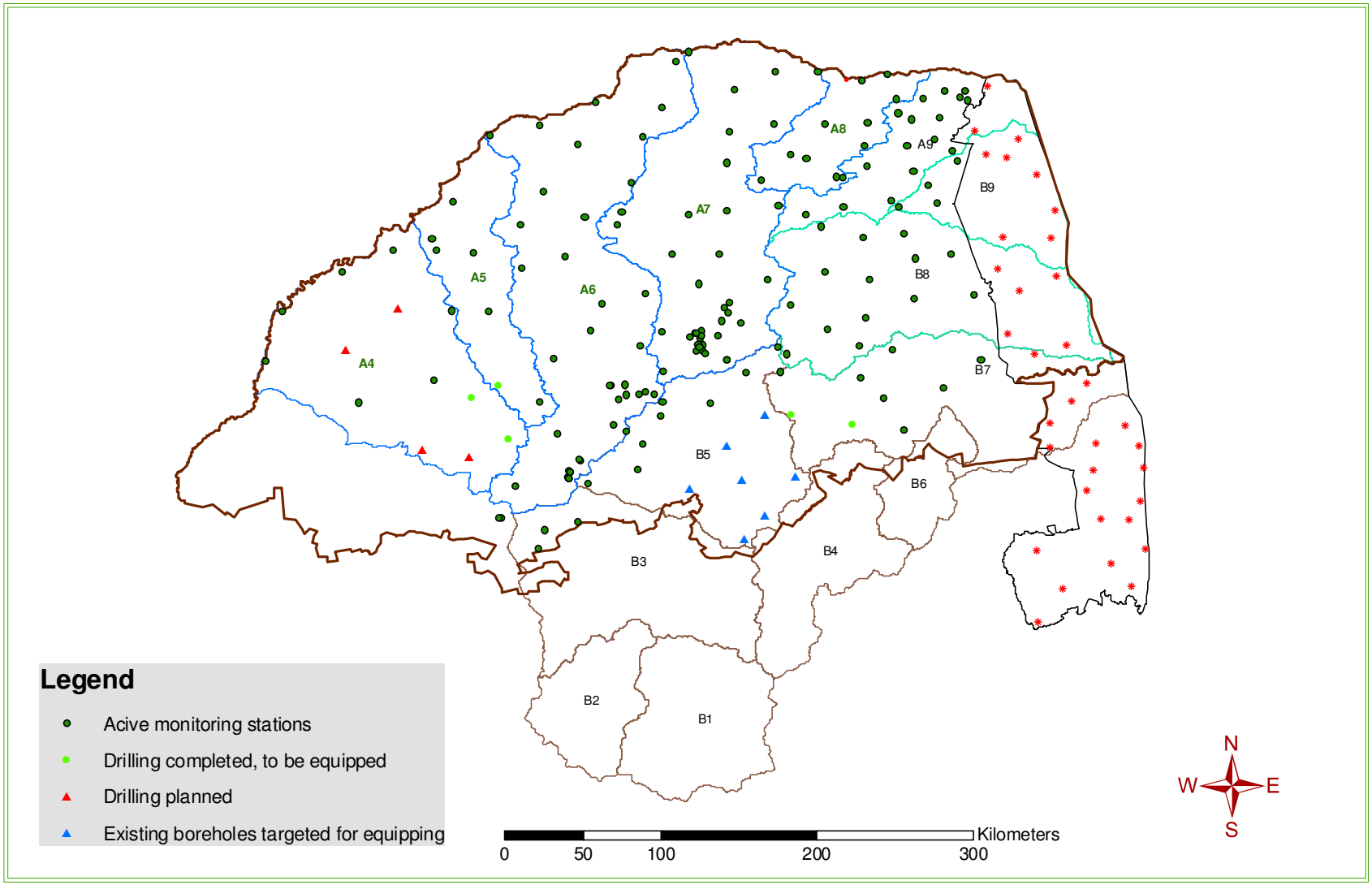
May 2008 to November 2008 (beginning to end of the dry season)

All 7 stations with data indicate lower water levels; average -0.9m **(GRAPHS 41&43)**

November 2007 to November 2008
6 Stations indicate lower water levels; average -1.24m and 1 higher **(GRAPHS 42&43)**.

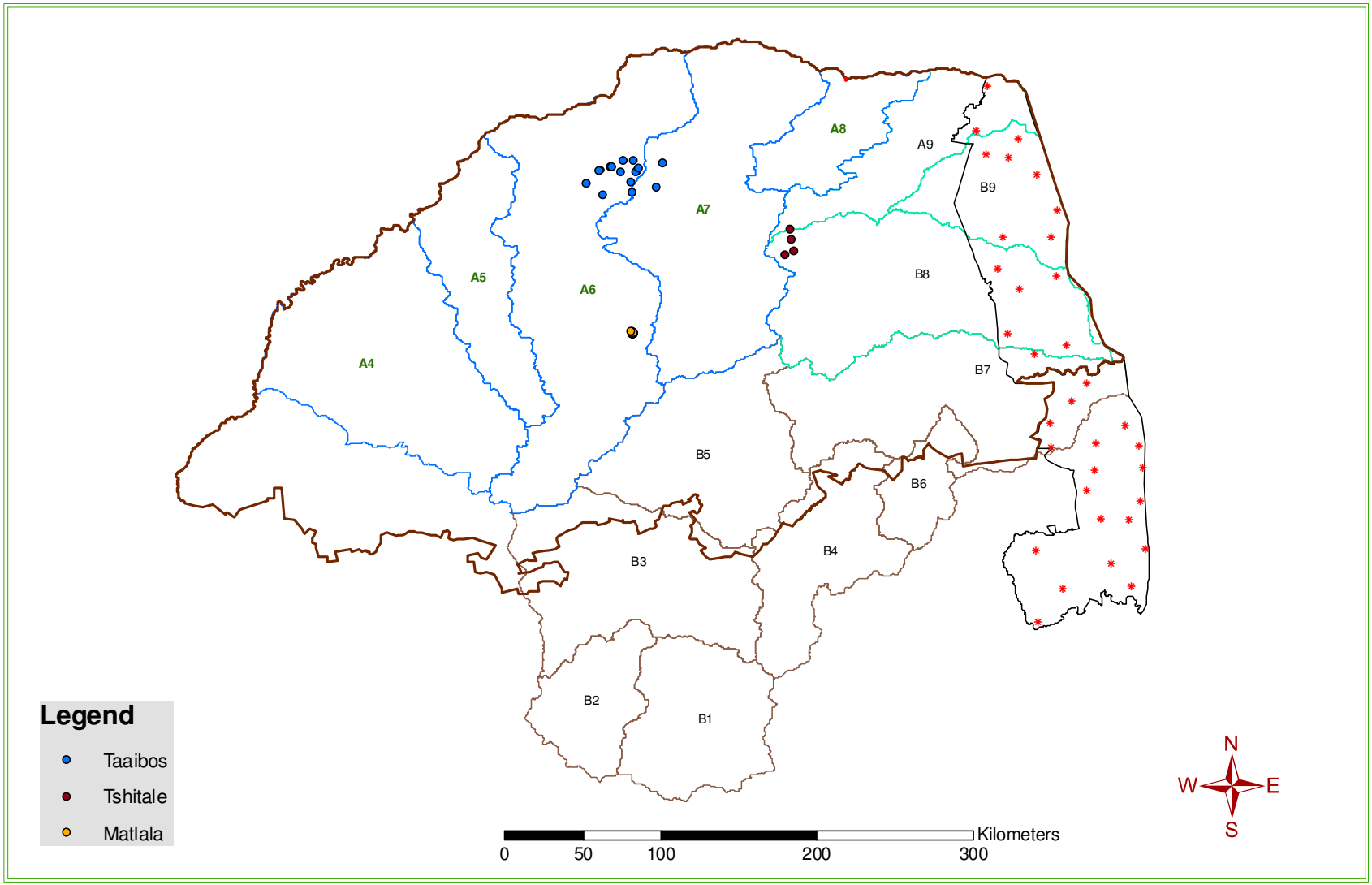
Overall a decline of -1m was recorded the past year.

Limpopo Groundwater Monitoring:
Positions of active and planned stations



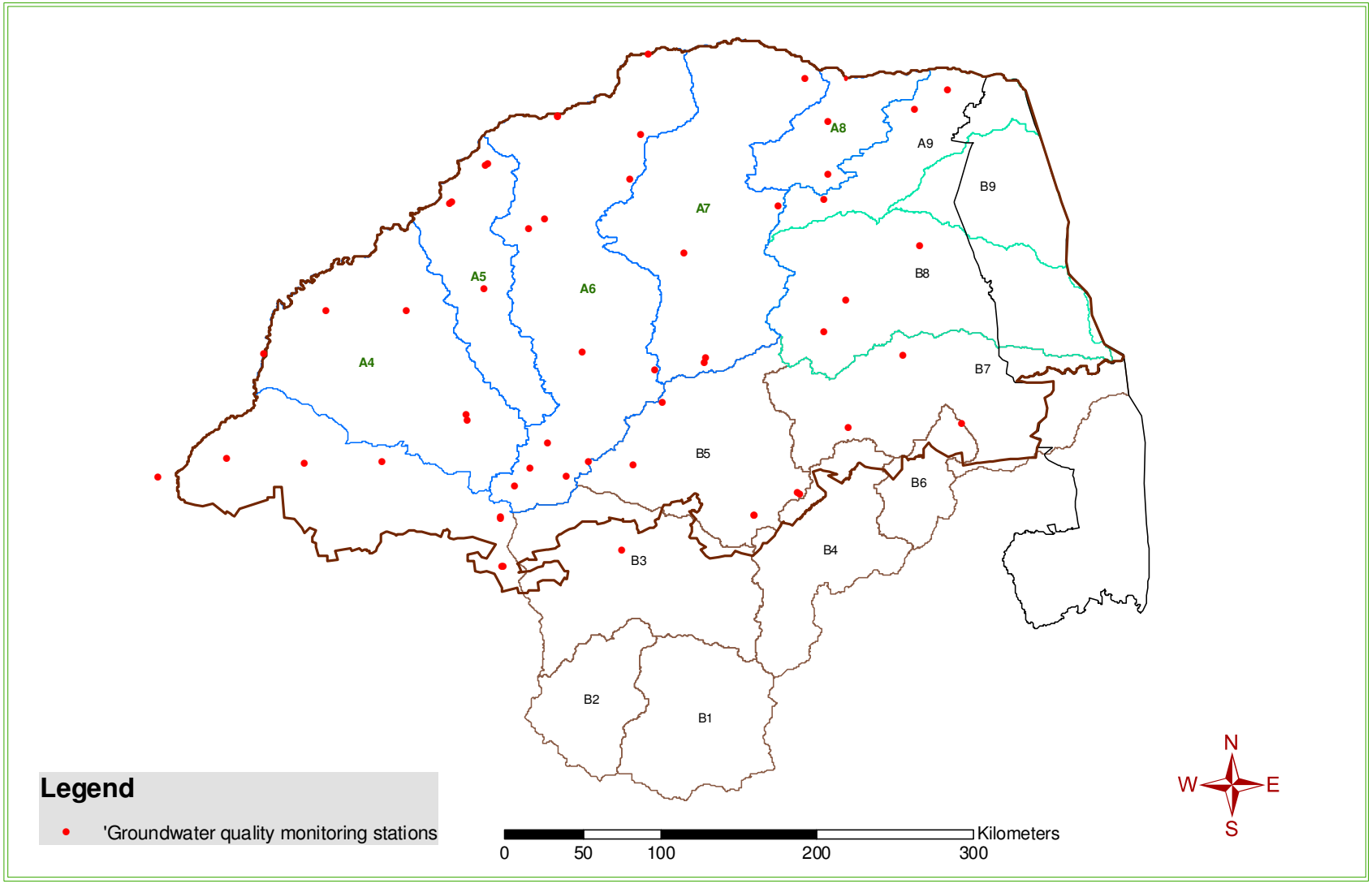
MAP 1

Limpopo Groundwater Monitoring:
Positions of project monitoring stations



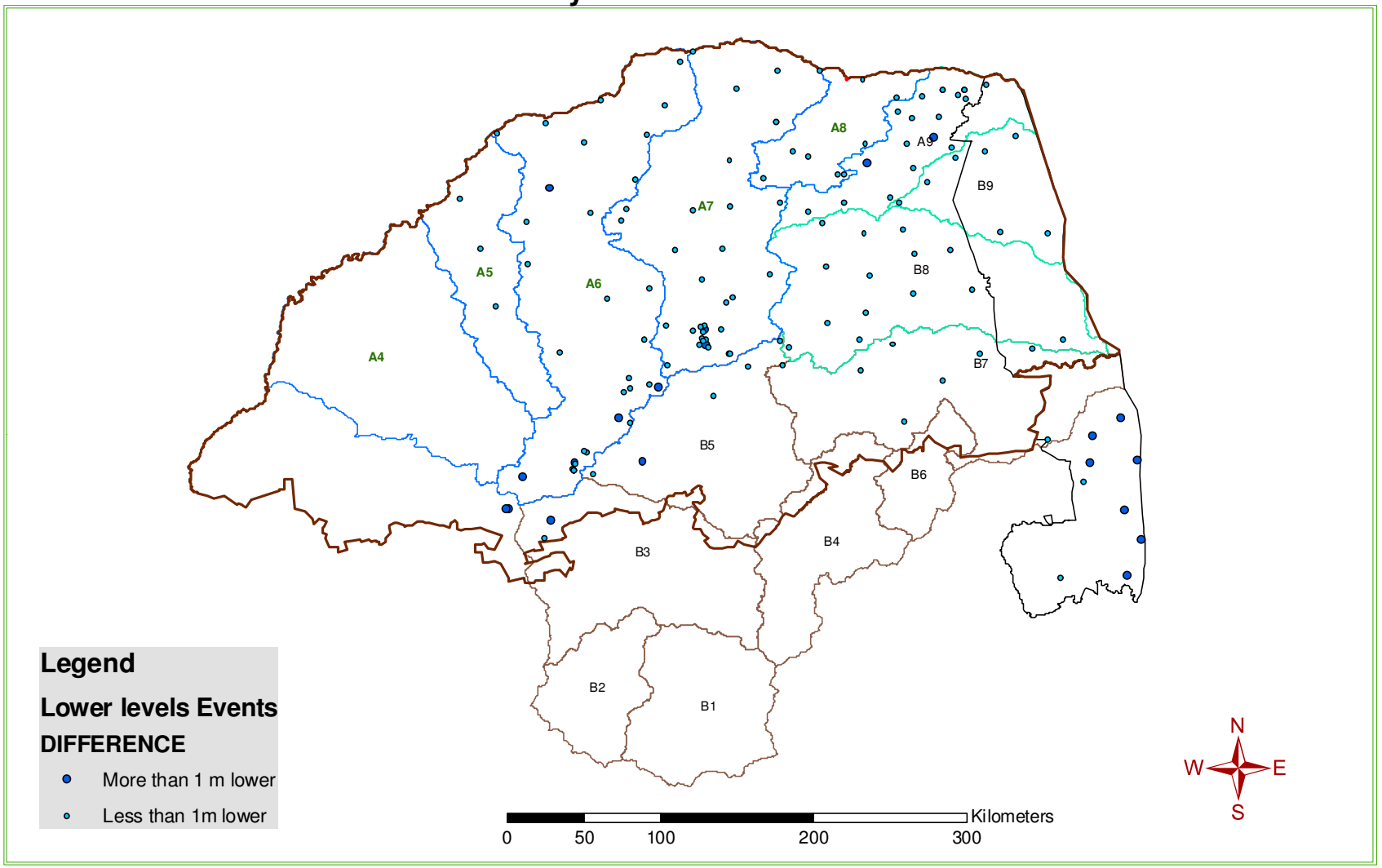
MAP 2

Limpopo Groundwater Monitoring:
Positions of goundwater quality monitoring stations



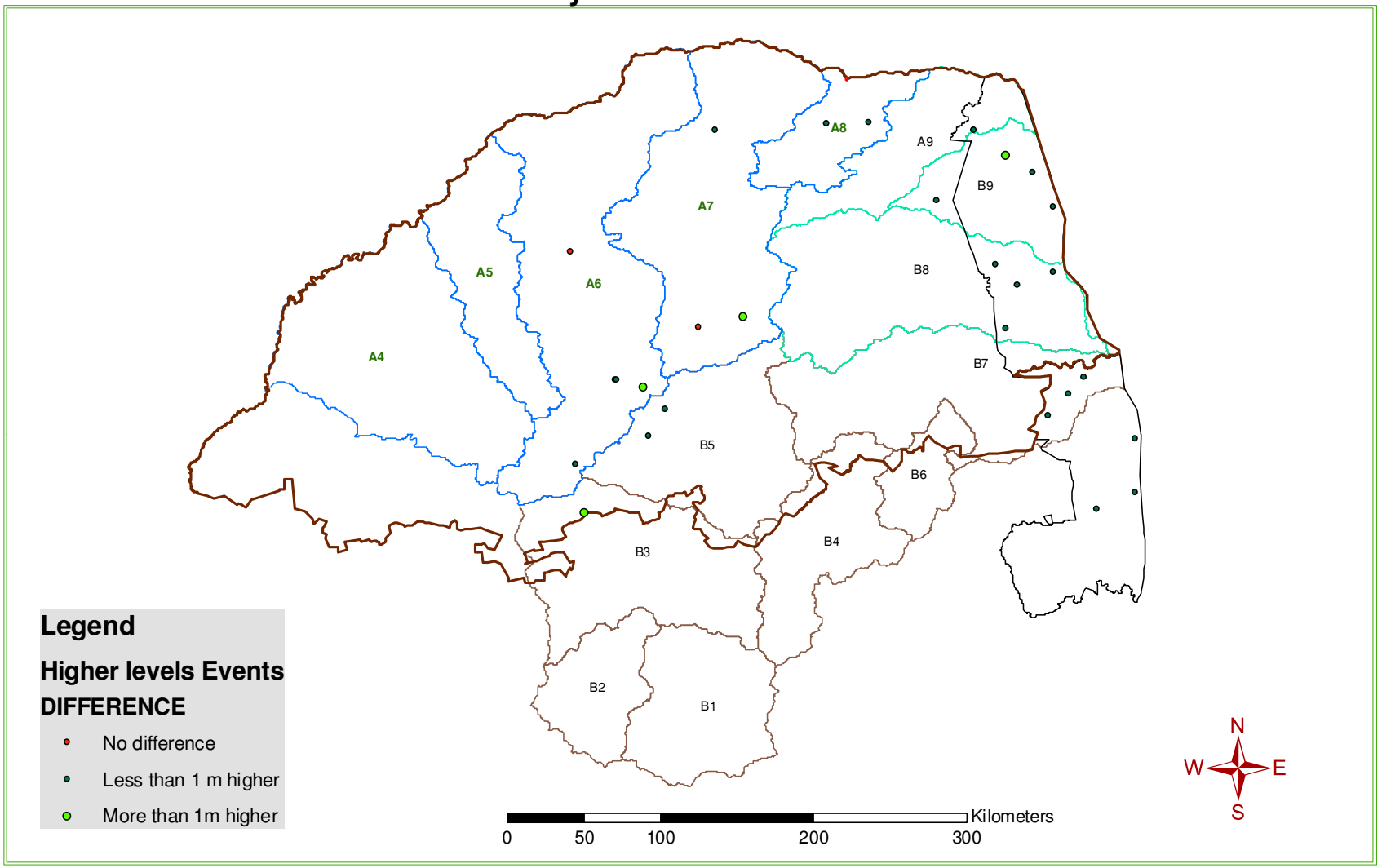
MAP 3

Limpopo Groundwater Monitoring:
Positions of goundwater monitoring stations with lower water levels, May to November 2008



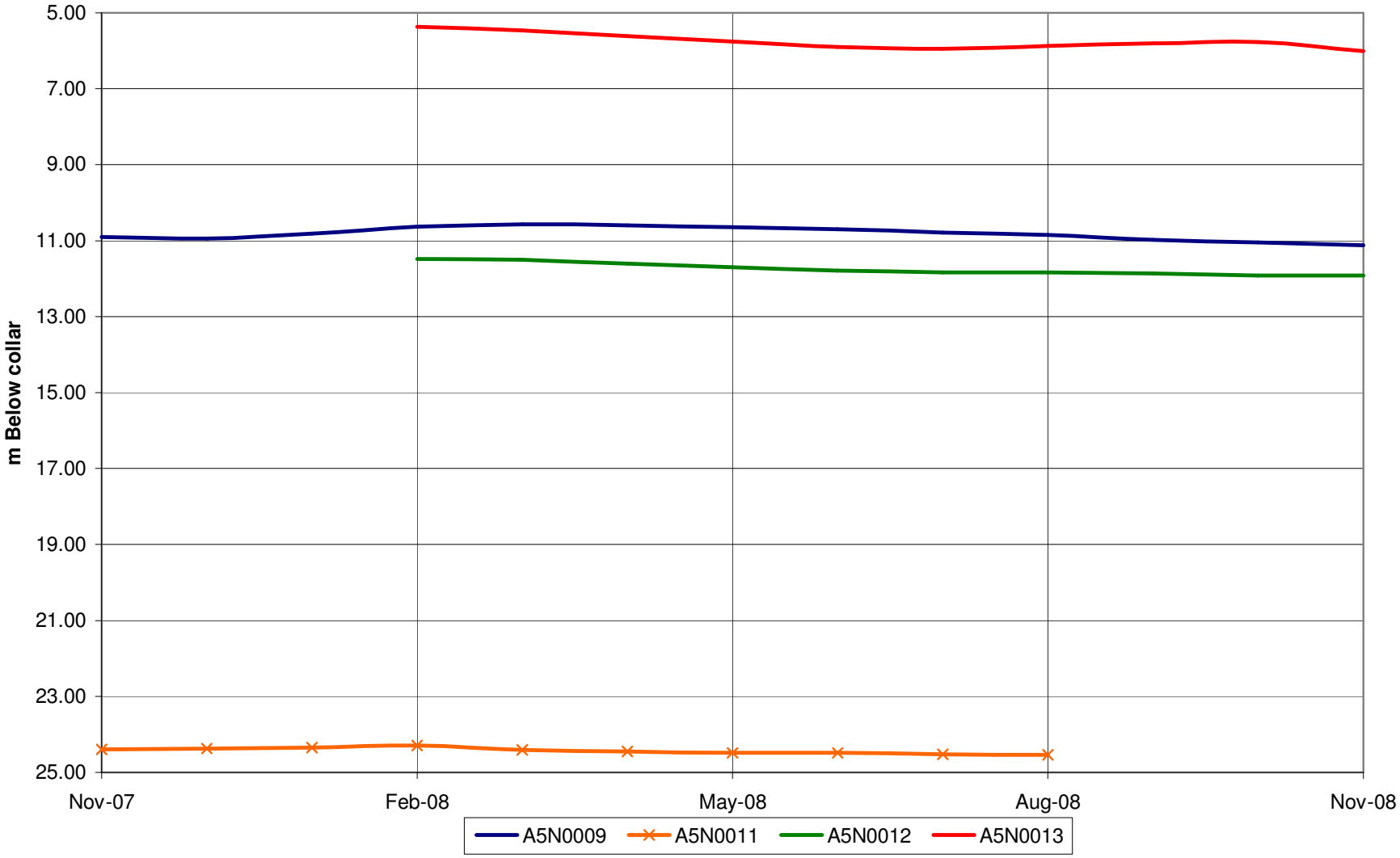
MAP 4

Limpopo Groundwater Monitoring:
Positions of goundwater monitoring stations with higher water levels, May to November 2008



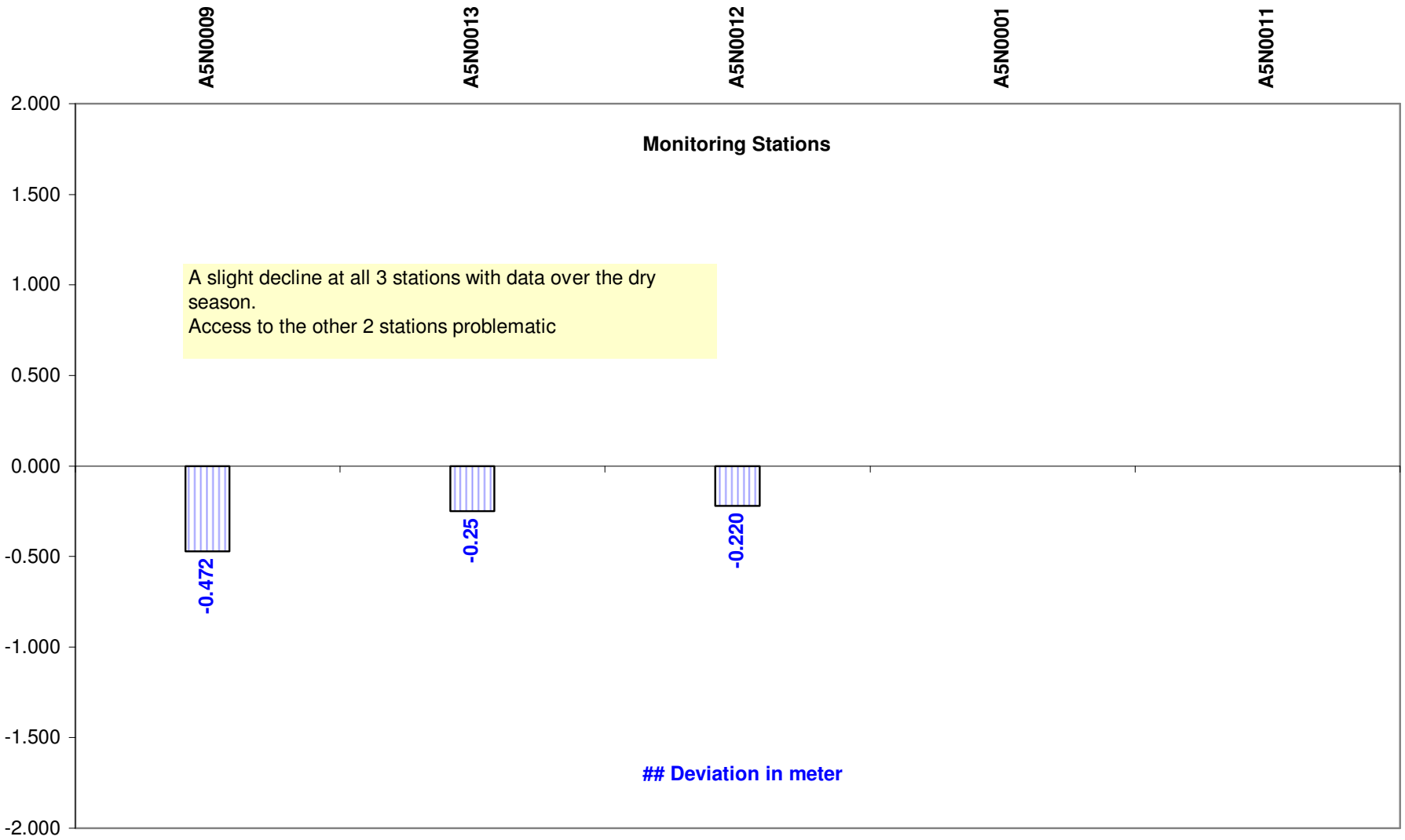
MAP 5

Comparison of water level trends at stations in A5 drainage: 1 November 2007 to 1 November 2008



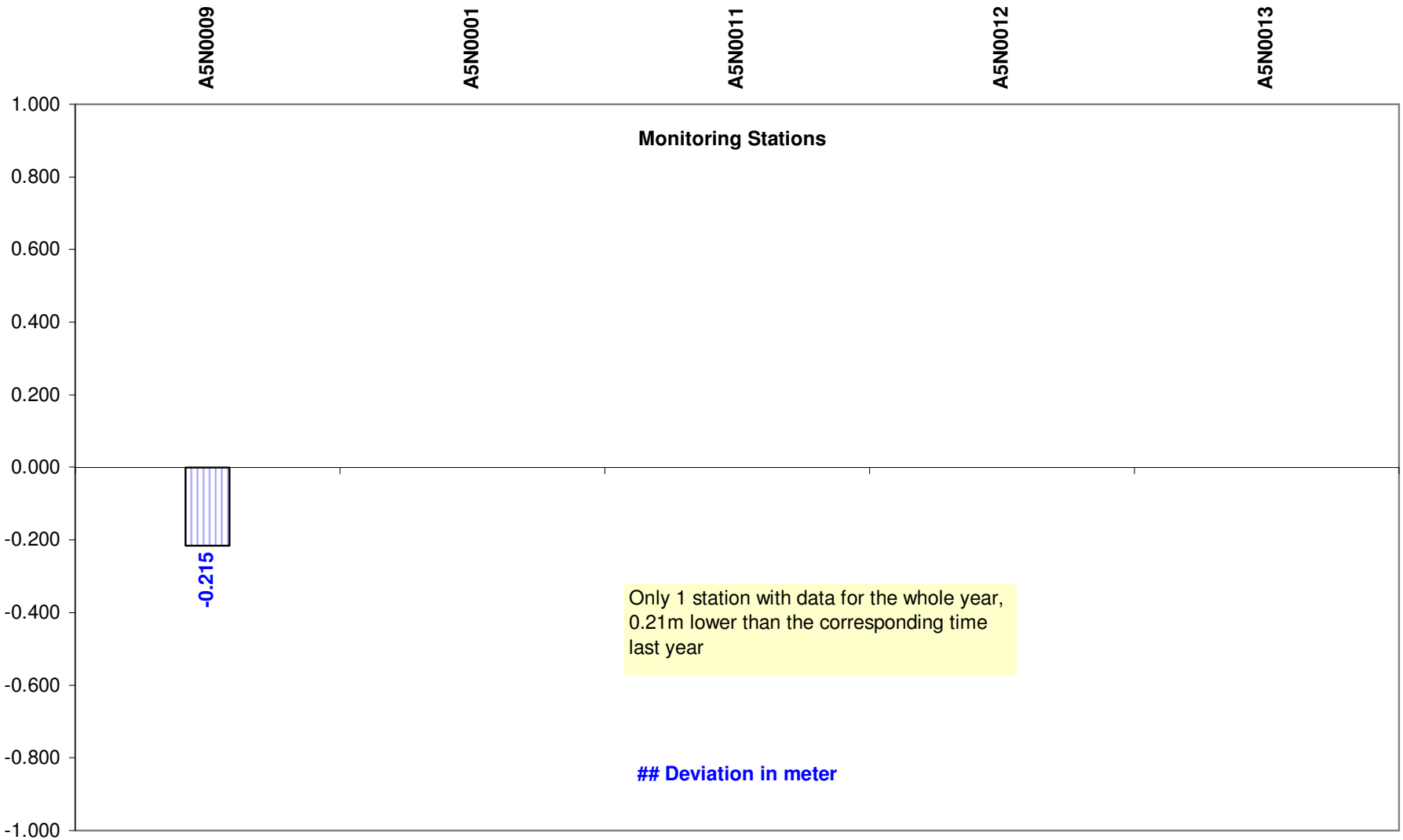
GRAPH 1

A5 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008

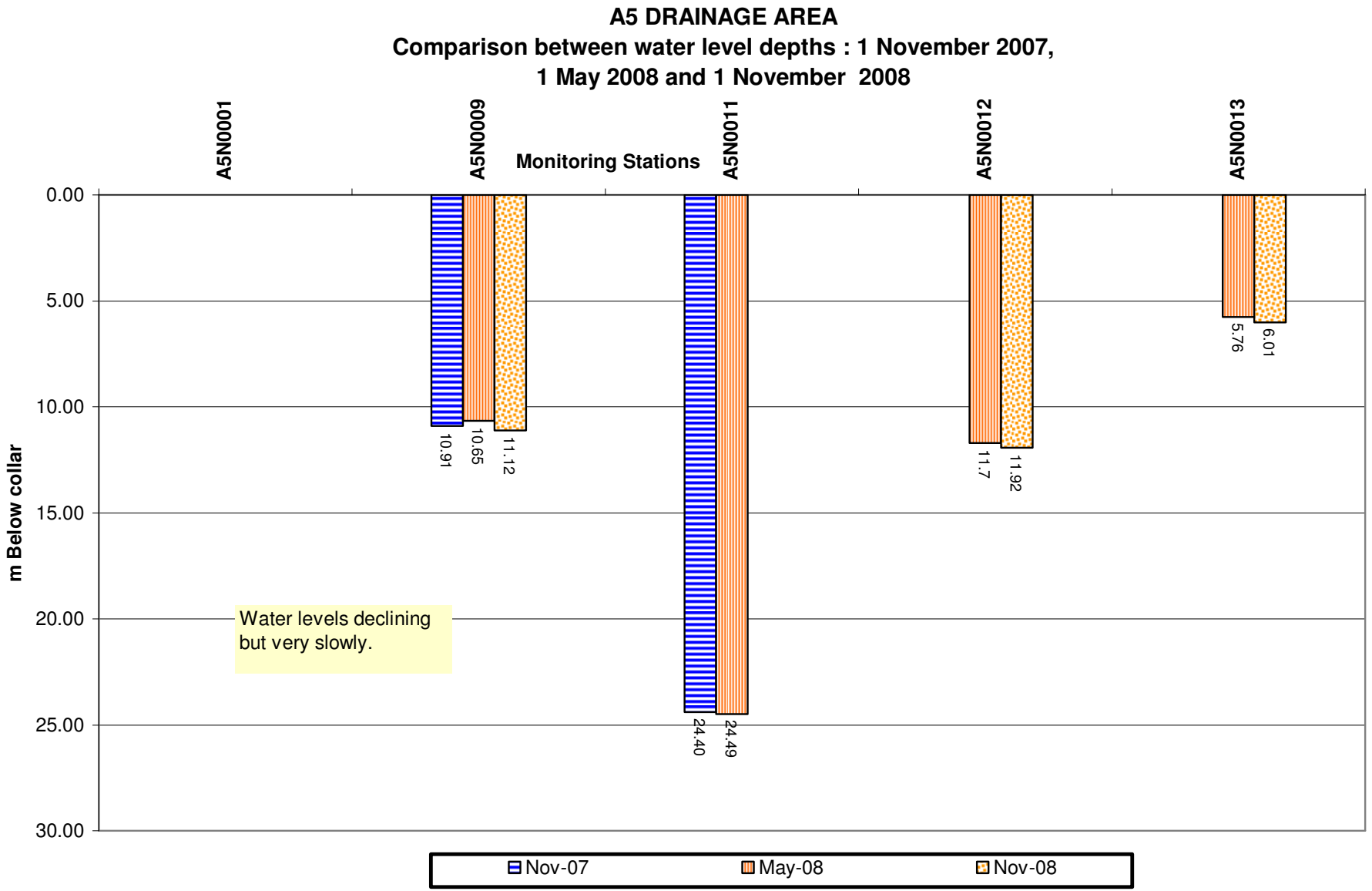


GRAPH 2

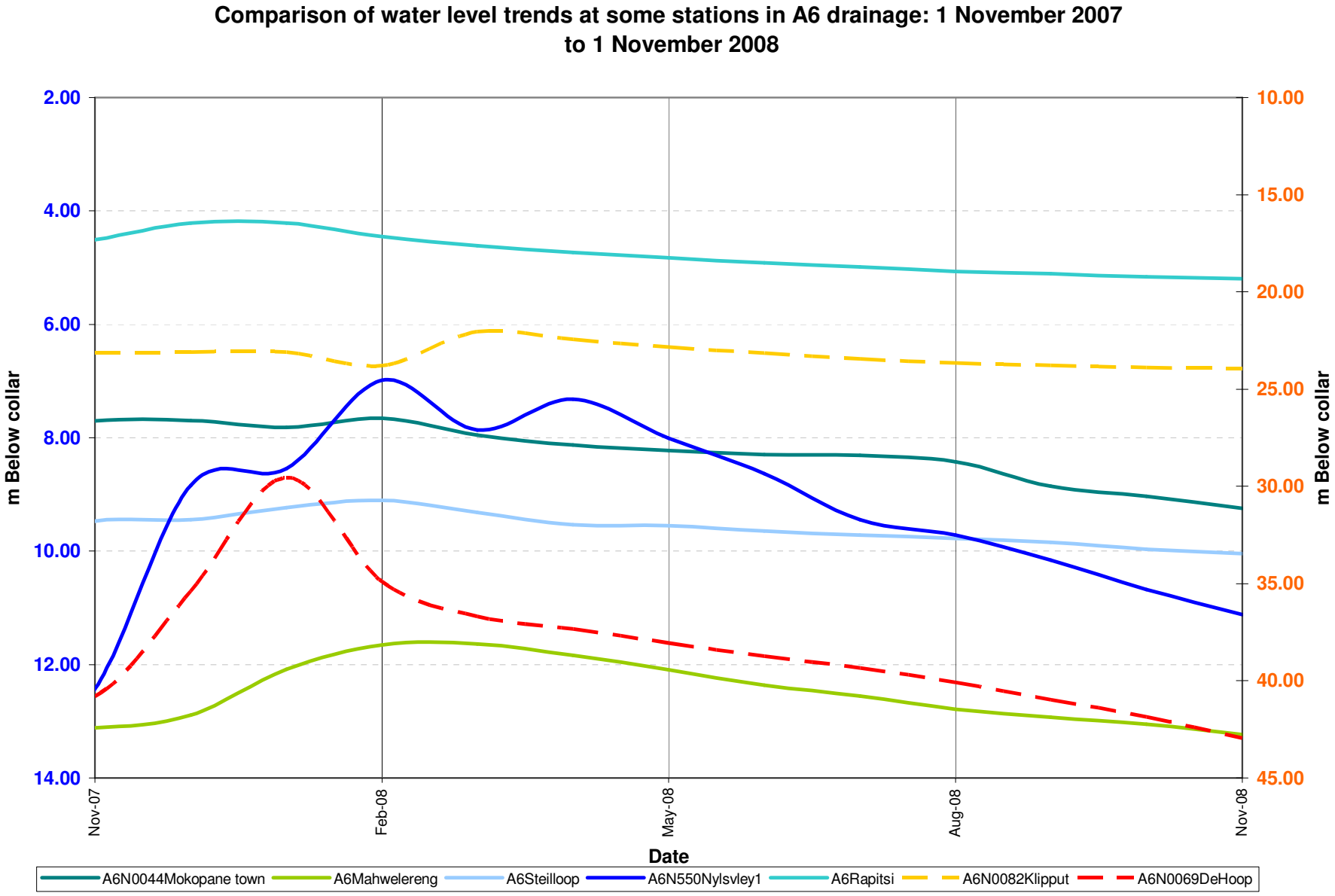
A5 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008



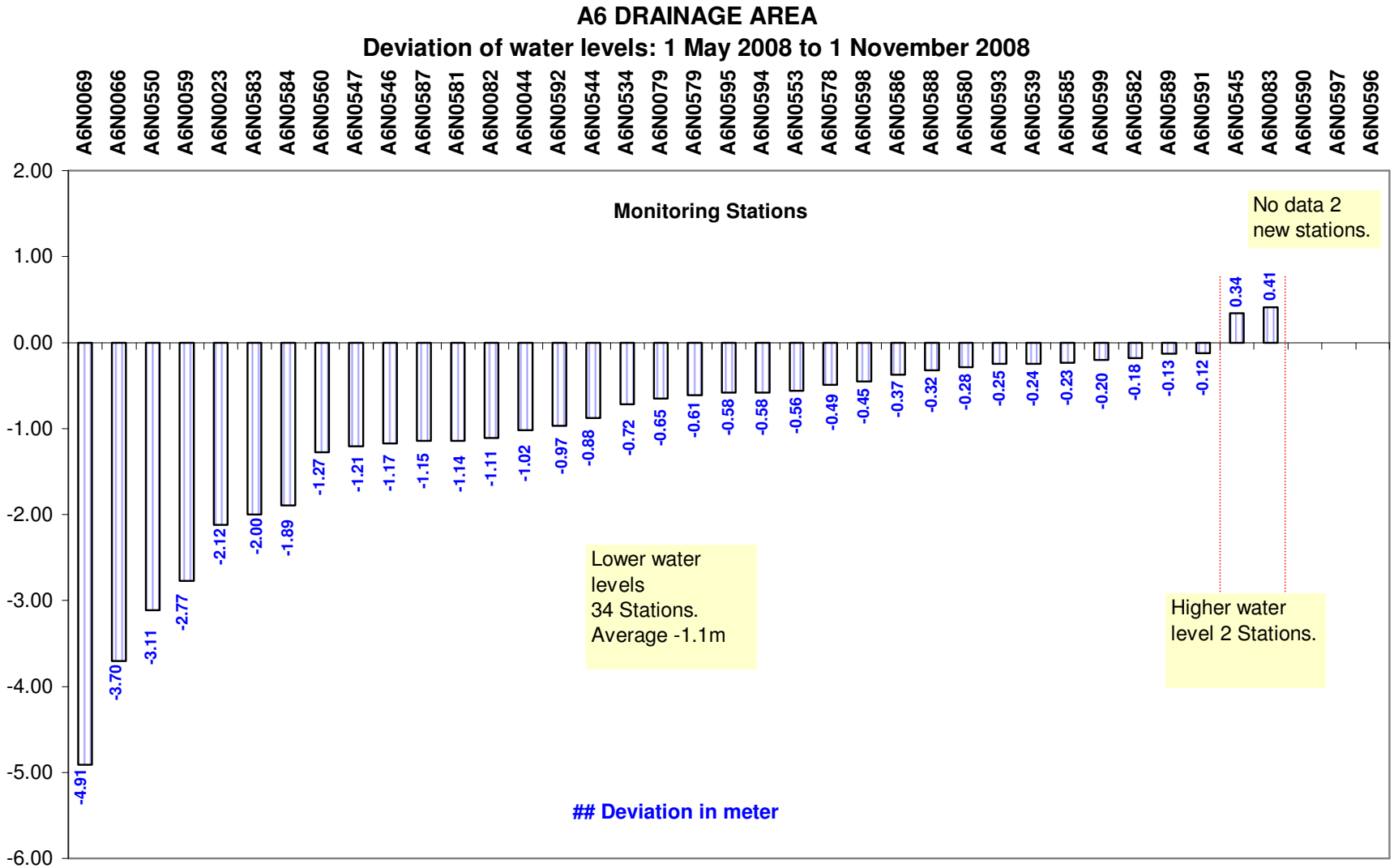
GRAPH 3


A5 DRAINAGE AREA
Comparison between water level depths : 1 November 2007,
1 May 2008 and 1 November 2008
A5N0001
A5N0009
A5N0011
A5N0012
A5N0013
Monitoring Stations
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
30.00
10.91
10.65
11.12
24.40
24.49
11.7
11.92
5.76
6.01
Water levels declining
but very slowly.
Nov-07
May-08
Nov-08

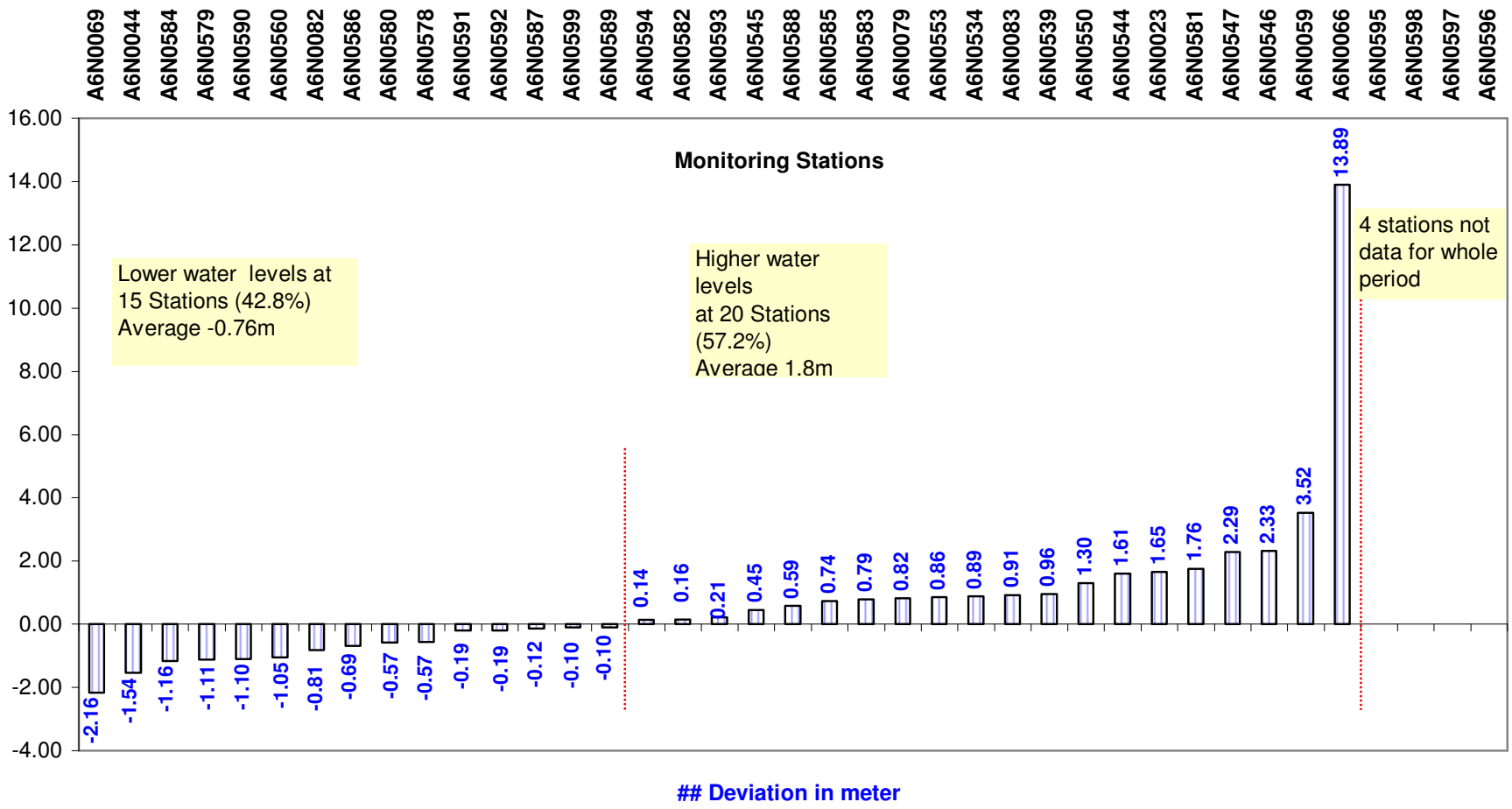
GRAPH 4


Comparison of water level trends at some stations in A6 drainage: 1 November 2007 to 1 November 2008
2.00
4.00
6.00
8.00
10.00
12.00
14.00
m Below collar
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
m Below collar
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
A6N0044Mokopane town
A6Mahwelereng
A6Steilloop
A6N550Nylsvley1
A6Rapitsi
A6N0082Klipput
A6N0069DeHoop

GRAPH 5

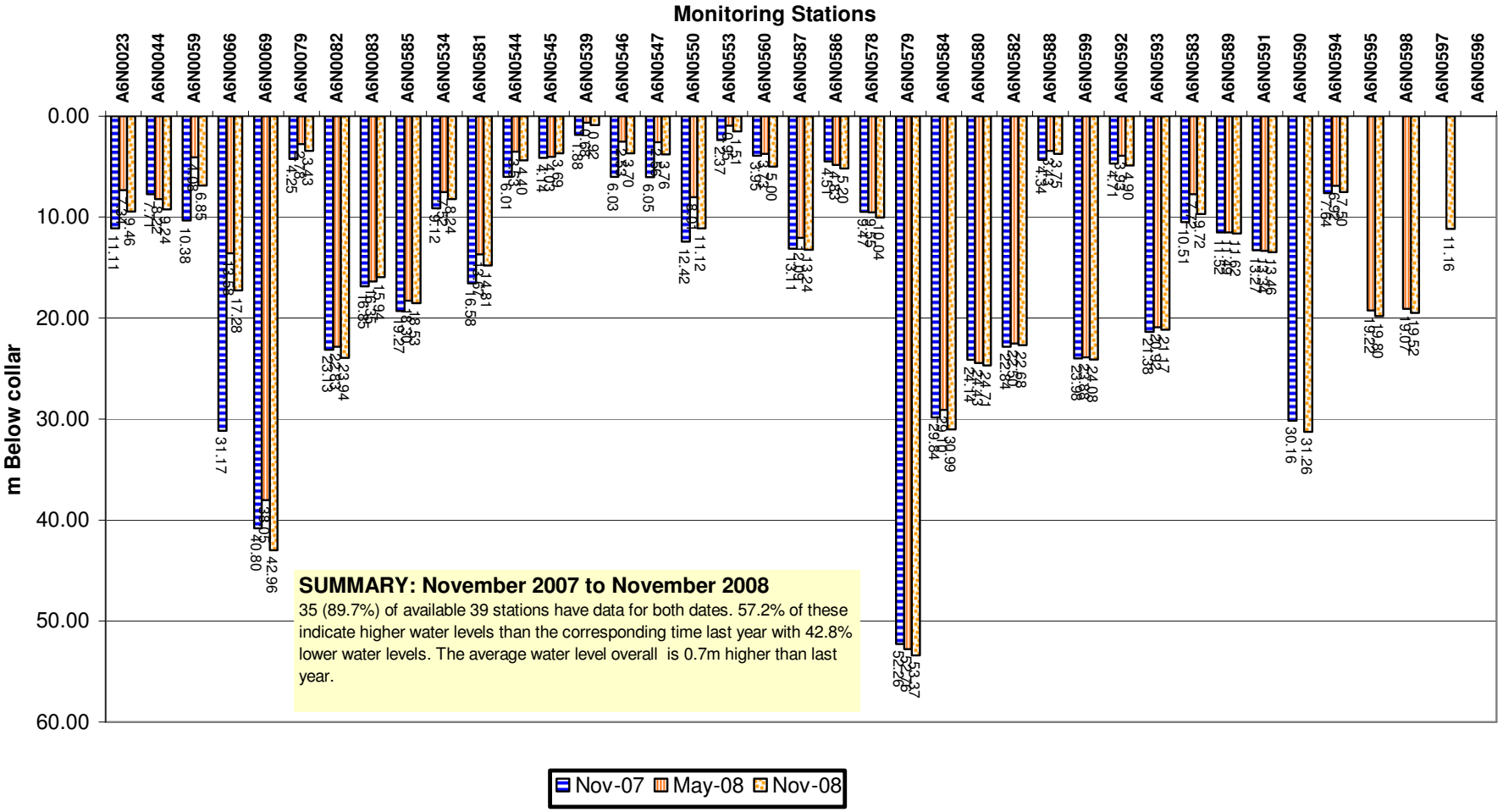

A6 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
A6N0069
A6N0066
A6N0550
A6N0059
A6N0023
A6N0583
A6N0584
A6N0560
A6N0547
A6N0546
A6N0587
A6N0581
A6N0082
A6N0044
A6N0592
A6N0544
A6N0534
A6N0079
A6N0579
A6N0595
A6N0594
A6N0553
A6N0578
A6N0598
A6N0586
A6N0588
A6N0580
A6N0593
A6N0539
A6N0585
A6N0599
A6N0582
A6N0589
A6N0591
A6N0545
A6N0083
A6N0590
A6N0597
A6N0596
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
Monitoring Stations
No data 2 new stations.
-4.91
-3.70
-3.11
-2.77
-2.12
-2.00
-1.89
-1.27
-1.21
-1.17
-1.15
-1.14
-1.11
-1.02
-0.97
-0.88
-0.72
-0.65
-0.61
-0.58
-0.58
-0.56
-0.49
-0.45
-0.37
-0.32
-0.28
-0.25
-0.24
-0.23
-0.20
-0.18
-0.13
-0.12
0.34
0.41
Lower water levels
34 Stations.
Average -1.1m
Higher water level 2 Stations.
Deviation in meter

GRAPH 6


A6 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
A6N0069 A6N0044 A6N0584 A6N0579 A6N0590 A6N0560 A6N0082 A6N0586 A6N0580 A6N0578 A6N0591 A6N0592 A6N0587 A6N0599 A6N0589 A6N0594 A6N0582 A6N0593 A6N0545 A6N0588 A6N0585 A6N0583 A6N0079 A6N0553 A6N0534 A6N0083 A6N0539 A6N0550 A6N0544 A6N0023 A6N0581 A6N0547 A6N0546 A6N0059 A6N0066 A6N0595 A6N0598 A6N0597 A6N0596
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
Monitoring Stations
Lower water levels at 15 Stations (42.8%) Average -0.76m
Higher water levels at 20 Stations (57.2%) Average 1.8m
4 stations not data for whole period
-2.16 -1.54 -1.16 -1.11 -1.10 -1.05 -0.81 -0.69 -0.57 -0.57 -0.19 -0.19 -0.12 -0.10 -0.10
0.14 0.16 0.21 0.45 0.59 0.74 0.79 0.82 0.86 0.89 0.91 0.96 1.30 1.61 1.65 1.76 2.29 2.33 3.52 13.89
Deviation in meter

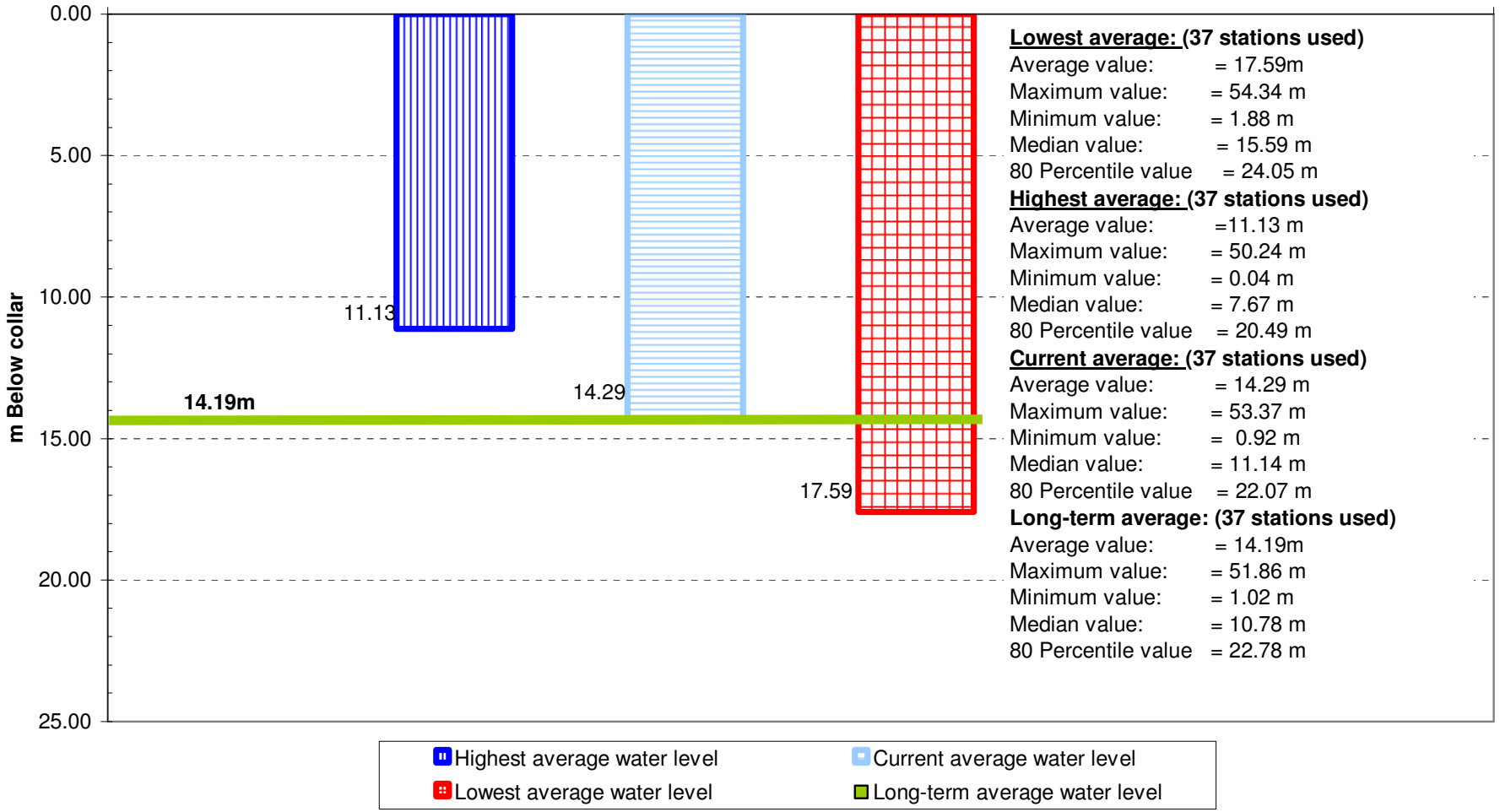
GRAPH 7

A6 DRAINAGE AREA
Comparison between water level depths: 1 November 2007, 1 May 2008, and 1 November 2008

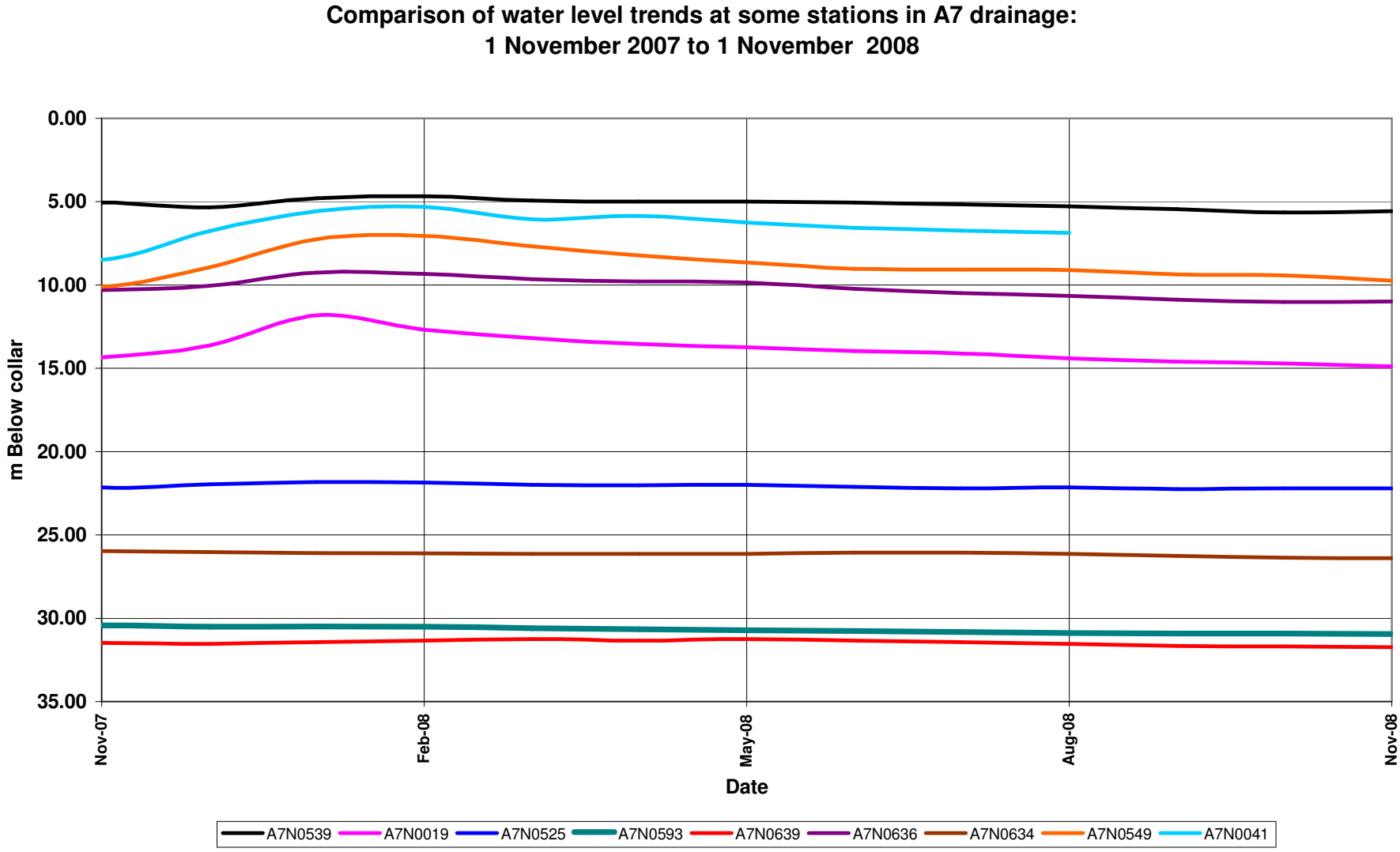


GRAPH 8

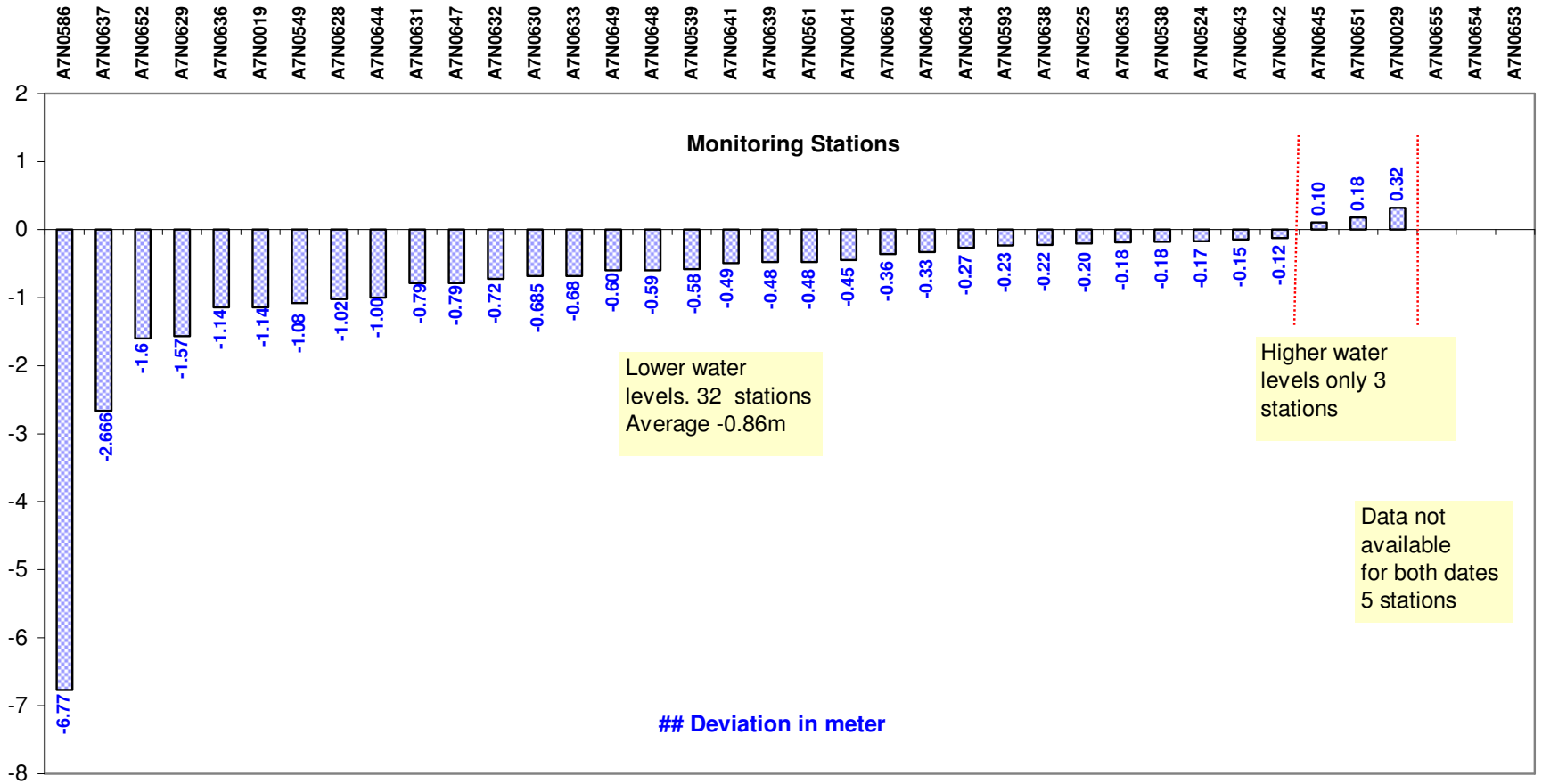
A6 DRAINAGE AREA
Comparison of average current water level depths with highest, lowest & long-term average water level depths recorded



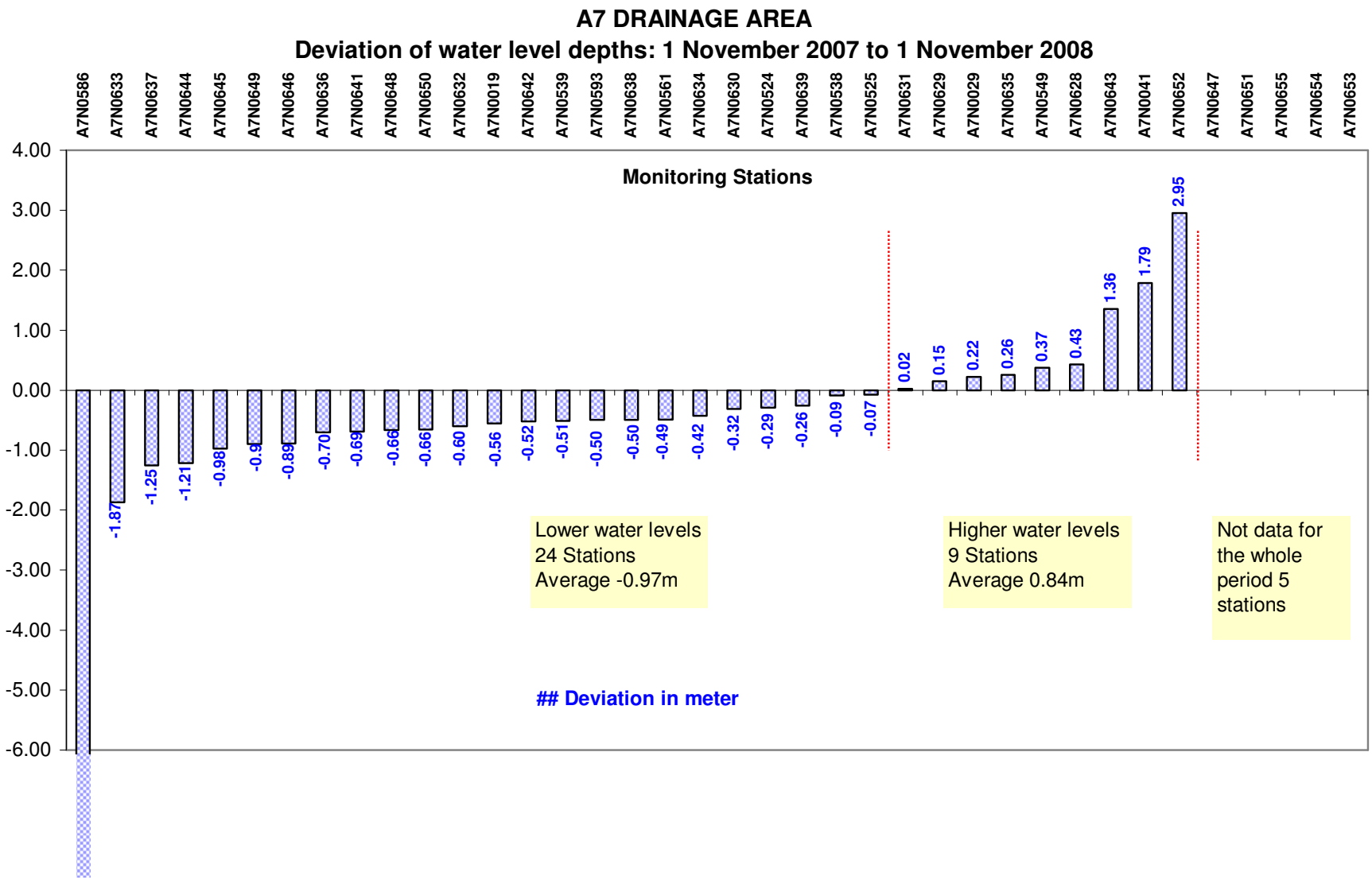
GRAPH 9


Comparison of water level trends at some stations in A7 drainage:
1 November 2007 to 1 November 2008
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
m Below collar
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
A7N0539
A7N0019
A7N0525
A7N0593
A7N0639
A7N0636
A7N0634
A7N0549
A7N0041

GRAPH 10

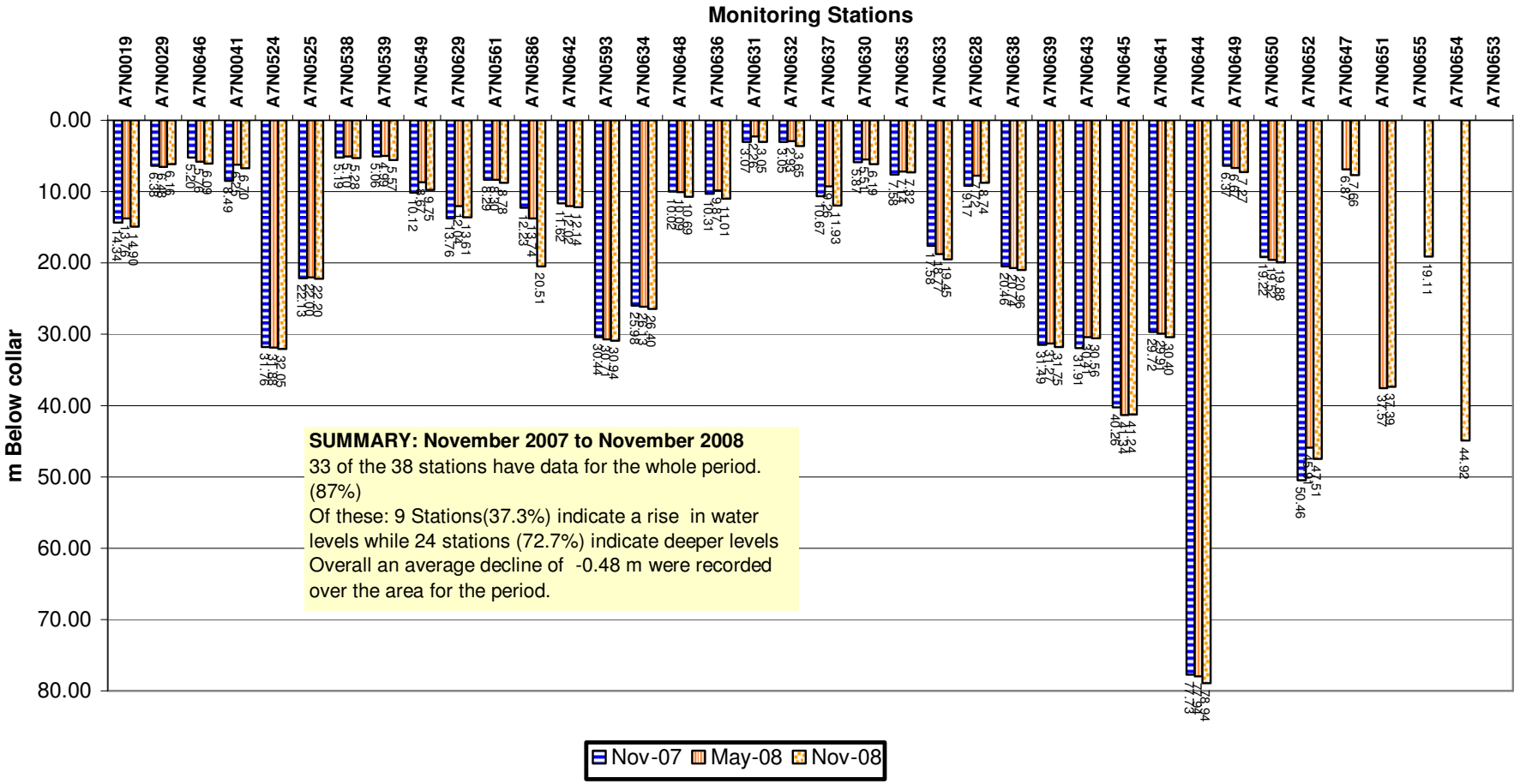

A7 DRAINAGE AREA
Deviation of water level depths: 1 May 2008
to 1 November 2008
A7N0586 A7N0637 A7N0652 A7N0629 A7N0636 A7N0019 A7N0549 A7N0628 A7N0644 A7N0631 A7N0647 A7N0632 A7N0630 A7N0633 A7N0649 A7N0648 A7N0539 A7N0641 A7N0639 A7N0561 A7N0041 A7N0650 A7N0646 A7N0634 A7N0593 A7N0638 A7N0525 A7N0635 A7N0538 A7N0524 A7N0643 A7N0642 A7N0645 A7N0651 A7N0029 A7N0655 A7N0654 A7N0653
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
Monitoring Stations
-6.77 -2.666 -1.6 -1.57 -1.14 -1.14 -1.08 -1.02 -1.00 -0.79 -0.79 -0.72 -0.685 -0.68 -0.60 -0.59 -0.58 -0.49 -0.48 -0.48 -0.45 -0.36 -0.33 -0.27 -0.23 -0.22 -0.20 -0.18 -0.18 -0.17 -0.15 -0.12 0.10 0.18 0.32
Lower water levels. 32 stations Average -0.86m
Higher water levels only 3 stations
Data not available for both dates 5 stations
Deviation in meter

GRAPH 11

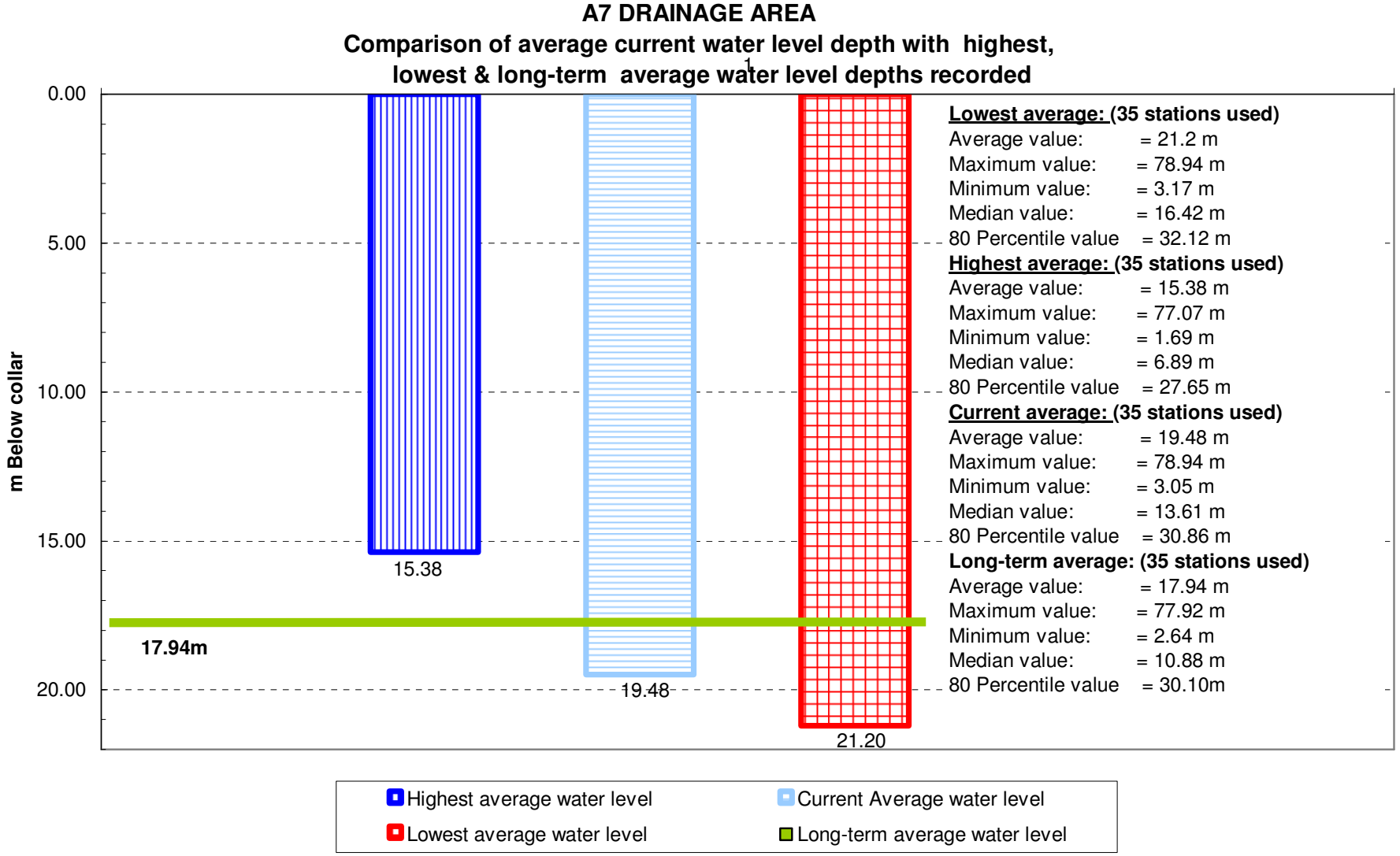

A7 DRAINAGE AREA
Deviation of water level depths: 1 November 2007 to 1 November 2008
A7N0586 A7N0633 A7N0637 A7N0644 A7N0645 A7N0649 A7N0646 A7N0636 A7N0641 A7N0648 A7N0650 A7N0632 A7N0019 A7N0642 A7N0539 A7N0593 A7N0638 A7N0561 A7N0634 A7N0630 A7N0524 A7N0639 A7N0538 A7N0525 A7N0631 A7N0629 A7N0029 A7N0635 A7N0549 A7N0628 A7N0643 A7N0041 A7N0652 A7N0647 A7N0651 A7N0655 A7N0654 A7N0653
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
Monitoring Stations
-1.87 -1.25 -1.21 -0.98 -0.9 -0.89 -0.70 -0.69 -0.66 -0.66 -0.60 -0.56 -0.52 -0.51 -0.50 -0.50 -0.49 -0.42 -0.32 -0.29 -0.26 -0.09 -0.07 0.02 0.15 0.22 0.26 0.37 0.43 1.36 1.79 2.95
Lower water levels
24 Stations
Average -0.97m
Higher water levels
9 Stations
Average 0.84m
Not data for the whole period 5 stations
Deviation in meter

GRAPH 12

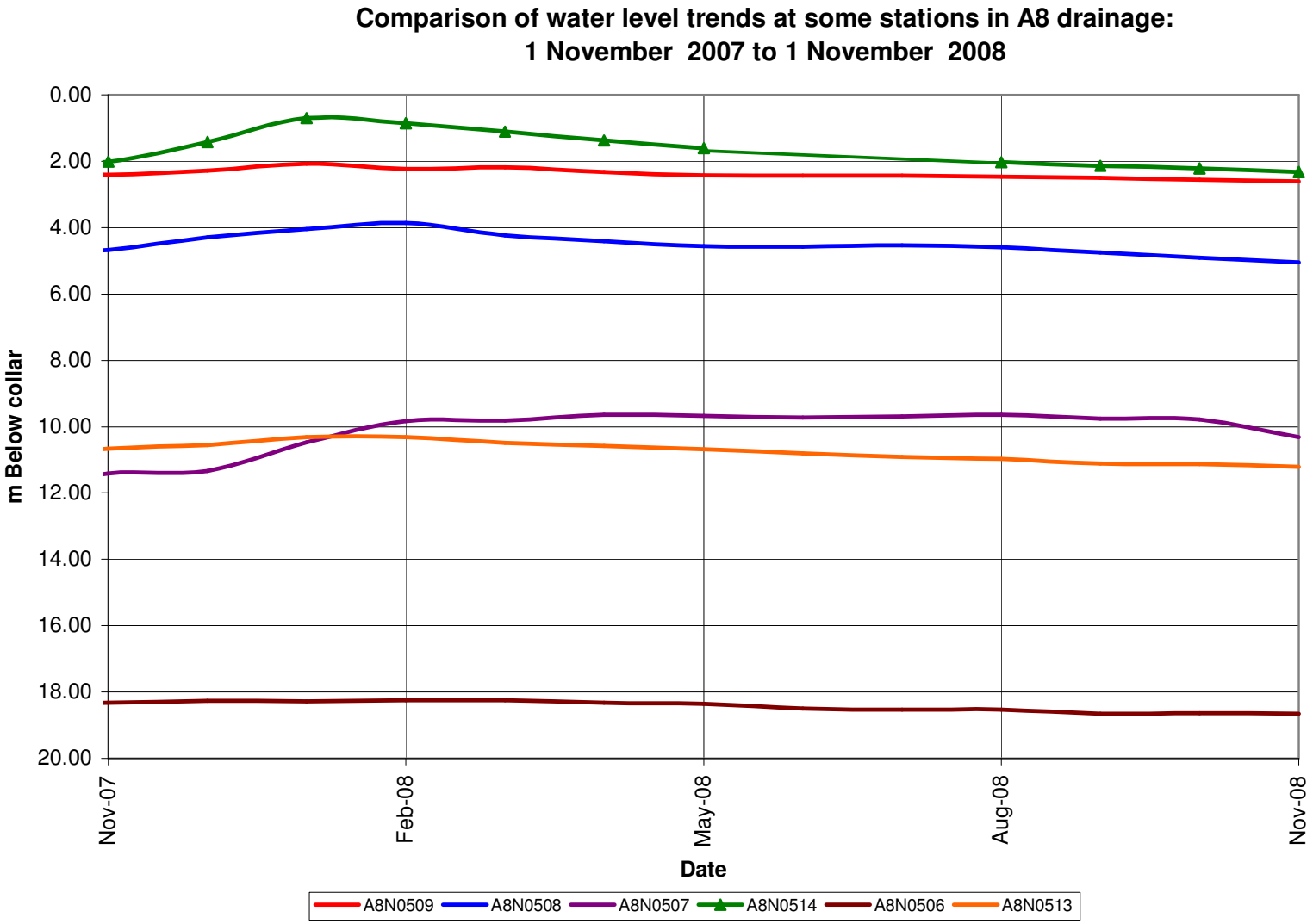
A7 DRAINAGE AREA
Comparison between water level depths: 1 November 2007,
1 May 2008 and 1 November 2008



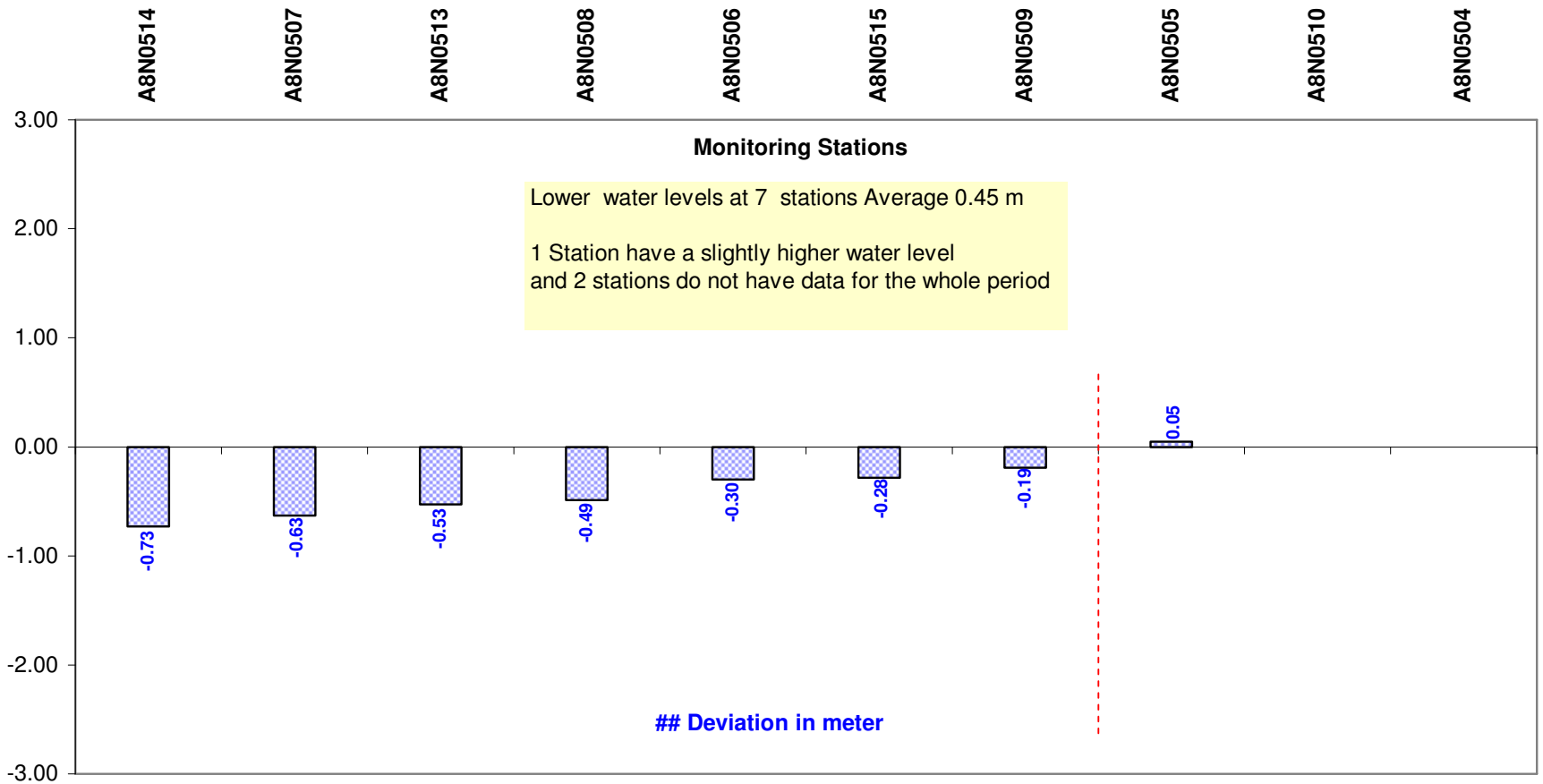
GRAPH 13


A7 DRAINAGE AREA
Comparison of average current water level depth with highest,
lowest & long-term average water level depths recorded
m Below collar
0.00
5.00
10.00
15.00
20.00
15.38
19.48
21.20
17.94m
Lowest average: (35 stations used)
Average value: = 21.2 m
Maximum value: = 78.94 m
Minimum value: = 3.17 m
Median value: = 16.42 m
80 Percentile value = 32.12 m
Highest average: (35 stations used)
Average value: = 15.38 m
Maximum value: = 77.07 m
Minimum value: = 1.69 m
Median value: = 6.89 m
80 Percentile value = 27.65 m
Current average: (35 stations used)
Average value: = 19.48 m
Maximum value: = 78.94 m
Minimum value: = 3.05 m
Median value: = 13.61 m
80 Percentile value = 30.86 m
Long-term average: (35 stations used)
Average value: = 17.94 m
Maximum value: = 77.92 m
Minimum value: = 2.64 m
Median value: = 10.88 m
80 Percentile value = 30.10m
Highest average water level
Current Average water level
Lowest average water level
Long-term average water level

GRAPH 14

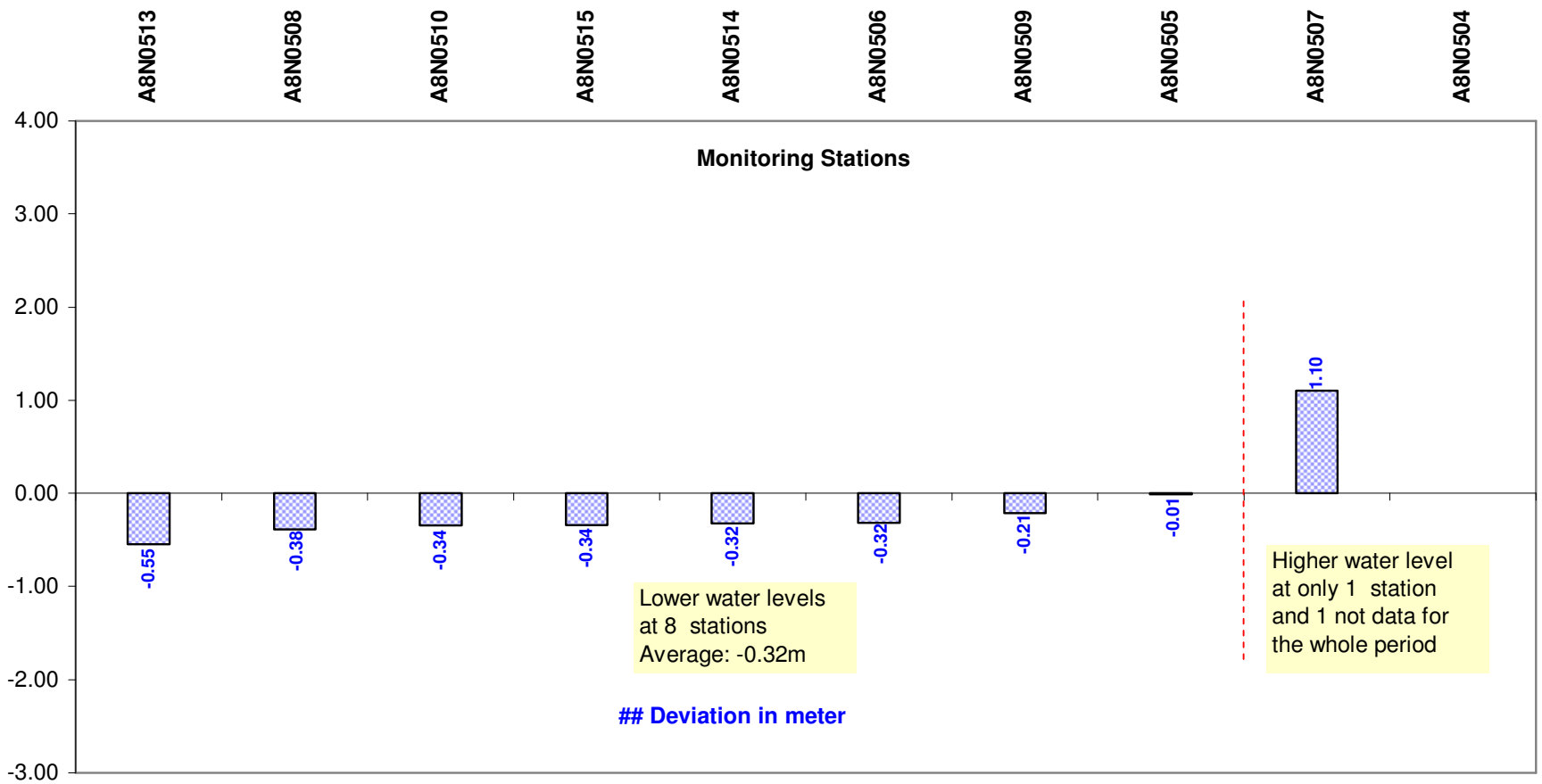

Comparison of water level trends at some stations in A8 drainage:
1 November 2007 to 1 November 2008
m Below collar
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
A8N0509
A8N0508
A8N0507
A8N0514
A8N0506
A8N0513

GRAPH 15

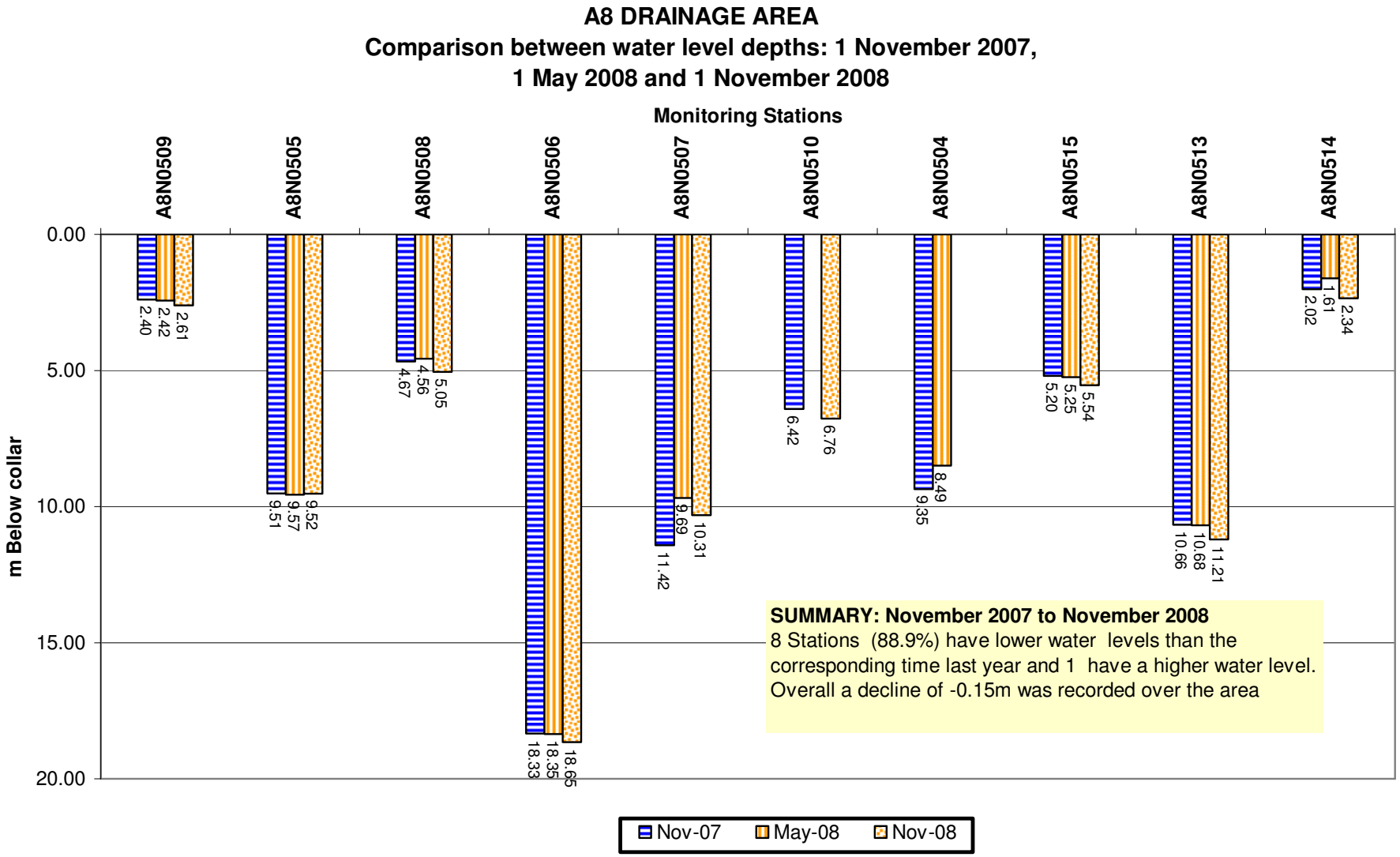

A8 DRAINAGE AREA
Deviation of water level depths: 1 May 2008 to 1 November 2008
A8N0514
A8N0507
A8N0513
A8N0508
A8N0506
A8N0515
A8N0509
A8N0505
A8N0510
A8N0504
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Monitoring Stations
Lower water levels at 7 stations Average 0.45 m
1 Station have a slightly higher water level
and 2 stations do not have data for the whole period
-0.73
-0.63
-0.53
-0.49
-0.30
-0.28
-0.19
0.05
Deviation in meter

GRAPH 16

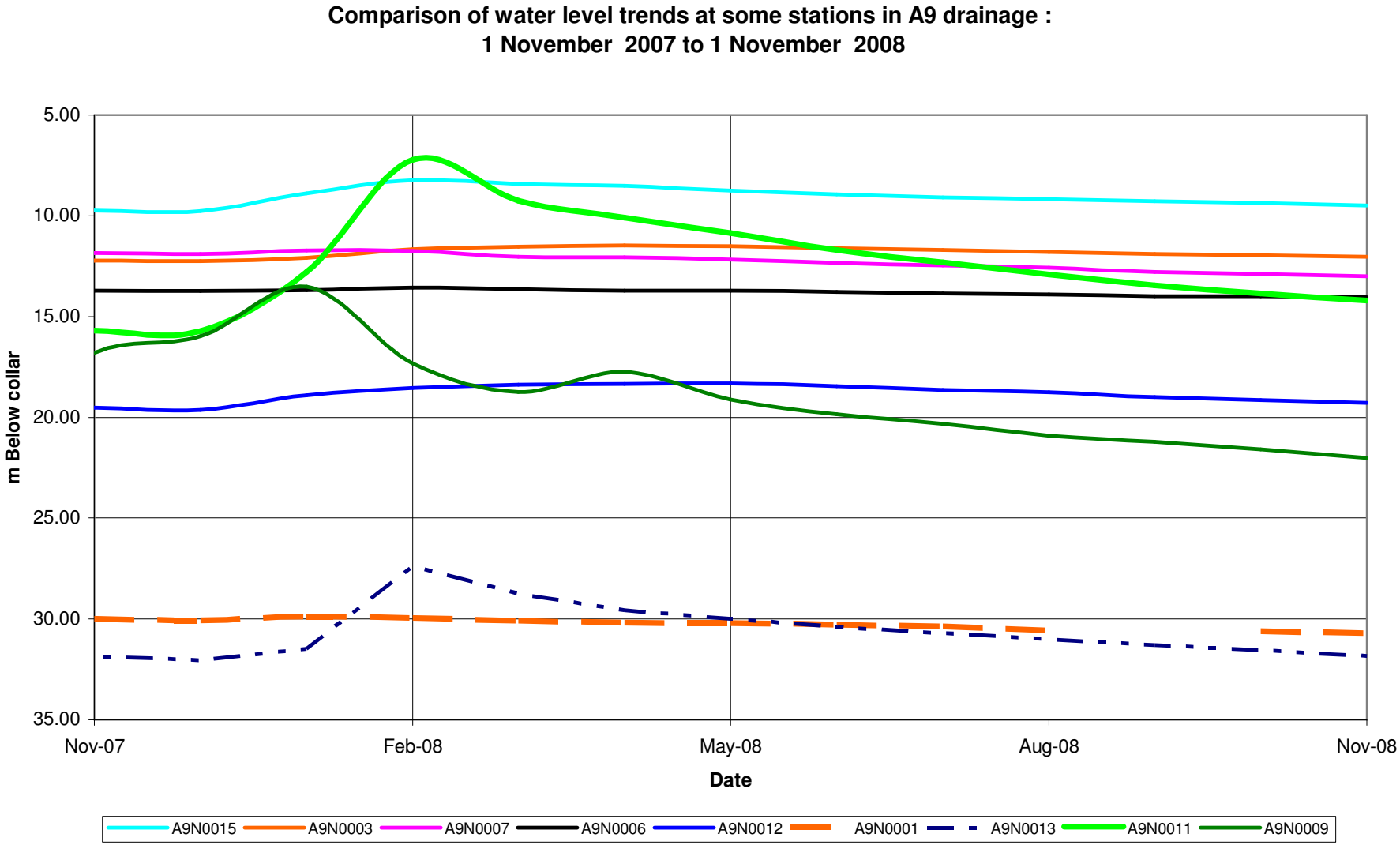
A8 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008



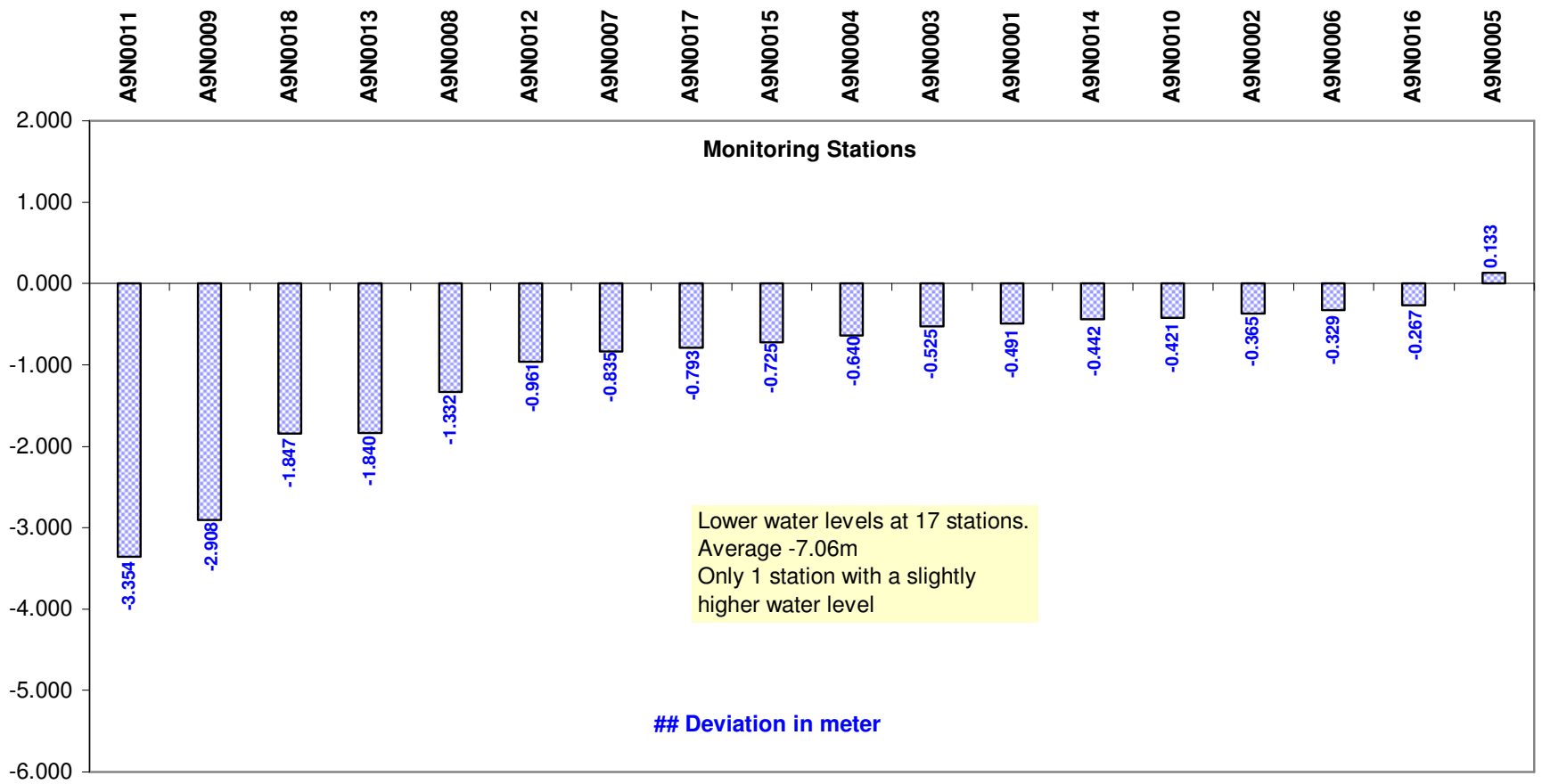
GRAPH 17


A8 DRAINAGE AREA
Comparison between water level depths: 1 November 2007,
1 May 2008 and 1 November 2008
Monitoring Stations
A8N0509
A8N0505
A8N0508
A8N0506
A8N0507
A8N0510
A8N0504
A8N0515
A8N0513
A8N0514
m Below collar
0.00
5.00
10.00
15.00
20.00
2.40
2.42
2.61
9.51
9.57
9.52
4.67
4.56
5.05
18.33
18.35
18.65
11.42
9.69
10.31
6.42
6.76
9.35
8.49
5.20
5.25
5.54
10.66
10.68
11.21
2.02
1.61
2.34
SUMMARY: November 2007 to November 2008
8 Stations (88.9%) have lower water levels than the corresponding time last year and 1 have a higher water level.
Overall a decline of -0.15m was recorded over the area
Nov-07
May-08
Nov-08

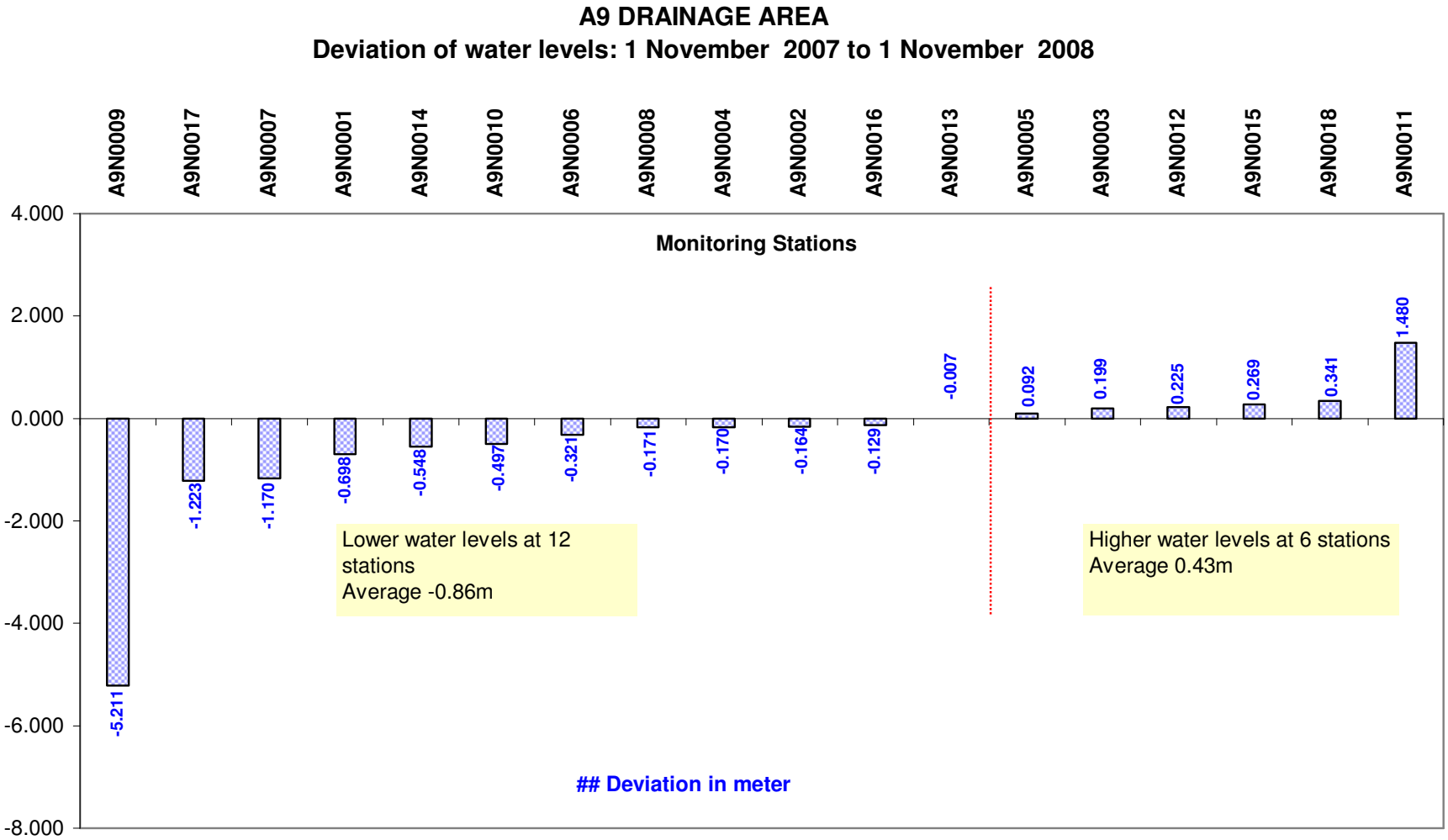
GRAPH 18


Comparison of water level trends at some stations in A9 drainage :
1 November 2007 to 1 November 2008
5.00
10.00
15.00
20.00
25.00
30.00
35.00
m Below collar
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
A9N0015
A9N0003
A9N0007
A9N0006
A9N0012
A9N0001
A9N0013
A9N0011
A9N0009

GRAPH 19

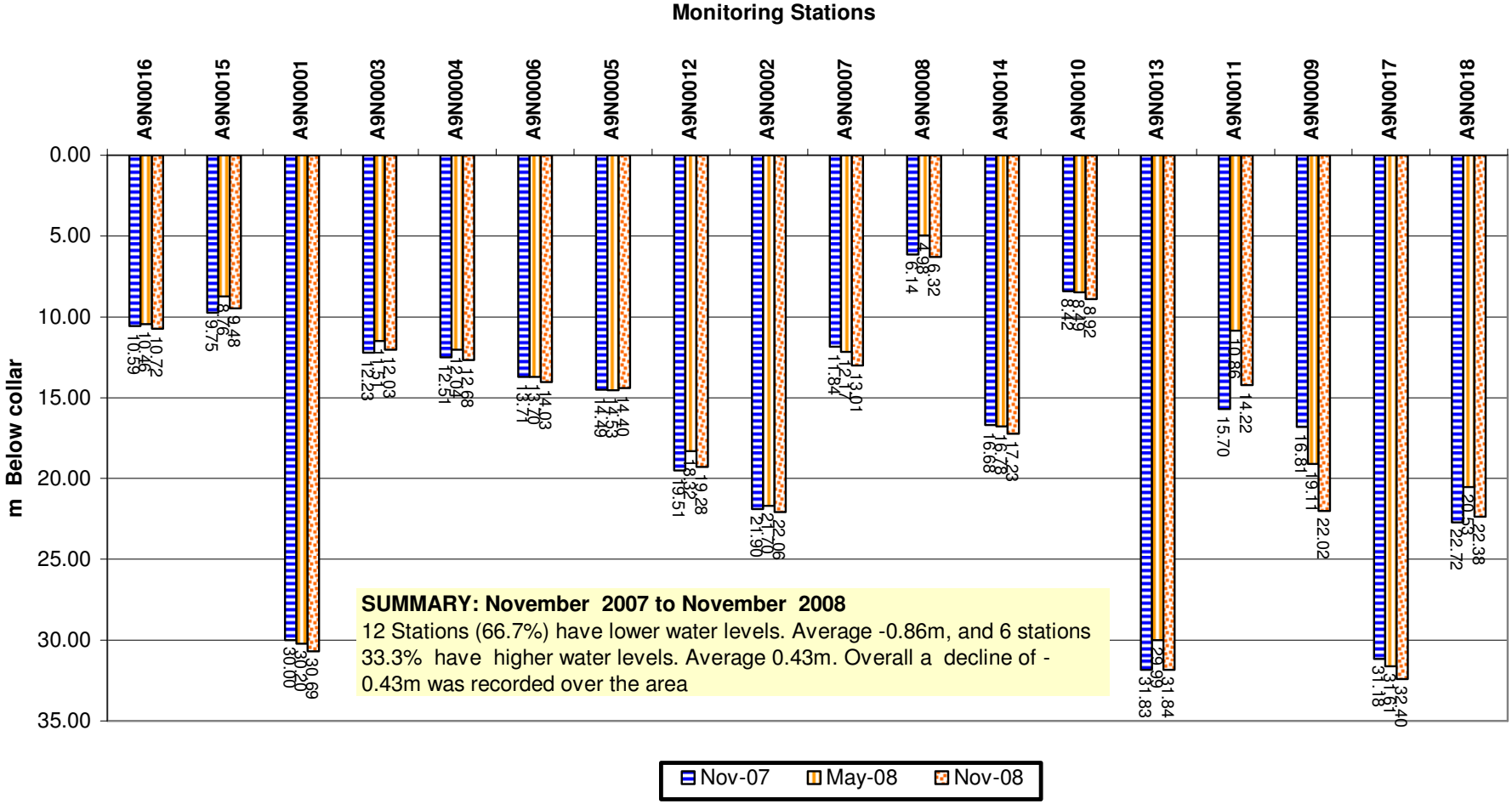

A9 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
A9N0011
A9N0009
A9N0018
A9N0013
A9N0008
A9N0012
A9N0007
A9N0017
A9N0015
A9N0004
A9N0003
A9N0001
A9N0014
A9N0010
A9N0002
A9N0006
A9N0016
A9N0005
2.000
1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
Monitoring Stations
-3.354
-2.908
-1.847
-1.840
-1.332
-0.961
-0.835
-0.793
-0.725
-0.640
-0.525
-0.491
-0.442
-0.421
-0.365
-0.329
-0.267
0.133
Lower water levels at 17 stations.
Average -7.06m
Only 1 station with a slightly
higher water level
Deviation in meter

GRAPH 20

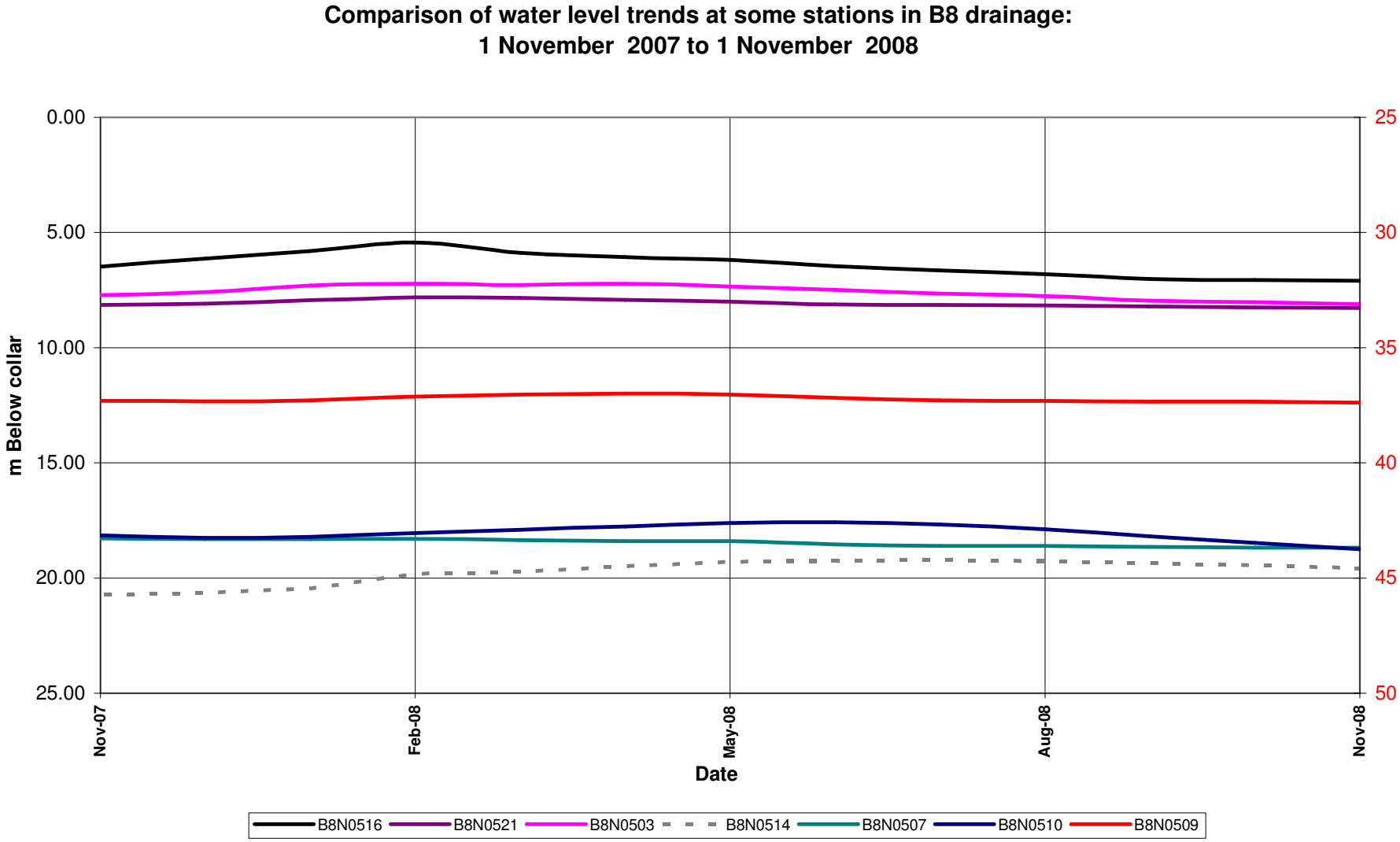

A9 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
A9N0009
A9N0017
A9N0007
A9N0001
A9N0014
A9N0010
A9N0006
A9N0008
A9N0004
A9N0002
A9N0016
A9N0013
A9N0005
A9N0003
A9N0012
A9N0015
A9N0018
A9N0011
4.000
2.000
0.000
-2.000
-4.000
-6.000
-8.000
Monitoring Stations
-5.211
-1.223
-1.170
-0.698
-0.548
-0.497
-0.321
-0.171
-0.170
-0.164
-0.129
-0.007
0.092
0.199
0.225
0.269
0.341
1.480
Lower water levels at 12 stations
Average -0.86m
Higher water levels at 6 stations
Average 0.43m
Deviation in meter

GRAPH 21

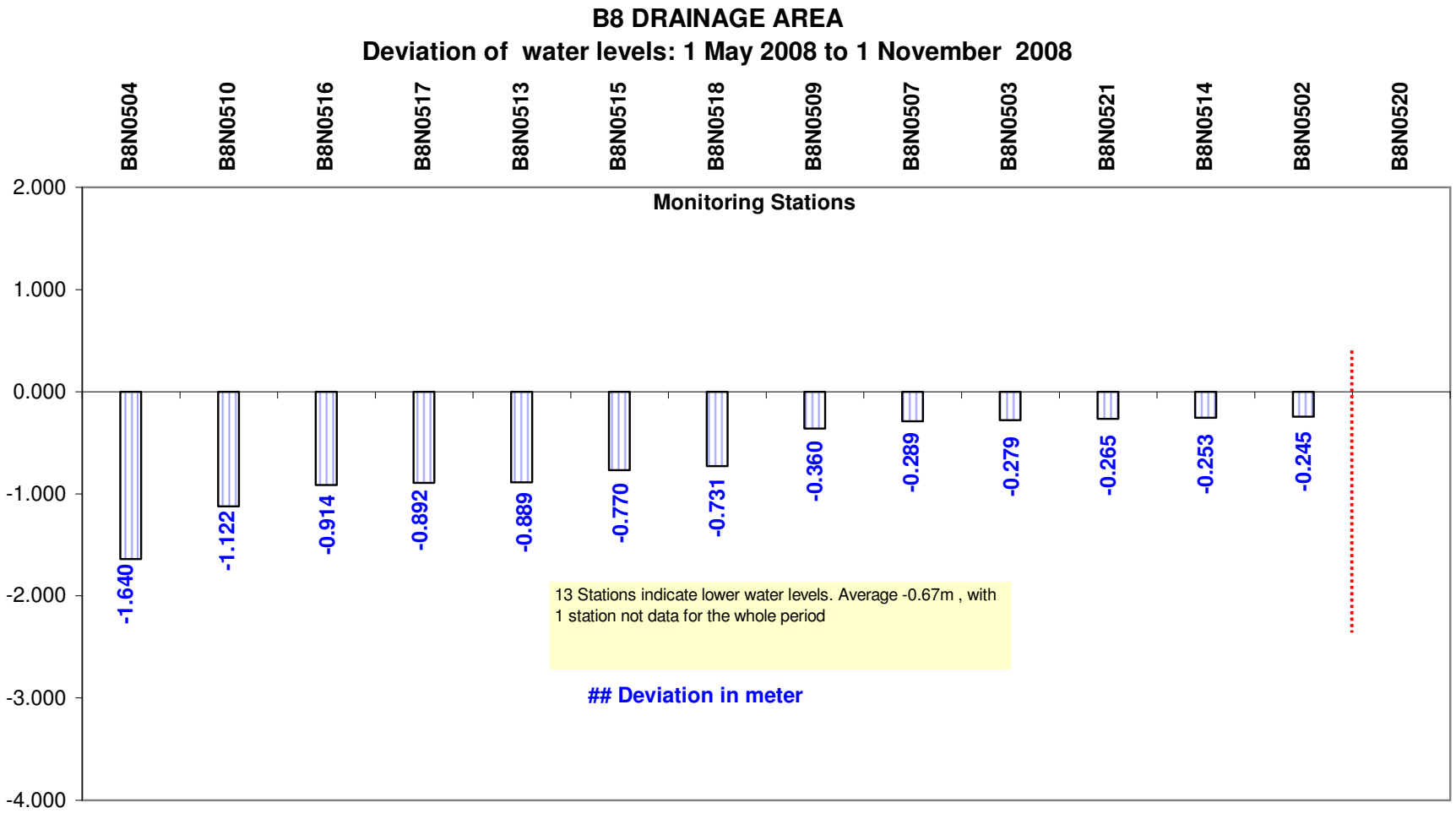
A9 DRAINAGE AREA
Comparison between water level depths: 1 November 2007, 1 May 2008 and 1 November 2008



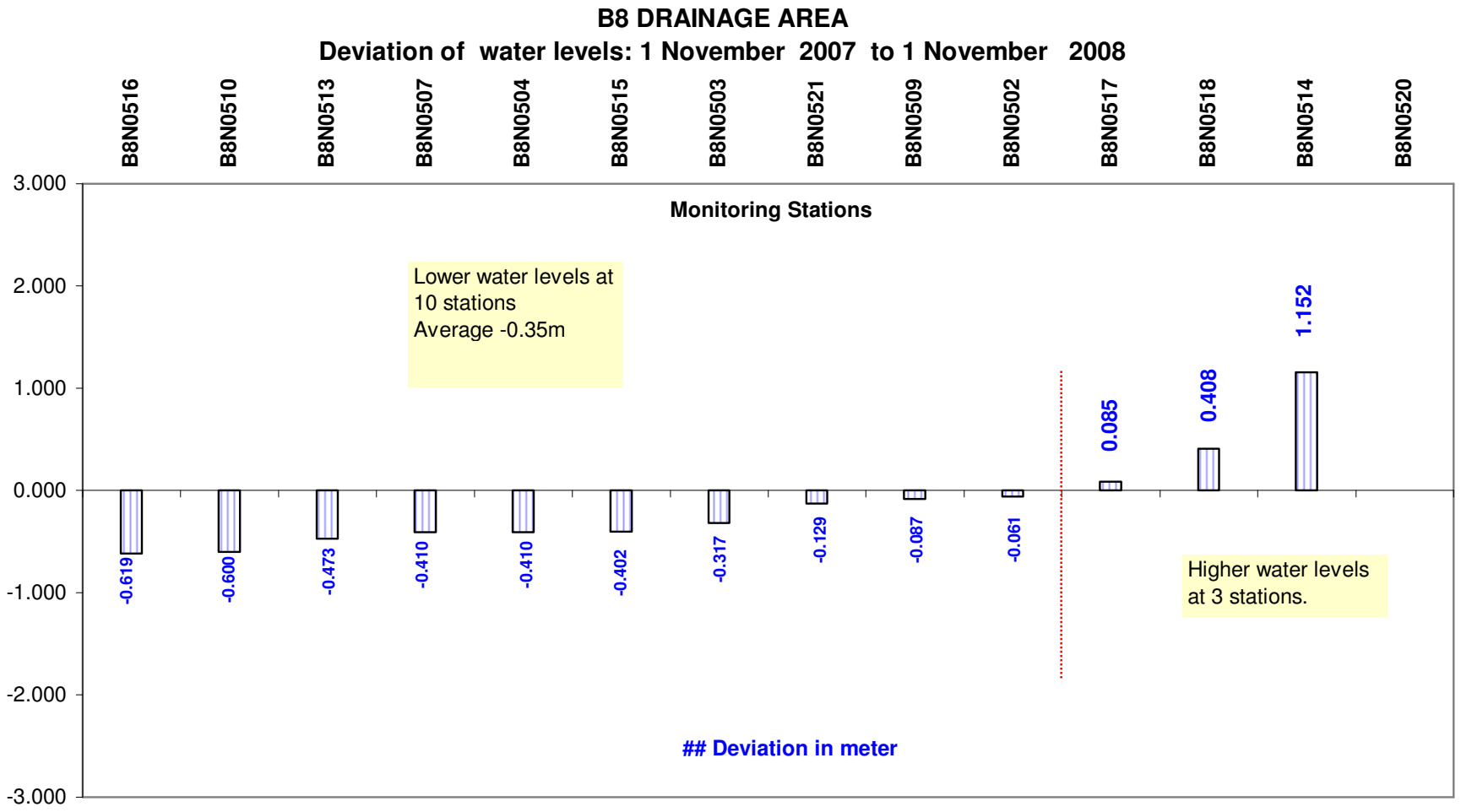
GRAPH 22


Comparison of water level trends at some stations in B8 drainage:
1 November 2007 to 1 November 2008
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
25
30
35
40
45
50
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
B8N0516
B8N0521
B8N0503
B8N0514
B8N0507
B8N0510
B8N0509

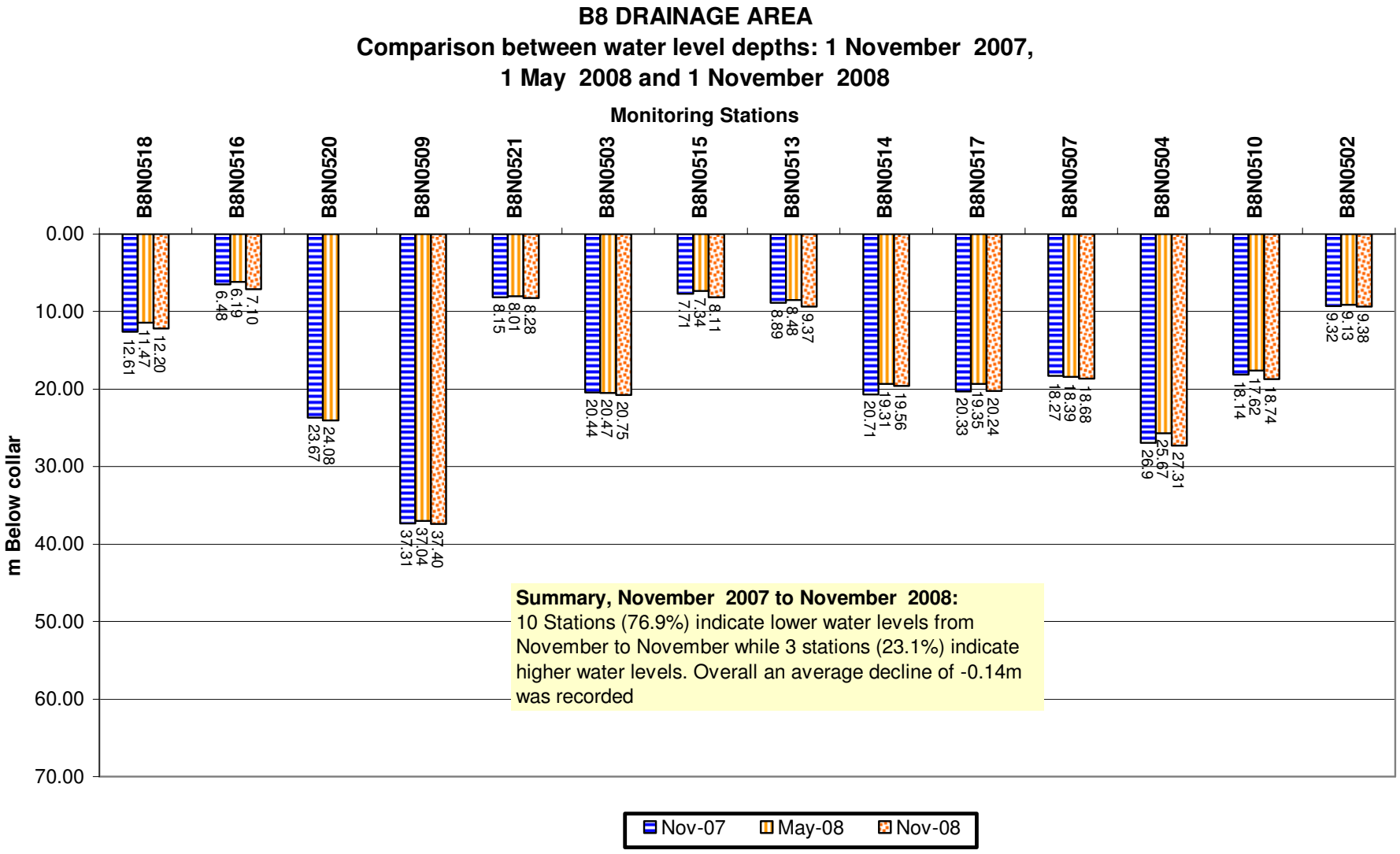
GRAPH 23


B8 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
B8N0504
B8N0510
B8N0516
B8N0517
B8N0513
B8N0515
B8N0518
B8N0509
B8N0507
B8N0503
B8N0521
B8N0514
B8N0502
B8N0520
2.000
1.000
0.000
-1.000
-2.000
-3.000
-4.000
Monitoring Stations
-1.640
-1.122
-0.914
-0.892
-0.889
-0.770
-0.731
-0.360
-0.289
-0.279
-0.265
-0.253
-0.245
13 Stations indicate lower water levels. Average -0.67m , with
1 station not data for the whole period
Deviation in meter

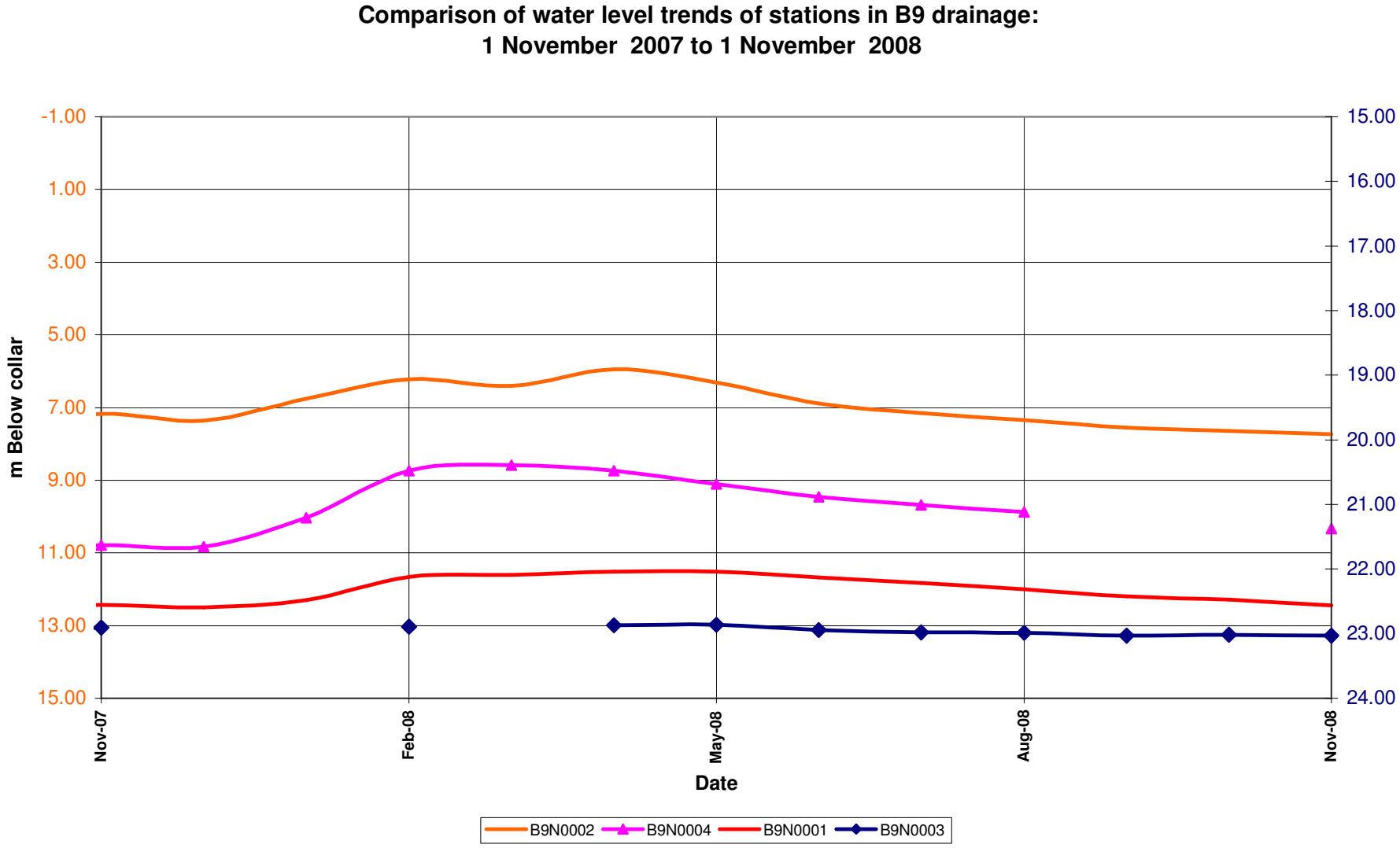
GRAPH 24


B8 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
B8N0516
B8N0510
B8N0513
B8N0507
B8N0504
B8N0515
B8N0503
B8N0521
B8N0509
B8N0502
B8N0517
B8N0518
B8N0514
B8N0520
3.000
2.000
1.000
0.000
-1.000
-2.000
-3.000
Monitoring Stations
Lower water levels at 10 stations
Average -0.35m
-0.619
-0.600
-0.473
-0.410
-0.410
-0.402
-0.317
-0.129
-0.087
-0.061
0.085
0.408
1.152
Higher water levels at 3 stations.
Deviation in meter

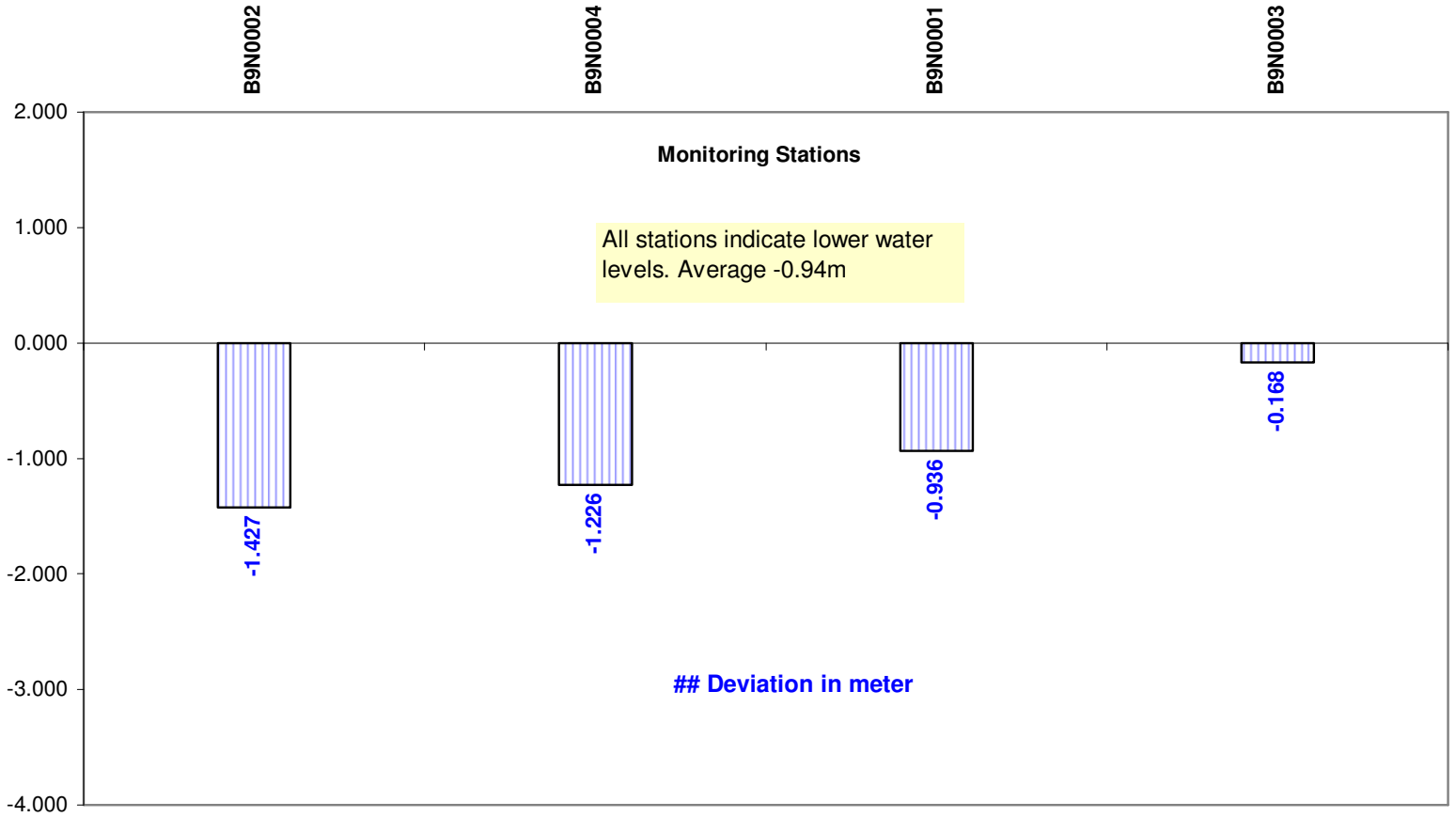
GRAPH 25


B8 DRAINAGE AREA
Comparison between water level depths: 1 November 2007,
1 May 2008 and 1 November 2008
Monitoring Stations
B8N0518
B8N0516
B8N0520
B8N0509
B8N0521
B8N0503
B8N0515
B8N0513
B8N0514
B8N0517
B8N0507
B8N0504
B8N0510
B8N0502
m Below collar
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
12.61
11.47
12.20
6.48
6.19
7.10
23.67
24.08
37.31
37.04
37.40
8.15
8.01
8.28
20.44
20.47
20.75
7.71
7.34
8.11
8.89
8.48
9.37
20.71
19.31
19.56
20.33
19.35
20.24
18.27
18.39
18.68
26.9
25.67
27.31
18.14
17.62
18.74
9.32
9.13
9.38
Summary, November 2007 to November 2008:
10 Stations (76.9%) indicate lower water levels from November to November while 3 stations (23.1%) indicate higher water levels. Overall an average decline of -0.14m was recorded
Nov-07
May-08
Nov-08

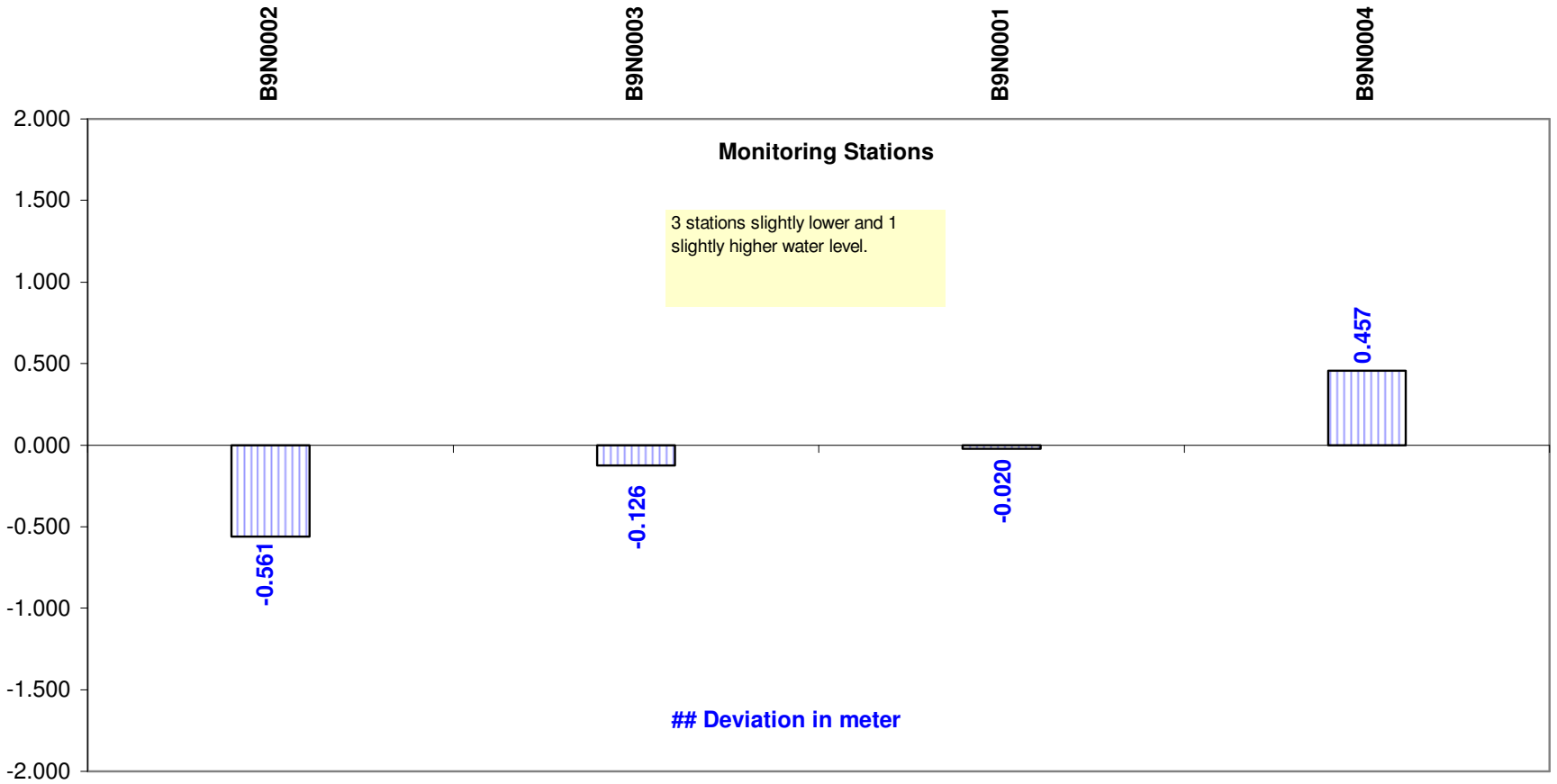
GRAPH 26


Comparison of water level trends of stations in B9 drainage:
1 November 2007 to 1 November 2008
m Below collar
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
13.00
15.00
15.00
16.00
17.00
18.00
19.00
20.00
21.00
22.00
23.00
24.00
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
B9N0002
B9N0004
B9N0001
B9N0003

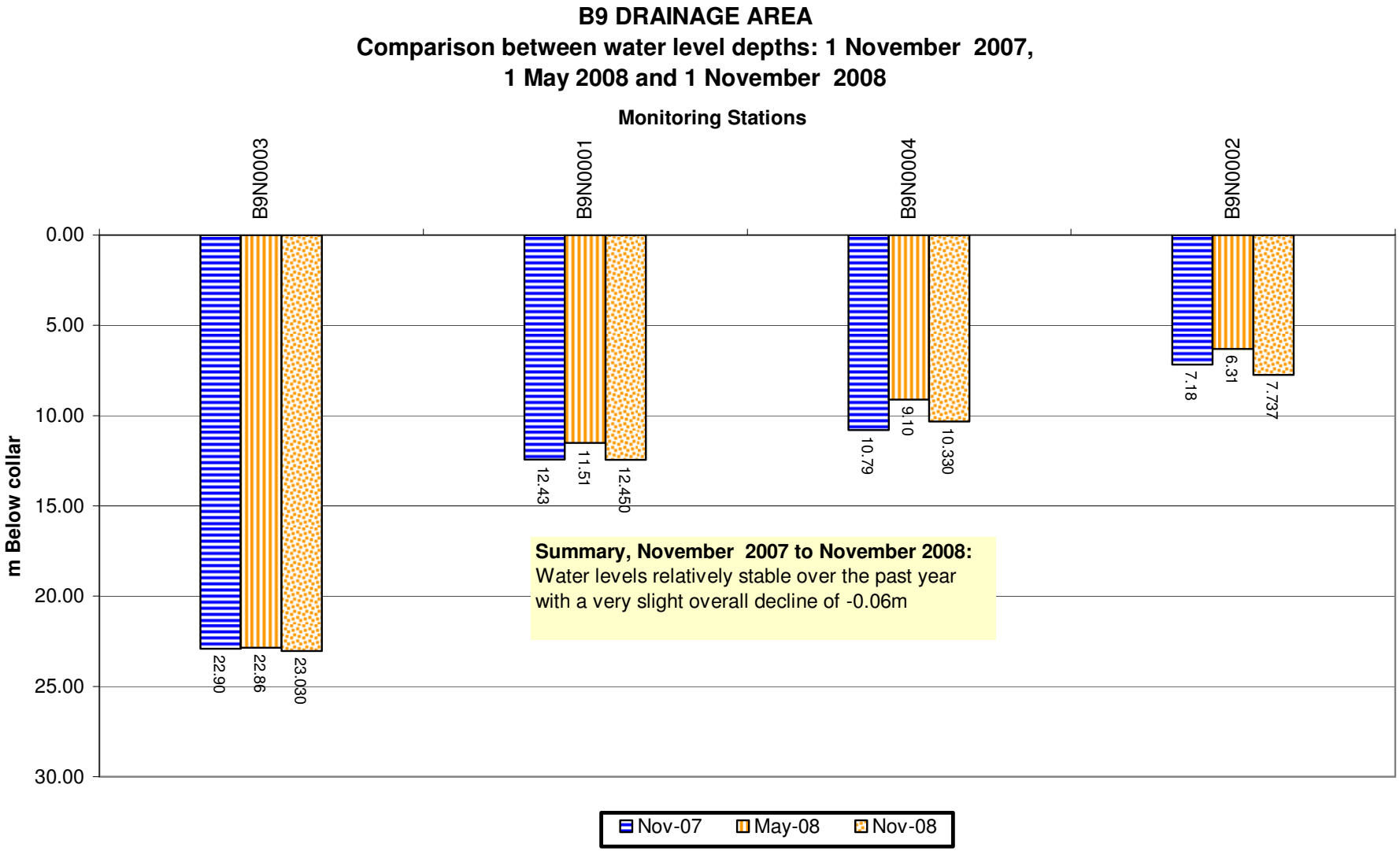
GRAPH 27


B9 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
B9N0002
B9N0004
B9N0001
B9N0003
2.000
1.000
0.000
-1.000
-2.000
-3.000
-4.000
Monitoring Stations
All stations indicate lower water levels. Average -0.94m
-1.427
-1.226
-0.936
-0.168
Deviation in meter

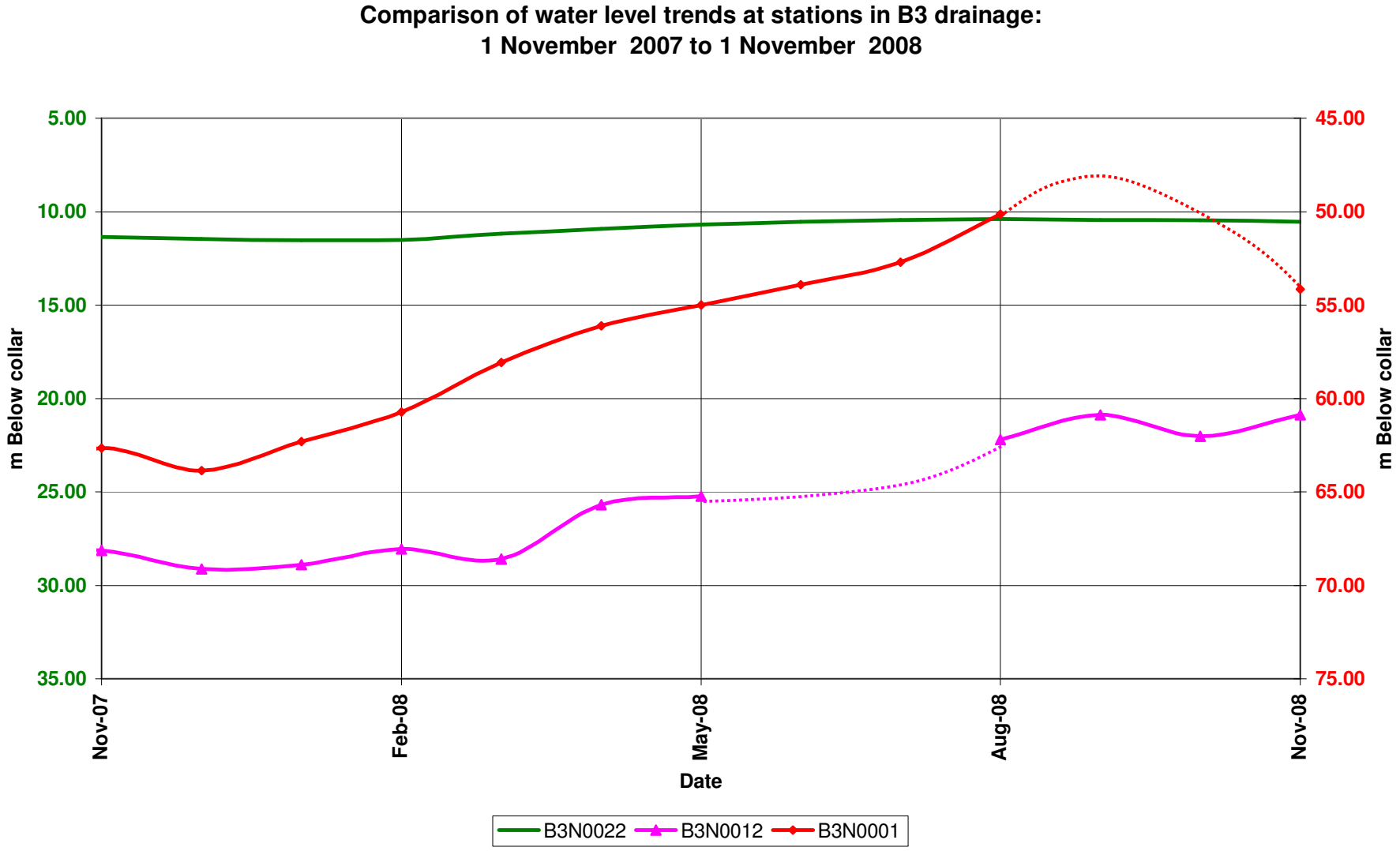
GRAPH 28


B9 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
B9N0002
B9N0003
B9N0001
B9N0004
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
-1.500
-2.000
Monitoring Stations
3 stations slightly lower and 1 slightly higher water level.
-0.561
-0.126
-0.020
0.457
Deviation in meter

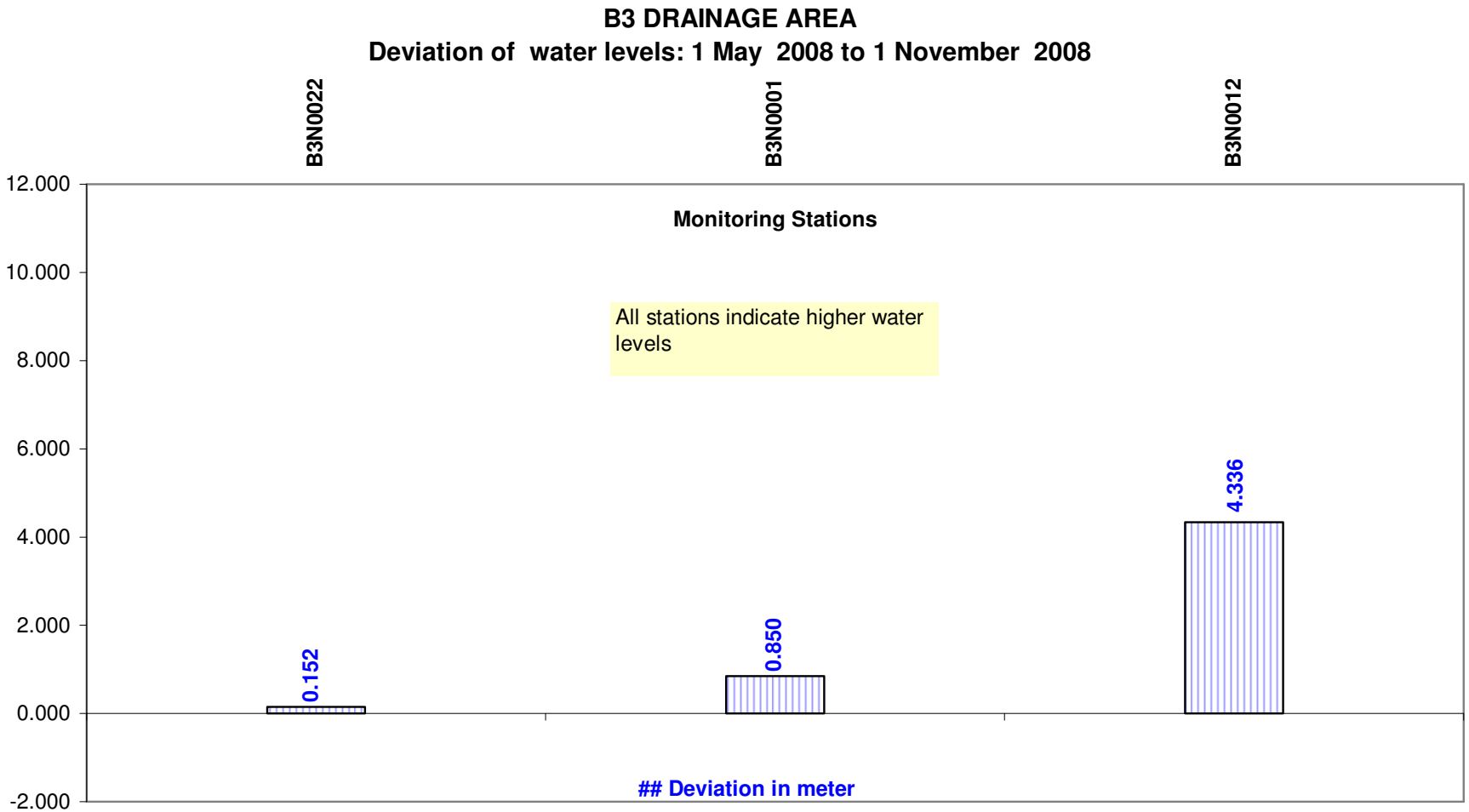
GRAPH 29


B9 DRAINAGE AREA
Comparison between water level depths: 1 November 2007,
1 May 2008 and 1 November 2008
Monitoring Stations
B9N0003
B9N0001
B9N0004
B9N0002
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
30.00
22.90
22.86
23.030
12.43
11.51
12.450
10.79
9.10
10.330
7.18
6.31
7.737
Summary, November 2007 to November 2008:
Water levels relatively stable over the past year
with a very slight overall decline of -0.06m
Nov-07
May-08
Nov-08

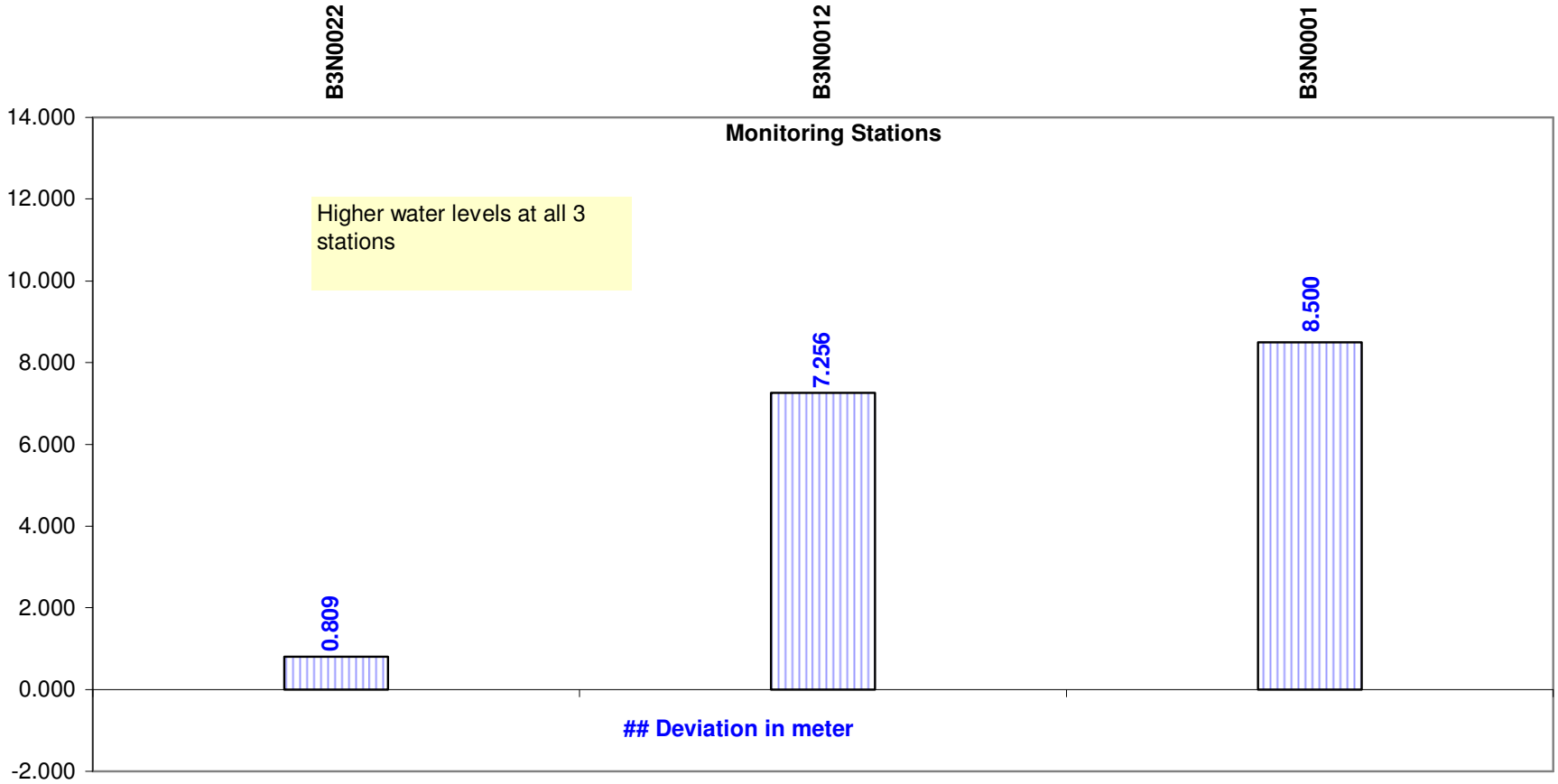
GRAPH 30


Comparison of water level trends at stations in B3 drainage:
1 November 2007 to 1 November 2008
5.00
10.00
15.00
20.00
25.00
30.00
35.00
m Below collar
45.00
50.00
55.00
60.00
65.00
70.00
75.00
m Below collar
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
B3N0022
B3N0012
B3N0001

GRAPH 31

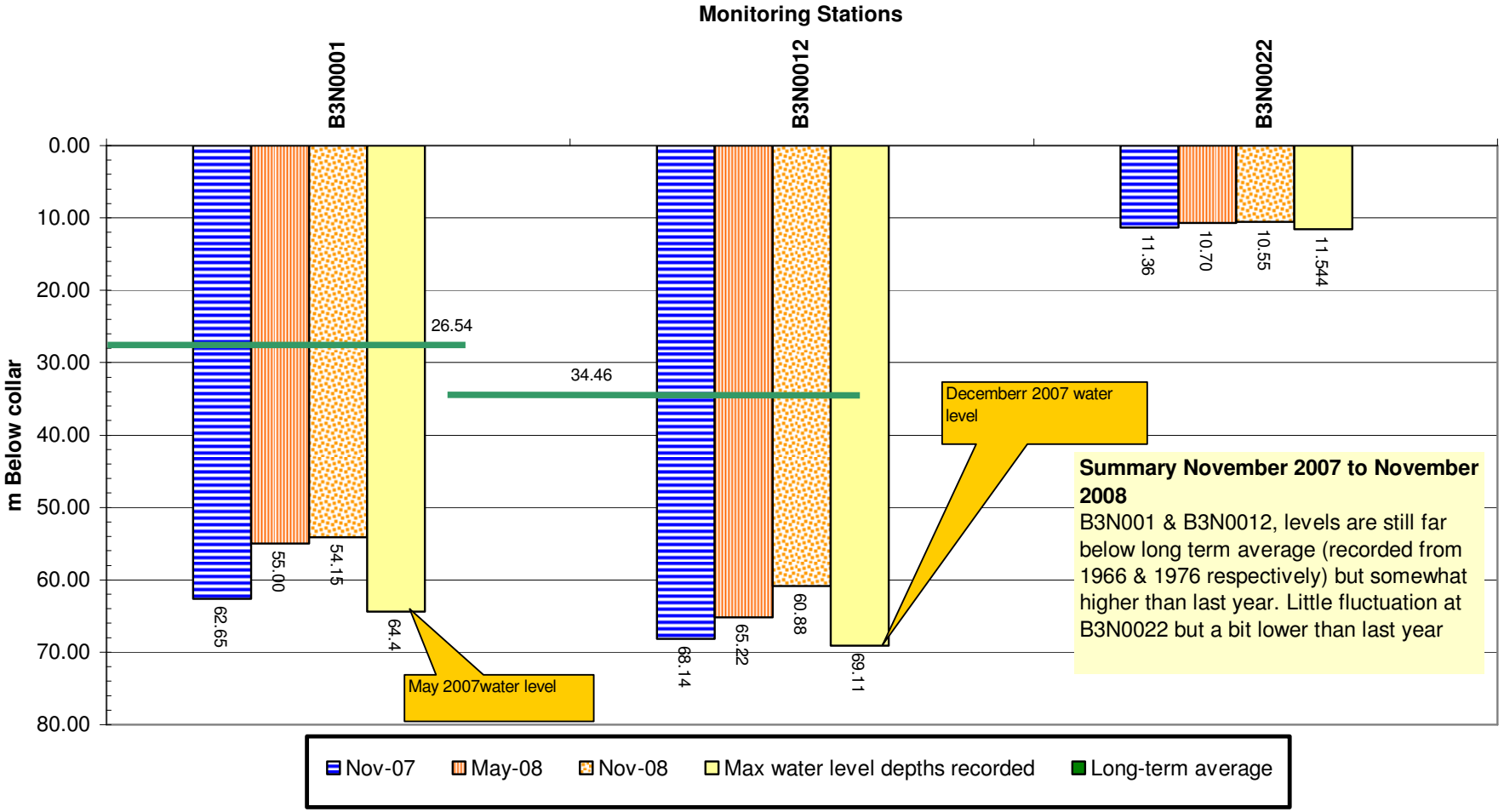

B3 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
B3N0022
B3N0001
B3N0012
12.000
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
Monitoring Stations
All stations indicate higher water levels
0.152
0.850
4.336
Deviation in meter

GRAPH 32

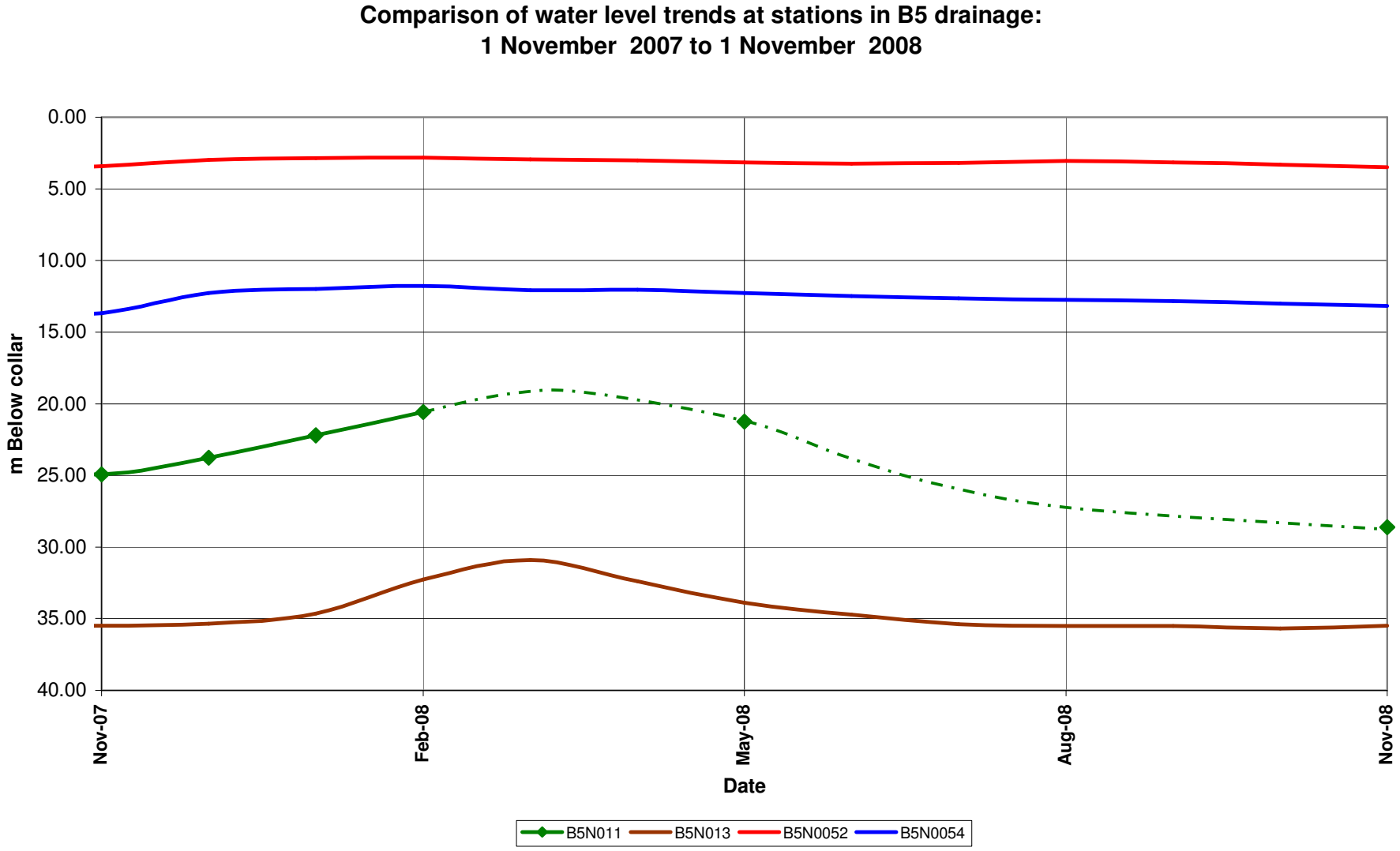

B3 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
B3N0022
B3N0012
B3N0001
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
Monitoring Stations
Higher water levels at all 3 stations
0.809
7.256
8.500
Deviation in meter

GRAPH 33

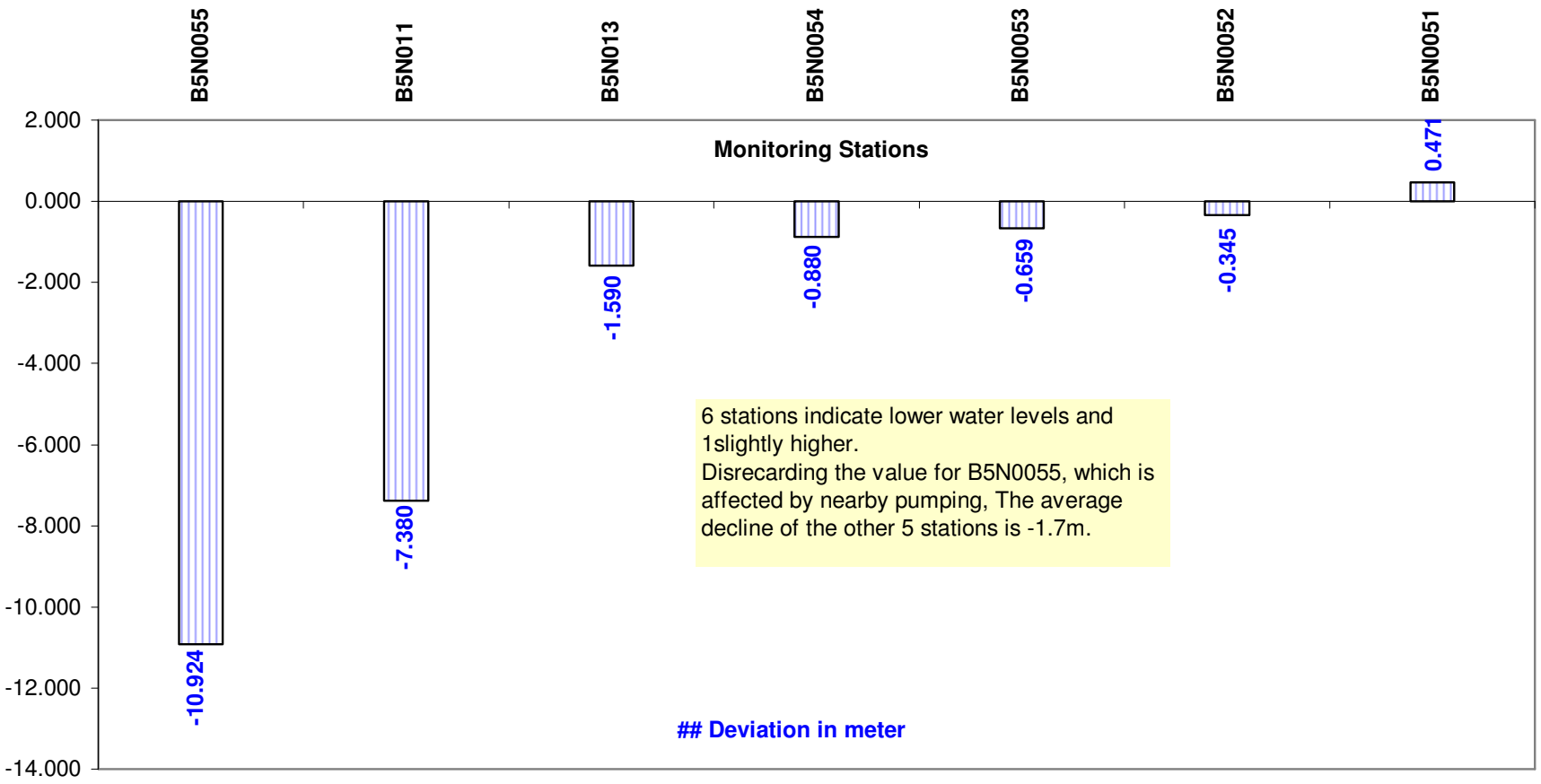
B3 DRAINAGE AREA
Comparison between water level depths: 1 November 2007
1 May 2008, 1 November 2008 and maximum depths recorded



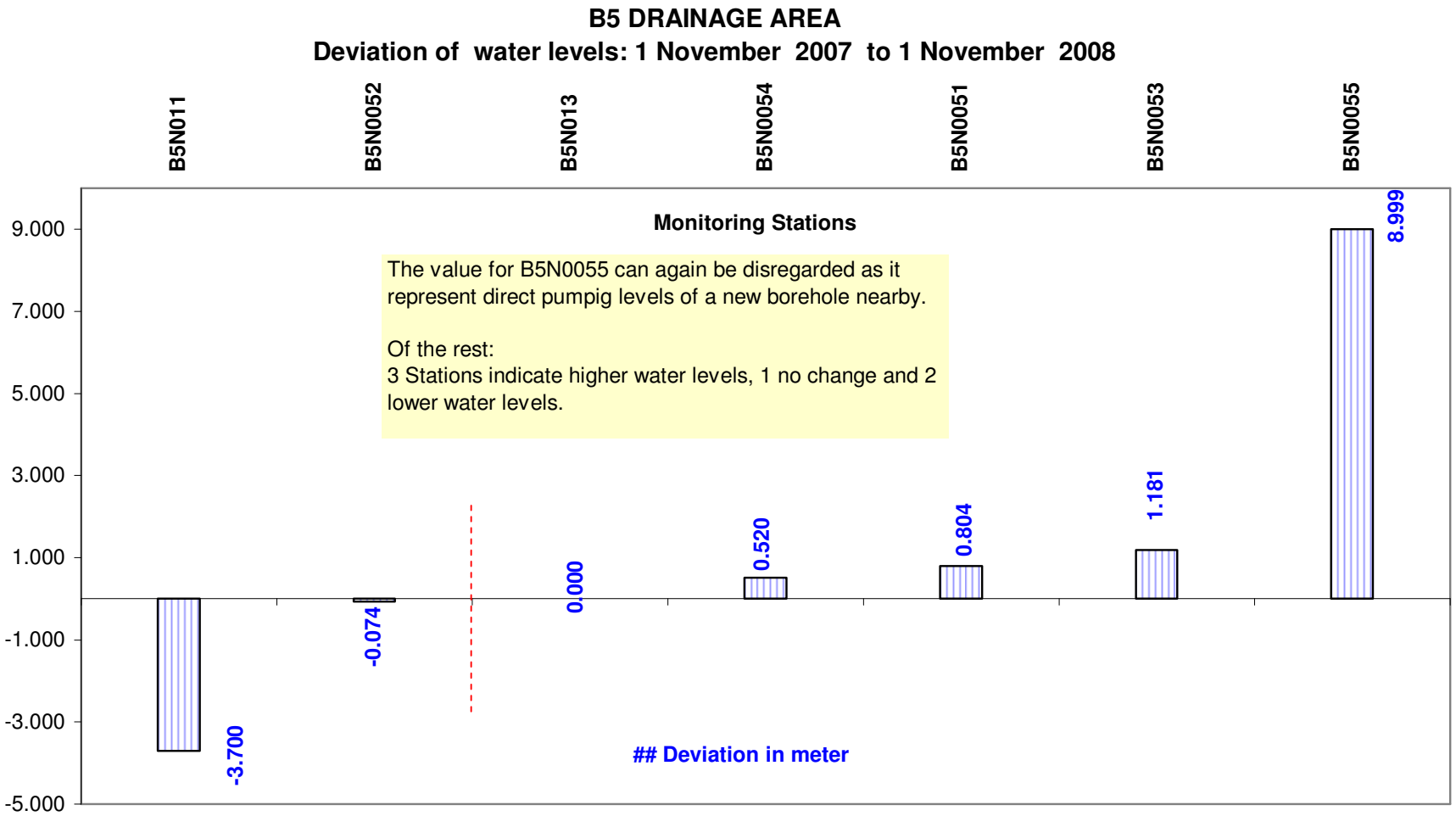
GRAPH 34


Comparison of water level trends at stations in B5 drainage:
1 November 2007 to 1 November 2008
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
m Below collar
Nov-07
Feb-08
May-08
Aug-08
Nov-08
Date
B5N011
B5N013
B5N0052
B5N0054

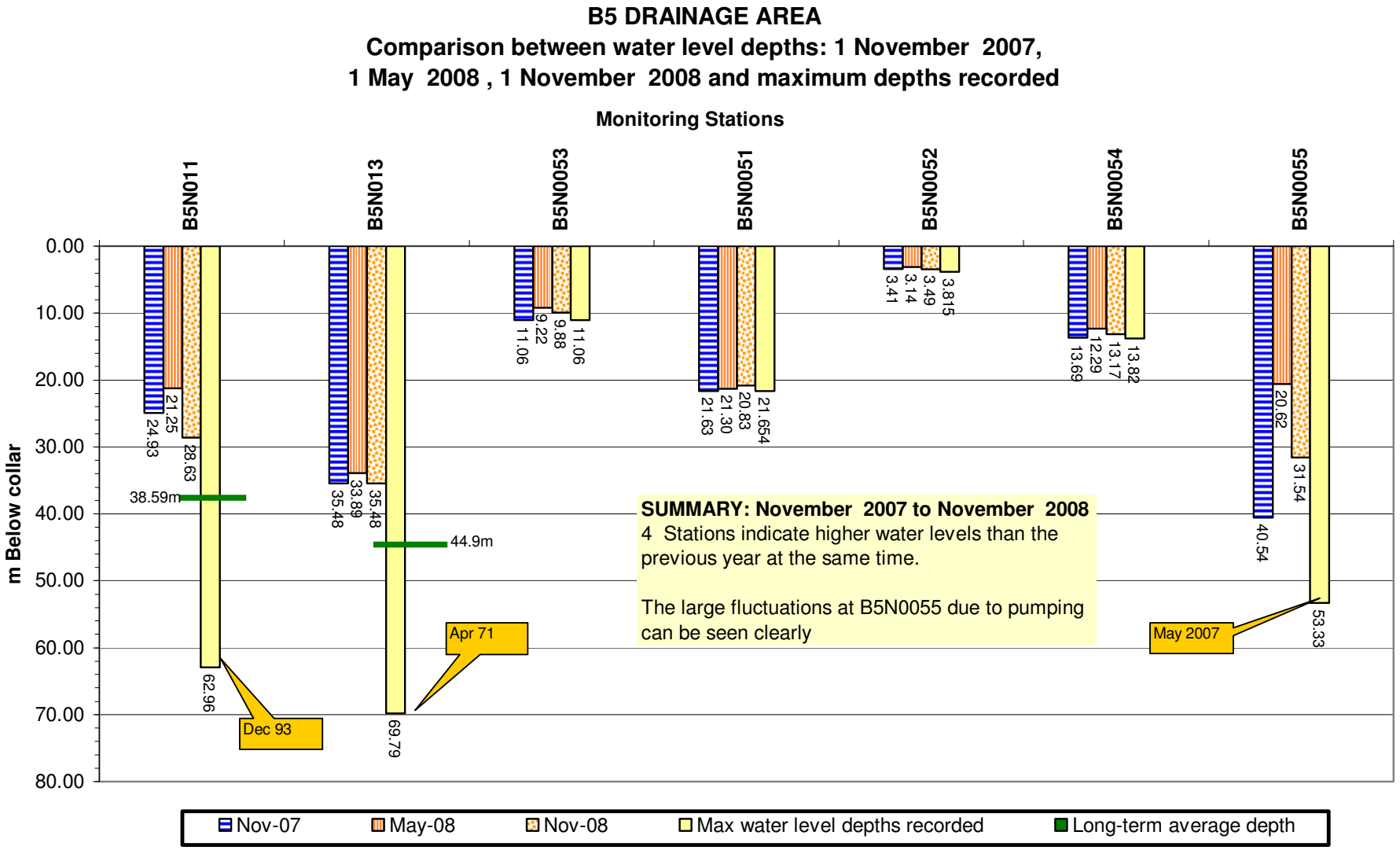
GRAPH 35


B5 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
B5N0055
B5N011
B5N013
B5N0054
B5N0053
B5N0052
B5N0051
2.000
0.000
-2.000
-4.000
-6.000
-8.000
-10.000
-12.000
-14.000
Monitoring Stations
-10.924
-7.380
-1.590
-0.880
-0.659
-0.345
0.471
6 stations indicate lower water levels and 1slightly higher.
Disrecarding the value for B5N0055, which is affected by nearby pumping, The average decline of the other 5 stations is -1.7m.
Deviation in meter

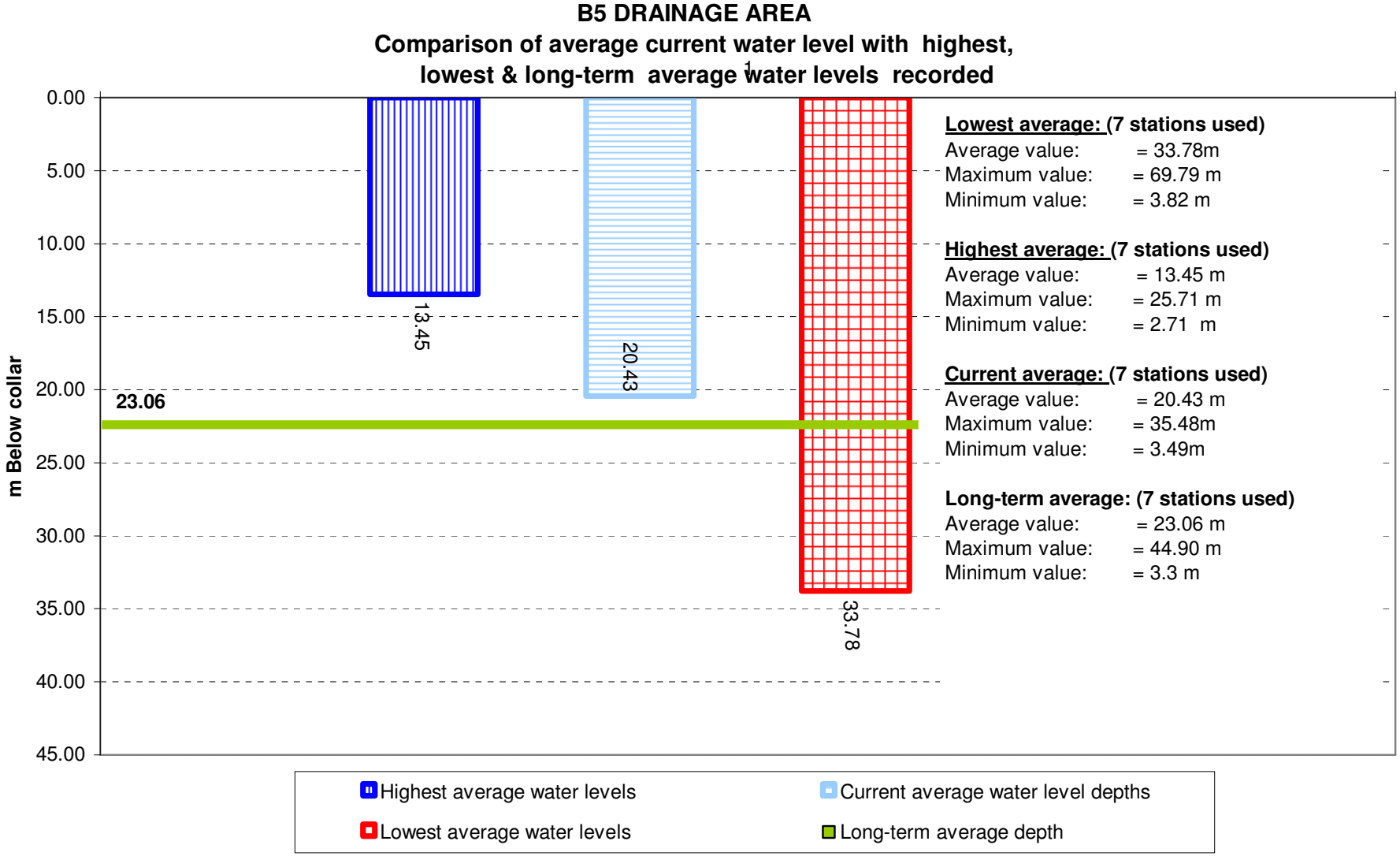
GRAPH 36


B5 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008
B5N011
B5N0052
B5N013
B5N0054
B5N0051
B5N0053
B5N0055
9.000
7.000
5.000
3.000
1.000
-1.000
-3.000
-5.000
Monitoring Stations
The value for B5N0055 can again be disregarded as it represent direct pumpig levels of a new borehole nearby.
Of the rest:
3 Stations indicate higher water levels, 1 no change and 2 lower water levels.
-3.700
-0.074
0.000
0.520
0.804
1.181
8.999
Deviation in meter

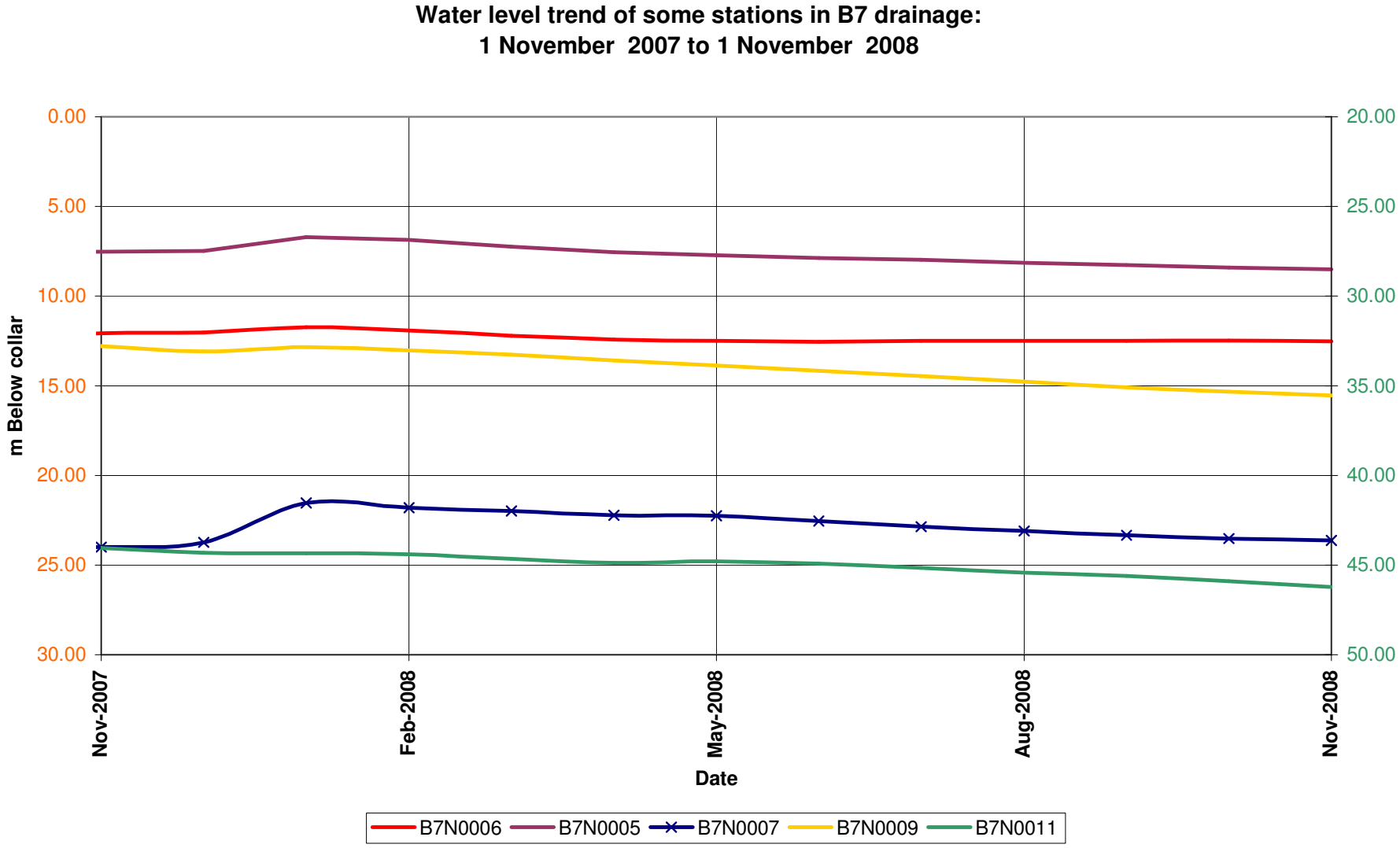
GRAPH 37


B5 DRAINAGE AREA
Comparison between water level depths: 1 November 2007,
1 May 2008 , 1 November 2008 and maximum depths recorded
Monitoring Stations
B5N011
B5N013
B5N0053
B5N0051
B5N0052
B5N0054
B5N0055
m Below collar
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
24.93
21.25
28.63
62.96
38.59m
35.48
33.89
35.48
69.79
44.9m
11.06
9.22
9.88
11.06
21.63
21.30
20.83
21.654
3.41
3.14
3.49
3.815
13.69
12.29
13.17
13.82
40.54
20.62
31.54
53.33
Dec 93
Apr 71
May 2007
SUMMARY: November 2007 to November 2008
4 Stations indicate higher water levels than the previous year at the same time.
The large fluctuations at B5N0055 due to pumping can be seen clearly
Nov-07
May-08
Nov-08
Max water level depths recorded
Long-term average depth

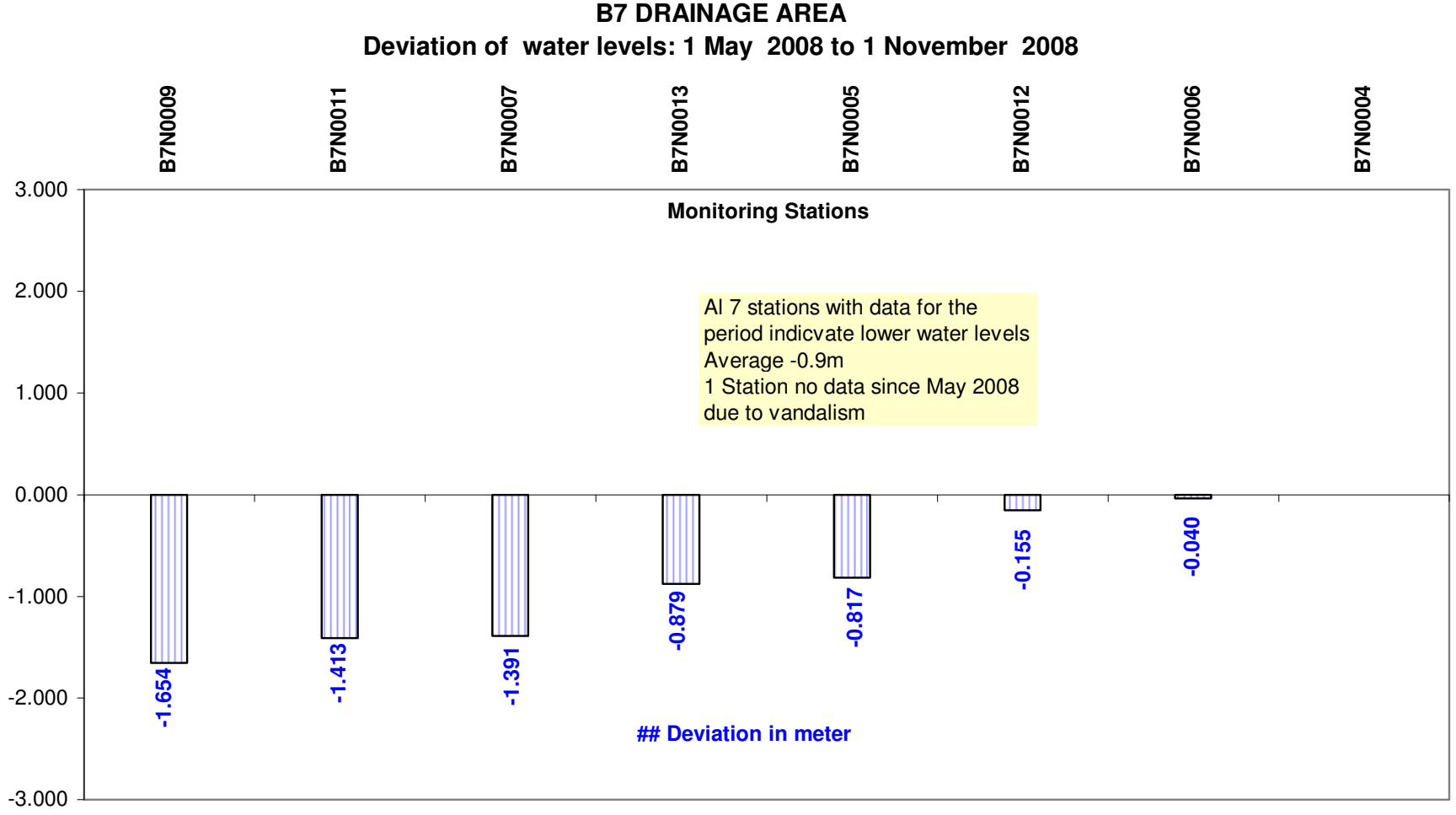
GRAPH 38


B5 DRAINAGE AREA
Comparison of average current water level with highest,
lowest & long-term average water levels recorded
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
13.45
20.43
33.78
23.06
Lowest average: (7 stations used)
Average value: = 33.78m
Maximum value: = 69.79 m
Minimum value: = 3.82 m
Highest average: (7 stations used)
Average value: = 13.45 m
Maximum value: = 25.71 m
Minimum value: = 2.71 m
Current average: (7 stations used)
Average value: = 20.43 m
Maximum value: = 35.48m
Minimum value: = 3.49m
Long-term average: (7 stations used)
Average value: = 23.06 m
Maximum value: = 44.90 m
Minimum value: = 3.3 m
Highest average water levels
Current average water level depths
Lowest average water levels
Long-term average depth

GRAPH 39

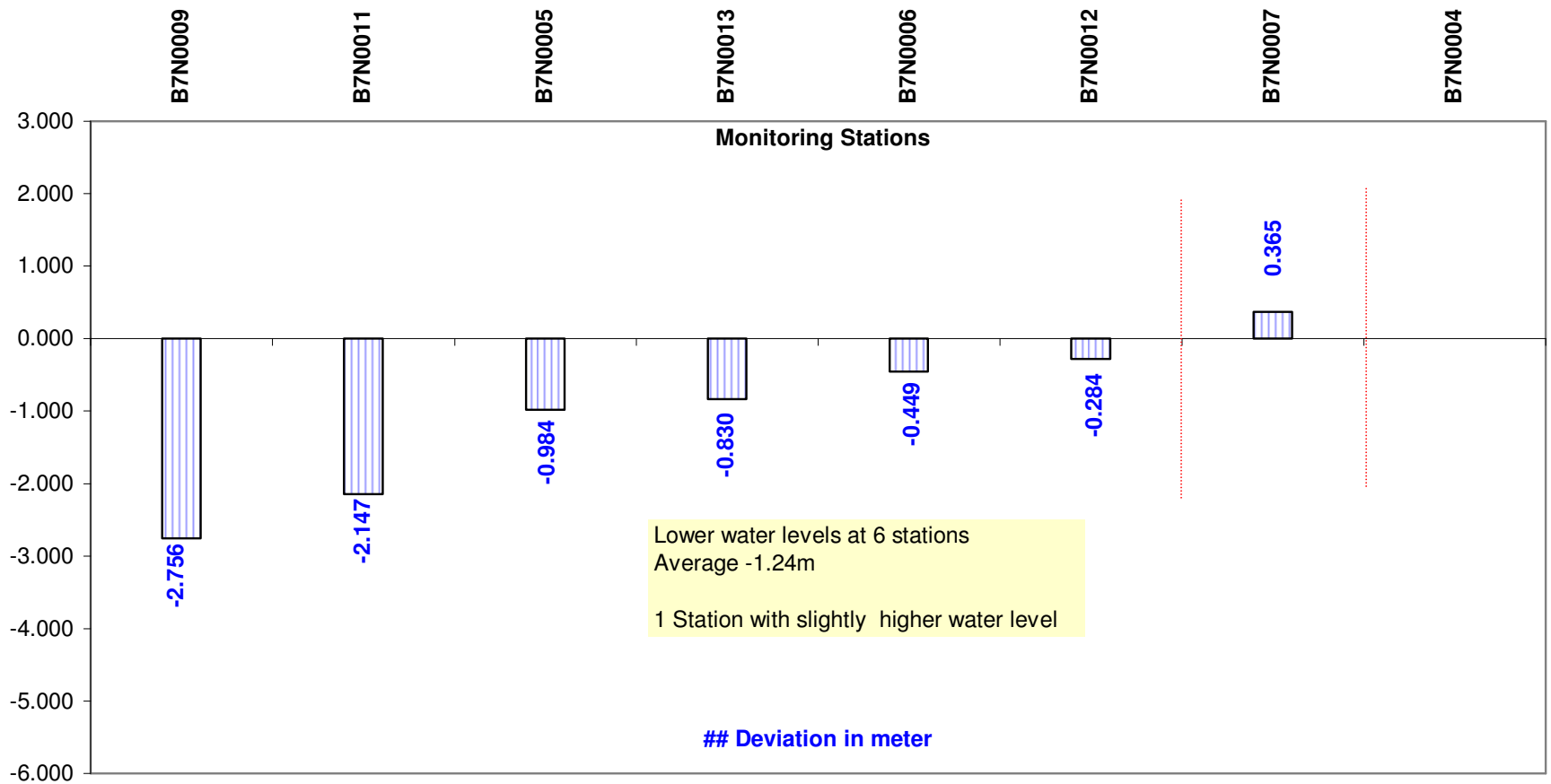

Water level trend of some stations in B7 drainage:
1 November 2007 to 1 November 2008
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
30.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Nov-2007
Feb-2008
May-2008
Aug-2008
Nov-2008
Date
B7N0006
B7N0005
B7N0007
B7N0009
B7N0011

GRAPH 40

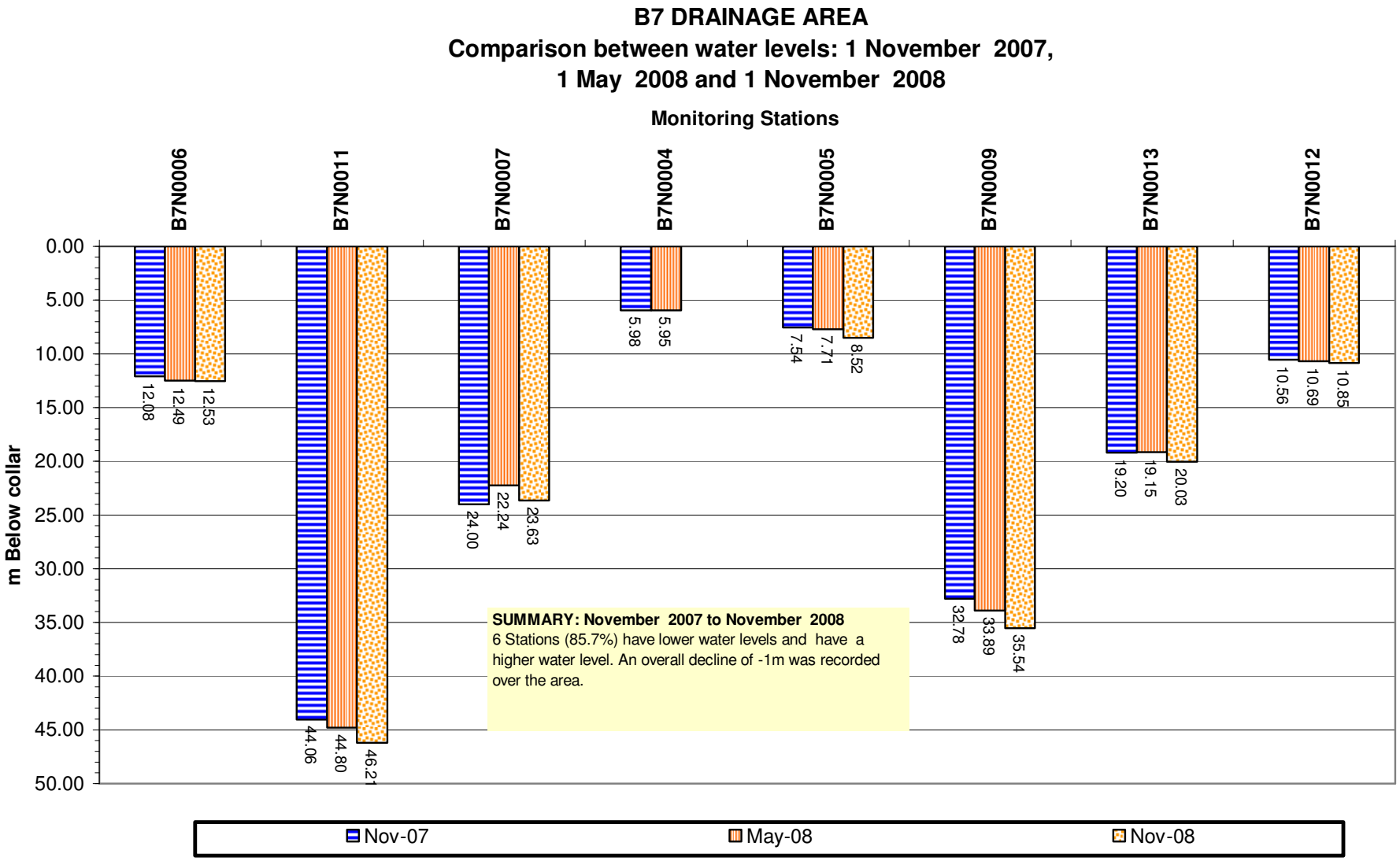

B7 DRAINAGE AREA
Deviation of water levels: 1 May 2008 to 1 November 2008
B7N0009
B7N0011
B7N0007
B7N0013
B7N0005
B7N0012
B7N0006
B7N0004
3.000
2.000
1.000
0.000
-1.000
-2.000
-3.000
Monitoring Stations
Al 7 stations with data for the period indicvate lower water levels
Average -0.9m
1 Station no data since May 2008 due to vandalism
-1.654
-1.413
-1.391
-0.879
-0.817
-0.155
-0.040
Deviation in meter

GRAPH 41

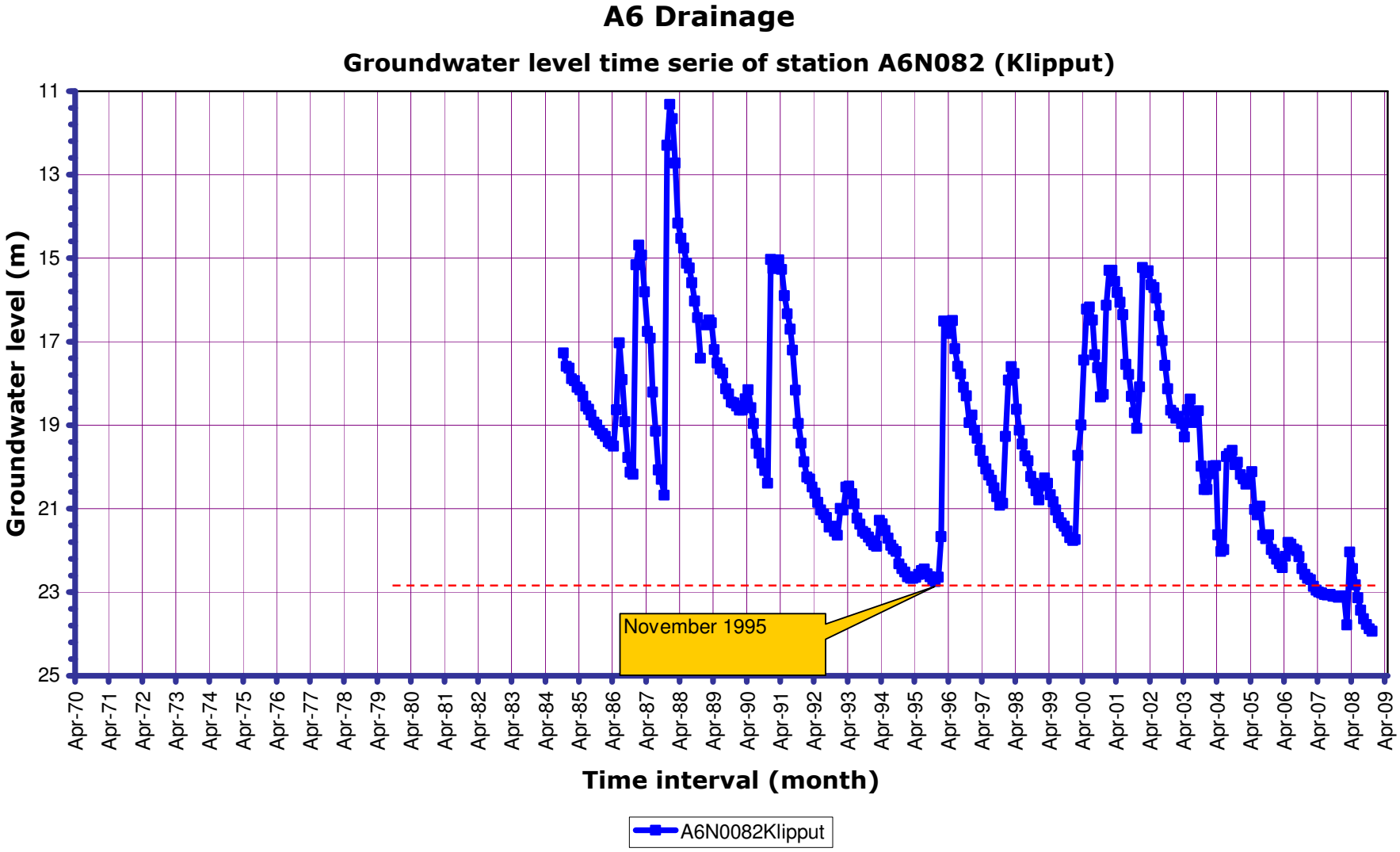
B7 DRAINAGE AREA
Deviation of water levels: 1 November 2007 to 1 November 2008



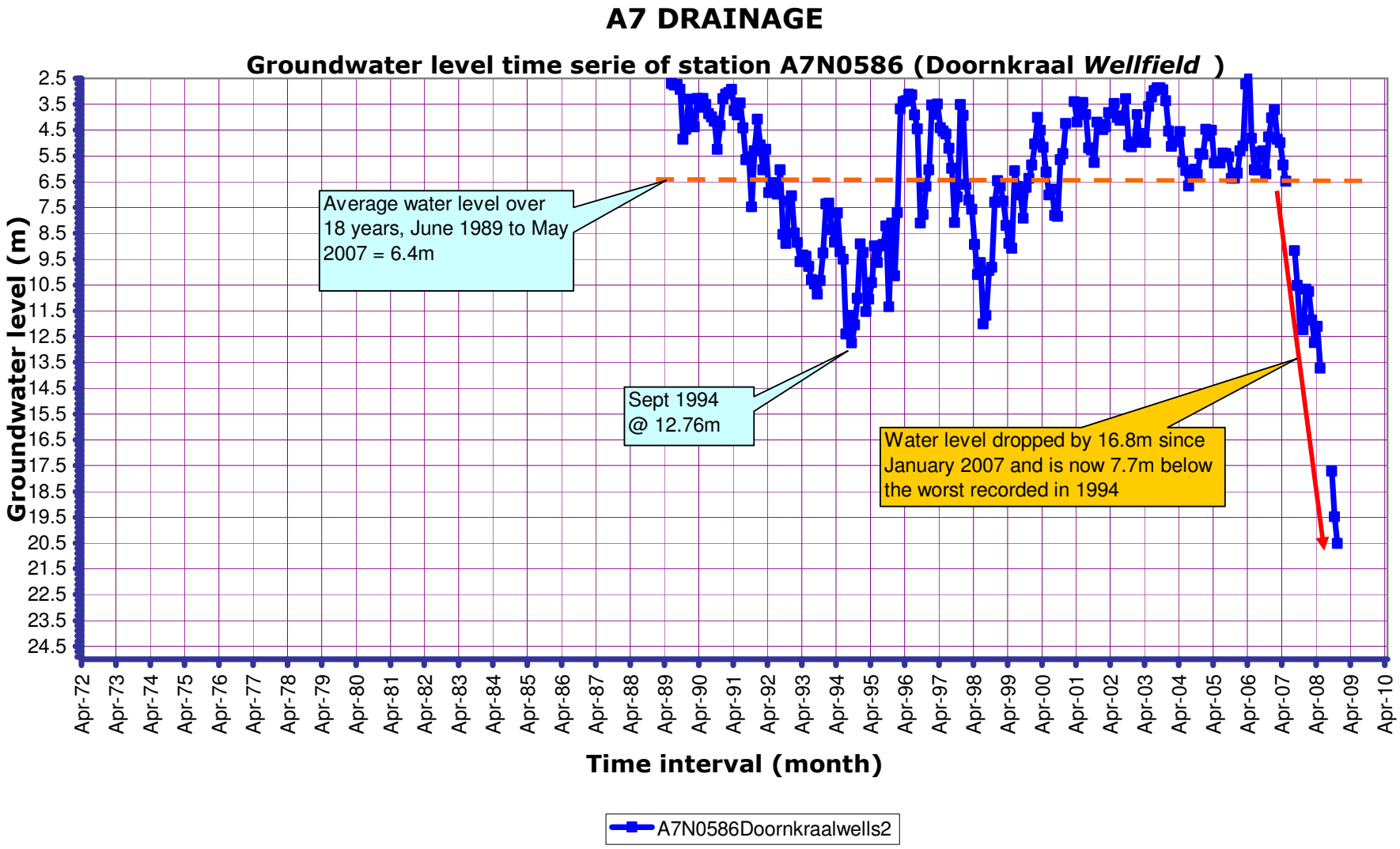
GRAPH 42


B7 DRAINAGE AREA
Comparison between water levels: 1 November 2007,
1 May 2008 and 1 November 2008
Monitoring Stations
B7N0006
B7N0011
B7N0007
B7N0004
B7N0005
B7N0009
B7N0013
B7N0012
m Below collar
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
12.08
12.49
12.53
44.06
44.80
46.21
24.00
22.24
23.63
5.98
5.95
7.54
7.71
8.52
32.78
33.89
35.54
19.20
19.15
20.03
10.56
10.69
10.85
SUMMARY: November 2007 to November 2008
6 Stations (85.7%) have lower water levels and have a higher water level. An overall decline of -1m was recorded over the area.
Nov-07
May-08
Nov-08

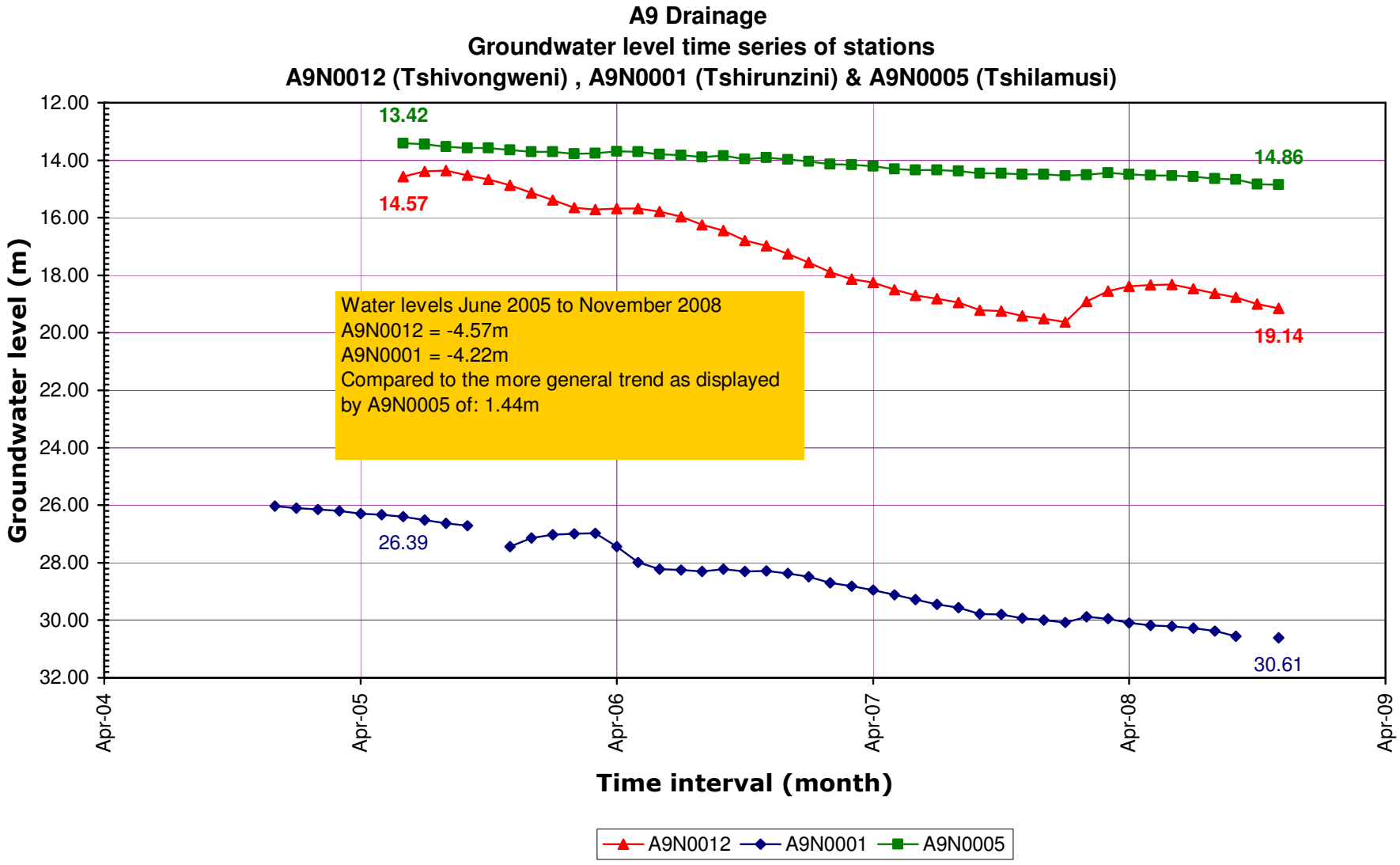
GRAPH 43


A6 Drainage
Groundwater level time serie of station A6N082 (Klipput)
Groundwater level (m)
11
13
15
17
19
21
23
25
Apr-70
Apr-71
Apr-72
Apr-73
Apr-74
Apr-75
Apr-76
Apr-77
Apr-78
Apr-79
Apr-80
Apr-81
Apr-82
Apr-83
Apr-84
Apr-85
Apr-86
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Apr-93
Apr-94
Apr-95
Apr-96
Apr-97
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
November 1995
Time interval (month)
A6N0082Klipput

ANNEXURE 1

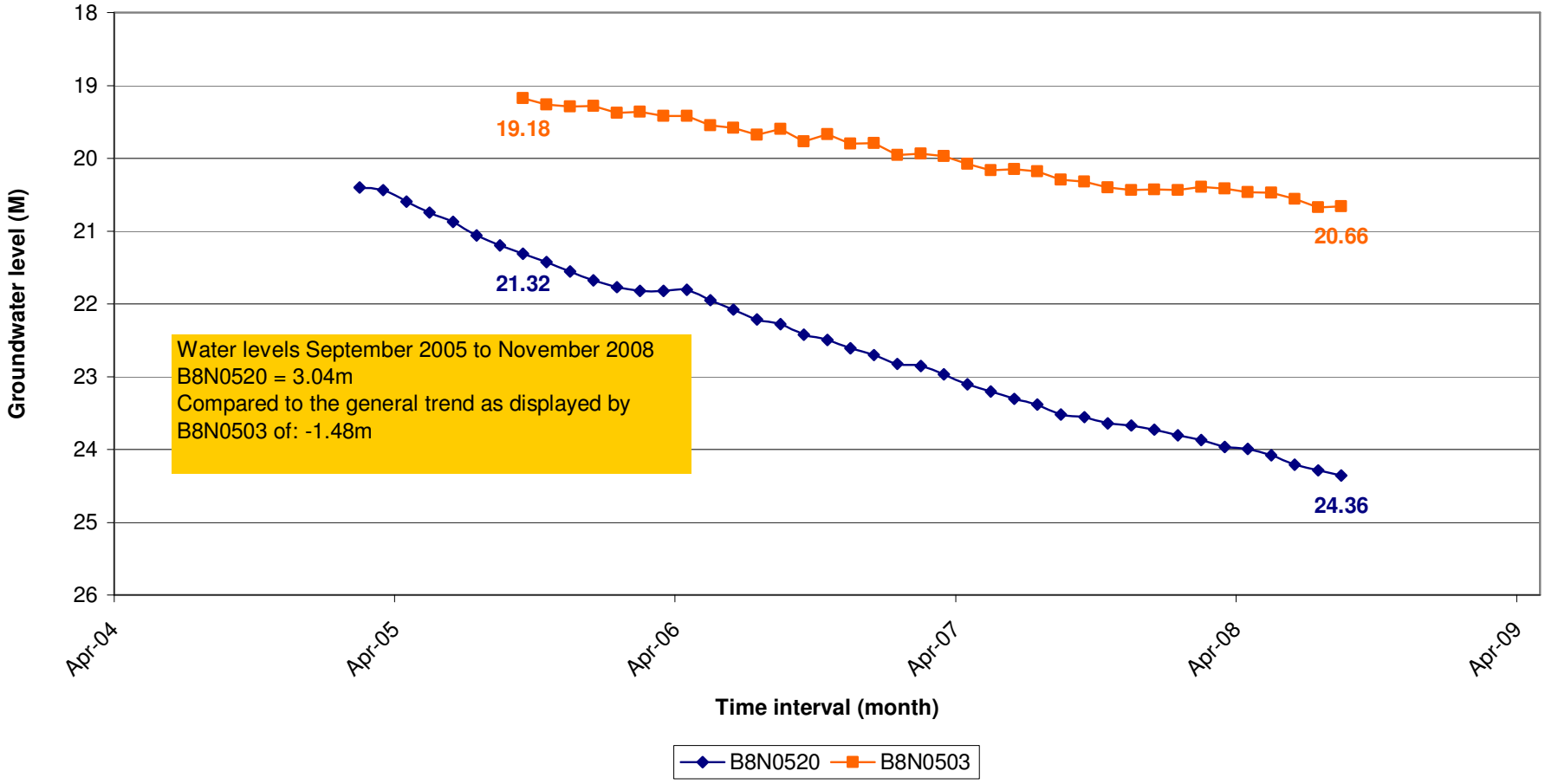

A7 DRAINAGE
Groundwater level time serie of station A7N0586 (Doornkraal *Wellfield*)
Groundwater level (m)
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5
10.5
11.5
12.5
13.5
14.5
15.5
16.5
17.5
18.5
19.5
20.5
21.5
22.5
23.5
24.5
Average water level over 18 years, June 1989 to May 2007 = 6.4m
Sept 1994 @ 12.76m
Water level dropped by 16.8m since January 2007 and is now 7.7m below the worst recorded in 1994
Apr-72
Apr-73
Apr-74
Apr-75
Apr-76
Apr-77
Apr-78
Apr-79
Apr-80
Apr-81
Apr-82
Apr-83
Apr-84
Apr-85
Apr-86
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Apr-93
Apr-94
Apr-95
Apr-96
Apr-97
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Time interval (month)
A7N0586Doornkraalwells2

ANNEXURE 2

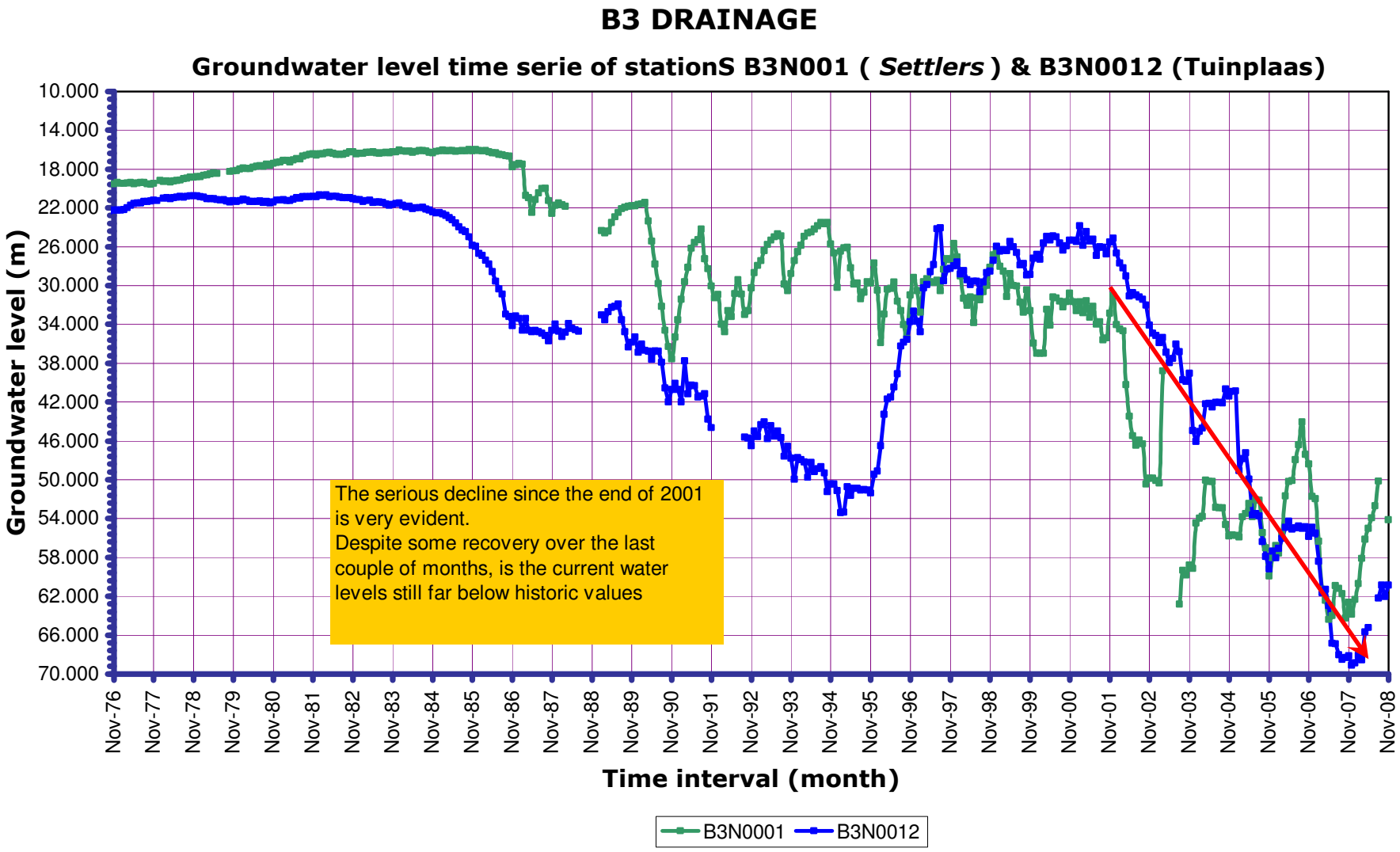

A9 Drainage
Groundwater level time series of stations
A9N0012 (Tshivongweni) , A9N0001 (Tshirunzini) & A9N0005 (Tshilamusi)
Groundwater level (m)
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
30.00
32.00
13.42
14.86
14.57
19.14
26.39
30.61
Water levels June 2005 to November 2008
A9N0012 = -4.57m
A9N0001 = -4.22m
Compared to the more general trend as displayed by A9N0005 of: 1.44m
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Time interval (month)
A9N0012
A9N0001
A9N0005

ANNEXURE 3

B8 DRAINAGE
Groundwater level time series of stations
B5N0503 (Vuheli) & B8N0520 (Sekgopo)



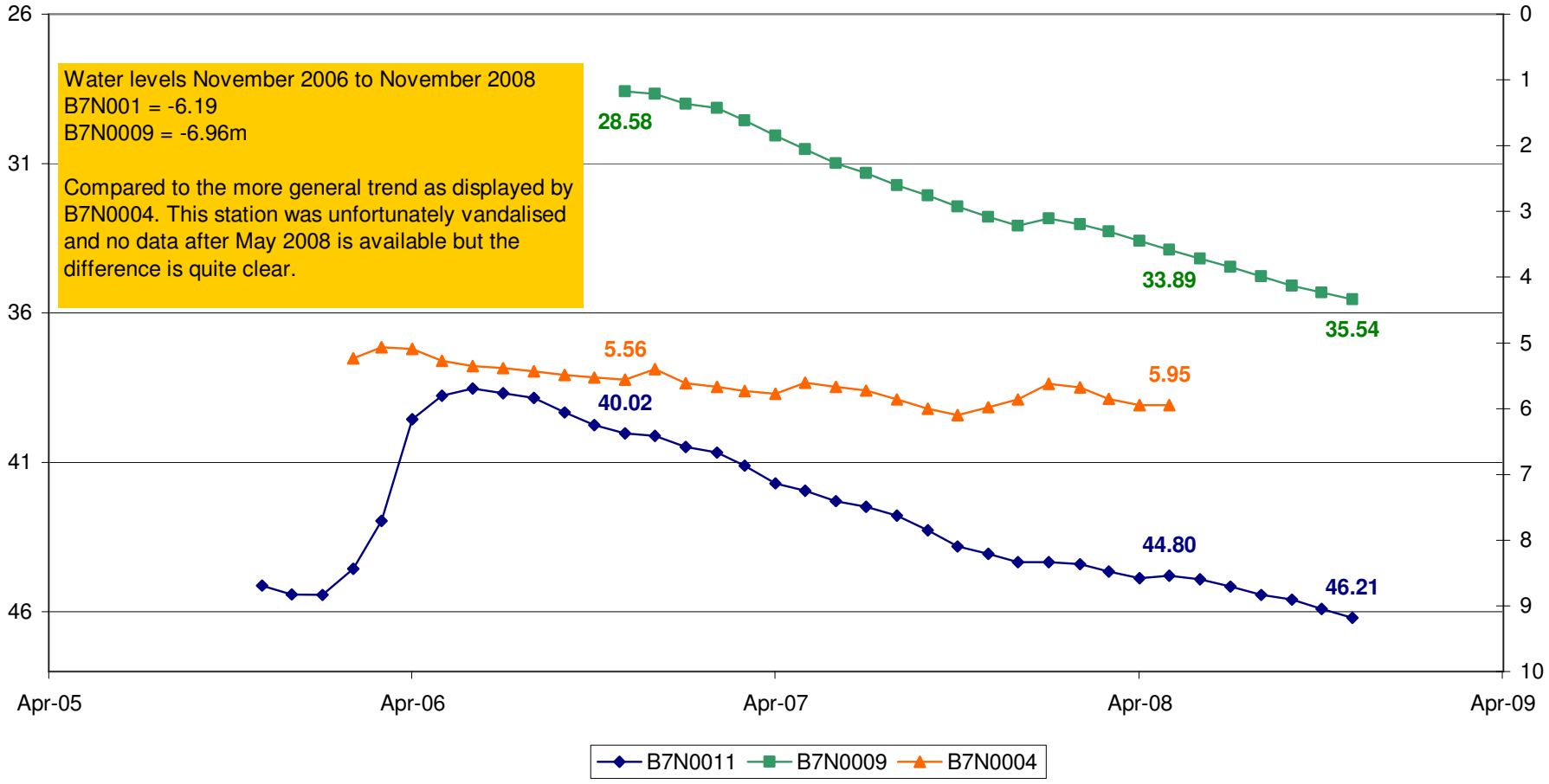
ANNEXURE 4


B3 DRAINAGE
Groundwater level time serie of stationS B3N001 (Settlers) & B3N0012 (Tuinplaas)
Groundwater level (m)
10.000
14.000
18.000
22.000
26.000
30.000
34.000
38.000
42.000
46.000
50.000
54.000
58.000
62.000
66.000
70.000
Nov-76
Nov-77
Nov-78
Nov-79
Nov-80
Nov-81
Nov-82
Nov-83
Nov-84
Nov-85
Nov-86
Nov-87
Nov-88
Nov-89
Nov-90
Nov-91
Nov-92
Nov-93
Nov-94
Nov-95
Nov-96
Nov-97
Nov-98
Nov-99
Nov-00
Nov-01
Nov-02
Nov-03
Nov-04
Nov-05
Nov-06
Nov-07
Nov-08
Time interval (month)
The serious decline since the end of 2001 is very evident.
Despite some recovery over the last couple of months, is the current water levels still far below historic values
B3N0001
B3N0012

ANNEXURE 5

B7 DRAINAGE

Groundwater level time series of stations
B7N0009 (The Willows), B7N0011 (Mica) & B7N0004 (Bismarck)



ANNEXURE 6