APPENDIX B

WOLWEDANS DAM STRUCTURAL ANALYSES

APPENDIX B

B. WOLWEDANS DAM STRUCTURAL ANALYSES

B.1. INTRODUCTION

Chapter 5 summarises the analysis on which basis it was possible to evaluate and quantify the early behaviour of the RCC of Wolwedans Dam under the hydration heating and subsequent heat dissipation cycle. In order to effectively illustrate the important finding that the RCC of Wolwedans clearly did not experience the shrinkage and creep that has been generally assumed to occur in RCC, as it does in CVC, only a summary of the analyses completed was presented in that Chapter.

In this Appendix, a more detailed presentation of the Wolwedans analysis is presented, illustrating clearly and specifically the impact of shrinkage and temperature drop on the structural function of the dam.

Wolwedans Dam is a 70 m high RCC structure, with a crest length of 270 m and an upstream face radius of 135 m. A 12.5 m deep by 13 m wide reinforced concrete inlet tower is attached to the upstream face immediately to the left flank side of the spillway and the full dam comprises approximately 200 000 m^3 of concrete. The dam was constructed with a high quality RCC, which typically indicated 180 day strengths exceeding 30 MPa. The surface was constructed in a conventional mass “skin” concrete and it was later found that the interface between the RCC and the skin concrete was porous and low strength. Although the RCC was high strength and of good quality, the dam was constructed in the early days of the RCC construction technology and the bond between layers was not always good and segregation of the RCC was occasionally evident.

The induced joints at Wolwedans Dam were grouted in two phases between June and November 1993[1]. The first phase encompassed grouting of the structure from the base to mid-height (RL 66.25 m) and this was completed during the winter months of June to August, during which time the impoundment water level was dropped by a maximum of 8 m. The second phase of grouting from RL 66.25 m to the RL 103 m crest level was undertaken between September and November 1993, when the impounded water level and seasonal temperatures were rising.

The dam is comprehensively instrumented and a full geodetic survey of the dam structure is undertaken twice a year, generally in early February and early August[2]. A continuous monitoring programme of the installed instrumentation is maintained and most of the instrumentation remains fully functional. The structure can be considered to have functioned very successfully to date.

B.2. FINITE ELEMENT MODEL

B.2.1. GENERAL

For the purposes of the investigative analyses completed, a comprehensive, 3 dimensional Finite Element model was established using the COSMOS[3] general structural analysis software for Wolwedans Dam. The model simulated the dam and the foundation, with each radial dam block between induced joints being developed as separate parts and joined with Gap elements. Ten-noded solid tetrahedral elements were used in a high-density mesh (see **Figures B1** & **B2**). For the analyses completed, only induced joint Nos 8, 14 and 17 were assumed to be open, replicating the actual situation at the dam. In addition, a Gap element was included at Joint No 3, where a formed joint was included in the dam. Otherwise, Gap elements were not included at the location of the closed induced joints. In COSMOS, Gap elements associate nodes through a friction factor when compressive contact exists. Under tension, the nodes are allowed to separate and form a gap.

To recreate the actual situation of the dam structure as closely as possible, the inlet tower was attached to the upstream face. The 13 m wide x 12.6 m deep tower contains wet wells, dry wells, shafts and a staircase and was modelled as a solid structure of the same external proportions. The equivalent stiffness of the prototype was modelled by reducing the applied E modulus such that the product of the E modulus and the second moment of area (EI value) of the model was equal to that of the actual tower.

The foundation block modelled with the dam structure extended 1.5 x the dam height upstream, downstream and beneath the dam and 1 x the dam height on either flank (see **Figure B1**). The external boundaries of the foundation model were constrained against movement in all directions.

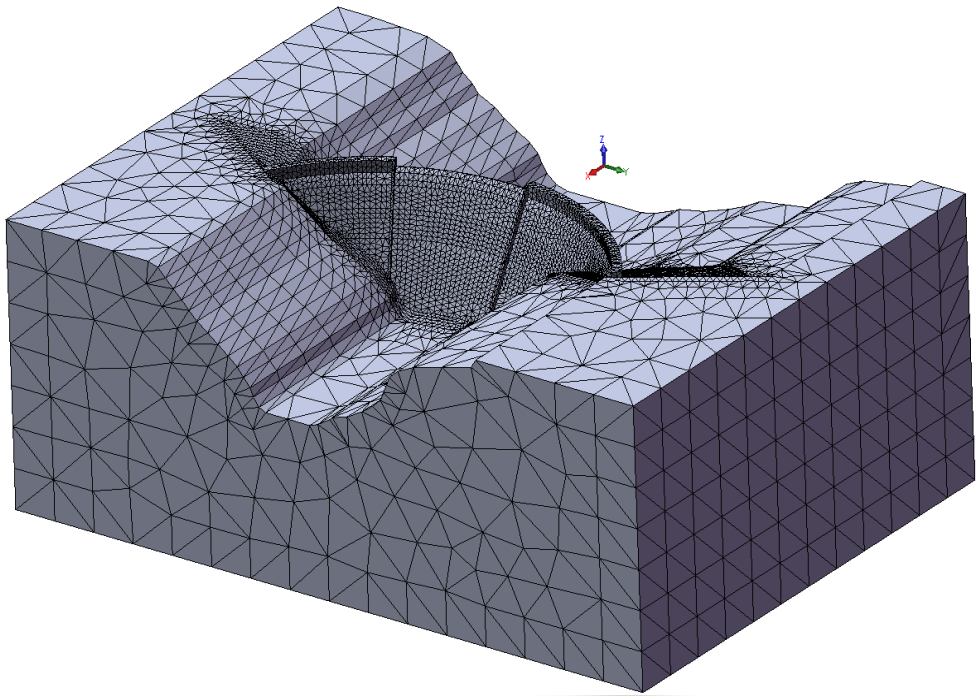


Figure B1: Wolwedans Dam & Foundation FE Analysis Mesh

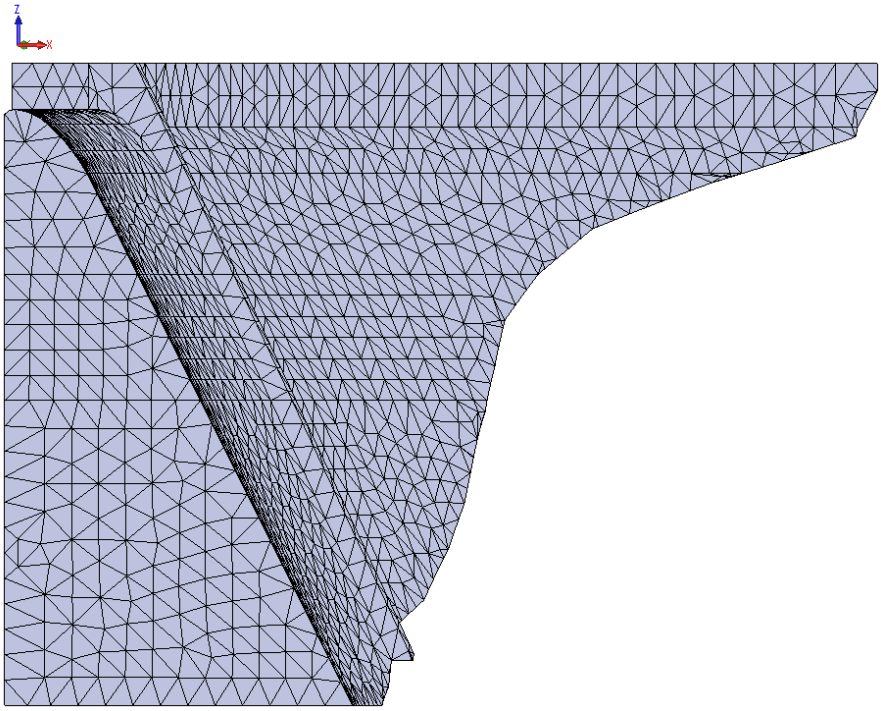


Figure B2: Wolwedans Dam FE Mesh

The basic layout of the dam is illustrated in **Figure B3**.

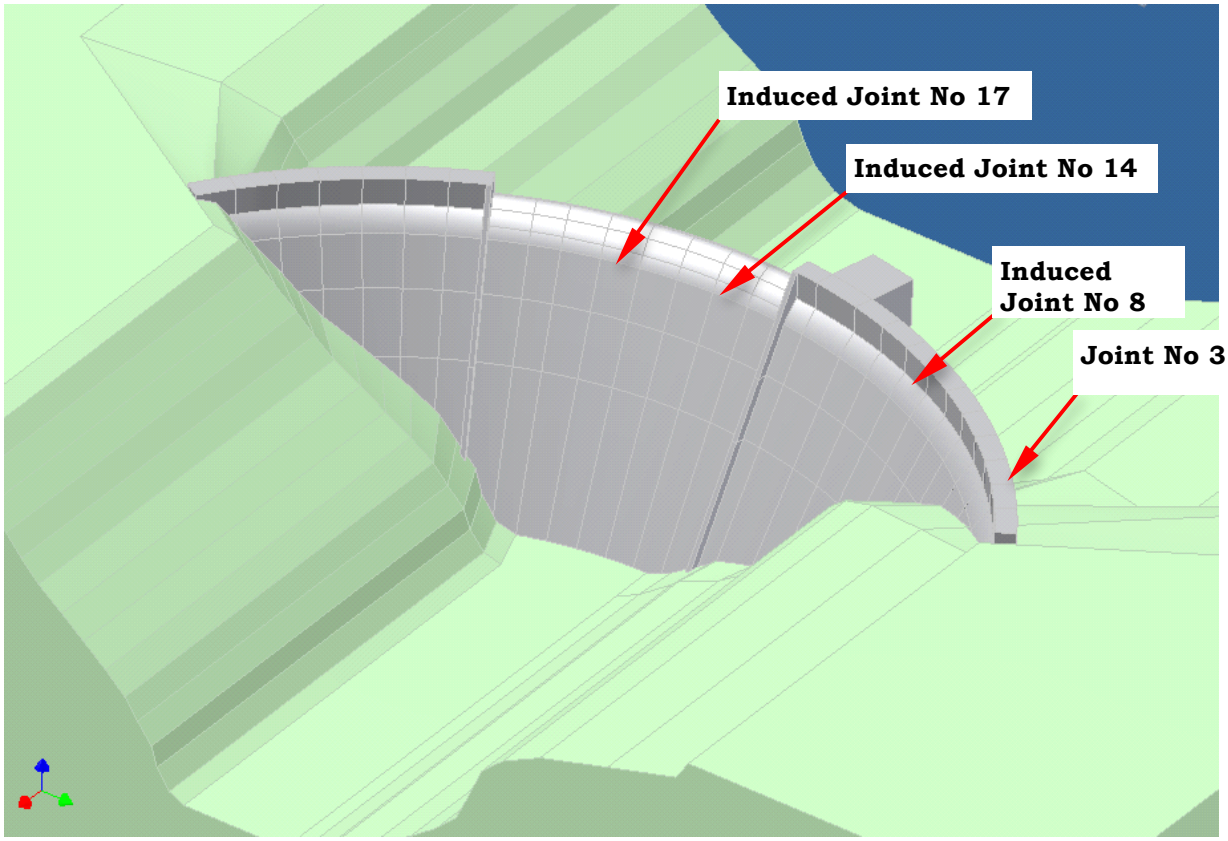


Figure B3: Illustration of Wolwedans Dam & Foundation

B.2.2. MATERIALS PROPERTIES & LOADING CONDITIONS

For the purposes of the analysis presented herein, the materials properties that were demonstrated in Chapter 5 to be most valid were applied. These and the loadings that were considered as constant are summarised in **Table B.1**.

Table B.1 (5.6): Materials Properties & Constant Loads Applied for All Analyses

Property	**Value Applied**	**Loading**	**Value Applied**
RCC Density	2400 kg/m^3	Hydrostatic	FSL (RL 98 m)
RCC Compressive strength	35 MPa	Uplift	50% Design
RCC Elastic Modulus	20 GPa	Silt	None
RCC Thermal Expansivity	10 x 10^{-6}/^{o}C	*Note:*	
RCC Poisson's Ratio	0.2	*"Massless" foundation applied & Jt. 8 opening reduced by 0.72 mm on all analyses to compensate for gravitational modelling effects (see 5.3.2.5).*	
Foundation Elastic Modulus	15 GPa		
Foundation Poisson's Ratio	0.17		
Foundation Thermal Expansivity	10 x 10^{-6}/^{o}C		

Uplift Loading

In accordance with the USACE. EM 1110-2-2200. *Gravity Dam Design.* 1995[4], standard practice in dam design assumes a distribution of uplift loading beneath the base of the structure as illustrated on the graphic below. Where a drainage curtain is included beneath the structure, it is assumed that the drainage relieves the pressure by 2/3 of the head difference between the upstream heel and the downstream toe.

accordingly $hd = 1/3\ (hm - hv) + hv$

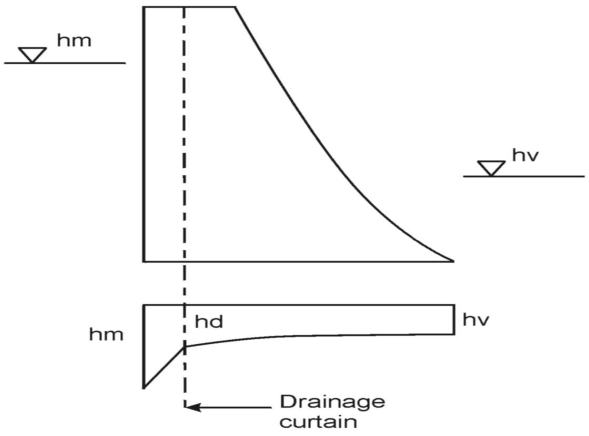


Figure B4: Standard Design Assumptions for Uplift Pressures[4]

The above approach represents an assumption that is generally applied in the case of a foundation rockmass that is grouted and drained. In the case of a competent

rockmass, the assumed loading is quite probably conservative and for the purposes of the analyses undertaken in this study, total forces equivalent to 50% of those applied in accordance with this design approach were applied in order to more realistically simulate probable service conditions.

B.3. INVESTIGATION METHODOLOGIES

B.3.1. GENERAL

The analyses undertaken as part of this investigation compare the impacts of various degrees of materials shrinkage on the structural behaviour/performance of the dam model with that measured on the prototype structure under the same loading conditions. The comparison is made in the form of displacements on two points on the dam crest and three points in the upper gallery of the dam and against the degree of opening at the centreline of the three open joints at approximately mid-height on the dam. These points were chosen as they were considered to represent points of definitive performance. While the situation in respect to the core RCC performance at mid-height of the dam is such that the behaviour is not clouded by foundation restraint, or surface cooling effects, as would have been the case at the top, or bottom instrumentation levels, the overall performance of the arch will always be clearly demonstrated through structural displacements. The more shrinkage that is experienced in an arch dam, the greater the crest must displace downstream in order to fully take up the imposed water load through arching (see **Appendix A**).

Simulating the equivalent loading state of the dam structure as at July 1993, a number of shrinkage strains were applied to the dam structure in the form of temperature drops. Noting the critical displacements and joint openings for each "shrinkage scenario" and comparing these with the values measured on the prototype, it would be possible to identify the degree of shrinkage that occurred in reality.

B.3.2. INDUCED JOINT GROUTING

B.3.2.1. General

The induced joints of Wolwedans Dam were grouted between June and November 1993, starting at the bottom and working upwards. While the impounded water level was dropped by a maximum of 8 m during the course of early grouting, it was maintained at that level for less than 1 month before being filled again by seasonal runoff. Accordingly, the dam structure was essentially under load during the course of grouting.

Examining the joint and crest displacement records, it is apparent that increased upstream movement of the crest occurred post-grouting, while reduced seasonal movement was also subsequently observed on the two joints that had opened most significantly (Nos 11 & 24). Otherwise, the grouting appears to have had very little impact on the structural behaviour of the dam. It is considered that this is a consequence of the fact that the dam structure was under load and significantly displaced, due to the temperature drop experienced at the time of grouting.

However, the records for all four levels of instrumentation demonstrate that the hydration heat had been fully dissipated from the dam by winter 1993 and, as the reservoir was full immediately before grouting, instrumentation data for the beginning of July 1993 reflects a full, but un-grouted dam with a nominal temperature drop load (at RL 66.25 m) of 8°C from placement.

B.3.3. MEASURED CREST DISPLACEMENTS

B.3.3.1. General

Copies of the key displacement data for Wolwedans Dam are attached at the end of this Appendix. From the beginning of 1993 and for the first decade of operation, the impoundment of Wolwedans Dam was fairly consistently full and, over this time, the geodetic survey data indicates that the central crest displacement generally moved seasonally by a maximum of approximately 11 mm in a horizontal, upstream-downstream direction. At the upper gallery level, the central displacements generally vary seasonally by between 5 and 7 mm.

Figure B5 illustrates the critical crest and upper gallery displacement measurement reference points, while **Table B2** compares the typical measured and predicted seasonal displacement variations under operational conditions.

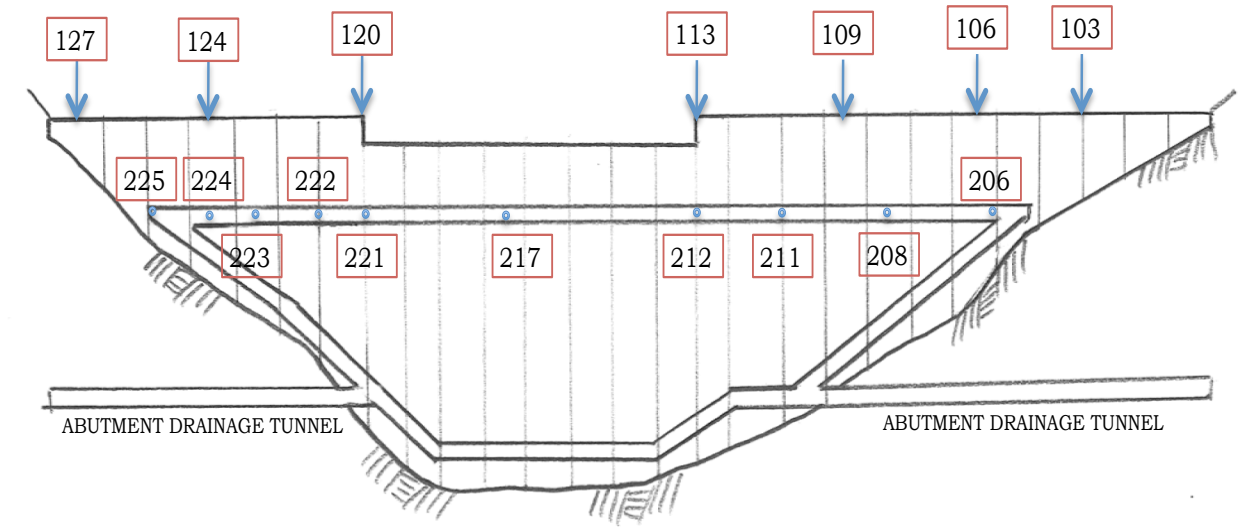


Figure B5: Illustration of Important Displacement Reference Points

Table B2: Predicted & Measured Seasonal Horizontal Movement Variations (mm)

Reference Point - Dam Crest	**103**	**106**	**109**	**113**	**120**	**124**	**127**
Measured (Average - Dam Full 1993 to 2008)	2.6	6.4	8.5	10.5	12.1*	6.3*	1.7
Predicted (for 8/11°C T Drop)	3.1	3.0	10.1	10.8	5.6	4.6	2.3

Table B2 *continued*

Reference Point - Top Gallery	**206**	**208**	**211**	**212**	**217**	**221**	**222**	**223**	**224**	**225**
Measured (Average - Dam Full 1993 to 2008)	1.2	2.8	3.8	4.3	5.9	4.5	3.5	2.4	2.3	1.8
Predicted (for 8/11°C T Drop)	1.4	1.7	5.9	6.0	8.2	3.8	3.5	3.1	2.6	1.6

The above table clearly illustrates that the displacement behaviour of the structure in the region of the crest and the upper gallery was consistent with expectations, except on the central right flank crest.

As can be seen from the measured readings highlighted in **Table B2** with an asterisk (*), two of the three displacements measured on the right flank crest exceeded expectations. With a lower dam height at the NOC on the right side of the spillway, compared to the left, and a steeper right abutment, a substantially stiffer right flank of the dam would be anticipated and this would be expected to be confirmed in lower crest displacements on the right flank compared to the left, as predicted by the FE model.

Reviewing all of the available data that could have some influence on the apparent displacements on the right flank, it is clear that the climatic conditions and the orientation of the site cause the right side of the valley at Wolwedans to be warmer than the left. At the top instrumentation level (RL 83.25 m), seasonal temperature variations of 12.5 to 21°C on the left flank can be compared directly with equivalent variations of 14 to 23.5°C on the right flank. With both sides of the NOC exposed to the atmosphere and the upstream side and the crest exposed to solar radiation for extended periods, it is more than likely that the crest above the water level on the right flank experiences temperatures that exceed the original RCC placement temperature.

Examining the displacement measurements recorded for the abutment drainage tunnels on both flanks at RL 48 m (indicated in **Figure B5**), it is apparent that seasonal movements of between 1 and 2 mm are recorded throughout the foundation rockmass. In view of the magnitude of the displacements recorded in relation to the accuracy of measurement, it is not considered possible, however, to meaningfully analyse these movements. Nonetheless, the consistency and repetition of direction of movement implies that the seasonal patterns observed cannot be denied.

Considering the higher temperatures measured in the dam on the right flank, the evidence of seasonal movement in the foundation rockmass and the elastic nature of the movements observed, it is considered that the exaggerated right flank displacements must be the result of seasonal temperature effects. With displacements measured within the upper gallery in line with corresponding measured temperature variations, it is considered most likely that the exaggerated crest displacements on the

right flank crest are the result of greater temperature variations in this region. Unfortunately, the installed instrumentation does not measure concrete temperatures above the upper gallery level and consequently no related data is available for the dam crest, the top of which is some 20 m above the gallery floor level. Consequently, the same seasonal temperature variations as measured within the upper gallery were applied for the crest on the analyses undertaken.

A further factor to be considered is the grouting of Joint No 24. With this joint grouted at a depressed temperature, and no other open joints on the right flank, a subsequent elevation of the temperature in the right flank crest would be translated directly into increased upstream movement. The tendency for the upper section of the dam to displace further upstream than anticipated is also evident on the induced joints at the highest instrumentation level (RL 84.25 m), where the downstream joint openings are greatest during winter and the upstream openings are greatest during summer, as indicated on **Figure B6**.

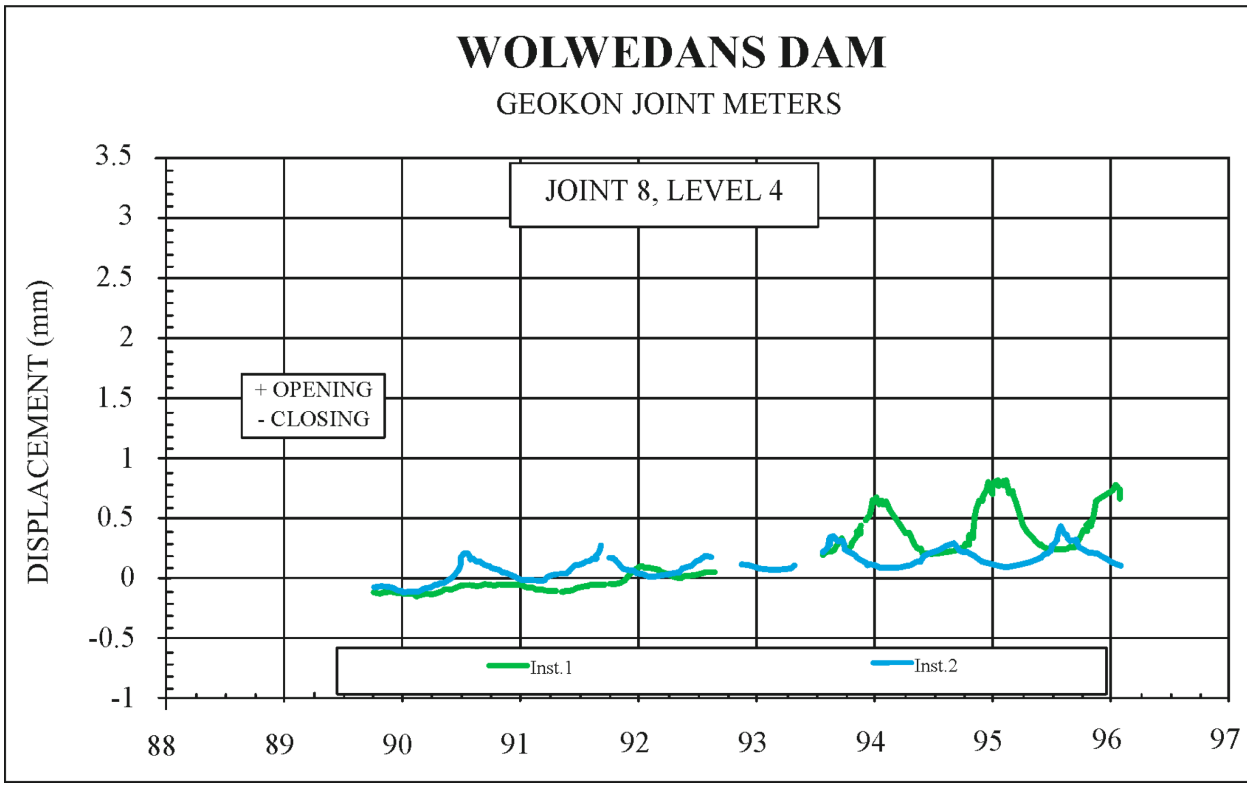


Figure B6: Displacement History at Induced Joint No. 8 RL 84.25 m

In view of the fact that the joints, even close to the surface, will tend to close during periods of warmer temperatures, the obvious explanation of the general pattern of the upper part of the joints opening during summer is an expansion movement of the upper part of the dam in an upstream direction.

Accordingly, it is considered very likely that the higher than expected seasonal crest movements observed on the right flank at Wolwedans Dam are the result of summer temperature increases within the right side NOC crest of the structure that exceed the

placement temperature and, to a lesser extent, summer temperature increases within the surface of the right abutment rockmass.

In view of the fact that the above hypothesis cannot be verified quantitatively, it is considered that a lower level of confidence exists for the comparison of modelled and measured displacements on the right flank crest of the dam. Considering the fact that this enigmatic behaviour takes the form of an increased upstream movement that recurs regularly during summer, however, would suggest that the "zero" stress temperature in the RCC is exceeded and this further serves to provide more confirmatory evidence that significant shrinkage of the RCC cannot have occurred.

While this upstream movement is most pronounced on the right flank, it undoubtedly also affects the left flank and this implies that the reference downstream displacements applied for the modelling analysis are almost certainly over-estimated. This will add further to the conservatism applied in the analysis.

B.3.3.2. Establishing Displacement Reference Values

A definitive interpretation of the structural displacement performance of Wolwedans Dam is frustrated by difficulties in establishing a realistic zero reference. The displacement performance of the dam was "zeroed" on 7th August 1992, when the water level had risen to 95% full for the first time. At that time, the hydration temperature had essentially been dissipated from the dam structure and the winter of 1992 does seem to have been particularly cold. Subsequently the dam structure has demonstrated additional downstream (+ve) displacement in colder winters and upstream displacement (-ve) in summer.

With the first displacement survey during the summer of early 1990, the recently completed and hydration-heated empty dam structure should have indicated its maximum upstream crest displacements at that time. Paradoxically, however, the upstream displacements at the reference points on either end of the NOC, immediately on either side of the spillway (113 and 120 – see **Figure B5**), peaked a year later (in early summer 1991), when the impounded water level had risen to approximately mid-height and internal temperatures were cooler than the previous year, due to dissipation of some of the hydration heat.

Structural modelling of the empty dam indicated that its heated state at the beginning of 1990 should have caused the crest to move upstream by 5 mm at point 113 and 3.5 mm at point 120. The same modelling suggested that this displacement would be translated into a 3.4 mm downstream crest movement at 113 and 3.2 mm at 120 when the dam impoundment filled and the hydration temperature had dissipated. In other words, the net downstream displacement from January 1990 to January 1993 should have been 8.4 mm for 113 and 6.7 for 120.

In relation to the predicted upstream movement as at January 1990, only 0.5 mm was associated with the temperature rise, with the balance associated with the imposition of gravity load. In fact the NOC crest displacement in early February 1993, as measured at reference points 113 and 120, indicated horizontal downstream

displacements of approximately 7.2 mm and 3.1 mm, respectively, while the crest level dropped by over 5 mm, confirming the impact of the measured drop in temperature.

The records demonstrate that the core sections of the dam experience a temperature of 6 to 7°C below placement temperature even during summer, while the upstream surface zones are generally at a maximum of 2 to 3°C below placement and the downstream surface zones reach a maximum temperature approximately equivalent to the placement temperature during summer. Considering the fact that the dam has remained under load and is generally at a temperature below placement, in theory, the structure should never displace upstream under operation to the extent experienced in January 1990. Taking note of the fact that only external, crest displacement measurement was made prior to August 1992, the only explanation is that perceptibly higher temperatures are experienced during summer in the crest of the dam, where no data is available, than elsewhere within the structure.

As a consequence of the above, defining a realistic zero reference point for the measured crest displacements was not possible and accordingly, it was decided that the information to be extracted from the model in respect to crest displacements should be the maximum movements experienced to July 1993 and the typical seasonal displacement variations. In view of the fact that part of the total seasonal crest displacement variations very likely relates to higher temperatures than measured elsewhere being experienced in the crest in summer, this approach implies a significant degree of conservatism in the analyses undertaken.

Displacement measurement in the upper gallery at Wolwedans Dam was only initiated in August 1992 and consequently it is not possible to ascertain a “zero” reference for the actual displacements. According to the FE analysis, ignoring temperature drop, the structural, downstream displacement associated with the hydrostatic load at reference points 212, 217 and 221 would be 3.35, 4.2 and 3.0 mm, respectively. Adding these displacements to the apparent measured maximum seasonal values (when the dam is consistently full) will indicate total maximum measured horizontal displacements.

Comparing the 1993 seasonal displacement variations in the upper gallery with the average maximum displacement variations measured during subsequent years during periods when the dam was full, it is apparent that the 1993 values are lower. Most of this difference is found in the form of increased upstream movement and this is undoubtedly a result of the open sections of the induced joints being filled with grout during the late winter of 1993. While this will have had little impact on the dam structure’s response to a temperature drop, it will have changed the response to an increase in temperature, tending to cause increased upstream displacement, particularly towards the crest of the dam.

Although not the major part, some of the additional displacement evident at the upper gallery reference points during the winter seasons following 1993 was downstream movement. It was consequently considered appropriate, if rather conservative, to

adopt the maximum seasonal displacement variation data in order to establish the reference behaviour for the dam, as opposed to the 1993 figures.

B.3.3.3. Measured Displacement Reference Data

On the basis of the above, reference behaviour for the prototype dam structure to a base date of July 1993 was developed as a target to be replicated through modelling. **Table B3** presents the measured displacement data for July 1993 that was used for comparison with predictions from the FE modelling.

Table B3: Measured Displacement Data at Important Reference Points 1993 (mm)

Reference Point	**113**	**120**	**212**	**217**	**221**
Horizontal / Downstream	14.5	11.7*	7.65	10.1	7.5
Seasonal Variations	8.0	10.5*	4.3	5.9	4.5

B.3.4. MATERIALS MODELS / LOADING CASES

With the properties listed in **Table B1** as constant, a net core temperature drop from placement of 8°C, as indicated on the installed instrumentation for winter 1993, was applied together with a number, or range of possible RCC thermal behaviour scenarios, as indicated in **Table B.4**. In accordance with the findings of Chapter 5, a model that assumed an 8°C core temperature drop in conjunction with an 11°C external, or surface zone drop, as indicated in **Figure 5.12**, was also investigated (Scenario 2).

Table B.4 (5.7): Analysis Scenarios

Scenario	**Temperature Drop** (°C)		**Volume Reduction / Shrinkage** (microstrain)	**Effective Total Temperature Drop** (°C)
	Core	**Surface**		
1	8	8	0	8
2	8	11	0	8 / 11
3	8	8	70	15
4	8	8	170	25
5	8	8	300	38

B.4. ANALYSIS RESULTS

B.4.1. Presentation of Results

The following figures present the behaviour of the dam under each of the “Shrinkage” Scenarios, as well as for a no shrinkage, or temperature drop “Scenario 0”.

B.4.2. Scenario 0: No Temperature Drop + FSL Hydrostatic + 50% Design Uplift

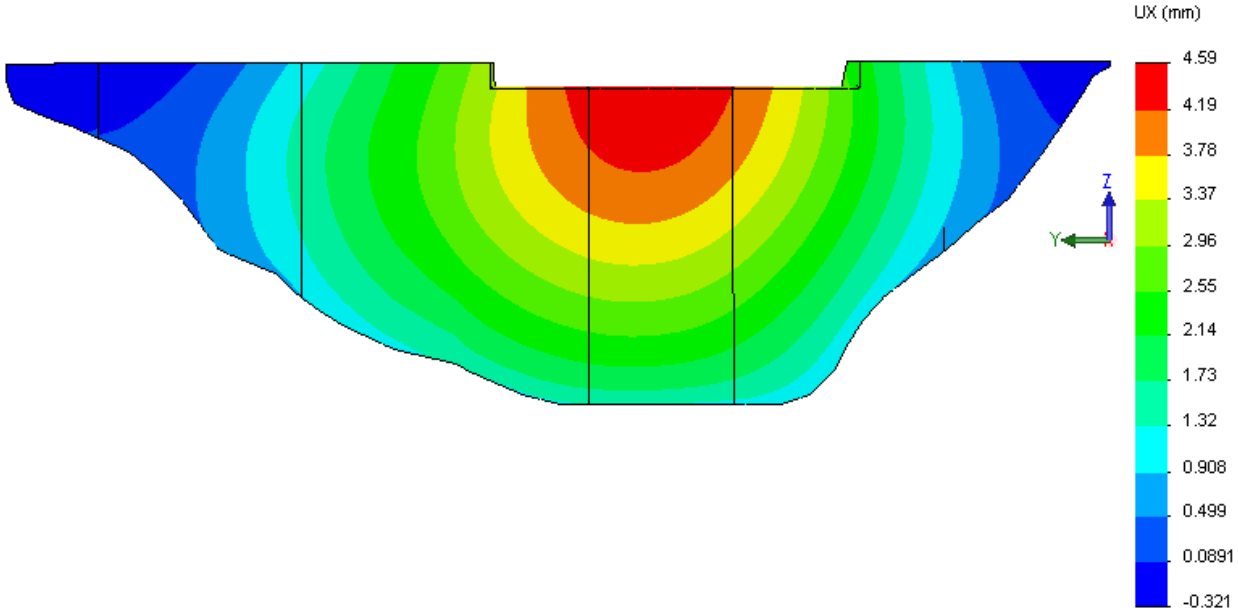


Figure B7: Sc 0 - Downstream Displacements (viewed from upstream)

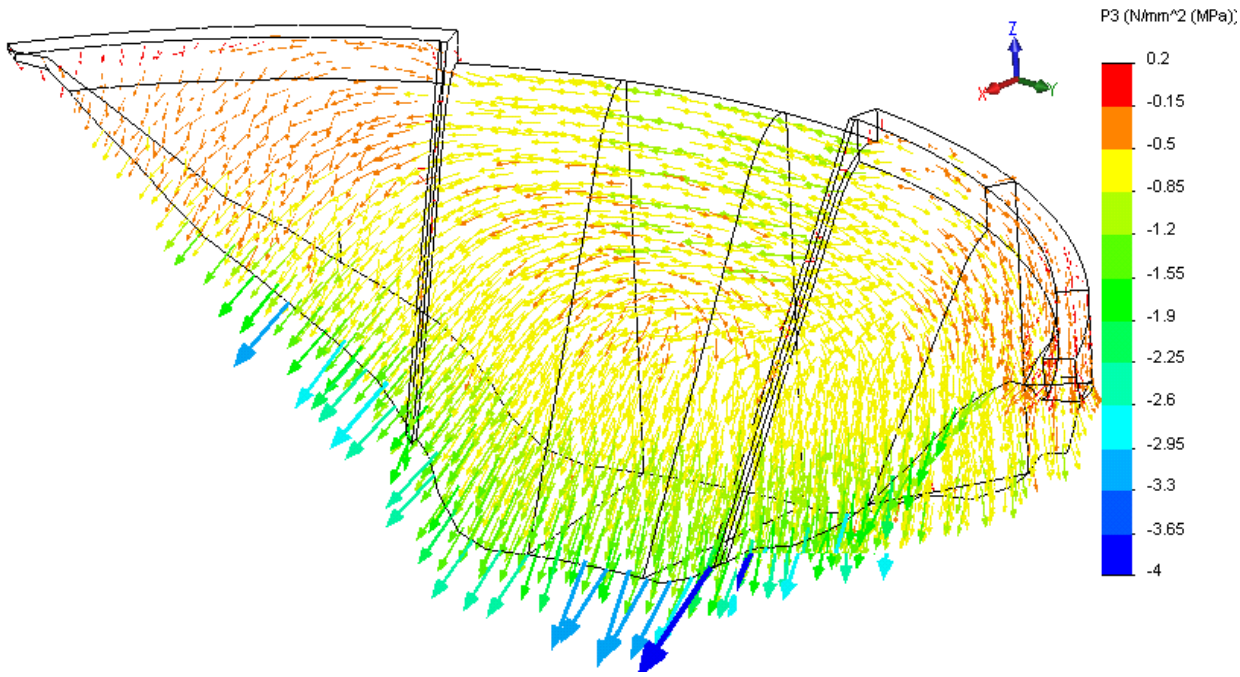


Figure B8: Sc 0 - Principal Stresses

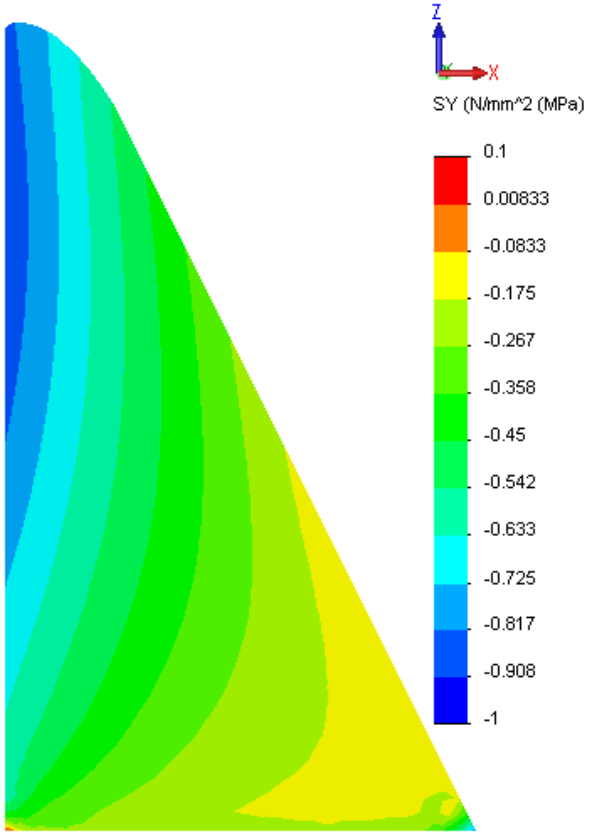


Figure B9: Sc 0 - Crown Cantilever Arch Stresses

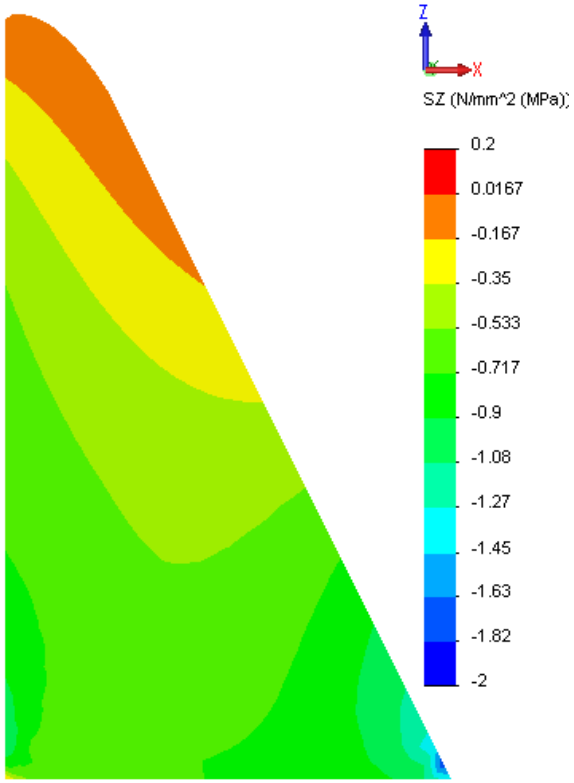


Figure B10: Sc 0 - Crown Cantilever Vertical Stresses

B.4.3. Scenario 1: 8°C Temperature Drop

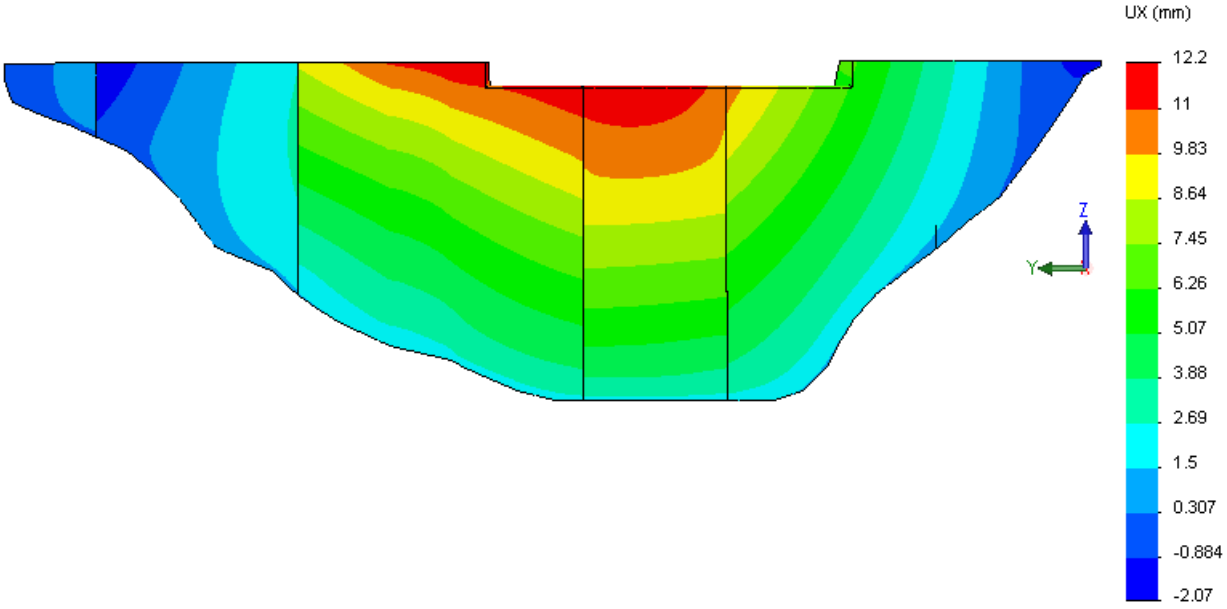


Figure B11: Sc 1 - Downstream Displacements (viewed from upstream)

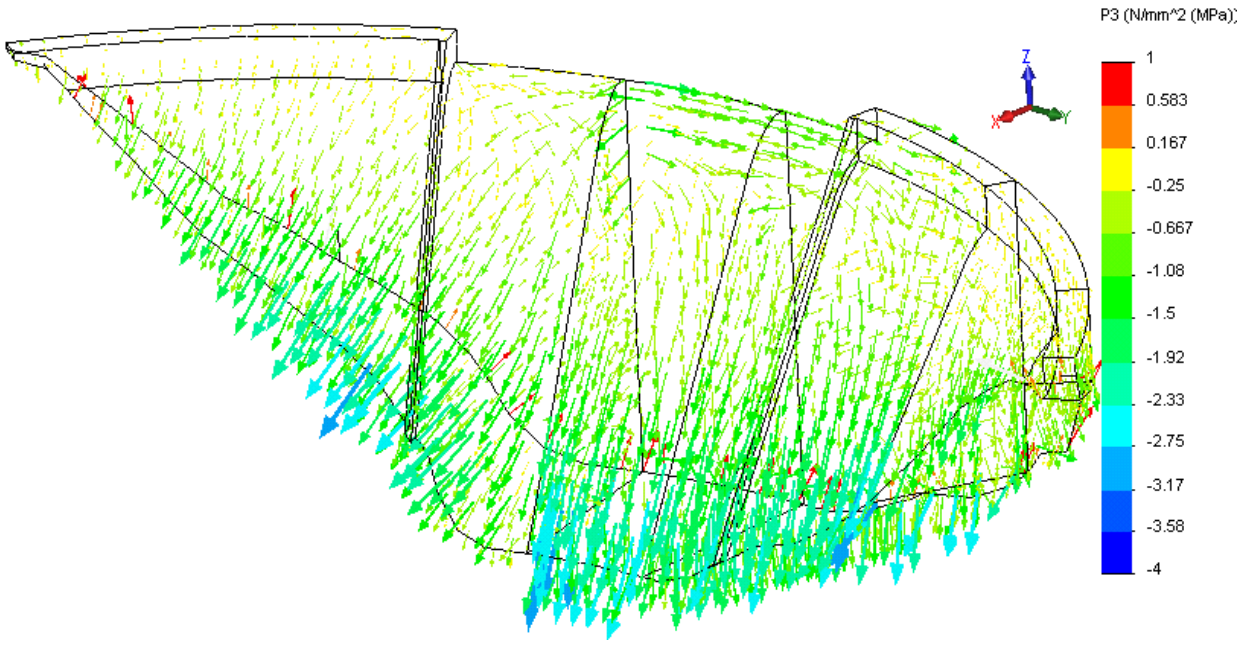


Figure B12: Sc 1 - Principal Stresses

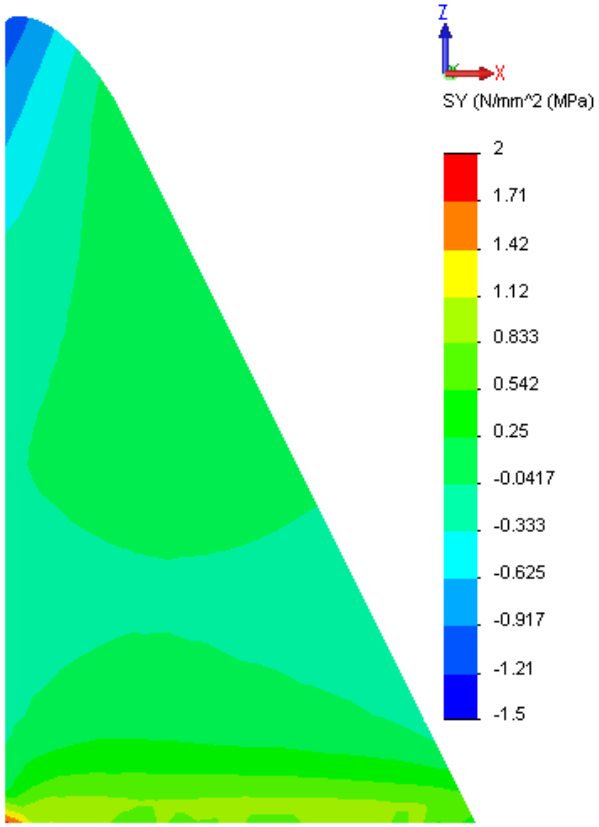


Figure B13: Sc 1 - Crown Cantilever Arch Stresses

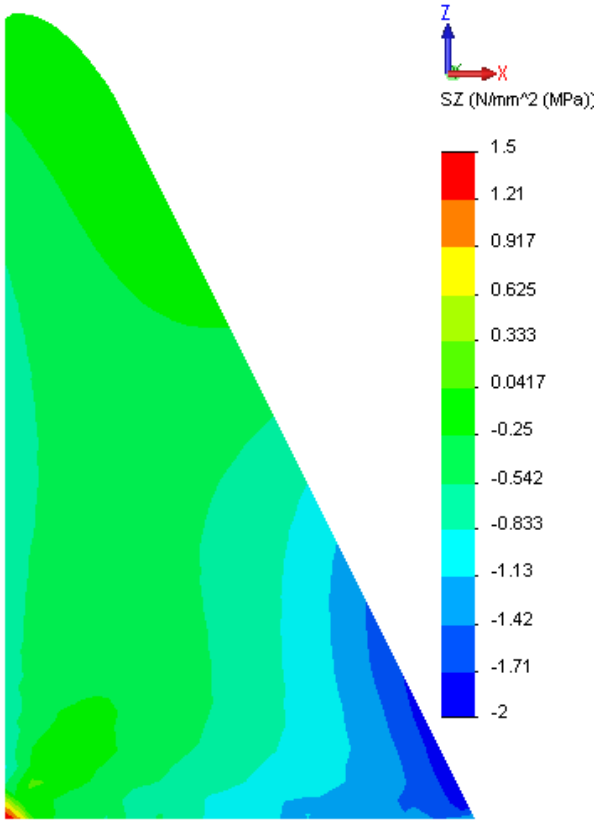


Figure B14: Sc 1 - Crown Cantilever Vertical Stresses

B.4.4. Scenario 2: 8°C Core & 11°C Surface Temperature Drop

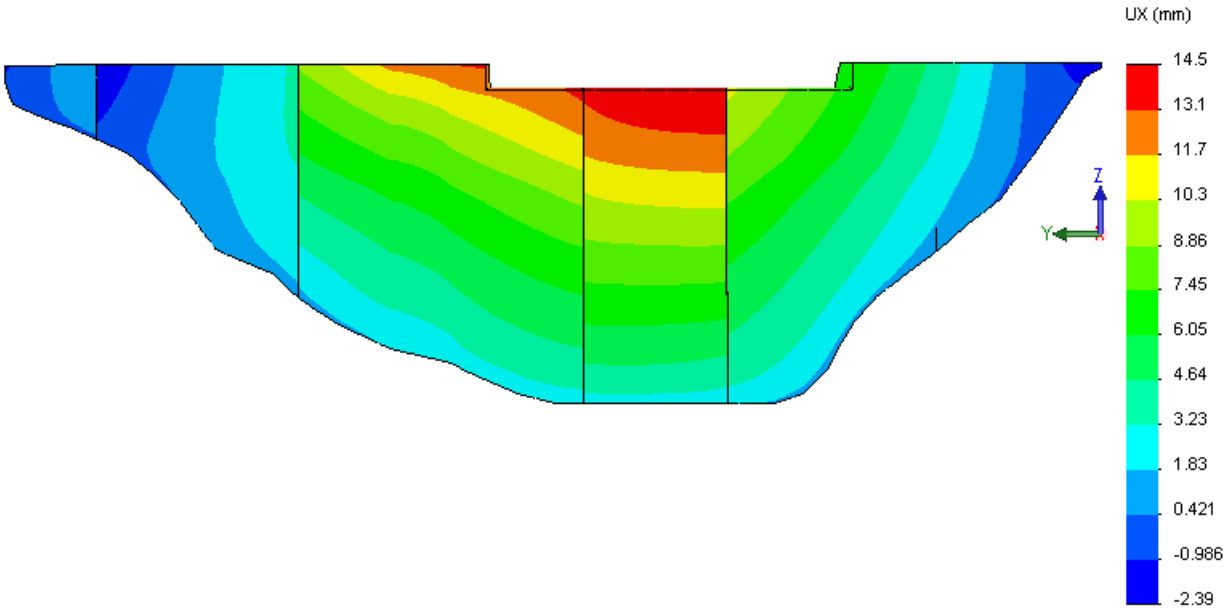


Figure B15: Sc 2 - Downstream Displacements (viewed from upstream)

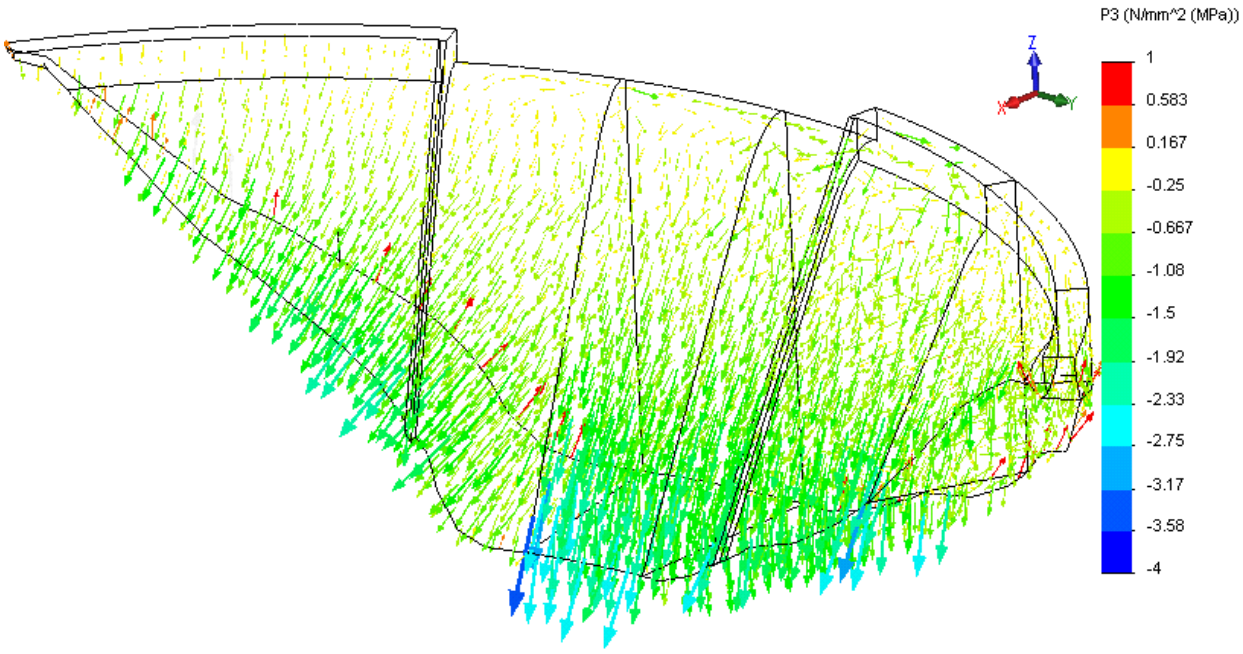


Figure B16: Sc 2 - Principal Stresses

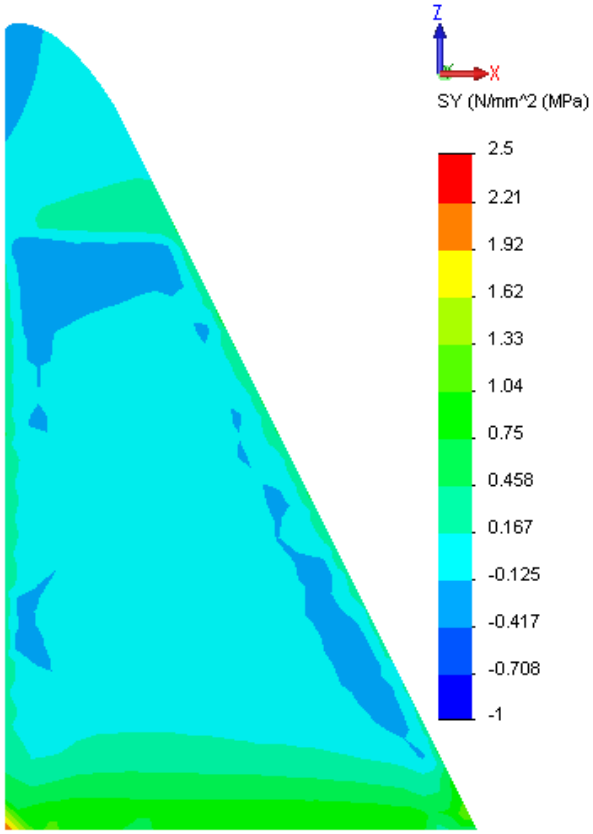


Figure B17: Sc 2 - Crown Cantilever Arch Stresses

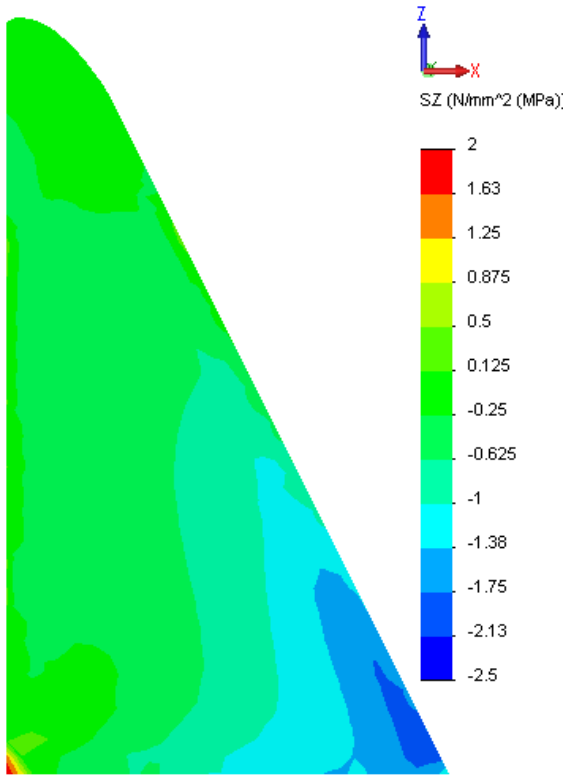


Figure B18: Sc 2 - Crown Cantilever Vertical Stresses

B.4.5. Scenario 3: 15°C Temperature Drop

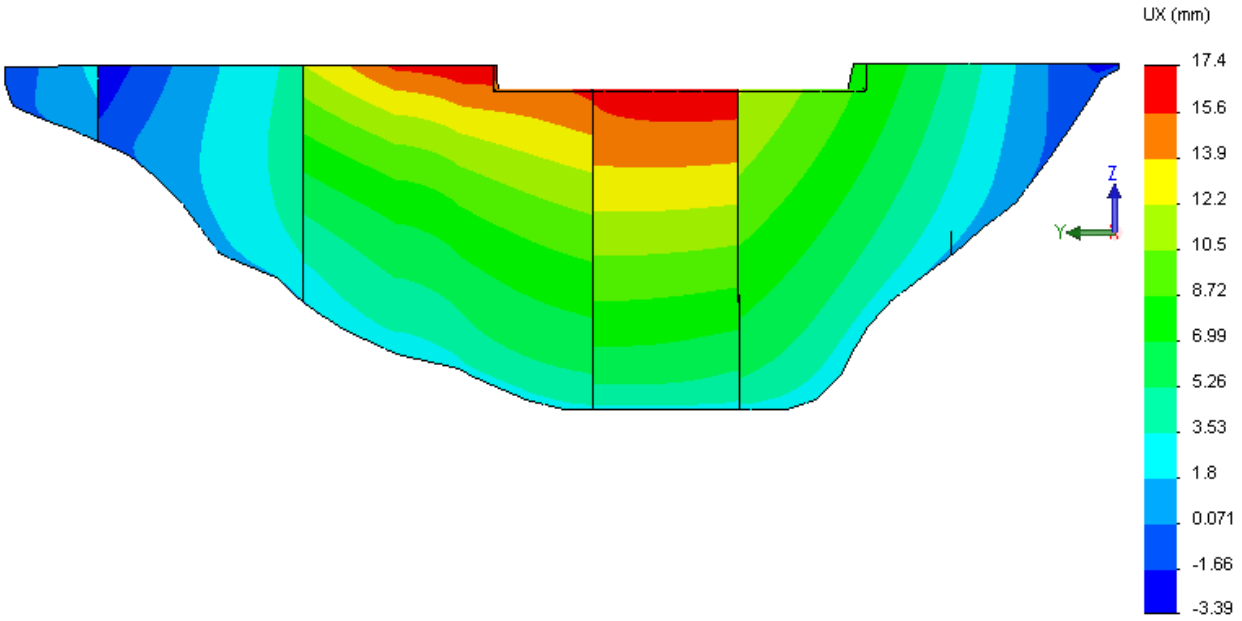


Figure B19: Sc 3 - Downstream Displacements (viewed from upstream)

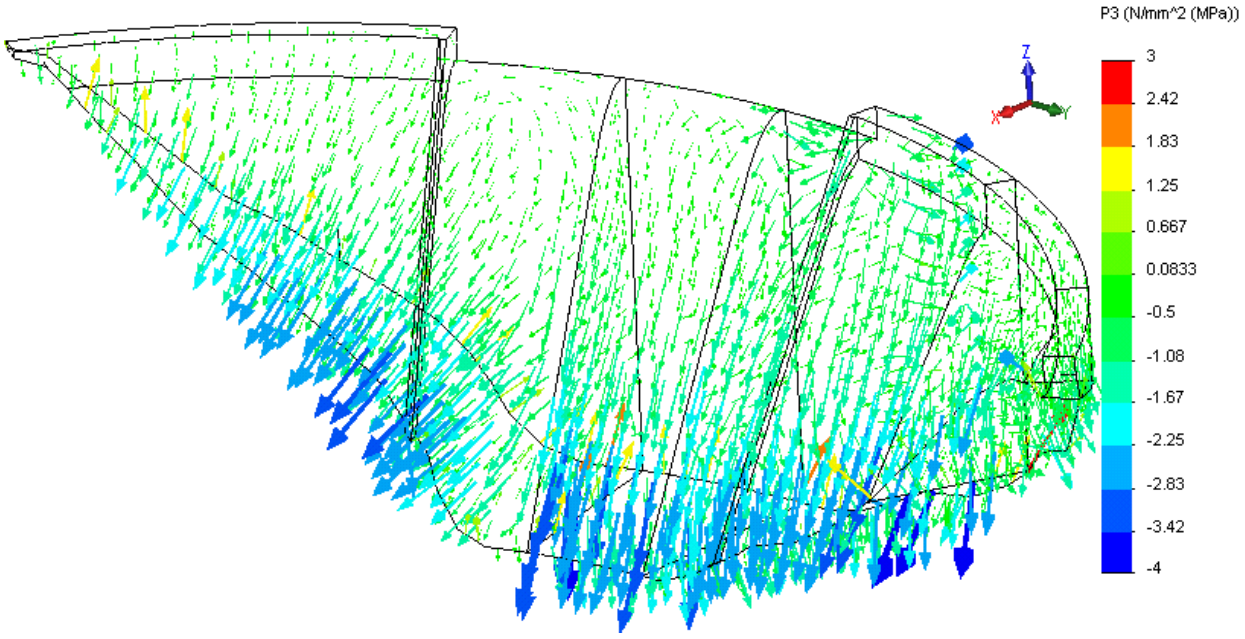


Figure B20: Sc 3 - Principal Stresses

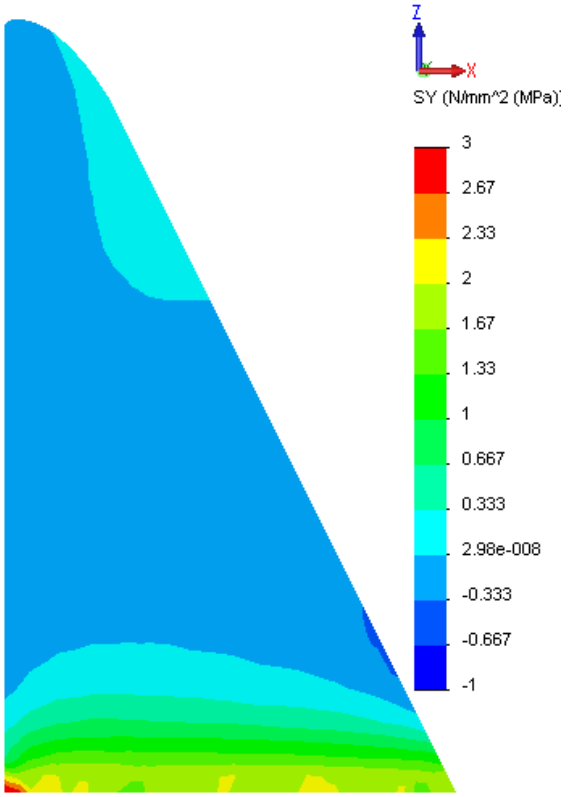


Figure B21: Sc 3 - Crown Cantilever Arch Stresses

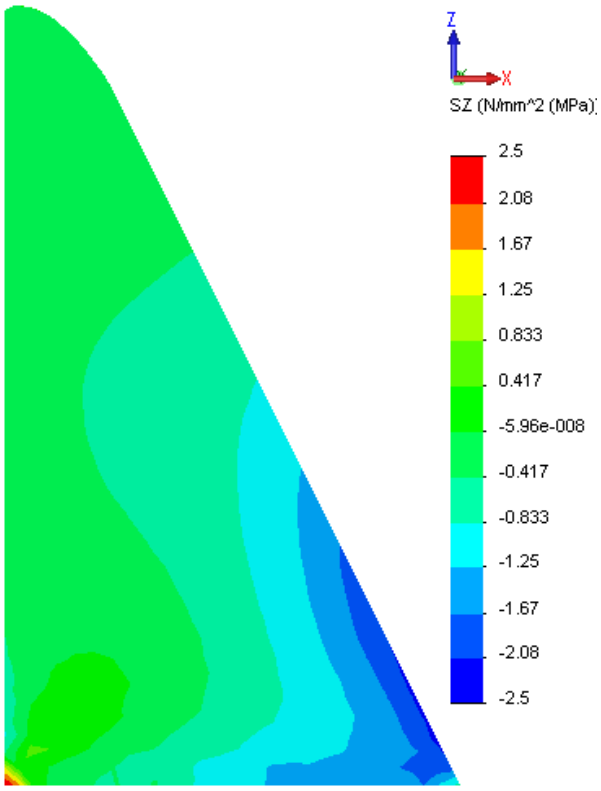


Figure B22: Sc 3 - Crown Cantilever Vertical Stresses

B.4.6. Scenario 4: 25°C Temperature Drop

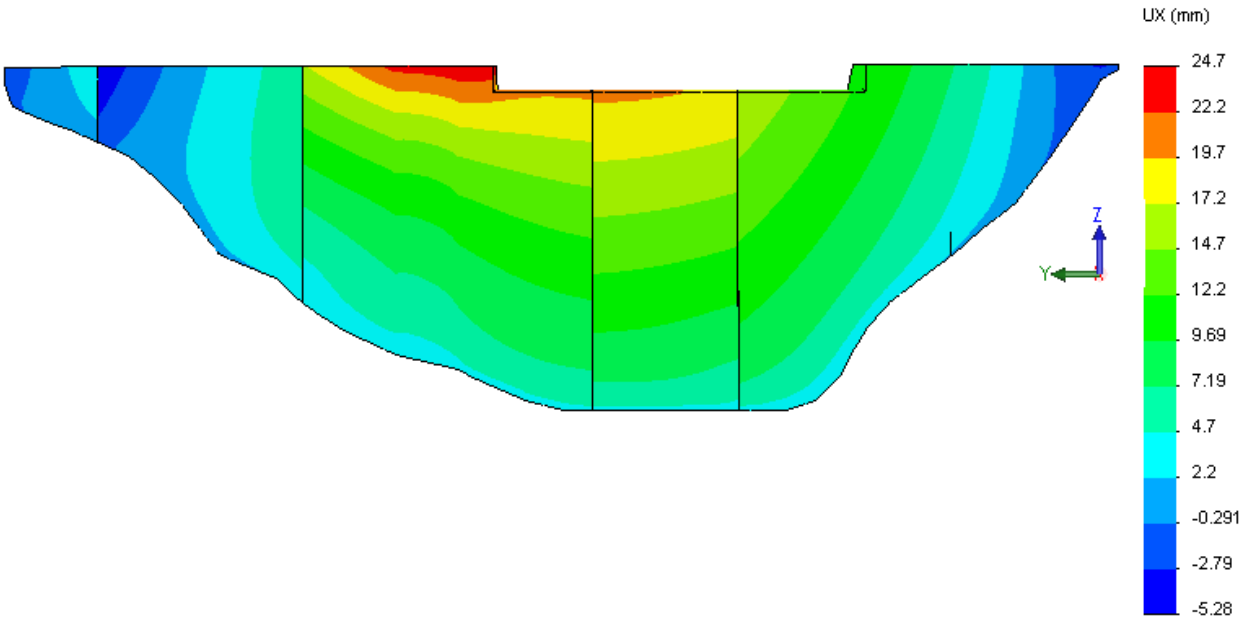


Figure B23: Sc 4 - Downstream Displacements (viewed from upstream)

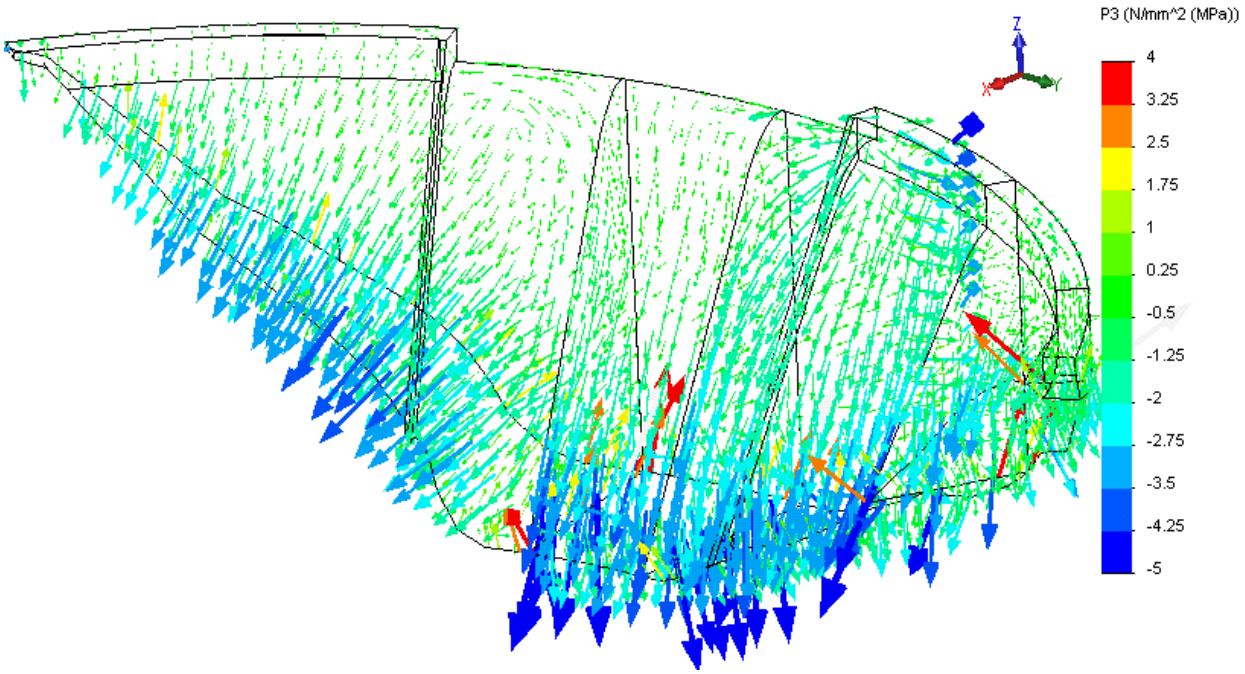


Figure B24: Sc 4 - Principal Stresses

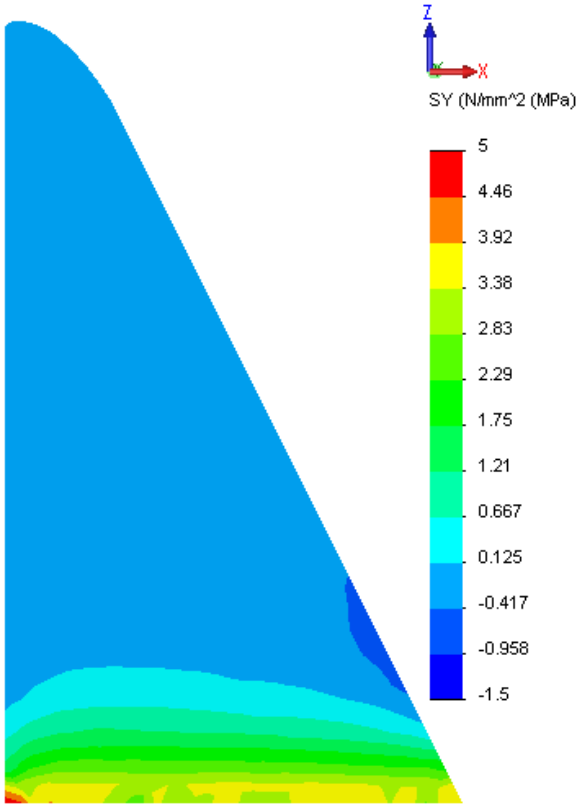


Figure B25: Sc 4 - Crown Cantilever Arch Stresses

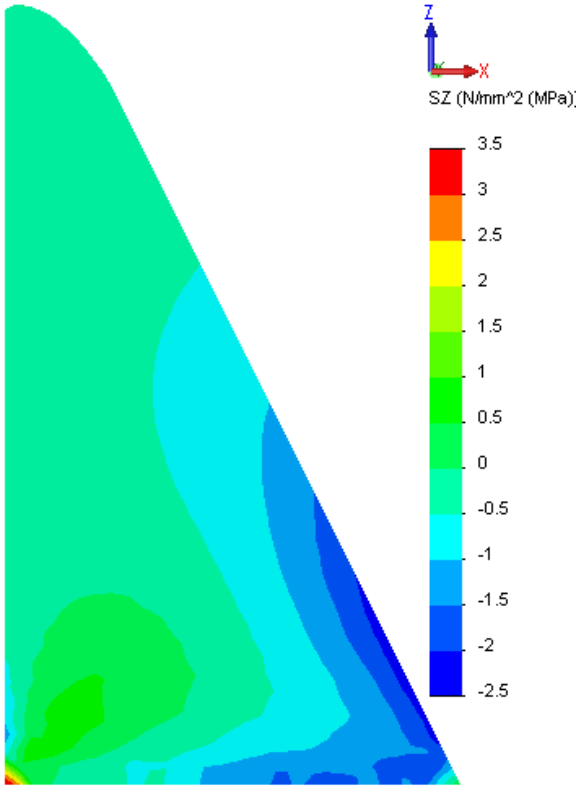


Figure B26: Sc 4 - Crown Cantilever Vertical Stresses

B.4.7. Scenario 5: 38°C Temperature Drop

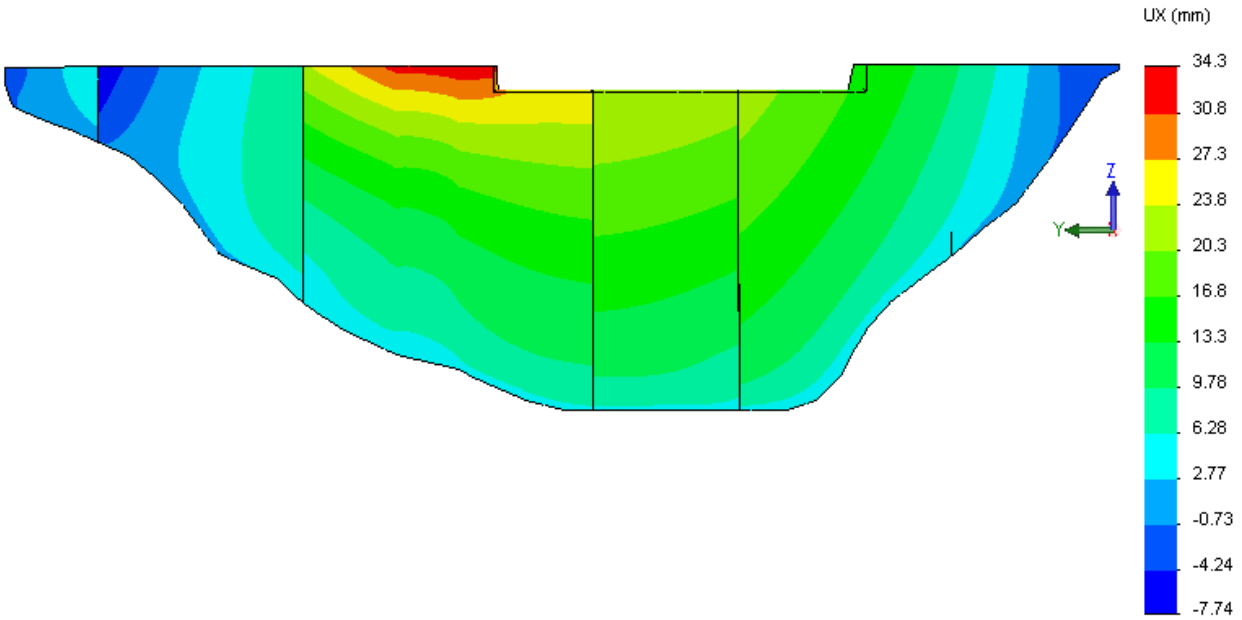


Figure B27: Sc 5 - Downstream Displacements (viewed from upstream)

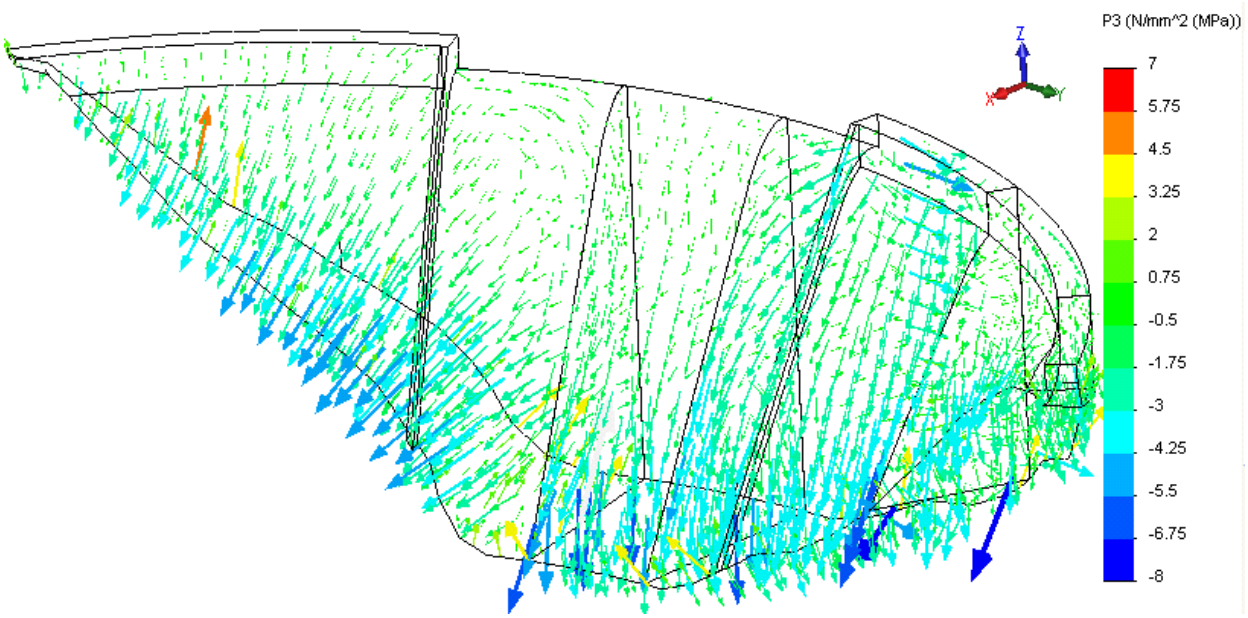


Figure B28: Sc 5 - Principal Stresses

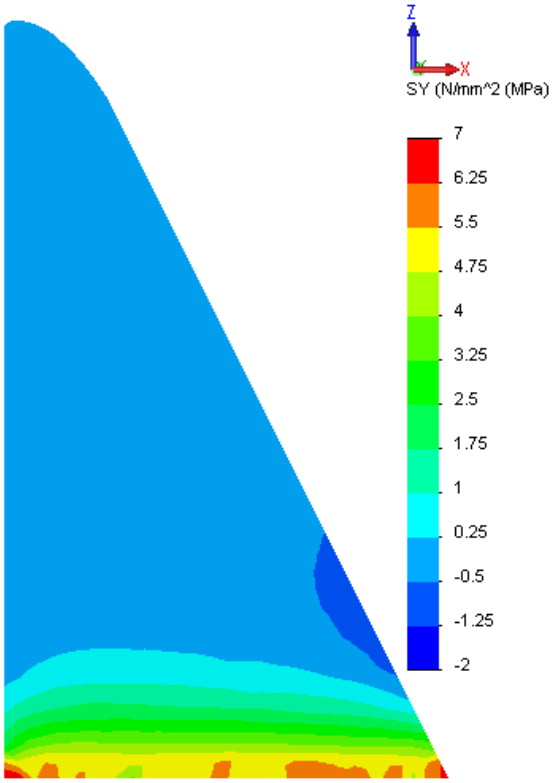


Figure B29: Sc 5 - Crown Cantilever Arch Stresses

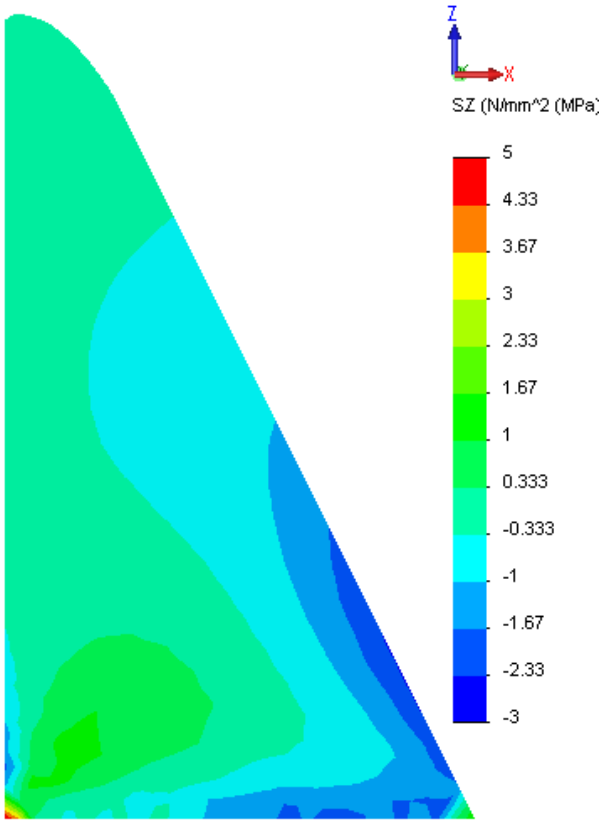


Figure B30: Sc 5 - Crown Cantilever Vertical Stresses

B.4.8. Summary of Displacements

The findings of the above analyses are compared in terms of predicted displacements at the indicated reference points with the equivalent measured values in **Table B5** below:

Table B5: Measured & Predicted Horizontal Displacement Data (mm- July 1993)

Reference Point	**113**	**120**	**212**	**217**	**221**
Measured Values					
Average Maximum Seasonal Variation	*10.5*	*12.1**	*4.3*	*5.9*	*4.5*
Seasonal Variations 1993	*8.0*	*10.5*	*3.2*	*4.5*	*3.5*
Reference Displacements (1993)	*14.5*	*11.7**	*7.65*	*10.1*	*7.5**
Scenario 0 Downstream Displacement	3.45	3.2	3.35	4.2	3.0
Scenario 1 Downstream Displacement	12.7	8.4	8.8	10.1	6.1
Scenario 2 Downstream Displacement	14.3	8.6	9.4	12.4	6.8
Scenario 3 Downstream Displacement	18.1	10.0	11.7	14.4	7.7
Scenario 4 Downstream Displacement	26.1	13.2	15.1	17.3	10.9
Scenario 5 Downstream Displacement	35.3	16.5	20.3	21.3	13.6

The figure marked with "*" are those in which a lower level of confidence is considered to exist.

B.4.9. Discussion of Results

B.4.9.1. General

Reviewing the above results and data, the following two factors must be given consideration:

1. While the induced joint Nos 3, 8, 14 and 17 were modelled as open over their entire height, in reality the instrumentation data recorded at RL 84.25 m confirmed that they did not actually open over the upper section, as the dam was under load by the time the hydration heat had dissipated. In the model, the

temperature drop will cause these induced joints to open and separate and, as each will indicate quite different stiffnesses, the blocks will deflect differentially before meeting together to re-develop arch action. To explain the impact of this effect further; a taller, more flexible block will indicate greater cantilever deflection than an adjacent shorter block under load and they will accordingly not make contact at the crest in the precise same orientation at which they were separated by shrinkage. This is demonstrated in the analyses through differential displacements on either side of the induced joints, particularly in the upper crest; i.e. by a block on one side of a joint indicating greater displacement than the block on the other side. As this separation did not occur in reality, the actual structure will have taken up the arching action more evenly and the predicted differential displacements were consequently not evident on the actual dam structure.

2. When heel tensions are low, the use of an elastic analysis will imply that the downstream crest displacements are over-stated. When the heel tensions are high, however, the elastic analysis will substantially under-estimate the extent of the downstream crest displacements.

B.4.9.2. Measured Displacements

Table B5 lists seasonal displacement variations for 1993 and the average values experienced over the record period from 1993 to 2008 in years when the dam was full year-round. While it is evident that the average annual displacement variations over the full period are greater than those experienced in 1993, the difference is seen primarily in the form of increased upstream movement. In view of the fact that records for displacement in the upper gallery only exist for a full, cooled dam, from August 1992, and no ambiguity is consequently created by behaviour when the dam was empty and heated by hydration, this effect is most evident in these data sets. As discussed under B 3.2.1, grouting of the open sections of the induced joints in late 1993 will have resulted in a situation in which upstream movement of the structure during times of increased temperature will increase, while downstream movement in times of low temperature will not have been decreased. Consequently, it is considered that adopting the average seasonal displacement variation data to establish the structural reference performance of the dam, as opposed to the 1993 data, is conservative.

B.4.9.3. Representivity

Considering the fact that the magnitude of the displacements measured at reference points 120 and 221 are probably exaggerated by higher temperature variations than assumed, the displacements indicated for Scenario 1, or Scenario 2 can be seen to most closely represent the actual displacements measured. Taking into account the level of the heel tensions for Scenarios 3 to 5, it is likely that the predicted displacements are under-stated. In view of the fact that the predicted displacements are already substantially higher than those measured, none of these Scenarios can be considered at all representative of the behaviour of the actual dam structure.

B.4.9.4. Scenario 0

With no temperature drop applied, the arch action can be seen to be even and well developed over the full dam structure, with compressive stresses being strongly defined over the top half of the dam wall. Downstream toe compressions peak locally at 4 MPa and there is no tension at the dam heel. Arch stresses are a maximum of 1 MPa, but the entire section of the dam on the crown cantilever is in compression.

B.4.9.5. Scenario 1

With just an 8°C temperature drop, the arch action can be seen to be substantially compromised, with arching effectively limited to the crest area and stresses being carried much more vertically down into the foundation, while heel tensions start to develop at the base, peaking very locally at 1.5 MPa. As a consequence, the maximum arch stress is increased to 1.5 MPa, although the maximum toe compression stress is not affected.

B.4.9.6. Scenario 2

With a more realistic distribution of temperature drops, the maximum arch stresses in fact reduce, as the total contact area of arching increases. Although the maximum toe compression value does not increase, a greater part of the toe contact area now indicates higher levels of compression stress. Heel tensions have increased, but a large portion of the base remains in compression and again, the extent of the arch action is significantly reduced, with the cantilevers playing a greater role and the stresses being directed more vertically into the foundation.

B.4.9.7. Scenario 3

For a 15°C temperature drop, the extent to which the arch action is compromised simply increases and the heel tension starts to reach a level that would undoubtedly result in cracking and increased tilting of the cantilevers. Tension stress can be seen to cover a more significant part of the dam base.

B.4.9.8. Scenario 4

For a 25°C temperature drop, the toe compressions start increasing and a number of significant tensile stresses develop on the upstream face and over significant portions of the crown-cantilever. It is considered that the structural problems on the prototype structure would start to become evident for the indicated levels of stress and it certainly would not be considered appropriate to design the dam for behaviour of the nature evident.

B.4.9.9. Scenario 5

For a 38°C temperature drop, toe compressions of up to 8 MPa are evident, together with heel tensions of 5 MPa. To develop a realistic assessment of the performance of the structure under such levels of stress, a non-linear analysis with limiting tensile strength would be required.

B.5. CONCLUSIONS

From the analyses presented, it is quite clear that the RCC of Wolwedans Dam did not suffer the reduction in volume that would normally be anticipated in CVC as a result of autogenous shrinkage and creep under early hydration heating. While the analyses demonstrate the significantly deleterious impact of such shrinkage on the structural action of the arch, the comparison of the modelled and measured structural displacements and joint openings allow a single, definitive conclusion. The structural modelling confirms that the RCC of Wolwedans Dam suffered no perceptible volume reduction during the hydration heating and subsequent cooling cycle as a consequence of autogenous shrinkage, or creep.

B.6. REFERENCES

[1] Hattingh LC, Heinz WF & Oosthuizen C. *Joint Grouting of a RCC Arch/Gravity Dam: Practical Aspects*. 2nd International Symposium on Roller Compacted Concrete Dams. Santander, Spain. pp 1037-1051. 1995.

[2] Precise Engineering Surveys. Department of Water Affairs. *Instrumentation Data for Wolwedans Dam. 1990 to 2008*. August 2008.

[3] Structural Research and Analysis Corporation (SRAC). *COSMOSM Finite Element Analysis Program.* General-purpose, modular FE Analysis system. SRAC, a division of SolidWorks Corporation, Dassault Systemes S.A., Paris, France.

[4] United States Army Corps of Engineers. *Gravity Dam Design.* Engineering Manual. EM 1110-2-2200. USACE. Washington. June 1995.

WOLWEDANS DAM

DEFORMATION DISPLACEMENT MEASUREMENTS: 1990 – 2008

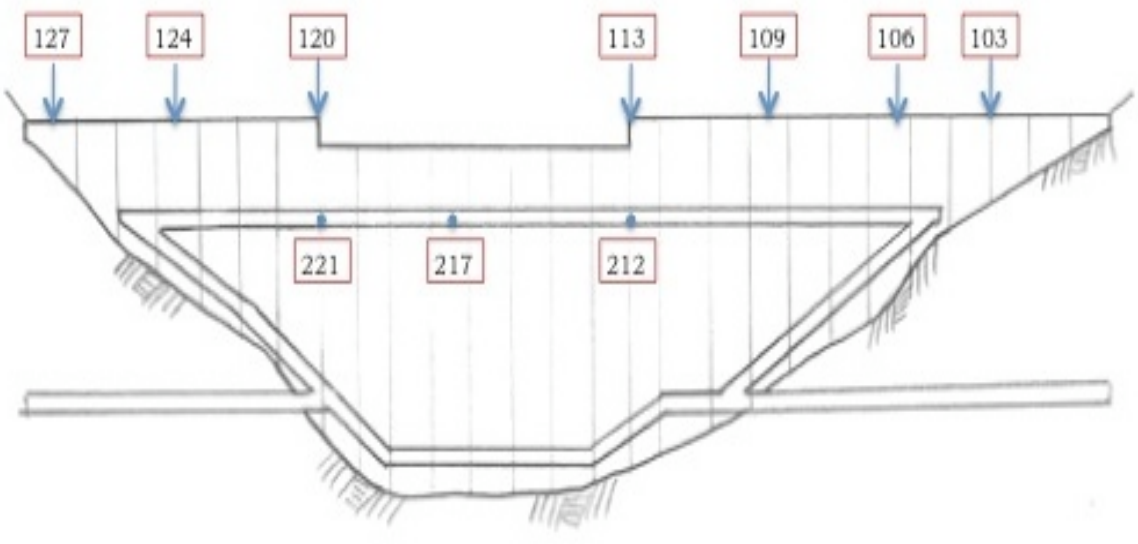
Courtesy of Precise Engineering Surveys

Department of Water Affairs

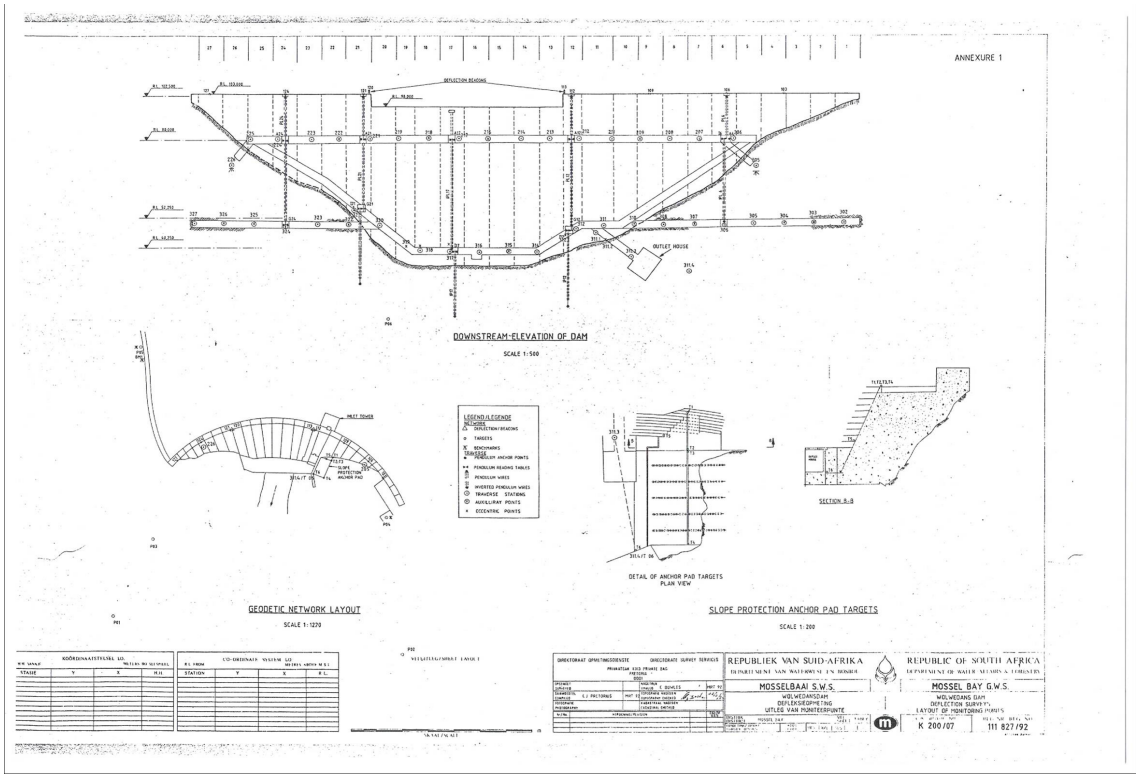
Schoeman Street

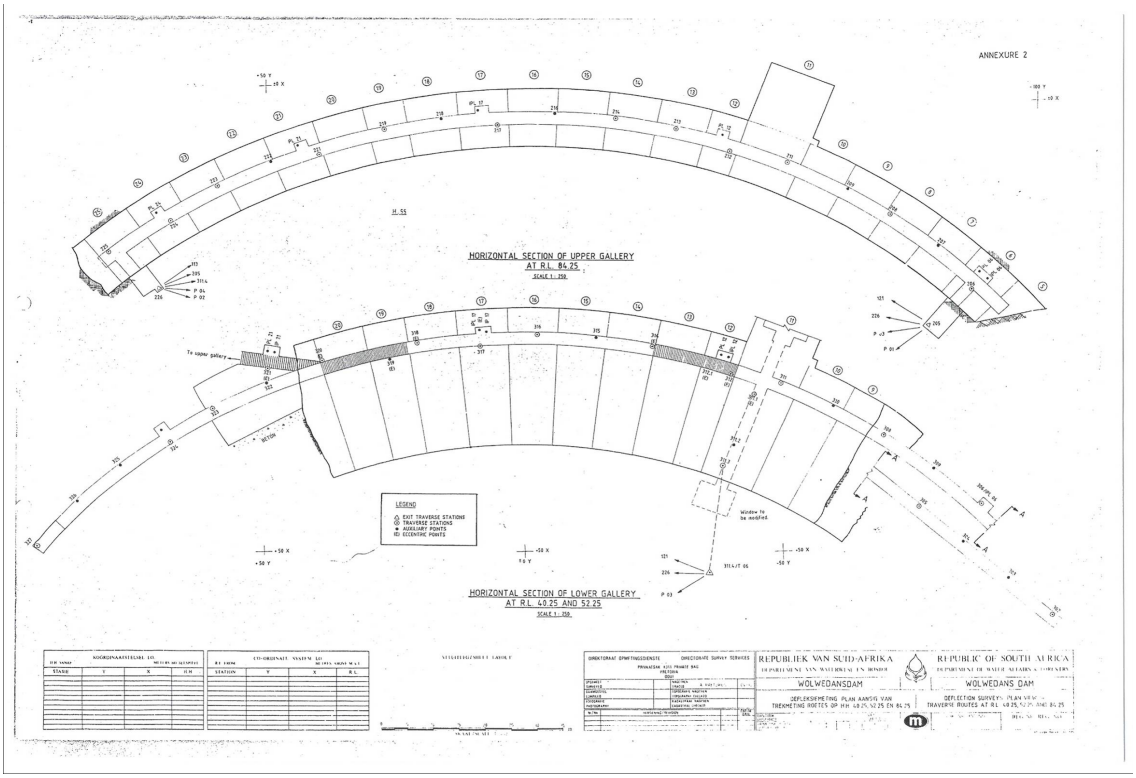
Pretoria

South Africa



Key to Reference Point Locations (Viewed from Downstream)





CO-ORDINATE SYSTEM
LOCAL SYSTEM (ON CENTRE OF DAM)

UPSTREAM

- X

RIGHT FLANK + Y **- Y** **LEFT FLANK**

+ X

DOWNSTREAM

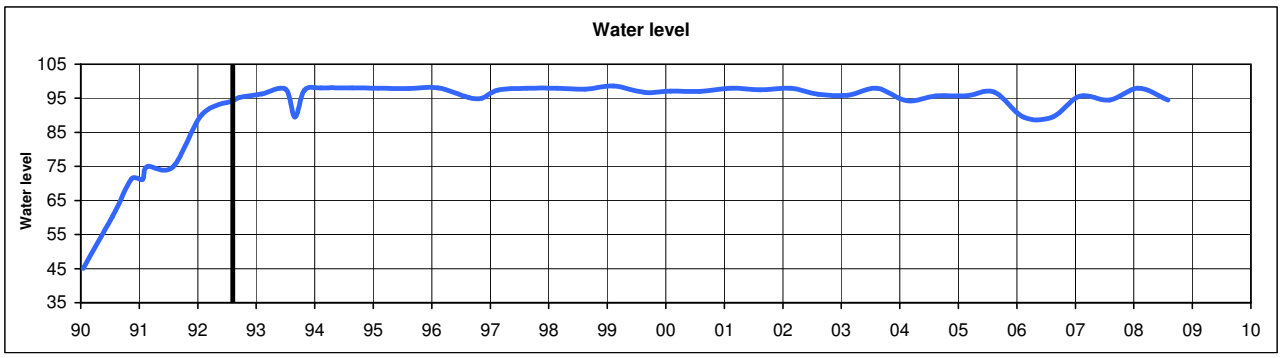
VERTICAL DISPLACEMENT: POSITIVE (+) - UPWARD
NEGATIVE (-) - DOWNWARD

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



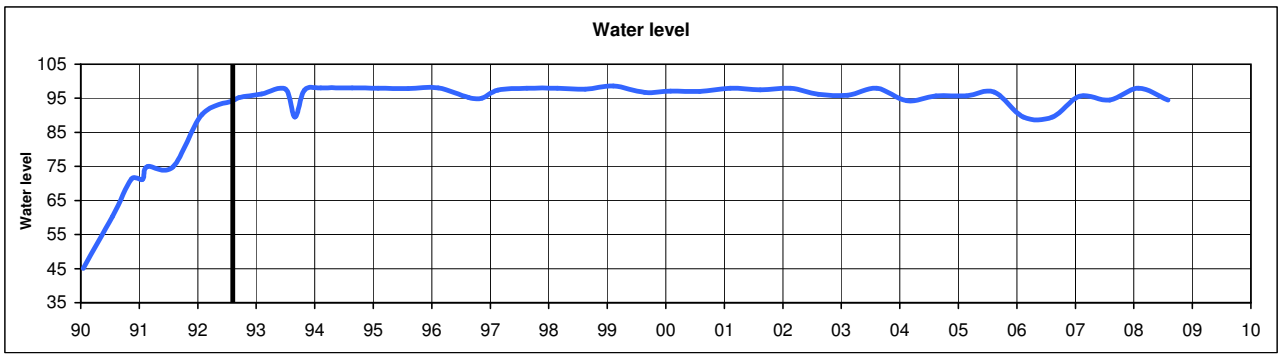
Date	Water Level	P01			P02			P03			P04			P05		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	0.7	0.3	0.5	-1.2	-1.2	3.5	0.1	-1.5	0.8	-0.5	0.2	0.0	0.2	-1.1	0.5
18/07/1990	60.30	0.1	0.6	0.4	#N/A	#N/A	1.8	#N/A	#N/A	0.9	#N/A	#N/A	0.0	#N/A	#N/A	1.7
13/11/1990	71.28	-0.2	-0.5	1.9	-1.0	-0.1	1.7	-0.7	-0.7	2.9	-0.5	0.5	0.0	1.1	-0.8	-0.3
22/01/1991	71.15	-0.8	-0.7	-1.2	-0.3	0.3	0.0	-0.6	-0.8	0.3	-0.5	0.8	0.0	1.7	-0.3	0.8
21/02/1991	74.97	-0.4	-0.7	1.6	-0.4	-0.1	1.6	-0.4	-0.5	0.2	-0.6	0.9	0.0	1.5	-0.1	0.0
30/07/1991	74.87	-1.1	-1.0	-1.5	-0.3	0.8	-0.2	-0.6	-0.7	0.1	0.0	0.4	0.0	1.9	-0.3	-0.1
29/01/1992	90.27	-0.3	0.0	1.4	-0.1	0.3	0.6	-0.1	-0.6	1.8	0.5	0.2	0.0	0.2	-0.5	0.6
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.1	0.3	0.3	0.2	-0.1	0.2	-0.2	-0.1	0.4	0.3	0.2	0.0	-0.1	-0.4	0.6
03/02/1993	96.22	-0.3	0.4	0.6	0.2	0.1	-2.4	-0.8	0.3	-0.2	0.4	0.4	0.0	-0.2	-0.7	0.7
03/07/1993	97.69	-0.5	0.1	-0.1	0.1	0.4	-0.2	-1.0	0.2	0.6	0.1	-0.7	0.0	0.0	-0.6	1.0
31/08/1993	89.47	-0.1	0.0	0.1	-0.2	0.0	-1.2	-1.1	-0.2	0.8	-0.3	-0.9	0.0	0.1	-0.3	0.3
29/10/1993	97.39	0.3	0.6	1.8	0.2	-0.3	2.6	-0.4	0.4	1.2	0.1	-0.1	0.0	-0.8	-0.1	1.4
09/02/1994	98.07	0.1	1.0	0.4	0.4	-0.3	-0.4	-0.9	0.5	1.2	-0.5	0.4	0.0	-1.0	-0.8	1.1
24/08/1994	98.04	-0.6	0.9	-1.0	0.6	0.1	0.8	0.0	0.4	0.1	-0.4	-0.1	0.0	-0.3	-1.2	1.3
01/02/1995	97.93	-0.4	0.8	0.4	0.4	-0.3	1.2	-0.1	-0.2	1.2	0.2	-0.3	0.0	0.1	-1.2	1.9
09/08/1995	97.90	-0.4	0.6	2.4	0.2	-0.4	0.7	-0.4	0.6	1.4	0.2	-1.5	0.0	0.3	-1.2	1.2
13/02/1996	98.02	0.6	0.8	1.0	-0.8	0.1	1.1	-0.3	0.8	0.5	-0.5	0.8	0.0	-1.8	-1.3	0.2
21/08/1996	95.22	-0.7	0.4	0.9	0.0	1.2	0.3	-1.8	0.7	0.9	-1.5	0.4	0.0	-0.9	-1.3	1.2
12/11/1996	95.05	-0.2	1.2	0.6	0.0	0.4	2.4	-0.7	0.6	0.9	-1.1	0.4	0.0	-1.6	-1.7	1.0
18/02/1997	97.43	0.2	0.1	4.6	-1.0	-0.5	1.5	-3.6	0.0	1.1	-2.4	0.1	0.0	-4.1	-1.5	-0.4
19/08/1997	98.00	-0.3	-0.4	1.7	-1.1	0.6	0.7	-3.2	-0.2	0.9	-2.4	-0.5	0.0	-3.9	-1.6	1.3
26/02/1998	97.92	0.3	0.1	1.7	-1.1	0.8	0.5	-2.4	0.5	0.0	-2.0	0.1	0.0	-1.5	-1.0	0.7
19/08/1998	97.71	-0.3	0.3	2.2	-0.7	1.0	0.7	-2.0	0.9	1.2	-1.8	0.2	0.0	-1.3	-1.5	1.6
10/02/1999	98.64	-0.2	0.7	0.8	0.8	-0.2	0.6	-0.4	0.5	0.5	-0.4	0.3	0.0	-0.2	-0.9	0.3
25/08/1999	96.75	-0.5	0.1	0.9	0.7	0.4	1.4	-1.1	1.1	1.5	-0.5	-0.2	0.0	0.3	-0.3	2.0
02/02/2000	97.11	0.0	0.9	1.3	0.8	-0.6	2.2	-0.2	0.6	-0.5	-0.3	0.2	0.0	-0.6	-0.5	-0.6
02/08/2000	96.99	-0.5	0.3	0.8	0.7	0.1	2.0	-0.7	0.9	0.3	-0.4	0.1	0.0	0.2	-0.5	1.0
08/02/2001	97.93	-0.8	-0.6	-1.0	0.4	0.8	0.8	-0.4	-0.3	-0.2	-0.5	-0.1	0.0	0.9	-0.1	0.0
15/08/2001	97.44	-0.3	0.5	-0.3	0.8	0.0	2.0	-0.3	0.7	-1.0	-0.4	-0.1	0.0	-0.1	-0.4	0.2
20/02/2002	97.99	-0.3	0.7	-0.2	0.6	0.2	0.5	-0.9	1.2	-0.1	0.0	-0.4	0.0	-0.4	-0.5	-0.9
15/08/2002	96.18	-0.8	0.2	-0.4	0.9	0.6	0.7	-0.6	-0.2	0.1	-0.5	-0.2	0.0	0.4	-0.6	0.5
13/02/2003	95.93	-0.7	0.0	0.4	0.7	0.7	0.9	-0.2	0.1	0.7	-0.5	-0.4	0.0	0.5	-0.3	0.9
13/08/2003	98.00	-0.4	1.6	2.0	1.2	-0.2	1.7	-0.6	1.3	1.8	0.1	-0.5	0.0	-1.0	-1.0	0.7
18/02/2004	94.30	-0.3	-0.1	1.8	0.5	0.6	1.1	-1.4	0.3	1.3	-0.6	-0.5	0.0	0.4	0.1	0.8
18/08/2004	95.69	-0.8	0.4	-1.0	1.1	0.8	1.2	-0.9	0.3	0.3	-0.6	-0.7	0.0	0.3	-0.5	0.3
23/02/2005	95.69	-1.0	1.7	1.0	1.5	0.2	2.2	0.0	0.3	0.3	0.2	-0.5	0.0	-0.7	-1.5	0.4
17/08/2005	96.85	-0.3	0.4	-0.5	0.9	0.5	1.3	-1.4	0.1	-0.4	-0.7	-0.7	0.0	0.0	-0.1	0.4
15/02/2006	89.48	-0.2	0.2	-1.8	0.5	0.5	0.6	1.2	-0.8	0.0	-0.4	-0.7	0.0	2.5	-1.9	-0.5
16/08/2006	89.48	0.2	1.8	4.5	1.8	-0.6	1.5	-0.4	1.0	2.0	-0.1	-0.7	0.0	-1.3	-1.4	0.5
01/02/2007	95.60	0.9	1.2	5.6	0.7	-0.1	0.2	-1.2	0.2	1.1	0.4	-0.8	0.0	-0.7	-0.4	-0.2
08/08/2007	94.48	0.3	0.8	3.1	0.8	0.2	1.7	-2.4	0.8	1.4	-0.3	-1.0	0.0	-0.7	0.0	-0.1
05/02/2008	97.91	0.9	1.9	5.2	1.2	-0.7	2.9	-0.4	1.6	1.8	-0.3	-1.0	0.0	-1.7	-0.2	-0.4
06/08/2008	94.48	0.0	1.2	4.5	1.3	0.4	2.3	-2.3	0.8	2.0	-0.6	-1.4	0.0	-0.8	-0.2	0.8

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



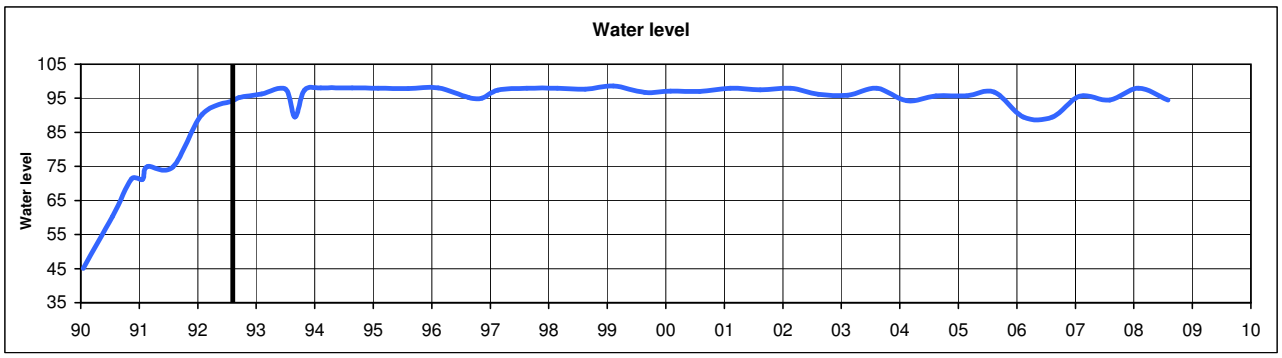
Date	Water Level	P06			P113			P120			R205			R226		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	0.3	2.1	4.0	-5.1	-11.5	7.0	3.7	-9.6	6.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	2.9	#N/A	#N/A	1.4	#N/A	#N/A	1.9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	0.1	1.5	2.6	-2.6	-8.6	2.5	1.0	-8.1	2.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	-0.6	0.9	2.1	-3.2	-12.8	3.9	1.9	-11.8	3.9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	-0.7	0.9	1.7	-3.6	-11.9	3.2	1.8	-11.1	4.3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	-0.5	0.6	-0.1	-2.0	-4.9	0.3	0.5	-2.9	0.9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	0.3	0.3	0.6	-1.2	-10.8	3.0	2.6	-12.1	3.1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.0	0.1	-0.4	0.5	-0.1	0.5	-0.7	-1.2	0.5	0.3	0.1	0.3	-0.7	-0.1	-0.1
03/02/1993	96.22	0.3	0.1	-0.5	-0.2	-6.2	1.7	2.2	-8.7	1.4	0.8	0.8	-0.3	-0.4	0.5	-0.9
03/07/1993	97.69	0.4	0.1	-0.4	0.9	1.7	0.0	0.2	1.6	0.1	0.0	0.1	-1.1	-0.4	-0.1	-1.5
31/08/1993	89.47	0.2	0.4	-1.0	0.2	-0.7	0.0	0.1	-0.8	0.3	0.3	-0.4	0.0	-0.9	0.5	-0.6
29/10/1993	97.39	0.3	-0.1	-0.6	0.3	-2.7	1.7	0.6	-4.4	1.9	-0.1	0.6	0.0	-0.7	0.3	0.4
09/02/1994	98.07	0.5	0.1	-1.2	-1.5	-7.8	2.3	2.1	-9.4	2.0	-0.4	1.2	0.3	-1.1	1.7	-1.0
24/08/1994	98.04	0.3	0.3	-0.8	-0.3	2.3	0.6	-0.1	1.4	0.5	-0.6	0.8	-0.6	0.0	0.5	-1.0
01/02/1995	97.93	0.0	0.8	-0.9	-0.7	-9.2	2.4	2.8	-11.4	2.4	-0.1	-0.3	0.6	0.5	1.1	-0.1
09/08/1995	97.90	-0.1	1.0	-4.4	0.8	2.0	0.3	0.8	2.2	0.4	-0.2	-0.5	-1.2	0.7	0.3	-2.0
13/02/1996	98.02	2.0	0.6	0.3	-1.8	-8.1	2.1	2.2	-10.4	1.4	-0.8	1.0	-0.4	-0.2	0.7	-1.2
21/08/1996	95.22	1.6	-0.1	0.8	-1.3	3.2	0.2	-0.9	3.1	0.7	-2.0	0.6	-0.7	-0.9	0.5	-1.5
12/11/1996	95.05	1.8	0.3	0.8	-0.7	-2.0	1.3	-0.1	-3.9	1.3	-1.4	1.2	-0.1	-0.9	0.4	-1.2
18/02/1997	97.43	0.6	1.6	2.0	-4.0	-7.8	2.2	-0.1	-9.9	2.1	-2.8	0.7	-0.3	-2.5	0.4	-0.8
19/08/1997	98.00	1.2	1.1	1.5	-2.4	1.8	0.6	-2.1	0.9	0.9	-3.1	0.3	0.0	-2.4	-0.4	-0.7
26/02/1998	97.92	2.3	0.2	1.1	-2.7	-8.0	2.1	1.5	-10.5	2.0	-2.1	0.3	-0.6	-0.8	1.5	-1.1
19/08/1998	97.71	2.3	0.3	1.0	-1.1	3.1	0.8	-1.0	2.9	1.5	-1.8	0.6	-0.2	-0.9	0.9	-0.2
10/02/1999	98.64	3.5	0.3	-0.5	-1.6	-8.1	2.4	2.8	-10.3	2.4	-0.4	1.1	-0.3	0.3	1.6	-0.9
25/08/1999	96.75	2.4	0.7	0.9	0.1	1.9	1.5	0.8	2.3	2.1	-0.6	0.2	-0.2	0.9	1.8	-0.6
02/02/2000	97.11	1.3	1.5	0.0	-1.3	-9.0	2.2	2.8	-11.1	1.3	-0.5	1.0	-0.6	0.6	0.8	-1.8
02/08/2000	96.99	0.7	2.5	-0.1	-0.3	2.9	1.5	0.3	3.5	1.5	-1.2	1.3	0.2	0.1	0.8	-0.3
08/02/2001	97.93	1.1	0.9	-2.5	-1.1	-7.5	2.5	1.9	-9.8	2.3	-0.7	0.9	0.0	0.2	1.3	-1.0
15/08/2001	97.44	1.8	-0.1	-0.7	0.3	3.2	0.3	0.0	2.9	1.0	-0.2	0.9	-0.8	0.0	0.9	-1.3
20/02/2002	97.99	2.4	0.4	-3.0	-0.7	-6.8	1.3	2.3	-8.3	1.1	-0.2	0.8	-1.9	0.7	1.7	-2.4
15/08/2002	96.18	1.8	-0.5	-1.3	0.0	2.0	0.5	-0.1	1.8	1.0	-1.3	0.7	-0.5	-0.2	0.5	-1.3
13/02/2003	95.93	2.0	-0.9	-2.3	-1.6	-11.0	2.1	2.8	-13.2	2.5	-0.8	0.5	-0.3	0.3	0.3	-1.8
13/08/2003	98.00	4.4	1.1	2.1	0.3	4.0	0.2	0.2	4.5	0.7	-0.8	0.6	-0.4	0.4	1.0	-1.2
18/02/2004	94.30	3.5	1.0	1.2	-2.1	-9.6	2.9	2.6	-11.1	2.4	-1.5	0.6	0.3	0.1	0.2	-0.6
18/08/2004	95.69	4.0	-0.7	1.7	0.2	1.6	0.4	0.0	1.5	1.1	-1.6	-0.3	-0.9	0.4	0.0	-1.2
23/02/2005	95.69	4.3	-0.4	1.3	-1.3	-8.9	2.9	2.7	-10.7	2.2	-0.4	0.6	-0.5	0.7	0.4	-1.2
17/08/2005	96.85	3.3	-0.6	-0.1	0.0	2.3	-0.2	-0.4	2.1	0.3	-1.3	0.1	-1.4	-0.1	0.2	-2.1
15/02/2006	89.48	4.3	-2.5	-2.1	-1.3	-11.7	2.3	3.9	-13.2	2.5	-0.3	-0.7	-0.3	1.1	-0.6	-1.7
16/08/2006	89.48	4.7	-0.4	0.6	0.4	2.7	0.1	-0.6	2.6	0.3	0.0	-0.1	0.0	0.0	0.7	-1.2
01/02/2007	95.60	5.3	0.8	1.4	-0.6	-10.6	2.0	3.2	-13.4	2.3	0.5	1.0	-0.1	0.8	0.8	-1.0
08/08/2007	94.48	4.5	0.8	1.3	0.4	2.1	-0.3	0.1	2.9	-0.1	-0.6	0.2	-1.0	0.0	1.2	-1.7
05/02/2008	97.91	5.5	0.1	1.9	0.7	-8.1	1.5	2.4	-10.0	2.1	0.3	-0.3	-0.6	0.3	1.4	-2.0
06/08/2008	94.48	3.7	0.3	0.9	-0.1	2.0	-0.2	-0.3	1.9	1.0	-1.0	0.5	-0.1	-0.5	0.4	-0.9

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



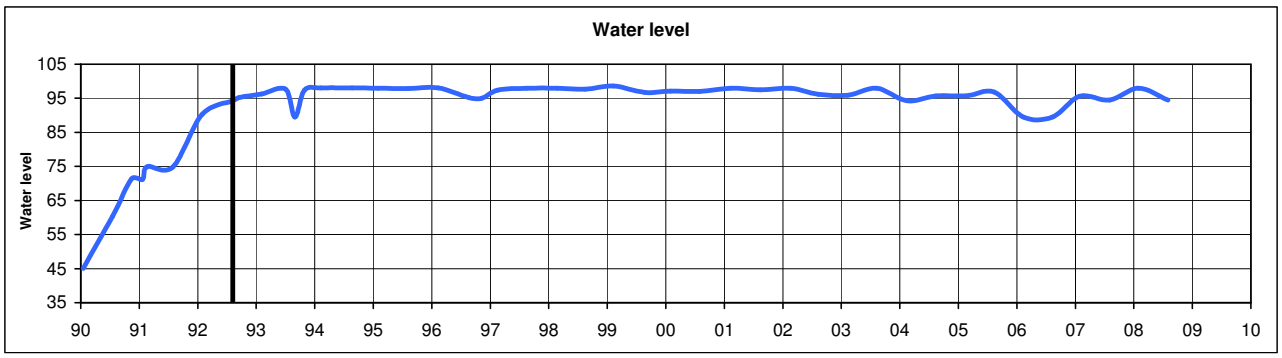
Date	R300	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0
17/09/1992	95.23	0.0	0.2	0.5
03/02/1993	96.22	0.5	1.1	-0.3
03/07/1993	97.69	-0.4	0.2	-1.0
31/08/1993	89.47	0.1	0.1	0.6
29/10/1993	97.39	-0.3	0.9	0.6
09/02/1994	98.07	-0.7	1.4	0.7
24/08/1994	98.04	-0.8	0.8	-1.1
01/02/1995	97.93	0.3	0.4	0.5
09/08/1995	97.90	-0.2	-0.5	-1.4
13/02/1996	98.02	-0.7	1.3	-0.7
21/08/1996	95.22	-2.1	0.9	-1.3
12/11/1996	95.05	-1.2	1.2	-0.5
18/02/1997	97.43	-2.4	0.6	-0.6
19/08/1997	98.00	-3.3	0.3	0.1
26/02/1998	97.92	-1.7	0.7	-0.8
19/08/1998	97.71	-1.9	0.7	0.4
10/02/1999	98.64	0.0	1.4	-0.4
25/08/1999	96.75	0.1	0.3	0.4
02/02/2000	97.11	0.0	1.3	-2.3
02/08/2000	96.99	-0.7	1.4	-0.1
08/02/2001	97.93	0.0	1.3	-0.4
15/08/2001	97.44	-0.6	1.1	-1.1
20/02/2002	97.99	0.3	1.7	-2.6
15/08/2002	96.18	-0.9	0.8	-0.6
13/02/2003	95.93	0.2	1.2	-1.1
13/08/2003	98.00	-0.2	0.8	-1.4
18/02/2004	94.30	-0.4	0.7	-0.1
18/08/2004	95.69	-0.7	-0.1	-1.3
23/02/2005	95.69	0.4	0.7	-1.0
17/08/2005	96.85	-1.1	0.5	-2.5
15/02/2006	89.48	0.5	-0.3	-0.9
16/08/2006	89.48	-0.1	0.3	-1.5
01/02/2007	95.60	0.9	0.9	-0.3
08/08/2007	94.48	0.2	0.8	-1.2
05/02/2008	97.91	1.1	0.5	-1.4
06/08/2008	94.48	-0.7	0.7	-0.2

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



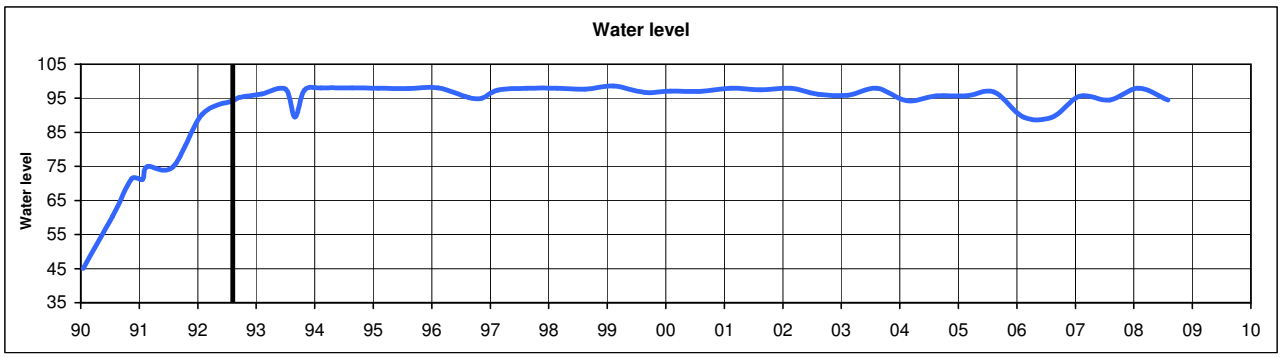
Date	Water Level	103			106			109			112			121		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	-3.6	0.3	2.4	-5.8	-2.6	3.9	-6.2	-7.8	5.4	-4.9	-10.7	7.1	4.4	-8.6	6.3
18/07/1990	60.30	#N/A	#N/A	-0.4	#N/A	#N/A	1.1	#N/A	#N/A	1.4	#N/A	#N/A	1.9	#N/A	#N/A	1.7
13/11/1990	71.28	-2.2	0.0	1.4	-3.2	-1.9	2.6	-3.0	-6.3	2.7	-2.4	-7.9	3.1	1.2	-7.3	1.9
22/01/1991	71.15	-3.8	0.0	2.1	-5.2	-3.2	3.6	-5.4	-9.1	4.2	-3.0	-12.0	4.4	2.7	-10.7	3.8
21/02/1991	74.97	-3.5	0.7	1.6	-4.7	-2.7	3.1	-4.5	-8.6	3.6	-3.0	-11.9	3.7	2.8	-10.2	3.9
30/07/1991	74.87	-0.6	0.2	1.0	-0.9	-0.4	1.2	-0.8	-3.8	1.1	-1.7	-5.1	0.9	0.5	-2.8	0.5
29/01/1992	90.27	-3.3	-0.2	0.8	-4.2	-3.4	2.1	-4.1	-8.5	2.5	-1.1	-10.7	2.7	2.6	-10.8	2.2
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.4	-0.6	0.9	-0.2	0.0	1.1	0.2	-0.8	1.1	0.4	0.3	1.2	-0.5	-1.2	0.7
03/02/1993	96.22	-2.1	0.1	1.6	-2.9	-2.1	2.3	-2.8	-5.3	2.6	-0.3	-5.5	2.8	2.8	-7.7	1.7
03/07/1993	97.69	-0.2	-1.1	0.6	0.0	-0.2	0.6	0.6	-0.2	0.5	1.0	1.0	0.7	0.9	1.2	-0.1
31/08/1993	89.47	-0.1	-0.7	0.8	-0.1	-0.9	0.9	0.0	-1.4	0.9	-0.3	-0.6	0.9	0.5	-0.9	0.2
29/10/1993	97.39	-0.7	-1.3	1.1	-1.3	-1.6	1.5	-1.2	-2.7	1.9	0.5	-2.0	2.6	0.9	-3.9	2.0
09/02/1994	98.07	-2.9	-0.7	2.1	-4.6	-2.8	2.5	-4.7	-5.7	2.8	-2.0	-6.8	3.2	2.4	-8.5	2.4
24/08/1994	98.04	-0.2	-0.6	-0.2	0.0	0.3	-0.9	0.2	0.5	-1.3	-0.4	1.8	-0.8	0.1	1.4	-1.3
01/02/1995	97.93	-2.9	-2.7	0.6	-4.6	-4.9	0.7	-4.6	-7.8	0.6	-1.1	-8.5	1.1	3.8	-10.4	0.7
09/08/1995	97.90	0.1	-2.5	-0.5	0.7	-0.9	-1.1	1.5	-0.3	-1.2	0.8	1.5	-0.8	1.3	2.0	-1.3
13/02/1996	98.02	-4.1	-1.9	1.7	-5.5	-4.0	1.6	-5.3	-7.2	1.7	-2.1	-7.9	2.1	2.9	-10.2	1.2
21/08/1996	95.22	-1.5	-1.0	-0.8	-1.2	1.0	-1.6	-0.5	1.2	-1.8	-1.3	2.8	-1.4	-1.0	2.9	-1.6
12/11/1996	95.05	-2.9	-0.8	-0.4	-3.4	-1.6	-0.4	-3.0	-2.8	-0.3	-1.4	-2.0	0.0	0.8	-3.6	-0.3
18/02/1997	97.43	-5.4	-1.8	2.1	-6.4	-3.7	2.3	-6.5	-6.3	2.2	-3.9	-7.1	2.4	0.1	-9.6	1.1
19/08/1997	98.00	-2.7	-1.0	-0.4	-2.5	0.0	-0.7	-2.0	0.2	-0.7	-2.0	1.5	-0.3	-1.4	0.6	0.6
26/02/1998	97.92	-4.7	-1.8	1.8	-6.0	-3.8	2.1	-5.8	-6.8	2.4	-2.8	-7.3	3.0	2.0	-9.5	2.3
19/08/1998	97.71	-1.4	-0.3	0.2	-1.3	1.1	0.3	-0.6	1.4	0.9	-1.1	3.0	1.4	-0.7	2.9	1.4
10/02/1999	98.64	-3.8	-0.7	2.4	-4.8	-3.4	2.8	-4.8	-6.7	3.4	-2.2	-8.0	3.9	3.4	-9.7	3.4
25/08/1999	96.75	-0.9	-0.9	1.3	-0.5	0.2	1.5	0.4	0.4	2.0	0.2	1.3	3.0	1.2	2.2	2.8
02/02/2000	97.11	-3.4	-1.9	2.3	-5.0	-4.2	2.7	-5.2	-6.9	3.2	-1.6	-8.3	3.9	4.0	-10.0	2.5
02/08/2000	96.99	-0.1	-0.5	1.3	0.1	1.0	1.4	0.9	1.3	1.9	0.3	2.5	3.0	0.7	3.0	2.1
08/02/2001	97.93	-3.2	-1.4	2.5	-6.5	-4.4	2.6	-4.2	-6.3	3.4	-1.4	-7.3	4.0	3.5	-8.9	3.6
15/08/2001	97.44	-1.1	-1.1	1.2	-0.4	0.8	0.9	0.0	1.1	1.1	-0.1	2.6	1.8	0.4	3.1	1.6
20/02/2002	97.99	-2.4	-2.4	2.3	-3.6	-3.6	2.4	-3.5	-5.3	2.7	-0.7	-5.9	3.1	2.8	-7.8	2.0
15/08/2002	96.18	-0.6	-1.7	1.1	0.0	0.3	1.0	0.6	0.5	1.3	0.2	2.2	1.9	0.3	1.2	1.9
13/02/2003	95.93	-3.9	-2.1	2.4	-5.2	-4.1	2.9	-5.4	-8.5	3.3	-1.9	-9.6	3.8	3.7	-12.4	4.0
13/08/2003	98.00	0.4	-2.2	0.7	0.8	0.5	0.5	1.6	1.4	0.9	0.6	3.2	1.6	0.7	3.4	1.6
18/02/2004	94.30	-4.8	-1.8	2.6	-6.3	-3.9	3.0	-4.6	-7.2	3.5	-2.1	-8.9	4.1	3.3	-11.0	3.7
18/08/2004	95.69	0.3	-2.1	1.3	0.3	-0.3	1.0	1.2	0.0	1.1	0.6	1.5	1.8	1.2	1.1	1.7
23/02/2005	95.69	-2.5	-3.1	2.7	-4.1	-4.4	3.4	-3.8	-7.2	3.9	-0.8	-8.6	4.5	3.6	-9.6	3.5
17/08/2005	96.85	-0.9	0.2	0.9	-0.5	-1.0	0.7	0.8	0.6	1.1	0.3	1.6	1.5	0.0	1.8	1.2
15/02/2006	89.48	-2.7	-3.6	3.0	-4.3	-5.4	3.5	-4.2	-9.3	3.9	-1.0	-10.9	4.1	4.5	-12.4	3.3
16/08/2006	89.48	0.0	-2.1	0.6	0.3	0.4	0.5	0.8	1.0	0.7	0.6	2.5	1.6	1.4	3.2	1.2
01/02/2007	95.60	-3.4	-2.8	2.7	-5.8	-4.6	3.0	-3.4	-4.5	3.5	-0.4	-10.8	3.7	4.9	-11.8	3.6
08/08/2007	94.48	0.7	-1.9	1.4	0.8	0.0	0.9	1.6	0.4	1.0	0.6	1.8	1.4	-0.2	2.4	0.5
05/02/2008	97.91	-0.7	-3.3	1.9	-4.1	-5.4	2.3	-3.3	-7.4	2.8	-0.2	-7.9	3.2	3.1	-9.4	3.4
06/08/2008	94.48	-0.5	-0.7	-0.3	-0.8	-0.1	-0.9	1.1	2.1	-0.7	0.9	1.5	0.2	0.3	1.6	0.8

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



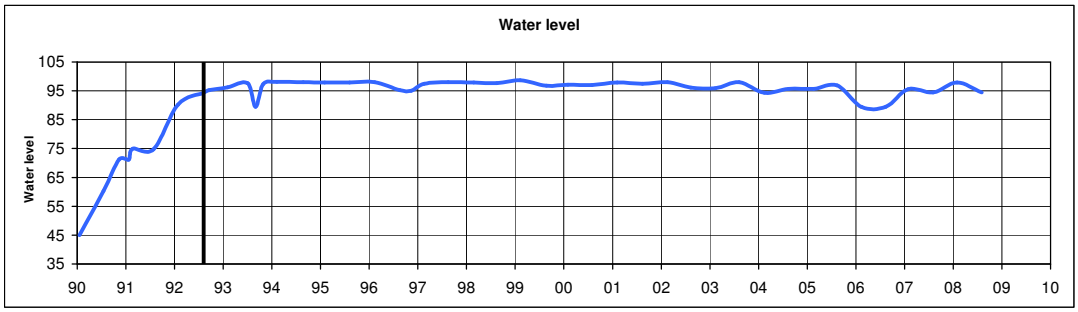
Date	Water Level	124			127		
		dy	dx	dz	dy	dx	dz
17/01/1990	45.03	8.7	-5.2	3.3	2.5	0.6	1.3
18/07/1990	60.30	#N/A	#N/A	0.7	#N/A	#N/A	0.7
13/11/1990	71.28	5.3	-5.3	1.4	0.6	0.3	0.7
22/01/1991	71.15	6.9	-6.4	3.1	2.4	0.4	1.8
21/02/1991	74.97	6.4	-6.0	3.1	1.9	-0.1	1.4
30/07/1991	74.87	-0.1	-0.8	1.0	0.6	0.1	0.4
29/01/1992	90.27	4.9	-4.7	2.9	2.5	0.4	1.1
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.7	-0.4	0.5	0.1	-0.7	0.5
03/02/1993	96.22	5.0	-3.3	2.5	2.1	0.8	1.6
03/07/1993	97.69	1.6	0.6	-0.1	0.3	-0.3	0.3
31/08/1993	89.47	1.3	-0.4	-0.1	-0.4	-0.3	-0.3
29/10/1993	97.39	3.7	-1.8	1.7	1.1	-0.3	1.1
09/02/1994	98.07	4.9	-3.6	2.8	1.4	0.9	1.7
24/08/1994	98.04	1.3	0.7	-1.1	0.2	0.2	-0.4
01/02/1995	97.93	6.8	-5.6	1.8	3.2	0.5	1.4
09/08/1995	97.90	2.7	0.7	-1.1	1.1	0.2	-0.1
13/02/1996	98.02	6.2	-5.5	1.8	3.0	0.6	1.5
21/08/1996	95.22	0.6	0.6	-1.1	-0.6	-0.4	-0.2
12/11/1996	95.05	4.0	-2.4	-0.1	1.3	-0.1	-0.1
18/02/1997	97.43	3.7	-5.1	1.1	0.3	-0.2	0.1
19/08/1997	98.00	1.0	0.0	-0.2	-0.8	-0.2	-0.1
26/02/1998	97.92	5.0	-4.7	2.6	1.6	0.8	1.5
19/08/1998	97.71	1.6	0.6	1.0	-0.4	0.7	1.2
10/02/1999	98.64	6.4	-5.0	3.6	3.0	0.6	2.3
25/08/1999	96.75	2.6	1.3	2.2	1.0	0.8	2.0
02/02/2000	97.11	6.9	-4.6	2.5	3.2	1.0	1.2
02/08/2000	96.99	2.8	2.0	1.3	1.1	1.0	1.8
08/02/2001	97.93	5.9	-4.1	3.4	2.6	0.4	2.1
15/08/2001	97.44	2.5	1.4	1.2	0.6	1.0	0.8
20/02/2002	97.99	7.2	-3.8	1.9	2.9	2.5	0.5
15/08/2002	96.18	2.2	0.5	1.3	0.4	-0.2	1.5
13/02/2003	95.93	7.1	-5.9	4.3	3.0	-0.2	2.9
13/08/2003	98.00	2.4	1.4	0.9	0.7	0.3	0.7
18/02/2004	94.30	6.6	-5.6	4.0	2.9	0.7	2.8
18/08/2004	95.69	4.5	0.2	1.0	1.6	0.3	0.9
23/02/2005	95.69	7.1	-5.0	3.4	3.9	-0.4	2.2
17/08/2005	96.85	2.9	0.7	0.8	1.3	-0.6	1.0
15/02/2006	89.48	7.7	-6.6	3.3	5.0	-0.6	1.9
16/08/2006	89.48	2.8	1.4	0.6	1.6	0.8	0.8
01/02/2007	95.60	8.7	-6.1	3.6	3.0	0.7	1.8
08/08/2007	94.48	2.3	1.1	-0.5	0.5	0.7	-0.6
05/02/2008	97.91	7.5	-5.3	3.1	3.1	0.4	1.6
06/08/2008	94.48	0.1	2.5	0.2	0.1	-0.1	0.3

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



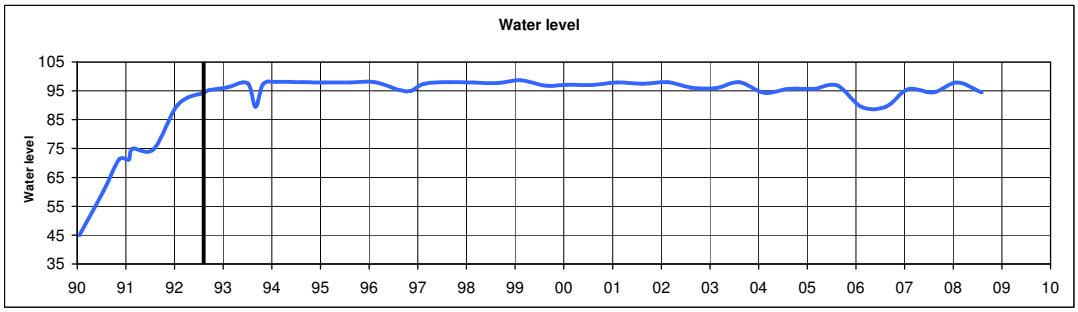
Date		206			207			208			210			211		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.5	-0.2	0.4	0.6	-0.1	0.4	0.6	-0.1	0.7	0.6	0.2	0.3	0.6	0.3	0.6
03/02/1993	96.22	-0.6	-0.1	-0.4	-1.0	-0.7	-0.4	-1.1	-1.5	-0.4	-0.6	-1.8	-0.2	-0.4	-2.1	-0.1
03/07/1993	97.69	0.3	-0.6	-0.8	0.5	-0.4	-0.7	0.7	-0.3	-0.8	1.0	0.0	-0.8	1.2	0.2	-0.7
31/08/1993	89.47	0.6	-0.7	0.1	0.8	-0.8	0.0	0.8	-0.7	-0.2	0.8	-0.7	-0.2	0.6	-0.7	-0.1
29/10/1993	97.39	-0.7	0.2	-0.1	-0.4	-0.9	0.0	-0.5	-0.3	0.1	-0.7	-0.8	0.2	-0.3	-0.6	0.5
09/02/1994	98.07	-1.6	0.7	-0.1	-1.9	-1.1	-0.1	-2.3	-1.2	-0.3	-2.4	-2.2	-0.1	-1.8	-2.5	0.0
24/08/1994	98.04	-0.3	0.9	0.1	0.1	0.0	0.1	0.0	0.8	0.1	-0.2	0.4	0.3	0.2	0.7	0.5
01/02/1995	97.93	-1.3	-1.1	0.3	-1.4	-2.8	0.3	-1.4	-2.9	0.1	-1.4	-3.9	0.5	-0.6	-4.0	0.7
09/08/1995	97.90	-0.2	-0.2	-0.7	-1.4	-2.8	0.3	-1.4	-2.9	0.1	-1.4	-3.9	0.5	-0.6	-4.0	0.7
13/02/1996	98.02	-1.8	0.3	-0.7	-2.2	-1.5	-0.6	-2.4	-1.9	-0.6	-2.6	-3.0	-0.3	-2.1	-3.4	-0.1
21/08/1996	95.22	-1.5	0.9	-0.2	-1.1	-0.1	-0.4	-0.9	1.1	-0.4	-1.2	0.5	-0.3	-1.0	1.0	-0.2
12/11/1996	95.05	-1.9	0.9	0.0	-1.6	-0.3	0.1	-1.5	0.5	0.2	-1.7	-0.2	0.5	-1.2	0.0	0.4
18/02/1997	97.43	-3.7	-0.2	-0.7	-3.8	-1.9	-0.8	-3.8	-1.7	-1.0	-4.0	-2.8	-0.3	-3.4	-2.9	-0.4
19/08/1997	98.00	-2.7	0.1	0.1	-2.2	-0.9	0.2	-2.0	0.0	0.8	-2.3	-0.6	0.5	-1.9	-0.3	0.9
26/02/1998	97.92	#N/A	#N/A	-1.2	#N/A	#N/A	-1.2	#N/A	#N/A	0.7	#N/A	#N/A	-0.6	#N/A	#N/A	1.3
19/08/1998	97.71	-1.4	0.4	0.3	-0.8	-0.5	0.3	-0.7	0.4	0.5	-0.7	0.1	0.7	-0.2	0.5	0.7
10/02/1999	98.64	-1.9	0.1	-0.6	-1.9	-1.8	-0.6	-1.8	-1.8	-0.3	-1.9	-3.1	-0.2	-1.2	-3.4	0.4
25/08/1999	96.75	-0.4	0.1	0.1	0.2	-1.0	0.2	0.4	-0.1	0.1	0.1	-0.3	0.3	0.6	0.1	0.1
02/02/2000	97.11	-2.0	0.2	-1.0	-2.2	-1.6	-1.0	-2.3	-1.7	-1.1	-2.4	-2.8	-0.6	-1.8	-3.2	-0.7
02/08/2000	96.99	-0.8	1.5	0.8	-0.3	0.4	0.9	-0.2	1.2	0.9	-0.4	0.8	1.1	0.0	1.1	0.9
08/02/2001	97.93	-2.2	0.0	-0.3	-2.3	-1.8	-0.2	-2.2	-1.8	-0.3	-2.4	-2.7	0.2	-1.7	-2.9	0.2
15/08/2001	97.44	0.0	1.0	-0.5	0.4	0.0	-0.5	0.5	1.0	-0.6	0.1	0.8	-0.3	0.4	1.2	-0.3
20/02/2002	97.99	-0.9	0.2	-2.1	-1.0	-1.5	-2.1	-0.9	-1.4	-2.2	-1.2	-2.1	-1.6	-0.7	-2.2	-1.6
15/08/2002	96.18	-0.8	1.0	-0.1	-0.3	0.0	0.0	-0.3	1.1	-0.1	-0.6	0.8	0.1	-0.3	1.4	1.2
13/02/2003	95.93	-2.1	-0.1	-1.0	-2.3	-2.2	-1.1	-2.4	-2.3	-1.3	-2.6	-3.5	-0.8	-1.9	-3.8	-0.9
13/08/2003	98.00	-0.1	0.7	0.3	0.6	-0.1	0.3	0.7	1.1	0.1	0.4	0.8	0.3	0.7	1.3	0.2
18/02/2004	94.30	-2.9	-0.4	-0.4	-3.0	-2.6	-0.5	-3.0	-3.0	-0.7	-3.2	-4.1	-0.2	-2.4	-4.5	-0.1
18/08/2004	95.69	-1.2	-0.4	-0.5	-0.6	-1.6	-0.6	-0.3	-0.7	-0.7	-0.4	-1.1	-0.5	0.1	-0.7	-0.7
23/02/2005	95.69	-1.7	-0.3	-1.3	-1.9	-2.3	-1.2	-1.9	-2.5	-1.2	-2.1	-3.5	-0.6	-1.4	-3.8	-0.5
17/08/2005	96.85	-0.8	0.4	-0.8	-0.3	-0.8	-0.9	-0.1	0.1	-1.1	-0.2	-0.2	-0.9	0.2	0.2	-1.1
15/02/2006	89.48	-1.7	-1.1	-0.5	-2.1	-3.5	-0.4	-2.2	-3.8	-0.5	-2.5	-5.1	0.1	-1.6	-5.6	0.2
16/08/2006	89.48	0.8	0.2	0.5	1.3	-0.8	0.4	1.2	0.1	0.2	0.8	-0.2	0.4	1.0	0.1	0.3
01/02/2007	95.60	-0.8	-0.1	-0.4	-0.9	-2.3	-0.3	-1.0	-2.6	-0.4	-1.2	-3.7	0.1	-0.6	-4.1	0.2
08/08/2007	94.48	0.4	0.5	0.0	0.9	-0.5	-0.1	1.1	0.7	-0.4	0.8	0.4	-0.2	1.3	0.9	-0.5
05/02/2008	97.91	-0.9	-1.0	-0.4	-1.0	-2.7	-0.3	-0.9	-2.6	-0.4	-1.0	-3.5	0.0	-0.4	-3.6	-0.1
06/08/2008	94.48	-0.5	0.5	0.1	0.0	-0.4	0.2	0.0	0.7	0.0	-0.3	0.4	0.2	0.0	0.8	0.1

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Date	Water Level	212			213			214			216			217		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.5	0.3	0.3	0.5	0.3	0.7	0.5	0.4	0.4	0.4	0.5	0.6	0.1	0.4	0.3
03/02/1993	96.22	-0.2	-2.6	0.2	0.1	-3.0	-0.4	0.5	-3.5	-0.4	0.7	-3.6	-0.7	1.0	-3.6	-0.2
03/07/1993	97.69	1.1	0.3	-0.5	1.2	0.5	-0.6	1.3	0.7	-0.6	1.2	0.8	-0.6	1.0	0.9	-0.6
31/08/1993	89.47	0.5	-0.7	-0.2	0.6	-0.7	-0.2	0.6	-0.7	-0.3	0.8	-0.6	-0.4	0.7	-0.6	-0.3
29/10/1993	97.39	-0.2	-0.3	0.6	0.0	-0.7	0.5	0.1	-0.9	0.7	0.3	-1.1	0.8	0.9	-0.9	0.9
09/02/1994	98.07	-1.5	-2.7	0.3	-1.3	-3.8	-0.4	-0.9	-4.1	-0.5	-0.4	-4.3	-0.5	0.4	-4.2	-0.3
24/08/1994	98.04	0.2	1.1	0.7	0.5	0.9	0.9	0.5	1.0	1.4	0.7	1.0	1.2	1.0	1.2	1.1
01/02/1995	97.93	-0.3	-4.2	0.8	0.1	-5.2	0.7	0.7	-5.6	0.7	1.4	-5.7	0.3	2.2	-5.5	1.0
09/08/1995	97.90	-0.3	-4.2	0.8	0.1	-5.2	0.7	0.7	-5.6	0.7	1.4	-5.7	0.3	2.2	-5.5	1.0
13/02/1996	98.02	-1.7	-3.7	0.0	-1.2	-4.7	-0.5	-0.6	-5.3	-0.5	0.0	-5.3	-0.8	0.9	-5.3	-0.1
21/08/1996	95.22	-1.0	1.9	-0.2	-0.9	1.9	0.1	-0.8	2.2	0.1	-0.7	2.7	0.1	-0.3	2.6	0.2
12/11/1996	95.05	-1.0	0.2	0.3	-0.9	-0.2	0.1	-0.8	-0.3	0.2	-0.5	-0.1	0.1	0.2	-0.4	0.3
18/02/1997	97.43	-3.3	-3.0	0.3	-3.0	-4.0	-0.5	-2.5	-4.5	-0.2	-1.9	-4.5	-0.7	-1.2	-4.8	0.2
19/08/1997	98.00	-1.8	0.3	0.4	-2.6	0.5	1.0	-1.9	0.5	0.7	-2.8	1.0	1.3	-2.2	0.8	1.3
26/02/1998	97.92	#N/A	#N/A	-0.3	#N/A	#N/A	1.1	#N/A	#N/A	-0.5	#N/A	#N/A	1.4	#N/A	#N/A	0.7
19/08/1998	97.71	-0.2	1.2	0.7	-1.1	1.7	0.9	-0.4	1.8	1.0	-1.3	2.1	1.2	-1.0	2.2	1.7
10/02/1999	98.64	-0.8	-3.5	0.5	-1.4	-4.2	0.3	-0.3	-4.8	0.0	-0.7	-4.7	0.1	0.4	-4.9	0.3
25/08/1999	96.75	0.8	0.8	0.4	1.1	0.5	0.3	1.2	1.0	0.7	1.6	1.5	0.4	2.0	1.5	0.9
02/02/2000	97.11	-1.5	-3.5	-0.2	-1.0	-4.7	-0.8	-0.5	-5.0	-0.5	0.4	-5.1	-1.0	1.3	-5.3	-0.1
02/08/2000	96.99	0.0	1.8	1.1	0.3	1.5	1.0	0.3	2.0	1.3	0.7	2.5	1.1	0.9	2.4	1.7
08/02/2001	97.93	-1.2	-3.0	0.6	-0.7	-4.1	-0.1	-0.3	-4.3	0.3	0.5	-4.1	-0.1	1.3	-4.2	0.8
15/08/2001	97.44	0.6	1.8	0.0	0.8	1.6	0.0	0.6	2.0	0.6	0.9	2.4	0.2	1.2	2.4	0.6
20/02/2002	97.99	-0.3	-2.1	-1.1	0.1	-3.0	-1.7	0.4	-3.1	-1.4	1.0	-2.9	-1.9	1.7	-3.1	-1.0
15/08/2002	96.18	-0.2	2.0	0.3	0.8	1.6	0.2	0.7	2.1	0.7	0.7	2.7	0.3	0.9	2.5	0.7
13/02/2003	95.93	-1.5	-4.2	-0.5	-1.1	-5.5	-1.2	-0.5	-6.1	-1.0	0.3	-6.1	-1.4	1.2	-6.6	-0.5
13/08/2003	98.00	0.8	2.2	0.5	1.0	2.0	0.6	1.1	2.6	1.1	1.4	3.1	0.7	1.5	3.0	1.0
18/02/2004	94.30	-2.1	-4.8	0.3	-1.5	-6.1	-0.4	-0.9	-6.6	-0.1	-0.1	-6.6	-0.5	0.7	-6.9	0.4
18/08/2004	95.69	0.2	-0.1	-0.4	0.3	-0.3	-0.4	0.4	0.1	0.0	0.7	0.6	-0.3	0.9	0.4	0.2
23/02/2005	95.69	-0.9	-4.1	-0.7	-0.5	-5.3	-1.2	-0.1	-5.6	-1.0	0.6	-5.5	-1.3	1.5	-5.8	-0.3
17/08/2005	96.85	0.2	0.9	-0.8	0.2	0.8	-0.8	0.4	1.4	-0.4	0.8	1.9	-0.7	1.0	1.7	-0.3
15/02/2006	89.48	-1.1	-6.1	-0.2	-0.9	-7.6	-0.9	-0.2	-8.1	-1.9	0.8	-8.1	-2.2	1.9	-8.4	-1.2
16/08/2006	89.48	1.1	0.9	0.6	1.0	0.7	0.6	0.9	1.2	1.0	1.1	1.7	0.7	1.5	1.6	1.1
01/02/2007	95.60	-0.3	-4.6	-0.3	0.0	-5.9	-0.8	0.4	-6.3	-0.6	1.1	-6.2	-1.0	2.1	-6.6	0.0
08/08/2007	94.48	1.3	1.5	-0.2	1.1	1.4	-0.3	1.0	1.9	0.2	1.3	2.4	-0.2	1.4	2.1	0.2
05/02/2008	97.91	-0.1	-3.8	0.3	-0.1	-4.6	-0.3	0.4	-4.6	-0.1	1.0	-4.3	-0.6	1.7	-4.5	0.2
06/08/2008	94.48	0.0	1.4	0.3	0.0	1.2	0.3	-0.2	1.6	0.6	0.0	1.9	0.3	0.3	1.6	0.7

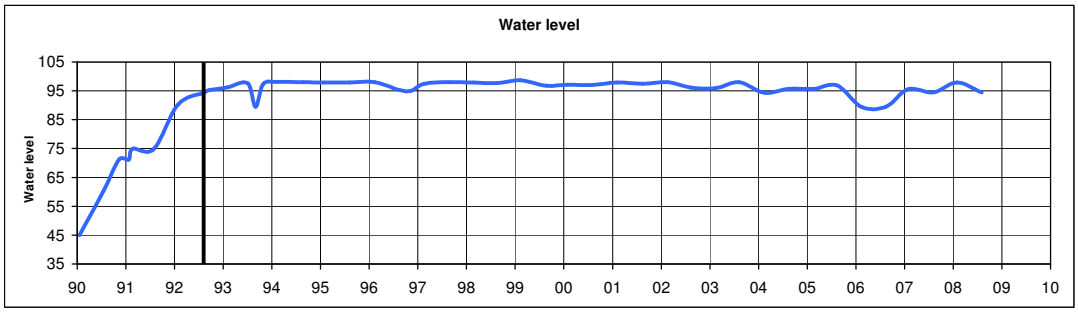
	32	33	34	35	36

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



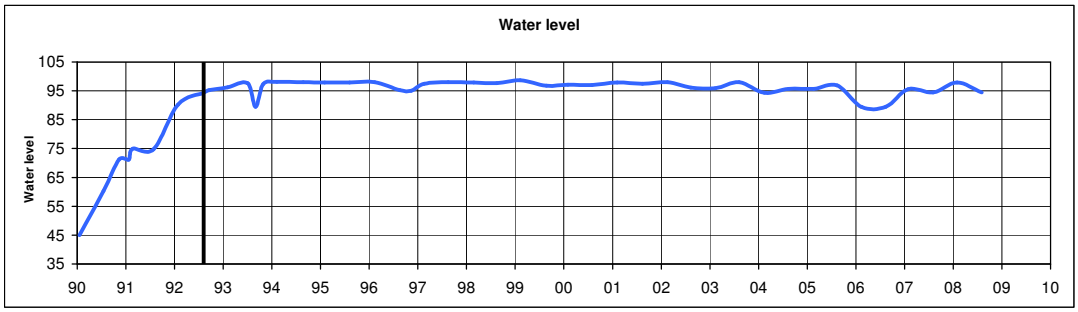
Date	Water Level	218			219			221			222			223		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.1	0.3	0.6	-0.2	0.3	0.2	-0.2	0.2	0.1	-0.2	0.3	0.3	-0.4	0.3	0.0
03/02/1993	96.22	1.4	-3.7	-0.7	1.7	-3.3	-0.4	1.8	-2.7	-0.1	2.2	-1.9	-0.3	2.2	-0.9	-0.2
03/07/1993	97.69	1.0	0.8	-0.8	1.0	0.9	-0.9	0.8	0.7	-1.0	0.8	0.7	-1.3	0.9	0.7	-1.4
31/08/1993	89.47	0.8	-0.6	-0.3	0.6	-0.4	-0.4	0.5	-0.4	-0.4	0.6	-0.1	-0.6	0.6	0.3	-0.5
29/10/1993	97.39	0.5	-1.1	1.0	0.3	-0.9	1.0	0.4	-0.6	0.8	0.9	-0.9	0.7	1.4	-0.1	0.6
09/02/1994	98.07	0.5	-4.5	-0.7	0.6	-3.6	-0.5	0.8	-2.5	-0.3	1.5	-2.0	-0.7	1.9	-0.4	-0.7
24/08/1994	98.04	0.8	0.9	1.0	0.5	1.1	0.9	0.5	1.2	0.4	0.9	0.6	-0.1	1.4	1.0	-0.2
01/02/1995	97.93	2.5	-5.6	0.2	2.6	-5.1	0.2	2.9	-3.7	0.6	3.6	-3.0	-0.1	3.8	-1.2	0.2
09/08/1995	97.90	2.5	-5.6	0.2	2.6	-5.1	0.2	2.9	-3.7	0.6	3.6	-3.0	-0.1	3.8	-1.2	0.2
13/02/1996	98.02	1.2	-5.4	-0.6	1.4	-4.9	-0.6	1.6	-3.7	-0.3	2.4	-3.2	-0.9	2.8	-1.5	-0.7
21/08/1996	95.22	-0.6	2.2	0.3	-0.9	2.2	0.2	-0.8	2.2	-0.3	-0.3	1.3	-0.7	0.3	1.4	-0.8
12/11/1996	95.05	0.0	-0.8	0.0	-0.1	-0.6	0.0	0.1	-0.3	-0.1	0.6	-0.6	-0.4	1.2	0.2	-0.5
18/02/1997	97.43	-1.0	-5.2	-0.7	-0.8	-4.6	-0.4	-0.6	-3.6	-0.1	0.1	-3.2	-1.0	0.7	-1.6	-0.6
19/08/1997	98.00	-2.4	0.3	1.7	-2.5	0.5	1.1	-2.1	0.7	0.7	-1.5	0.0	0.8	-0.8	0.3	0.1
26/02/1998	97.92	#N/A	#N/A	1.4	#N/A	#N/A	-0.2	#N/A	#N/A	0.0	#N/A	#N/A	1.3	#N/A	#N/A	-0.4
19/08/1998	97.71	-1.2	1.8	1.7	-1.3	2.0	1.6	-1.0	2.0	1.1	-0.4	1.2	0.8	0.3	1.5	0.5
10/02/1999	98.64	0.8	-5.3	0.0	1.3	-4.6	-0.1	1.9	-3.3	0.2	2.8	-2.8	0.0	3.4	-0.9	-0.2
25/08/1999	96.75	1.8	1.1	0.5	1.6	1.4	0.7	1.8	1.7	0.4	2.4	1.1	0.1	3.0	1.8	-0.1
02/02/2000	97.11	1.6	-5.8	-1.0	1.9	-5.1	-0.9	2.3	-3.9	-0.6	3.1	-3.3	-1.2	3.7	-1.7	-1.4
02/08/2000	96.99	0.6	1.8	1.7	0.5	2.1	1.9	0.6	2.1	1.3	1.0	1.3	0.9	1.5	1.5	0.6
08/02/2001	97.93	1.4	-4.8	-0.1	1.7	-4.1	0.0	2.1	-3.1	0.2	2.9	-2.7	-0.3	3.4	-1.1	-0.3
15/08/2001	97.44	0.9	1.9	0.2	0.6	2.1	0.4	0.7	2.1	0.0	1.3	1.3	-0.4	1.7	1.6	-0.6
20/02/2002	97.99	1.8	-3.6	-1.8	2.0	-3.0	-1.6	2.4	-2.1	-1.4	3.1	-1.8	-1.9	3.7	-0.4	-1.9
15/08/2002	96.18	0.4	2.0	0.3	0.2	2.1	0.5	0.4	2.1	0.2	0.9	1.3	-0.2	1.3	1.5	-0.4
13/02/2003	95.93	1.4	-7.2	-1.5	1.8	-6.6	-1.3	2.3	-5.4	-0.8	3.1	-4.6	-1.3	3.6	-2.6	-1.3
13/08/2003	98.00	1.1	2.5	0.7	0.9	2.7	0.9	1.2	2.7	0.4	1.5	1.8	0.1	2.0	1.9	-0.1
18/02/2004	94.30	1.0	-7.4	-0.5	1.4	-6.6	-0.3	1.9	-5.3	0.1	2.8	-4.6	-0.4	3.5	-2.8	-0.3
18/08/2004	95.69	0.6	0.0	-0.2	0.6	0.3	0.0	1.2	0.4	-0.4	1.8	-0.2	-0.7	2.6	0.2	-0.8
23/02/2005	95.69	1.7	-6.3	-1.0	2.0	-5.6	-0.7	2.3	-4.4	-0.3	3.2	-3.9	-0.7	3.8	-2.2	-0.7
17/08/2005	96.85	0.7	1.1	-0.7	0.6	1.3	-0.5	0.8	1.1	-0.9	1.3	0.2	-1.4	1.9	0.5	-1.6
15/02/2006	89.48	2.4	-8.9	-1.9	3.0	-7.9	-1.8	3.2	-6.6	-1.4	4.3	-5.8	-1.7	4.9	-3.8	-1.5
16/08/2006	89.48	1.0	1.2	0.6	0.9	1.5	0.7	0.8	1.5	0.3	1.2	0.9	-0.1	1.7	1.2	-0.3
01/02/2007	95.60	2.4	-7.1	-0.8	2.9	-6.5	-0.6	3.3	-5.3	-0.2	4.3	-4.3	-0.4	4.7	-2.4	-0.3
08/08/2007	94.48	1.0	1.7	-0.2	0.8	2.0	-0.1	0.7	1.8	-0.5	1.3	1.1	-0.9	1.8	1.5	-1.0
05/02/2008	97.91	1.8	-5.0	-0.6	2.1	-4.1	-0.4	2.1	-3.3	-0.2	3.0	-2.8	-0.6	3.7	-1.3	-0.6
06/08/2008	94.48	0.1	1.1	0.2	0.0	1.2	0.5	0.0	1.0	0.1	0.8	0.3	-0.3	1.4	0.7	-0.5
			37			38										

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



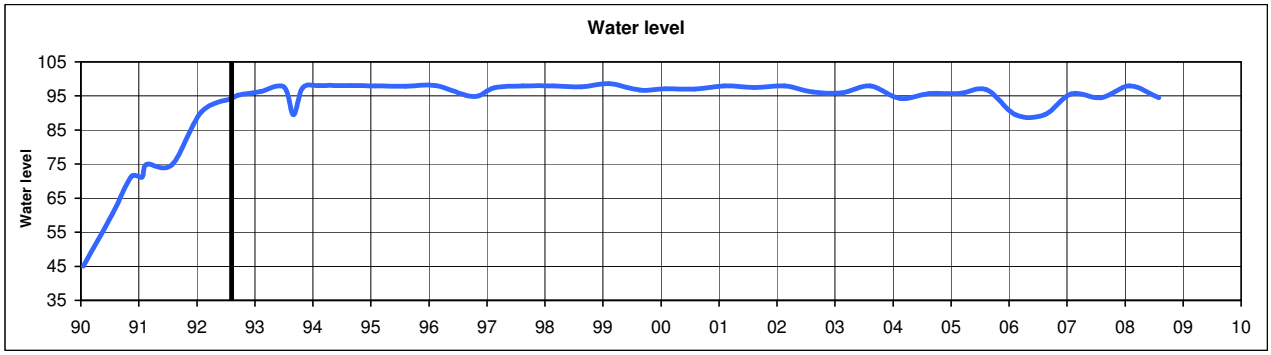
Date	Water Level	224			225		
		dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.3	0.3	-0.1	-0.6	0.3	-0.2
03/02/1993	96.22	2.2	0.1	-0.4	0.7	0.5	-0.7
03/07/1993	97.69	0.9	0.7	-1.5	0.0	0.4	-1.6
31/08/1993	89.47	0.5	0.7	-0.6	-0.2	0.8	-0.6
29/10/1993	97.39	1.1	0.2	0.5	0.3	-0.1	0.6
09/02/1994	98.07	1.4	0.7	-0.6	0.3	1.1	-0.8
24/08/1994	98.04	1.0	1.0	-0.4	0.7	0.5	-0.3
01/02/1995	97.93	3.1	0.2	0.3	2.2	0.8	0.1
09/08/1995	97.90	3.1	0.2	0.3	2.2	0.8	0.1
13/02/1996	98.02	2.3	-0.2	-0.6	1.3	0.2	-1.0
21/08/1996	95.22	0.0	1.3	-0.9	-0.2	0.7	-0.9
12/11/1996	95.05	1.1	0.5	-0.7	0.3	0.3	-0.8
18/02/1997	97.43	0.1	-0.5	-0.4	-1.0	-0.1	-0.6
19/08/1997	98.00	-0.9	0.2	-0.2	-1.4	-0.4	-0.2
26/02/1998	97.92	#N/A	#N/A	-0.3	#N/A	#N/A	-0.8
19/08/1998	97.71	0.1	1.4	0.3	-0.3	0.7	0.2
10/02/1999	98.64	2.9	0.4	-0.2	2.0	1.0	-0.7
25/08/1999	96.75	2.5	1.9	-0.3	1.9	1.6	-0.2
02/02/2000	97.11	3.1	-0.5	-1.4	2.1	0.0	-1.8
02/08/2000	96.99	1.2	1.4	0.4	0.8	0.7	0.4
08/02/2001	97.93	3.0	0.0	-0.3	2.0	0.4	-0.8
15/08/2001	97.44	1.3	1.5	-0.8	0.6	0.7	-0.8
20/02/2002	97.99	3.2	0.7	-1.9	2.2	0.9	-2.3
15/08/2002	96.18	1.0	1.3	-0.7	0.4	0.6	-0.9
13/02/2003	95.93	3.2	-1.2	-1.3	1.9	-0.5	-1.8
13/08/2003	98.00	1.5	1.6	-0.4	1.0	0.9	-0.6
18/02/2004	94.30	2.9	-1.4	-0.1	1.9	-0.8	-0.6
18/08/2004	95.69	2.1	0.2	-1.0	1.8	0.0	-0.9
23/02/2005	95.69	3.4	-1.0	-0.6	2.4	-0.5	-1.1
17/08/2005	96.85	1.6	0.4	-1.7	1.0	-0.2	-1.7
15/02/2006	89.48	4.3	-2.2	-1.4	3.2	-1.4	-1.7
16/08/2006	89.48	1.4	1.2	-0.5	1.0	0.7	-0.5
01/02/2007	95.60	4.1	-1.0	-0.3	3.1	-0.1	-0.7
08/08/2007	94.48	1.3	1.2	-1.2	0.9	0.8	-1.5
05/02/2008	97.91	3.6	-0.1	-0.7	2.5	0.3	-1.1
06/08/2008	94.48	0.9	0.6	-0.7	0.6	0.2	-0.8

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



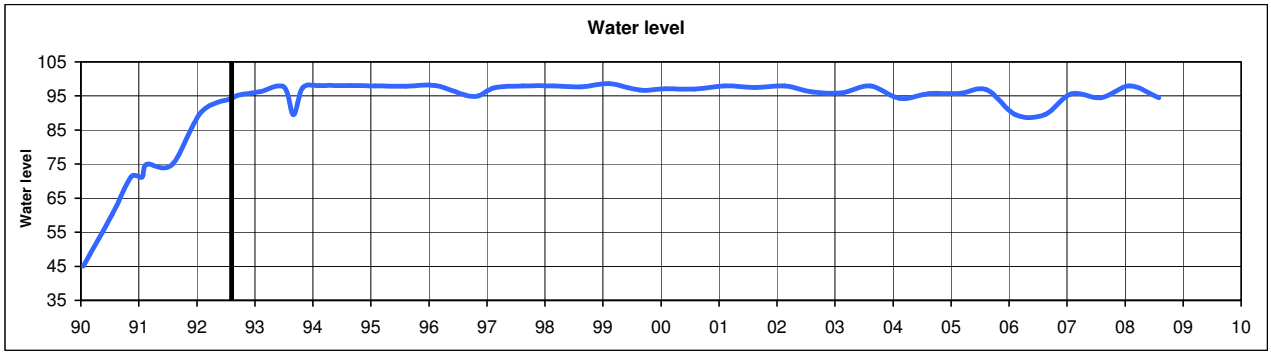
Date	Water Level	301			302			304			305			306		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/90	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/90	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/90	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/91	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/91	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/91	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/92	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/92	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/92	95.23	-0.7	0.7	0.7	-0.6	0.6	0.7	-0.4	0.3	0.7	-0.2	0.2	0.8	-0.1	-0.1	0.4
03/02/93	96.22	0.1	1.9	-0.5	0.1	1.8	-1.6	0.0	1.4	-1.6	0.0	1.5	-1.4	0.1	1.0	-1.0
03/07/93	97.69	0.2	-0.4	-0.4	0.2	-0.4	-0.9	0.2	-0.6	-0.8	0.0	-0.6	-0.7	0.2	-0.8	-0.7
31/08/93	89.47	-0.4	-1.3	0.8	-0.2	-1.2	0.4	-0.2	-1.1	0.3	0.0	-0.7	0.6	0.2	-0.8	0.5
29/10/93	97.39	0.9	1.7	1.7	0.7	1.5	1.5	0.5	1.2	1.4	0.3	0.9	1.5	0.3	0.5	1.3
09/02/94	98.07	0.2	2.8	0.4	0.3	2.7	0.1	0.0	2.2	0.1	-0.1	1.9	0.3	-0.3	1.6	0.2
24/08/94	98.04	-1.4	0.9	-0.2	-1.0	0.8	-0.9	-1.1	0.4	-0.8	-1.0	0.3	-0.7	-0.9	-0.1	-0.5
01/02/95	97.93	0.2	1.7	-0.3	0.1	1.4	-0.9	-0.1	0.8	-0.6	0.1	0.5	-0.4	0.2	0.0	-0.2
09/08/95	97.90	0.2	1.7	-0.3	0.1	1.4	-0.9	-0.1	0.8	-0.6	0.1	0.5	-0.4	0.2	0.0	-0.2
13/02/96	98.02	-0.5	4.9	-1.6	-0.9	4.3	-2.4	-1.0	3.8	-2.2	-1.2	3.4	-1.9	-1.1	2.7	-1.7
21/08/96	95.22	-4.0	2.0	-0.3	-3.5	2.0	-0.9	-3.4	1.5	-1.0	-3.1	1.4	-0.9	-2.9	0.9	-0.8
12/11/96	95.05	-2.0	2.7	0.3	-2.0	2.5	-0.4	-1.9	2.1	-0.6	-1.8	1.8	-0.5	-1.8	1.2	-0.5
18/02/97	97.43	-0.9	1.7	0.4	-1.3	1.6	-0.5	-1.4	1.1	-0.5	-1.4	0.9	-0.5	-1.3	0.3	-0.2
19/08/97	98.00	-3.1	3.6	1.0	-3.1	3.2	0.6	-3.2	2.7	0.5	-3.1	2.2	0.6	-3.1	1.4	0.4
26/02/98	97.92	#N/A	#N/A	2.1	#N/A	#N/A	3.4	#N/A	#N/A	3.3	#N/A	#N/A	3.4	#N/A	#N/A	1.7
19/08/98	97.71	-1.6	3.4	1.4	-1.4	3.1	0.0	-1.4	2.5	-0.1	-1.4	2.0	-0.1	-1.4	1.3	0.5
10/02/99	98.64	-1.3	3.0	-0.6	-1.3	2.6	-1.2	-1.2	2.1	-1.2	-0.9	1.8	-1.1	-0.6	1.2	-1.2
25/08/99	96.75	0.5	0.4	1.6	0.5	0.2	0.6	0.3	0.1	0.5	0.4	0.1	0.5	0.4	-0.4	0.9
02/02/00	97.11	0.1	3.3	-1.4	-0.1	3.1	-2.5	-0.2	2.7	-2.7	-0.1	2.4	-2.7	-0.1	1.7	-2.2
02/08/00	96.99	-0.6	4.3	1.2	-0.7	3.9	0.2	-0.8	3.4	0.1	-0.8	3.1	0.2	-0.6	2.2	0.7
08/02/01	97.93	-0.9	4.1	0.4	-1.1	3.6	-0.6	-1.1	3.1	-0.7	-1.0	2.7	-0.8	-0.7	1.8	-0.4
15/08/01	97.44	1.5	3.4	-0.2	1.3	3.1	-1.1	0.9	2.7	-1.1	0.8	2.4	-1.0	0.8	1.7	-0.5
20/02/02	97.99	1.3	3.6	-1.7	1.1	3.4	-2.7	0.7	3.0	-2.8	0.6	2.8	-2.8	0.8	2.1	-2.3
15/08/02	96.18	-1.3	3.0	0.3	-1.2	2.8	-0.6	-1.3	2.3	-0.7	-1.1	2.0	-0.7	-0.8	1.2	-0.2
13/02/03	95.93	1.8	4.8	-1.3	1.4	4.5	-2.3	1.0	4.0	-2.4	0.7	3.6	-2.3	0.7	2.8	-1.8
13/08/03	98.00	0.4	3.1	-0.2	0.3	2.9	-1.2	0.1	2.5	-1.3	0.1	2.1	-1.3	0.3	1.4	-0.7
18/02/04	94.30	-0.5	0.0	0.3	-0.6	-0.1	-0.7	-0.5	-0.4	-0.8	-0.4	-0.4	-0.7	-0.2	-0.9	-0.3
18/08/04	95.69	-1.8	1.0	-0.5	-1.7	0.7	-1.5	-1.6	0.1	-1.5	-1.2	-0.3	-1.4	-0.7	-1.1	-1.0
23/02/05	95.69	0.5	1.7	-0.7	0.3	1.5	-1.7	0.1	1.1	-1.8	0.3	0.7	-1.7	0.4	0.1	-1.3
17/08/05	96.85	-1.6	2.2	-0.6	-1.9	2.3	-1.6	-1.9	1.5	-1.8	-1.5	0.9	-1.8	-1.2	-0.1	-1.4
15/02/06	89.48	-0.5	-0.2	-1.1	-0.5	-0.1	-2.2	-0.4	-0.4	-2.3	-0.1	-0.6	-2.3	0.3	-1.2	-1.8
16/08/06	89.48	2.1	0.6	0.0	1.8	0.8	-1.0	1.6	0.6	-1.1	1.6	0.3	-1.1	1.7	-0.5	-0.7
01/02/07	95.60	1.1	-0.4	0.1	1.0	-0.3	-0.9	1.2	-0.5	-1.0	1.3	-0.7	-1.0	1.6	-1.4	-0.6
08/08/07	94.48	0.9	0.9	0.2	0.7	1.1	-0.8	0.6	0.6	-0.9	0.7	0.4	-0.9	0.8	-0.3	-0.4
05/02/08	97.91	0.0	0.8	-1.2	0.0	0.8	-2.3	-0.1	0.3	-2.4	0.2	0.0	-2.4	0.5	-0.8	-2.0
06/08/08	94.48	1.3	1.4	0.6	1.0	1.5	-0.5	1.0	1.1	-0.6	1.0	0.8	-0.6	1.0	0.2	-0.1

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



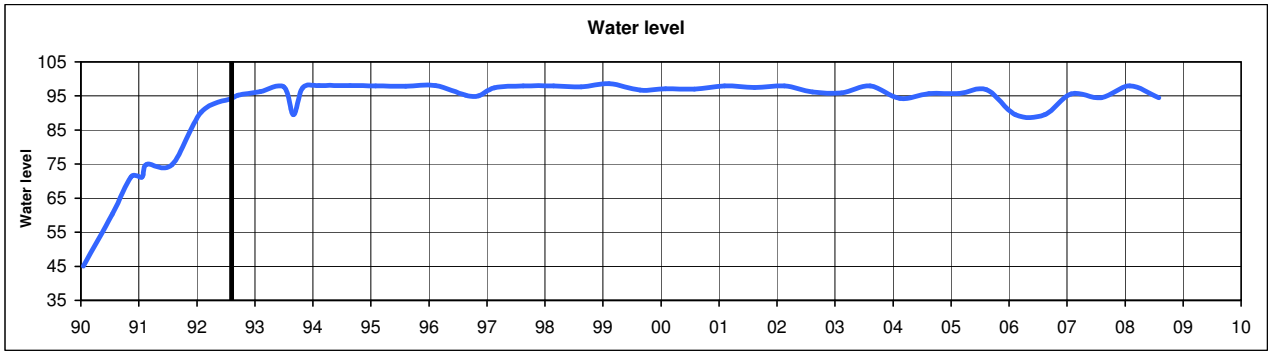
Date	Water Level	307			308			310			311			312		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.1	-0.2	0.7	0.0	-0.3	0.5	0.3	-0.1	0.9	0.5	-0.1	0.5	0.6	-0.1	0.6
03/02/1993	96.22	0.1	1.0	-1.4	0.1	0.7	-0.8	0.3	0.6	-0.9	0.5	0.4	-0.8	0.4	0.0	-0.6
03/07/1993	97.69	0.3	-0.6	-0.6	0.4	-0.7	-0.4	0.7	-0.4	-0.3	0.9	-0.5	-0.2	0.9	-0.5	0.0
31/08/1993	89.47	0.4	-0.6	0.4	0.5	-0.6	0.4	0.7	-0.3	0.2	0.8	-0.3	0.3	0.6	-0.3	0.4
29/10/1993	97.39	0.4	0.4	1.5	0.0	0.1	1.4	0.1	0.3	1.3	-0.3	-0.1	1.5	-0.1	-0.6	1.5
09/02/1994	98.07	-0.3	1.3	0.2	-0.6	1.0	0.1	-0.7	0.9	-0.1	-1.1	0.3	0.3	-0.9	-0.4	0.0
24/08/1994	98.04	-0.5	-0.3	-0.8	-0.4	-0.4	-0.6	0.0	-0.3	-1.0	-0.5	-0.6	-0.5	-0.1	-0.8	-0.8
01/02/1995	97.93	0.4	-0.3	-0.5	0.4	-0.7	-0.4	0.7	-0.4	-1.0	0.1	-1.2	-0.7	0.4	-1.7	-0.6
09/08/1995	97.90	0.4	-0.3	-0.5	0.4	-0.7	-0.4	0.7	-0.4	-1.0	0.1	-1.2	-0.7	0.4	-1.7	-0.6
13/02/1996	98.02	-1.1	2.3	-1.9	-1.3	1.6	-1.7	-1.4	1.2	-2.0	-1.5	0.4	-1.8	-1.1	-0.4	-1.9
21/08/1996	95.22	-2.4	0.9	-1.1	-2.4	0.7	-0.9	-1.9	1.3	-0.9	-2.3	0.5	-0.6	-1.8	0.3	-1.0
12/11/1996	95.05	-1.6	1.1	-0.7	-1.8	0.8	-0.7	-1.4	1.2	-1.5	-1.8	0.5	-0.9	-1.4	0.0	-0.9
18/02/1997	97.43	-1.5	0.4	-0.6	-1.7	0.0	-0.5	-1.9	0.4	-0.7	-2.3	-0.4	-0.3	-2.3	-1.0	-0.7
19/08/1997	98.00	-2.8	1.1	0.3	-3.0	0.6	0.0	-2.7	0.8	0.5	-3.2	-0.1	0.6	-2.7	-0.7	0.2
26/02/1998	97.92	#N/A	#N/A	3.2	#N/A	#N/A	1.3	#N/A	#N/A	2.9	#N/A	#N/A	1.6	#N/A	#N/A	0.0
19/08/1998	97.71	-1.3	1.2	-0.3	-1.6	0.8	0.5	-1.4	0.9	0.6	-1.7	0.3	1.0	-1.3	-0.2	0.7
10/02/1999	98.64	-0.4	1.1	-1.3	-0.6	0.8	-1.4	-0.4	1.2	-1.4	-0.8	0.1	-1.2	-0.3	-0.6	-1.2
25/08/1999	96.75	0.6	-0.3	0.3	0.3	-0.4	0.8	0.5	0.2	0.3	0.1	-0.7	1.0	0.6	-0.9	0.7
02/02/2000	97.11	0.0	1.6	-2.8	-0.4	1.1	-2.3	-0.2	1.3	-2.9	-0.6	0.0	-2.2	-0.2	-0.8	-2.3
02/08/2000	96.99	-0.6	2.2	0.1	-0.9	1.8	0.6	-0.6	2.1	0.3	-1.0	1.0	1.0	-0.6	0.5	0.2
08/02/2001	97.93	-0.7	1.7	-1.0	-1.0	1.2	-0.6	-0.7	1.5	-1.1	-1.1	0.3	-0.5	-0.6	-0.5	-0.8
15/08/2001	97.44	0.8	1.6	-0.9	0.3	1.2	-0.5	0.4	1.7	-0.8	-0.2	0.7	-0.1	0.3	0.1	-0.3
20/02/2002	97.99	0.6	1.9	-2.9	0.3	1.5	-2.4	0.4	2.0	-2.9	-0.2	0.9	-2.2	0.3	0.2	-2.3
15/08/2002	96.18	-0.7	1.2	-0.9	-0.9	0.9	-0.3	-0.4	1.3	-0.5	-0.8	0.3	0.3	-0.4	0.0	-0.1
13/02/2003	95.93	0.4	2.5	-2.4	-0.1	2.0	-1.9	-0.1	2.2	-2.6	-0.8	0.8	-1.9	-0.5	-0.1	-2.2
13/08/2003	98.00	0.4	1.3	-1.3	0.0	1.1	-0.7	0.4	1.6	-1.0	-0.2	0.7	-0.2	0.2	0.2	-0.3
18/02/2004	94.30	-0.2	-0.9	-0.9	-0.5	-1.2	-0.5	-0.2	-0.7	-1.1	-0.6	-1.7	-0.5	-0.3	-2.4	-0.6
18/08/2004	95.69	-0.5	-1.0	-1.6	-0.6	-1.3	-1.0	0.0	-0.7	-1.4	-0.5	-1.6	-0.8	0.0	-2.1	-1.0
23/02/2005	95.69	0.5	-0.1	-1.8	-0.3	-0.2	-1.3	0.0	0.3	-1.8	-0.5	-0.9	-1.2	-0.1	-1.6	-1.3
17/08/2005	96.85	-0.8	-0.3	-2.0	-0.8	-0.9	-1.6	-0.1	-0.6	-1.9	-0.1	-1.7	-1.3	0.0	-1.9	-1.6
15/02/2006	89.48	0.5	-1.2	-2.4	0.3	-1.5	-2.0	0.5	-1.1	-2.7	0.1	-2.1	-2.1	0.3	-2.7	-2.3
16/08/2006	89.48	1.6	-0.5	-1.3	1.2	-0.7	-0.8	1.4	-0.1	-1.0	0.9	-1.0	-0.4	0.9	-1.4	-0.6
01/02/2007	95.60	1.6	-1.3	-1.2	1.3	-1.7	-0.8	1.5	-1.1	-1.4	0.9	-2.1	-0.8	1.2	-2.6	-1.1
08/08/2007	94.48	0.8	-0.4	-1.2	0.4	-0.6	-0.7	0.7	0.1	-1.1	0.1	-0.9	-0.5	0.2	-1.2	-0.8
05/02/2008	97.91	0.6	-1.0	-2.7	0.5	-1.3	-2.2	0.9	-0.7	-2.7	0.5	-1.7	-2.1	0.8	-2.0	-2.1
06/08/2008	94.48	0.9	0.2	-0.7	0.5	-0.1	-0.2	0.8	0.5	-0.6	0.1	-0.4	0.1	0.2	-0.7	-0.6

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



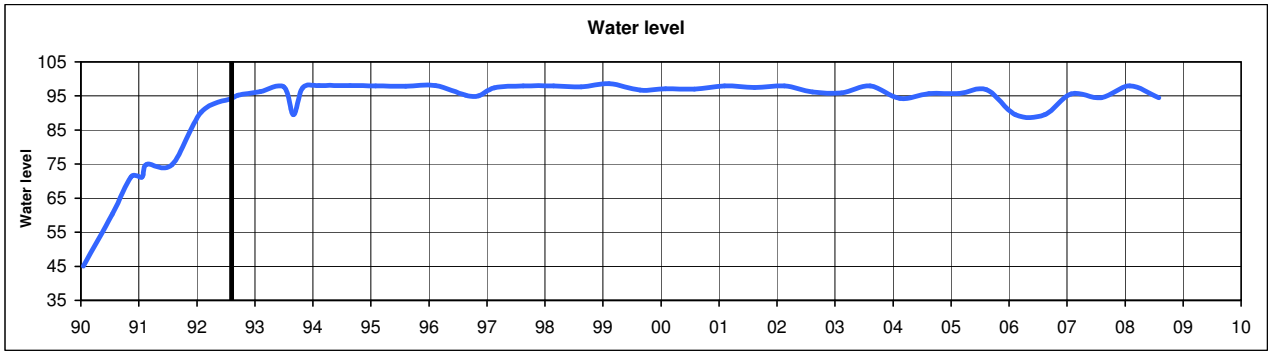
Date	Water Level	50 E313			51 314			52 315			53 316			54 317		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.2	0.1	0.5	-0.1	0.3	0.9	0.2	0.3	1.1	0.5	0.4	0.7	0.4	0.4	0.7
03/02/1993	96.22	0.3	0.1	-0.4	0.1	0.2	-0.4	0.3	0.1	-0.6	0.4	0.0	-0.4	0.6	-0.1	-0.4
03/07/1993	97.69	0.8	-0.3	-0.1	0.7	-0.3	0.2	0.9	-0.1	-0.2	0.9	0.0	-0.2	0.8	0.1	-0.3
31/08/1993	89.47	0.5	-0.1	0.3	0.5	0.0	0.5	0.7	0.2	0.2	0.5	0.2	0.3	0.5	0.2	0.3
29/10/1993	97.39	0.4	-0.6	1.3	0.5	-0.4	1.5	0.3	-0.5	1.3	1.3	-0.8	1.1	0.6	-0.6	1.2
09/02/1994	98.07	-0.7	-0.3	0.3	-0.5	0.0	0.2	-0.6	-0.2	-0.3	0.5	-0.5	-0.2	0.0	-0.3	-0.3
24/08/1994	98.04	0.2	-1.2	-0.9	-0.1	-0.4	-0.3	-0.1	-0.5	-0.7	1.0	-0.8	-0.6	0.6	-0.7	-0.6
01/02/1995	97.93	1.0	-1.6	-0.7	0.8	-1.0	-0.5	0.9	-1.3	-0.8	2.0	-1.4	-1.0	1.6	-1.2	-0.9
09/08/1995	97.90	1.0	-1.6	-0.7	0.8	-1.0	-0.5	0.9	-1.3	-0.8	2.0	-1.4	-1.0	1.6	-1.2	-0.9
13/02/1996	98.02	-0.6	-0.2	-2.1	-1.0	0.0	-1.9	-0.8	0.0	-2.1	0.5	-0.8	-2.2	0.2	-0.7	-2.1
21/08/1996	95.22	-1.1	0.2	-1.2	-1.6	0.5	-0.8	-1.5	0.3	-0.9	-0.2	-0.1	-1.1	-0.4	0.1	-1.2
12/11/1996	95.05	-0.7	0.0	-1.2	-1.1	0.2	-0.8	-1.2	0.0	-1.1	0.0	-0.4	-1.2	-0.3	-0.3	-1.3
18/02/1997	97.43	-1.4	-1.3	-1.1	-1.8	-0.5	-0.8	-2.1	-0.7	-1.0	-0.9	-1.0	-1.1	-1.4	-0.9	-1.1
19/08/1997	98.00	-2.2	-0.7	0.0	-2.7	-0.5	0.4	-2.7	-0.5	0.5	-1.4	-1.2	-0.1	-1.7	-1.0	-0.3
26/02/1998	97.92	#N/A	#N/A	0.7	#N/A	#N/A	0.9	#N/A	#N/A	2.8	#N/A	#N/A	0.9	#N/A	#N/A	1.1
19/08/1998	97.71	-0.6	-0.2	0.8	-1.3	0.0	1.0	-1.3	-0.2	0.7	-0.1	-0.6	0.5	-0.5	-0.5	0.3
10/02/1999	98.64	-0.1	-0.7	-1.0	-0.5	0.3	-0.9	-0.4	0.1	-1.0	1.0	-0.2	-1.5	0.7	-0.1	-1.3
25/08/1999	96.75	1.2	-1.1	0.3	1.1	-0.4	0.6	1.2	-0.5	-0.4	2.3	-0.7	-0.1	1.9	-0.4	-0.3
02/02/2000	97.11	0.1	-0.8	-2.3	-0.2	-0.4	-2.3	-0.1	-0.6	-3.1	1.1	-1.1	-2.6	0.6	-1.1	-2.5
02/08/2000	96.99	-0.5	0.4	0.4	-0.8	0.8	0.5	-0.7	0.3	-0.3	0.4	-0.1	0.0	0.2	-0.1	-0.2
08/02/2001	97.93	-0.5	-0.6	-0.6	-0.9	0.0	-0.8	-0.6	-0.4	-1.8	0.8	-0.8	-1.4	0.6	-0.7	-1.7
15/08/2001	97.44	0.4	0.1	-0.3	-0.1	0.4	0.0	-0.2	0.1	-0.8	1.0	-0.3	-0.4	0.6	-0.2	-0.5
20/02/2002	97.99	0.4	0.2	-2.3	0.1	0.6	-2.2	0.3	0.1	-3.0	1.5	-0.3	-2.6	1.4	-0.3	-2.8
15/08/2002	96.18	-0.4	0.0	0.0	-0.7	0.2	0.1	-0.4	0.1	-0.9	0.8	-0.3	-0.5	0.4	-0.1	-0.8
13/02/2003	95.93	0.1	-0.1	-2.3	-0.5	0.2	-2.4	-0.4	-0.5	-3.2	1.0	-1.1	-2.8	0.9	-1.2	-2.8
13/08/2003	98.00	0.7	0.1	-0.5	0.2	0.3	-0.3	0.1	0.0	-1.0	1.1	-0.4	-0.4	0.7	-0.3	-0.4
18/02/2004	94.30	0.6	-2.3	-0.8	0.1	-1.8	-0.6	0.3	-2.0	-1.4	1.4	-2.3	-0.9	1.0	-2.2	-1.0
18/08/2004	95.69	0.4	-2.2	-1.1	-0.3	-1.7	-0.8	0.1	-1.9	-1.6	1.5	-2.3	-1.0	1.2	-2.0	-1.1
23/02/2005	95.69	-0.1	-1.4	-1.5	-0.2	-1.2	-1.3	-0.1	-1.6	-2.2	1.3	-2.0	-1.7	1.0	-1.9	-1.8
17/08/2005	96.85	-0.4	-1.9	-1.3	-0.7	-1.6	-1.0	-0.2	-1.8	-1.7	1.2	-2.1	-1.2	1.2	-1.8	-1.2
15/02/2006	89.48	0.3	-2.4	-2.1	0.0	-2.1	-2.2	0.3	-2.4	-3.1	1.5	-3.0	-2.8	1.5	-2.9	-2.8
16/08/2006	89.48	0.9	-1.4	-0.4	0.6	-1.2	-0.2	0.6	-1.4	-0.9	1.7	-1.7	-0.3	1.3	-1.6	-0.4
01/02/2007	95.60	1.2	-2.4	-0.9	0.9	-2.0	-0.6	1.0	-2.1	-1.7	2.0	-2.7	-1.1	1.8	-2.6	-1.2
08/08/2007	94.48	0.2	-1.2	-0.6	-0.1	-0.9	-0.4	0.1	-0.8	-1.2	1.2	-1.1	-0.5	1.1	-0.7	-1.0
05/02/2008	97.91	0.4	-1.7	-1.8	0.2	-1.3	-1.7	0.4	-1.6	-2.6	1.7	-2.0	-2.0	1.6	-1.9	-2.1
06/08/2008	94.48	0.3	-0.8	-0.7	0.2	-0.4	-0.4	0.0	-0.5	-1.2	1.0	-0.8	-0.7	0.6	-0.6	-0.9

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



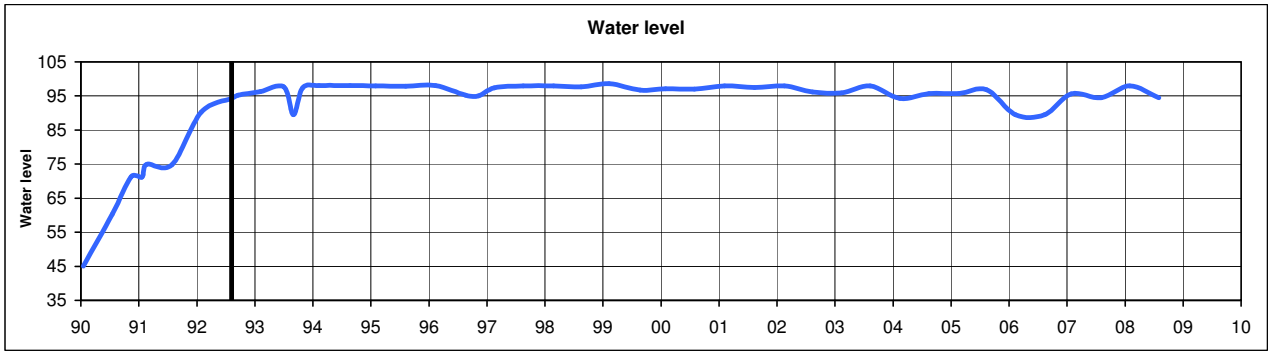
		55			56			57			58			59		
Date	Water Level	318			E319			E319.1			320			321		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.3	0.6	0.6	-0.3	0.4	0.4	-0.2	0.4	0.2	-0.4	0.5	0.3	-0.5	0.4	0.6
03/02/1993	96.22	0.8	-0.1	-0.3	0.7	-0.3	-0.4	0.7	-0.3	-0.3	0.8	-0.2	-0.4	0.7	0.2	-0.4
03/07/1993	97.69	0.7	0.2	-0.5	0.6	0.1	-0.6	0.5	0.2	-0.6	0.4	0.3	-0.6	0.4	0.4	-0.7
31/08/1993	89.47	0.3	0.3	0.3	0.3	0.3	0.2	0.4	0.2	0.2	0.4	0.4	0.3	0.2	0.5	0.4
29/10/1993	97.39	0.4	-0.4	1.1	0.3	-0.5	0.9	0.2	-0.6	0.9	0.4	-0.8	0.8	0.1	-0.2	0.8
09/02/1994	98.07	-0.1	0.0	-0.7	-0.2	-0.1	-0.7	-0.1	-0.2	-0.5	0.1	-0.4	-0.7	0.0	0.4	-0.8
24/08/1994	98.04	0.5	-0.6	-0.5	0.3	-0.4	-0.5	0.5	-0.7	-0.5	0.6	-0.9	-0.4	0.5	-0.4	-0.6
01/02/1995	97.93	1.6	-0.8	-0.9	1.1	-0.6	-0.4	1.5	-1.0	-0.8	1.8	-1.1	-0.9	1.5	-0.1	-1.0
09/08/1995	97.90	1.6	-0.8	-0.9	1.1	-0.6	-0.4	1.5	-1.0	-0.8	1.8	-1.1	-0.9	1.5	-0.1	-1.0
13/02/1996	98.02	0.4	-0.5	-2.2	-0.1	-0.3	-1.7	0.4	-0.8	-2.1	0.6	-1.0	-2.1	0.4	-0.1	-2.1
21/08/1996	95.22	-0.4	0.1	-1.4	-0.6	0.3	-1.3	-0.5	-0.1	-1.3	-0.3	-0.4	-1.3	-0.4	0.0	-1.3
12/11/1996	95.05	-0.3	-0.2	-1.4	-0.4	-0.1	-1.3	-0.3	-0.3	-1.3	-0.1	-0.5	-1.2	-0.2	0.0	-1.3
18/02/1997	97.43	-1.5	-0.6	-1.4	-1.8	-0.3	-1.4	-1.7	-0.9	-1.5	-1.2	-1.0	-1.3	-1.8	-0.3	-1.4
19/08/1997	98.00	-1.7	-0.9	-0.5	-1.9	-1.2	-0.4	-1.9	-1.1	-0.4	-1.6	-1.3	-0.3	-1.8	-0.5	0.1
26/02/1998	97.92	#N/A	#N/A	1.0	#N/A	#N/A	1.0	#N/A	#N/A	0.8	#N/A	#N/A	-0.3	#N/A	#N/A	1.5
19/08/1998	97.71	-0.6	-0.3	0.1	-0.9	-0.5	0.2	-0.9	-0.3	0.2	-0.5	-0.6	0.1	-0.5	-0.1	0.1
10/02/1999	98.64	0.9	0.1	-1.5	0.5	0.3	-1.2	0.9	-0.2	-1.5	1.3	-0.4	-1.4	1.2	0.6	-1.2
25/08/1999	96.75	1.9	-0.1	-0.7	1.7	0.3	-0.8	1.8	-0.2	-0.8	1.9	-0.3	-0.6	1.8	0.5	-1.0
02/02/2000	97.11	0.8	-1.0	-2.7	0.7	-1.2	-2.6	0.9	-1.3	-2.7	1.2	-1.5	-2.5	1.1	-0.6	-2.6
02/08/2000	96.99	0.3	0.0	-0.4	0.1	-0.3	-0.2	0.2	-0.4	-0.2	0.6	-0.6	-0.1	0.5	0.0	-0.8
08/02/2001	97.93	0.7	-0.5	-2.0	0.7	-0.8	-1.9	0.7	-0.7	-1.7	1.1	-1.1	-1.9	1.2	-0.2	-2.2
15/08/2001	97.44	0.5	-0.1	-0.6	0.5	-0.3	-0.7	0.4	-0.3	-0.6	0.6	-0.5	-0.5	0.5	0.1	-0.9
20/02/2002	97.99	1.3	-0.2	-3.2	1.4	-0.3	-3.2	1.4	-0.4	-3.2	1.7	-0.7	-3.1	1.5	0.3	-3.3
15/08/2002	96.18	0.2	0.0	-1.0	0.2	-0.1	-1.1	0.1	-0.2	-0.9	0.3	-0.4	-0.9	0.1	0.1	-1.1
13/02/2003	95.93	1.0	-1.1	-3.1	0.9	-1.3	-3.1	1.0	-1.6	-2.9	1.4	-1.9	-3.0	1.2	-1.1	-3.2
13/08/2003	98.00	0.7	-0.2	-0.7	0.6	-0.3	-0.7	0.7	-0.4	-0.6	0.9	-0.6	-0.6	0.9	-0.1	-1.0
18/02/2004	94.30	1.1	-1.8	-1.1	0.9	-2.1	-1.0	0.9	-2.0	-0.9	1.3	-2.3	-1.1	1.1	-1.2	-1.3
18/08/2004	95.69	1.4	-1.8	-1.3	1.3	-1.8	-1.3	1.2	-1.9	-1.1	1.5	-2.1	-1.3	1.7	-1.3	-1.6
23/02/2005	95.69	1.2	-1.7	-2.1	0.9	-1.4	-1.9	1.2	-1.7	-1.9	1.5	-2.1	-1.9	1.4	-1.0	-2.0
17/08/2005	96.85	1.4	-1.6	-1.2	1.0	-1.9	-1.5	0.6	-1.8	-1.6	0.6	-2.0	-1.7	0.8	-1.2	-2.0
15/02/2006	89.48	1.5	-2.8	-3.1	1.5	-2.9	-3.3	1.7	-3.2	-3.0	2.1	-3.4	-2.9	1.8	-2.3	-3.1
16/08/2006	89.48	0.9	-1.4	-0.4	0.8	-1.5	-0.6	0.9	-1.2	-0.5	1.2	-1.4	-0.1	0.7	-0.7	-0.5
01/02/2007	95.60	1.8	-2.3	-1.4	1.8	-2.5	-1.6	2.0	-2.4	-1.3	2.2	-2.5	-1.0	1.8	-1.4	-1.2
08/08/2007	94.48	0.8	-0.5	-1.0	0.7	-0.5	-1.0	0.7	-0.5	-0.8	1.1	-0.7	-0.8	0.8	0.0	-1.1
05/02/2008	97.91	1.4	-1.6	-2.3	1.3	-1.8	-2.3	1.6	-1.6	-2.2	1.8	-1.9	-2.1	1.6	-0.9	-2.3
06/08/2008	94.48	0.4	-0.4	-0.8	0.3	-0.5	-0.8	0.4	-0.6	-0.7	0.6	-0.8	-0.7	0.2	-0.3	-1.0
		60			61			62			63			64		

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



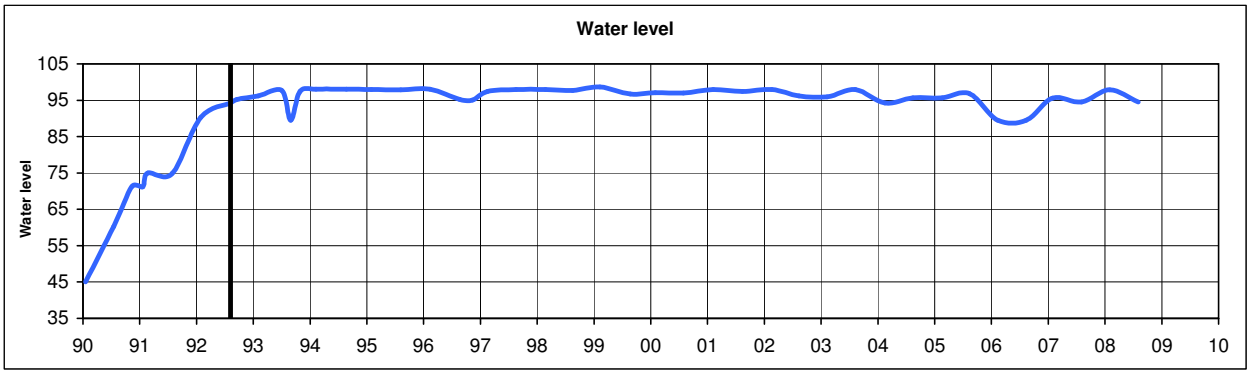
Date	Water Level	322			324			325			326			327		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.2	0.2	0.2	-0.1	0.2	0.3	-0.2	0.1	0.3	-0.2	0.3	0.7	0.0	0.1	0.3
03/02/1993	96.22	0.6	0.4	-0.2	0.6	0.9	-0.1	0.7	1.3	-0.1	0.6	1.9	-0.6	0.6	2.2	-0.2
03/07/1993	97.69	0.8	0.2	-0.7	0.8	0.3	-0.6	0.7	0.3	-0.6	0.6	0.6	-0.6	0.8	0.7	-0.7
31/08/1993	89.47	0.2	0.4	0.4	0.1	0.5	0.5	-0.3	0.4	0.6	-0.5	0.7	0.6	-0.4	0.7	0.6
29/10/1993	97.39	0.3	-0.3	0.8	0.3	-0.1	0.9	0.2	-0.1	1.0	-0.1	0.1	1.2	0.0	0.3	0.9
09/02/1994	98.07	-0.1	0.5	-0.7	-0.2	0.8	-0.6	-0.2	0.9	-0.6	-0.4	1.3	-0.6	-0.3	1.4	-0.7
24/08/1994	98.04	0.7	-0.5	-0.4	0.8	-0.2	-0.3	0.7	-0.1	-0.2	0.7	0.4	-0.4	0.8	0.5	-0.2
01/02/1995	97.93	1.6	-0.2	-1.0	1.6	0.2	-0.9	1.5	0.4	-0.9	1.4	0.9	-1.1	1.4	1.2	-0.9
09/08/1995	97.90	1.6	-0.2	-1.0	1.6	0.2	-0.9	1.5	0.4	-0.9	1.4	0.9	-1.1	1.4	1.2	-0.9
19/08/1997	98.00	-1.3	-0.9	-0.4	-1.1	-0.6	-0.4	-1.0	-0.5	-0.3	-1.1	-0.1	-0.1	-0.9	0.2	-0.3
26/02/1998	97.92	#N/A	#N/A	0.1	#N/A	#N/A	0.1	#N/A	#N/A	0.1	#N/A	#N/A	1.7	#N/A	#N/A	0.0
19/08/1998	97.71	-0.2	-0.1	0.0	-0.2	0.2	0.0	-0.2	0.3	0.1	-0.4	0.8	-0.6	-0.1	1.0	0.1
10/02/1999	98.64	1.4	0.7	-1.4	1.3	1.1	-1.3	1.4	1.3	-1.3	1.2	1.8	-1.3	1.6	2.2	-1.3
25/08/1999	96.75	1.9	0.6	-0.9	1.7	1.0	-0.9	1.6	1.4	-0.9	1.9	1.0	-1.5	1.2	2.4	-0.9
02/02/2000	97.11	1.3	-0.6	-2.4	1.2	-0.1	-2.3	1.3	0.1	-2.3	2.0	-0.5	-2.9	1.4	0.8	-2.3
02/08/2000	96.99	0.7	-0.1	-0.7	0.7	0.2	-0.7	0.8	0.3	-0.8	1.3	-0.3	-1.5	0.5	0.9	-0.8
08/02/2001	97.93	1.5	-0.2	-2.1	1.6	0.4	-2.0	1.6	0.5	-2.0	2.2	0.0	-2.7	1.7	1.4	-2.1
15/08/2001	97.44	0.6	0.0	-0.9	0.5	0.2	-0.8	0.2	0.3	-0.7	0.6	-0.4	-1.4	-0.3	0.7	-0.7
20/02/2002	97.99	1.6	0.3	-3.1	1.4	0.7	-3.0	1.3	0.9	-3.0	1.6	0.4	-3.6	0.9	1.6	-3.0
15/08/2002	96.18	0.2	0.0	-1.1	0.0	0.2	-1.1	-0.3	0.3	-1.2	0.0	-0.3	-1.8	-0.8	0.9	-1.2
13/02/2003	95.93	1.4	-1.2	-2.9	1.3	-0.9	-2.9	1.2	-1.0	-2.9	2.0	-1.7	-3.6	1.6	-0.6	-2.9
13/08/2003	98.00	1.2	-0.3	-1.0	1.1	-0.1	-1.0	1.0	0.0	-0.9	1.5	-0.8	-1.5	0.8	0.4	-0.8
18/02/2004	94.30	1.2	-1.2	-1.1	0.9	-0.7	-1.0	0.8	-0.5	-1.0	1.2	-1.0	-1.6	0.5	0.4	-1.0
18/08/2004	95.69	2.0	-0.9	-1.5	1.8	-0.3	-1.5	1.8	0.3	-1.4	2.4	0.2	-2.0	1.8	2.0	-1.4
23/02/2005	95.69	1.4	-0.9	-1.8	1.2	-0.4	-1.7	1.4	0.0	-1.6	1.9	-0.3	-2.2	1.2	1.1	-1.5
17/08/2005	96.85	1.3	-0.8	-1.9	1.3	-0.1	-1.9	1.5	0.5	-1.8	2.1	0.4	-2.5	1.7	2.1	-1.8
15/02/2006	89.48	2.0	-2.4	-2.8	2.0	-1.8	-2.7	2.1	-1.7	-2.7	2.5	-2.2	-3.3	1.9	-0.9	-2.7
16/08/2006	89.48	0.9	-0.8	-0.5	0.5	-0.4	-0.5	0.4	0.1	-0.5	0.5	-0.3	-1.1	-0.3	1.1	-0.5
01/02/2007	95.60	1.9	-1.2	-1.0	1.6	-0.4	-0.9	1.6	0.1	-1.0	1.9	-0.2	-1.6	1.0	1.4	-1.1
08/08/2007	94.48	1.0	0.1	-1.0	0.9	0.6	-1.0	0.9	0.9	-1.0	1.3	0.7	-1.6	0.4	2.2	-1.0
05/02/2008	97.91	2.0	-0.8	-2.2	1.8	-0.2	-2.2	1.7	0.1	-2.2	2.2	-0.2	-2.8	1.4	1.4	-2.2
06/08/2008	94.48	0.4	-0.3	-0.8	0.3	0.0	-0.7	0.2	0.3	-0.7	0.6	-0.3	-1.3	-0.2	1.1	-0.6

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



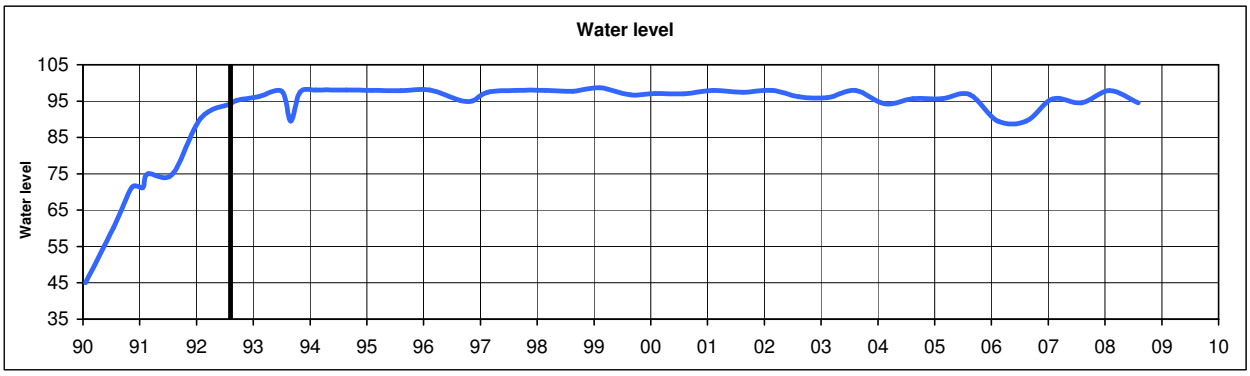
Date	Water Level	T01			T02			T03			T04			T05		
		dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	-1.0	-1.3	2.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.8	0.1	2.1	-0.4	-0.6	1.4
22/01/1991	71.15	-1.3	-3.1	2.4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	-0.7	0.9	3.9	-0.8	-1.7	2.8
21/02/1991	74.97	-1.1	-2.3	3.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.0	1.0	4.6	-0.8	0.0	2.5
30/07/1991	74.87	-0.9	-1.8	1.6	-0.2	-2.5	1.7	1.1	-1.8	2.7	0.4	-2.2	2.8	-1.1	-1.8	2.5
29/01/1992	90.27	0.0	-2.0	2.5	-0.1	-1.3	2.9	-0.3	-0.9	3.9	0.2	0.9	3.1	0.6	-1.8	2.2
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.0	0.0	0.7	-0.1	-0.1	1.4	0.0	0.1	1.2	0.0	0.1	1.1	-0.2	0.1	0.8
03/02/1993	96.22	0.1	-0.2	1.1	-0.3	0.0	1.4	0.2	0.7	1.5	0.2	2.9	1.5	0.2	0.1	0.6
03/07/1993	97.69	0.4	-1.0	0.8	-0.4	-0.7	0.7	0.3	-0.1	0.9	-0.6	-0.3	-0.5	0.2	-0.4	0.5
31/08/1993	89.47	0.2	-0.6	0.9	0.2	-0.6	1.1	1.3	-0.1	2.1	-0.1	0.3	0.8	0.3	-0.5	1.0
29/10/1993	97.39	0.1	-0.6	2.3	0.1	-0.6	1.9	1.1	-0.1	2.5	-0.1	1.4	2.1	0.1	-0.2	2.1
09/02/1994	98.07	-0.8	0.0	1.5	-1.0	0.3	2.0	-0.7	0.5	2.2	-0.7	2.7	0.6	-0.6	0.2	0.7
24/08/1994	98.04	-1.2	-0.4	-0.3	-0.9	0.1	-0.6	0.1	0.2	0.7	-1.0	-0.2	-1.0	-1.3	-0.4	-0.1
01/02/1995	97.93	-1.7	-1.9	1.0	-2.0	-1.2	1.8	-0.6	-0.6	2.9	-1.6	2.0	1.1	-1.4	-0.6	0.7
09/08/1995	97.90	-0.1	-1.4	-0.7	0.1	-1.7	-1.1	1.5	-1.0	0.0	-0.2	-1.1	-1.1	-0.5	-1.5	-0.8
13/02/1996	98.02	-2.5	-0.4	0.7	-2.6	0.0	1.8	-1.3	0.5	2.5	-2.7	2.9	1.0	-2.1	0.3	-0.1
21/08/1996	95.22	-2.0	-0.5	-0.1	-1.5	-1.1	-0.3	-0.5	0.1	0.8	-2.0	-0.5	-0.8	-2.5	0.0	0.4
12/11/1996	95.05	-2.5	-0.5	0.5	-2.5	-0.2	0.5	-1.3	0.4	1.6	-2.4	1.9	-0.6	-2.5	0.3	0.2
18/02/1997	97.43	-2.7	-1.3	0.5	-2.6	-0.7	1.1	-1.7	-0.6	2.7	-3.7	2.4	0.3	-2.3	-1.0	0.4
19/08/1997	98.00	-2.9	-0.4	0.3	-2.8	-1.2	0.7	-1.4	-0.7	0.8	-2.7	-0.6	-0.3	-3.3	-1.1	0.6
26/02/1998	97.92	-2.3	-1.2	-0.1	-2.3	-1.1	0.8	-1.5	0.0	2.0	-2.8	2.6	0.9	-2.0	-0.9	-0.5
19/08/1998	97.71	-1.5	-0.3	0.9	-1.5	-0.9	1.1	-0.1	-0.6	1.9	-1.7	-0.6	0.2	-2.0	-1.1	1.2
10/02/1999	98.64	-1.4	-1.0	0.4	-2.1	0.0	2.3	-0.5	0.0	2.4	-2.1	3.7	0.8	-1.0	-0.2	0.1
25/08/1999	96.75	-0.6	-0.4	1.6	-0.2	-0.8	0.4	1.1	-0.2	1.5	-0.8	-0.5	0.5	-1.0	-1.1	1.7
02/02/2000	97.11	-1.1	-0.6	0.0	-1.2	0.6	0.3	0.4	0.4	0.7	-1.8	3.2	-0.1	-1.2	0.2	0.1
02/08/2000	96.99	-0.5	0.1	0.9	-0.3	-0.2	0.6	0.9	0.8	1.8	-0.5	0.6	0.3	-0.8	0.1	0.9
08/02/2001	97.93	-1.0	-0.6	0.2	-1.5	0.4	0.8	-0.4	0.5	2.3	-1.7	4.1	0.6	-1.1	0.0	-0.5
15/08/2001	97.44	-0.6	0.2	1.0	-1.0	-0.2	1.5	1.1	0.8	1.7	-1.1	0.2	-0.2	-1.0	-0.1	0.6
20/02/2002	97.99	-0.2	-0.9	-0.4	-0.5	-0.2	0.4	0.8	-0.7	1.6	-0.4	3.1	-0.6	0.2	-0.7	-0.6
15/08/2002	96.18	-0.7	-0.1	1.1	-0.7	0.0	0.6	0.8	0.6	1.5	-0.7	0.2	-0.2	-1.2	0.0	1.1
13/02/2003	95.93	-0.8	-1.6	0.4	-1.3	0.2	1.2	-1.3	0.3	1.8	0.1	4.6	1.2	-1.0	0.8	0.6
13/08/2003	98.00	-0.2	0.1	0.9	0.3	-0.9	-0.3	1.6	0.5	1.1	-0.5	-0.4	-0.6	-0.6	-0.5	1.0
18/02/2004	94.30	-1.9	-0.1	1.6	-1.2	3.4	1.7	-2.5	2.2	2.1	-3.3	3.3	0.0	-0.4	-1.1	-0.7
18/08/2004	95.69	-0.8	-0.2	1.4	-0.4	-0.9	0.9	2.1	-0.4	2.9	-0.8	-0.3	0.2	-1.2	-0.9	0.6
23/02/2005	95.69	0.7	-0.9	1.8	-0.8	-0.4	1.1	0.4	0.7	2.6	-1.3	3.2	1.1	0.0	0.2	0.7
17/08/2005	96.85	-0.9	-0.4	0.3	-0.8	-0.7	0.2	-0.8	-0.6	0.0	-1.5	-1.5	-1.1	-2.2	0.5	0.3
15/02/2006	89.48	0.3	-2.6	0.4	-0.3	-1.3	1.3	1.0	-1.3	2.6	-1.1	2.0	0.9	0.0	-1.2	0.8
16/08/2006	89.48	-0.9	-0.3	-0.3	-0.6	-1.5	-0.2	0.7	-0.4	1.1	0.3	-1.1	0.2	-2.5	-0.4	-0.6
01/02/2007	95.60	0.0	-0.5	0.7	0.0	2.5	1.8	-2.3	3.6	2.2	-1.8	3.7	1.4	-0.3	0.1	0.2
08/08/2007	94.48	-0.2	0.3	0.1	0.4	-1.3	-1.2	1.8	0.3	0.7	-0.5	-0.1	-0.8	-0.5	-0.1	-0.6
05/02/2008	97.91	1.0	-1.4	0.3	0.3	1.6	0.9	-3.2	1.6	1.5	-1.8	3.0	0.5	0.3	-1.0	-0.7
06/08/2008	94.48	0.3	0.3	1.2	0.5	1.5	0.9	-0.4	4.4	2.0	-1.1	1.7	-0.2	-1.4	0.2	1.8

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



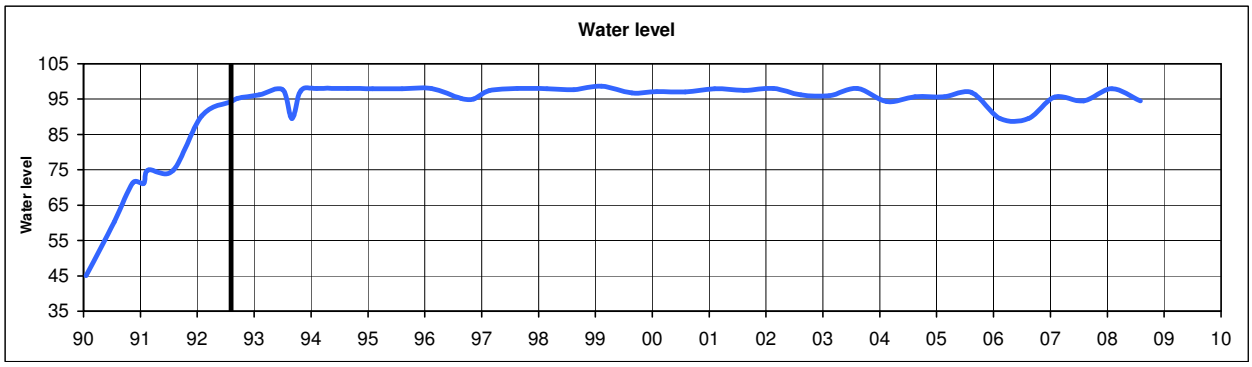
Date	Water Level	T06		
		dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A
13/11/1990	71.28	0.4	0.6	1.5
22/01/1991	71.15	0.2	1.2	1.9
21/02/1991	74.97	-0.3	1.3	2.6
30/07/1991	74.87	-0.8	-1.1	1.8
29/01/1992	90.27	0.5	0.0	1.5
07/08/1992	94.30	0.0	0.0	0.0
17/09/1992	95.23	-0.4	0.8	1.1
03/02/1993	96.22	0.5	2.0	0.0
03/07/1993	97.69	0.1	-0.4	0.2
31/08/1993	89.47	0.2	0.2	0.8
29/10/1993	97.39	0.0	1.3	1.3
09/02/1994	98.07	-0.1	1.9	-0.5
24/08/1994	98.04	-1.0	-0.1	-0.1
01/02/1995	97.93	-1.3	1.2	0.1
09/08/1995	97.90	-0.4	-1.6	-0.5
13/02/1996	98.02	-2.0	2.0	-0.8
21/08/1996	95.22	-2.8	-0.5	1.1
12/11/1996	95.05	-1.8	1.1	-0.8
18/02/1997	97.43	-2.5	1.0	-0.6
19/08/1997	98.00	-3.4	-0.6	1.3
26/02/1998	97.92	-2.2	1.5	0.2
19/08/1998	97.71	-2.1	-1.0	1.5
10/02/1999	98.64	-0.9	2.3	0.1
25/08/1999	96.75	-1.0	-1.1	1.7
02/02/2000	97.11	-0.2	2.1	-1.3
02/08/2000	96.99	-1.7	0.7	3.1
08/02/2001	97.93	-0.2	2.1	-1.6
15/08/2001	97.44	-0.8	-0.1	0.7
20/02/2002	97.99	-0.1	2.4	-1.5
15/08/2002	96.18	-0.9	-0.2	0.9
13/02/2003	95.93	-0.5	2.7	-0.8
13/08/2003	98.00	-0.9	-1.6	0.8
18/02/2004	94.30	-1.0	0.7	-1.2
18/08/2004	95.69	-1.4	-0.4	0.4
23/02/2005	95.69	0.3	2.1	0.1
17/08/2005	96.85	-1.9	-0.6	-0.7
15/02/2006	89.48	0.6	0.9	0.0
16/08/2006	89.48	-2.2	0.8	-0.7
01/02/2007	95.60	0.1	2.0	-0.2
08/08/2007	94.48	-0.7	0.1	0.1
05/02/2008	97.91	1.1	-0.2	-1.4
06/08/2008	94.48	-1.1	-0.2	1.5

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



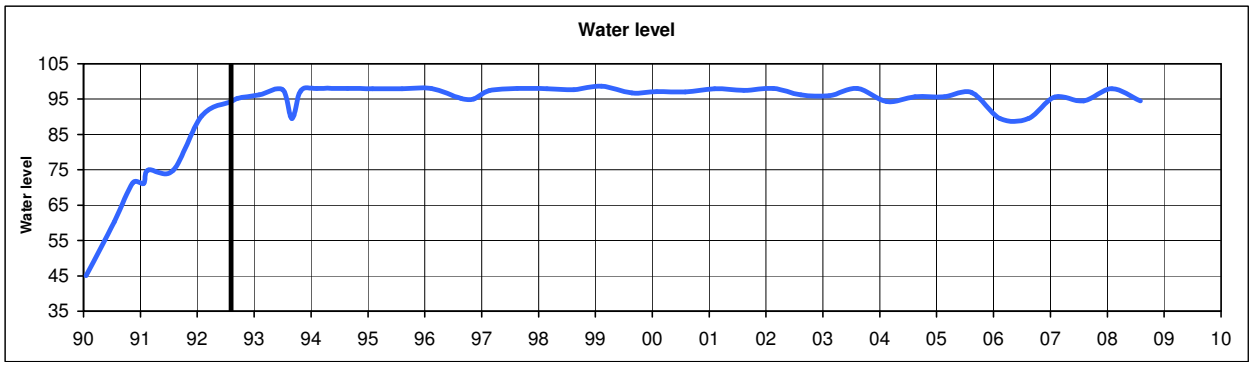
Date	Water Level	PL06		IPL06		PL12		IP12		IPL17	
		dy	dx	dy	dx	dy	dx	dy	dx	dy	dx
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.2	-0.1	0.3	-0.2	0.8	-0.2	0.5	-0.2	0.2	0.2
03/02/1993	96.22	-3.1	-1.8	0.5	0.5	-0.2	-6.0	0.6	0.0	0.1	-0.4
03/07/1993	97.69	0.3	-0.1	0.4	-0.9	1.2	1.0	0.8	-1.0	0.6	-0.1
31/08/1993	89.47	0.4	-0.9	0.3	-0.9	0.7	-1.1	0.4	-0.8	0.6	0.1
29/10/1993	97.39	-2.8	-1.5	-0.2	0.4	-1.1	-1.5	-6.8	2.5	0.2	-0.2
09/02/1994	98.07	-5.6	-2.9	0.0	1.5	-3.2	-6.3	-8.3	4.6	-0.7	0.5
24/08/1994	98.04	-1.2	0.3	-0.4	-0.5	-1.2	2.4	-7.8	3.6	0.2	-0.2
01/02/1995	97.93	-5.6	-5.2	0.3	-0.1	-1.8	-8.0	-6.6	1.3	1.1	-0.8
09/08/1995	97.90	-5.6	-5.2	0.3	-0.1	-1.8	-8.0	-6.6	1.3	1.1	-0.8
13/02/1996	98.02	-6.4	-4.2	-1.1	2.6	-3.2	-7.4	-8.2	2.2	-0.3	-0.5
21/08/1996	95.22	-2.0	0.6	-2.7	0.8	-2.1	3.2	-9.2	3.0	-0.8	0.3
12/11/1996	95.05	-4.6	-1.6	-2.3	1.5	-2.0	-1.3	-8.9	3.2	-0.5	0.1
18/02/1997	97.43	-7.0	-3.1	-2.8	1.4	-4.6	-6.7	-9.3	2.2	-1.9	-0.6
19/08/1997	98.00	-3.4	-0.3	-3.2	1.3	-3.1	1.4	-10.1	2.0	-2.5	-1.3
26/02/1998	97.92	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
19/08/1998	97.71	-1.9	0.1	-1.9	0.9	-1.8	3.4	-6.4	3.9	-1.2	-0.5
10/02/1999	98.64	-5.7	-3.6	-0.9	0.9	-2.7	-6.8	-7.6	3.9	-0.1	-0.2
25/08/1999	96.75	-1.3	-0.2	-0.7	0.0	0.0	1.4	-6.9	3.0	1.2	0.3
02/02/2000	97.11	-6.2	-4.3	-0.7	2.1	-2.6	-7.7	-7.6	3.1	0.5	-0.7
02/08/2000	96.99	-1.3	1.2	-0.8	2.5	-1.1	2.8	-7.7	1.3	0.4	0.2
08/02/2001	97.93	-6.8	-4.6	-0.9	2.1	-2.4	-6.6	-7.8	5.3	0.6	-0.4
15/08/2001	97.44	-0.8	0.4	0.4	2.1	-0.3	2.9	-7.5	3.7	0.7	0.2
20/02/2002	97.99	-4.6	-3.6	0.4	2.4	-1.4	-5.7	-7.3	4.9	1.0	-0.3
15/08/2002	96.18	-1.5	0.3	-1.3	1.4	-0.8	2.6	-8.1	3.8	0.3	-0.3
13/02/2003	95.93	-6.4	-4.2	0.6	2.8	-2.7	-9.2	-7.9	4.4	-0.1	-1.2
13/08/2003	98.00	-0.2	0.6	-0.1	1.8	0.0	3.7	-7.7	5.4	0.6	-0.2
18/02/2004	94.30	-6.6	-4.4	-1.9	-0.1	-3.0	-9.4	-7.7	3.2	0.8	-1.8
18/08/2004	95.69	-1.1	-0.5	-1.2	-0.7	-0.8	0.8	-7.7	2.8	0.5	-2.5
23/02/2005	95.69	-5.6	-4.1	-1.2	1.1	-2.2	-8.2	-5.4	5.0	0.7	-1.8
17/08/2005	96.85	-1.8	-0.6	-1.1	0.1	-0.6	2.0	-8.6	3.1	0.8	-1.9
15/02/2006	89.48	-5.7	-5.0	-0.3	-0.6	-2.4	-10.7	-5.4	3.0	0.9	-3.1
16/08/2006	89.48	0.2	-0.5	0.5	-0.3	-0.2	2.2	-6.9	2.9	0.9	-2.0
01/02/2007	95.60	-5.6	-5.0	0.3	-0.3	-1.5	-9.9	-6.3	2.8	2.0	-2.1
08/08/2007	94.48	-0.2	-0.2	0.5	0.0	0.8	2.4	-7.7	3.4	1.1	-0.4
05/02/2008	97.91	-5.2	-5.2	0.1	-0.3	-0.7	-7.6	-6.7	2.2	1.4	-1.7
06/08/2008	94.48	-1.2	-0.3	1.0	0.5	0.0	1.4	-7.6	4.4	-0.2	-0.5

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



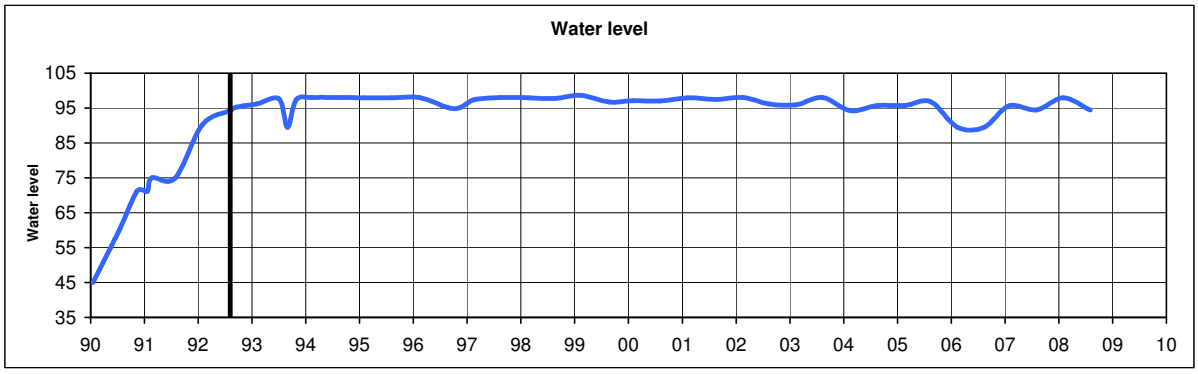
Date	Water Level	IP17		PL21		IP21		PL24	
		dy	dx	dy	dx	dy	dx	dy	dx
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.6	0.2	-0.2	-0.7	-0.3	0.2	0.5	-0.2
03/02/1993	96.22	1.0	0.0	3.1	-7.4	0.1	-1.5	4.6	-3.1
03/07/1993	97.69	1.0	-0.3	0.8	1.4	-0.3	-1.6	0.9	1.1
31/08/1993	89.47	1.4	0.6	1.1	-0.8	-0.2	-1.2	0.9	0.2
29/10/1993	97.39	2.1	0.4	-1.3	-0.2	-0.9	-3.3	2.4	-3.2
09/02/1994	98.07	0.1	1.8	-0.1	-4.6	-2.7	-10.1	3.5	-4.7
24/08/1994	98.04	2.1	1.6	-1.8	5.2	-0.7	-8.2	0.5	-0.5
01/02/1995	97.93	1.8	1.0	1.8	-6.2	-0.5	-9.1	5.7	-6.2
09/08/1995	97.90	1.8	1.0	1.8	-6.2	-0.5	-9.1	5.7	-6.2
13/02/1996	98.02	-0.5	0.6	0.6	-5.8	-1.7	-10.3	4.7	-6.1
21/08/1996	95.22	-1.7	0.3	-3.1	6.5	-2.1	-9.1	-0.7	0.1
12/11/1996	95.05	-0.2	1.4	-1.9	0.1	-1.9	-9.0	2.4	-2.6
18/02/1997	97.43	-1.3	1.1	-1.9	-5.5	-3.5	-8.3	2.2	-5.6
19/08/1997	98.00	-1.7	0.8	-4.2	3.9	-3.5	-10.0	-1.2	-1.6
26/02/1998	97.92	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
19/08/1998	97.71	-1.2	0.5	-3.2	6.2	-2.1	-7.2	-0.3	0.2
10/02/1999	98.64	0.5	1.8	1.1	-5.8	-0.4	-5.8	5.2	-5.1
25/08/1999	96.75	2.3	1.5	-0.8	5.9	0.2	-4.8	2.2	0.6
02/02/2000	97.11	0.4	0.8	1.2	-6.0	-0.9	-7.9	5.5	-6.3
02/08/2000	96.99	0.6	2.1	-0.1	6.3	-1.1	-7.6	0.7	0.5
08/02/2001	97.93	0.8	1.6	0.5	-5.2	-0.7	-7.8	5.3	-5.1
15/08/2001	97.44	0.9	1.9	-0.6	6.4	-0.9	-5.4	0.9	0.5
20/02/2002	97.99	1.9	2.4	1.0	-3.5	-0.1	-5.5	5.3	-4.2
15/08/2002	96.18	0.8	1.9	-1.0	5.7	-1.3	-4.9	2.3	-0.9
13/02/2003	95.93	1.3	1.5	1.4	-9.0	0.5	-5.6	5.9	-7.5
13/08/2003	98.00	1.5	1.7	0.4	6.4	-0.4	-6.7	0.8	0.7
18/02/2004	94.30	1.7	0.7	1.1	-7.6	-0.6	-7.4	4.9	-6.4
18/08/2004	95.69	1.7	0.3	-1.6	4.3	-0.1	-7.5	2.0	-0.3
23/02/2005	95.69	1.8	0.7	1.1	-6.3	0.5	-3.4	5.4	-5.7
17/08/2005	96.85	1.4	0.5	-3.0	5.3	-0.3	-5.0	1.2	0.3
15/02/2006	89.48	2.0	-0.3	2.0	-8.4	0.5	-8.8	6.5	-7.2
16/08/2006	89.48	1.8	0.4	-1.9	6.0	-0.3	-6.4	0.9	0.3
01/02/2007	95.60	3.5	1.4	2.5	-9.2	1.1	-6.9	7.1	-6.7
08/08/2007	94.48	1.7	1.2	-1.7	5.7	0.0	-5.9	0.9	0.4
05/02/2008	97.91	2.2	-1.4	1.1	-5.6	0.7	-6.2	5.9	-5.9
06/08/2008	94.48	1.3	0.9	-2.4	4.9	-4.9	-5.9	0.4	0.3

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Lower Exit Gallery

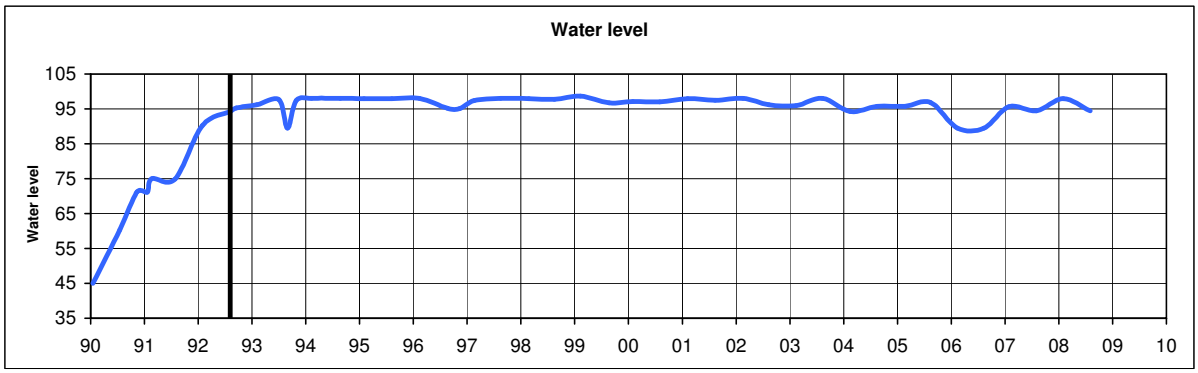
Date	Water Level	311.1			311.2			311.3		
		dy	dx	dz	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.3	-0.2	0.4	0.2	0.0	0.6	0.3	0.2	0.2
03/02/1993	96.22	0.4	0.2	-0.8	0.5	0.4	-0.8	0.7	0.8	-0.5
03/07/1993	97.69	0.7	-0.6	-0.2	0.5	-0.3	-0.4	0.3	0.0	-0.5
31/08/1993	89.47	0.7	-0.3	0.2	0.7	-0.1	0.2	0.5	0.0	0.5
29/10/1993	97.39	0.3	-0.6	1.5	0.5	0.0	1.1	1.1	0.3	1.0
09/02/1994	98.07	-0.4	-0.3	0.2	0.1	0.2	0.2	1.1	0.8	0.5
24/08/1994	98.04	0.2	-0.9	-0.6	0.6	-0.3	-1.3	1.0	0.3	-1.1
01/02/1995	97.93	0.8	-1.6	-0.7	1.0	-1.0	-1.0	1.9	-0.1	-0.7
09/08/1995	97.90	0.8	-1.6	-0.7	1.0	-1.0	-1.0	1.9	-0.1	-0.7
13/02/1996	98.02	-0.8	-0.1	-1.8	-0.2	0.3	-1.8	0.8	1.3	-1.7
21/08/1996	95.22	-1.6	0.4	-0.8	-1.2	1.0	-1.1	-0.8	1.2	-1.2
12/11/1996	95.05	-1.1	0.1	-0.8	-0.7	0.7	-1.0	-0.1	1.2	-1.4
18/02/1997	97.43	-1.9	-1.0	-0.3	-1.6	-0.1	-0.5	-0.7	0.4	-0.4
19/08/1997	98.00	-2.6	-0.5	0.6	-2.2	0.1	0.6	-1.3	0.3	0.5
26/02/1998	97.92	#N/A	#N/A	0.1	#N/A	#N/A	3.3	#N/A	#N/A	1.5
19/08/1998	97.71	-1.2	0.0	0.9	-0.8	0.4	0.7	-0.4	0.5	0.9
10/02/1999	98.64	-0.1	-0.4	-1.0	0.5	0.1	-0.8	1.0	0.9	-0.7
25/08/1999	96.75	0.7	-1.0	1.0	0.8	-0.7	0.4	1.3	-0.1	1.0
02/02/2000	97.11	0.1	-0.6	-2.1	1.9	1.9	-2.5	1.4	0.5	-2.0
02/08/2000	96.99	-0.6	0.6	0.8	-0.2	0.8	0.1	0.4	1.5	0.4
08/02/2001	97.93	-0.3	-0.2	-0.4	0.6	0.0	-0.7	1.5	0.8	-0.1
15/08/2001	97.44	0.3	0.3	-0.1	0.7	0.3	-0.9	1.2	0.4	-0.5
20/02/2002	97.99	0.4	0.4	-2.1	1.0	0.6	-2.5	1.7	1.4	-2.0
15/08/2002	96.18	-0.3	0.1	0.3	0.0	0.1	-0.4	0.5	0.3	-0.1
13/02/2003	95.93	-0.5	0.2	-1.8	0.1	0.2	-2.1	0.6	0.9	-1.4
13/08/2003	98.00	0.1	0.4	-0.1	0.3	0.5	-1.2	0.7	0.8	-1.0
18/02/2004	94.30	-0.2	-2.2	-0.3	0.3	-2.2	-0.7	0.9	-1.2	-0.2
18/08/2004	95.69	-0.1	-1.9	-0.6	0.2	-1.8	-1.6	0.7	-1.0	-1.3
23/02/2005	95.69	0.1	-1.3	-1.0	0.9	-0.9	-1.5	1.7	0.1	-1.1
17/08/2005	96.85	0.1	-2.0	-1.3	0.4	-1.5	-2.3	1.0	-0.7	-2.3
15/02/2006	89.48	0.4	-2.6	-1.8	0.7	-2.4	-2.0	1.1	-1.4	-1.3
16/08/2006	89.48	1.1	-1.3	-0.4	1.3	-1.4	-1.4	1.7	-1.2	-1.3
01/02/2007	95.60	1.3	-2.6	-0.7	1.8	-2.3	-1.0	2.4	-1.2	-0.6
08/08/2007	94.48	0.6	-1.2	-0.4	1.0	-1.2	-1.3	1.6	-1.0	-1.0
05/02/2008	97.91	1.0	-2.0	-2.0	1.4	-1.8	-2.6	1.8	-1.0	-2.2
06/08/2008	94.48	0.3	-0.6	0.1	0.4	-0.6	-0.8	0.7	-0.2	-0.6

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Points on slope left flank of Lower gallery

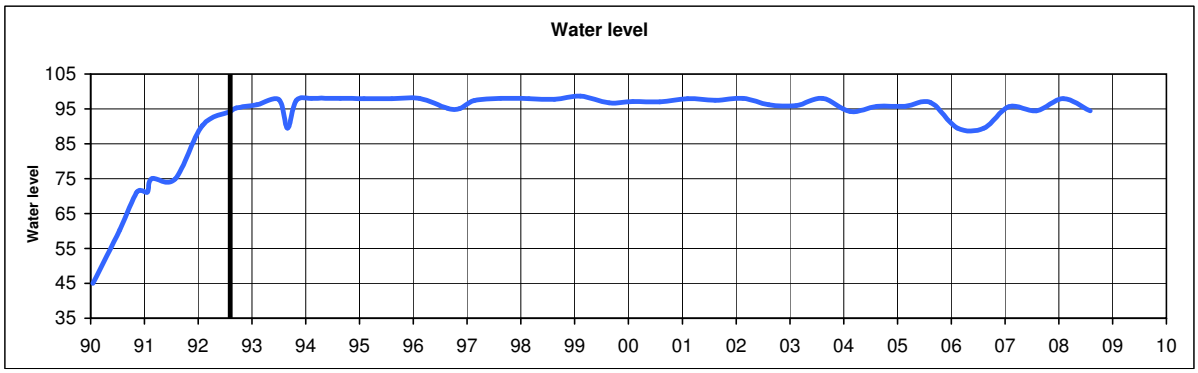
Date	Water Level	323			323.1		
		dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.6	0.3	0.1	-0.5	0.3	-0.1
03/02/1993	96.22	0.7	-0.2	-0.3	1.1	0.0	-0.6
03/07/1993	97.69	0.4	0.2	-0.6	0.5	0.3	-1.0
31/08/1993	89.47	0.5	0.4	0.4	0.7	0.6	0.0
29/10/1993	97.39	0.1	-0.3	0.8	1.8	0.5	0.6
09/02/1994	98.07	0.2	0.1	-0.6	1.9	0.9	-0.8
24/08/1994	98.04	0.6	-0.4	-0.2	2.0	0.4	-0.2
01/02/1995	97.93	1.8	-0.7	-0.5	3.4	0.1	-0.2
09/08/1995	97.90	1.8	-0.7	-0.5	3.4	0.1	-0.2
13/02/1996	98.02	0.7	-0.6	-1.7	2.5	0.0	-1.4
21/08/1996	95.22	-0.4	0.1	-1.1	1.2	0.9	-1.0
12/11/1996	95.05	-0.2	0.0	-1.0	1.4	0.6	-0.8
18/02/1997	97.43	-1.5	-0.8	-1.2	0.4	-0.1	-1.0
19/08/1997	98.00	-1.6	-0.8	-0.2	0.0	-0.1	-0.1
26/02/1998	97.92	#N/A	#N/A	3.1	#N/A	#N/A	0.5
19/08/1998	97.71	-0.6	0.0	0.2	1.1	0.9	0.4
10/02/1999	98.64	1.3	0.0	-1.2	3.2	0.7	-1.1
25/08/1999	96.75	1.7	0.3	-0.4	3.4	1.3	-0.2
02/02/2000	97.11	1.2	-1.2	-2.2	3.2	-0.4	-2.2
02/08/2000	96.99	0.6	0.0	0.2	2.1	0.8	0.3
08/02/2001	97.93	1.3	-0.6	-1.5	3.1	0.1	-1.3
15/08/2001	97.44	0.5	0.1	-0.3	1.9	1.0	-0.7
20/02/2002	97.99	1.7	-0.1	-2.8	3.5	0.8	-2.6
15/08/2002	96.18	0.3	0.2	-0.7	1.8	1.0	-0.8
13/02/2003	95.93	1.5	-1.5	-2.6	3.2	-0.8	-2.4
13/08/2003	98.00	0.8	0.0	-0.6	2.3	0.9	-0.5
18/02/2004	94.30	1.2	-1.9	-0.8	2.8	-1.1	-0.9
18/08/2004	95.69	1.3	-1.5	-1.1	3.0	-0.4	-1.0
23/02/2005	95.69	1.6	-1.6	-1.6	3.4	-0.7	-1.5
17/08/2005	96.85	0.2	-1.5	-1.9	1.8	-0.4	-1.9
15/02/2006	89.48	2.1	-3.1	-2.7	4.2	-2.2	-2.1
16/08/2006	89.48	0.9	-0.8	-0.1	2.4	0.4	-0.3
01/02/2007	95.60	2.4	-1.9	-0.7	4.1	-0.9	-0.7
08/08/2007	94.48	1.2	0.0	-0.6	2.4	0.8	-0.8
05/02/2008	97.91	2.0	-1.4	-1.6	3.4	-0.4	-1.6
06/08/2008	94.48	0.6	-0.4	-0.6	2.1	0.4	-0.8

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Eccentric points near traverse stations

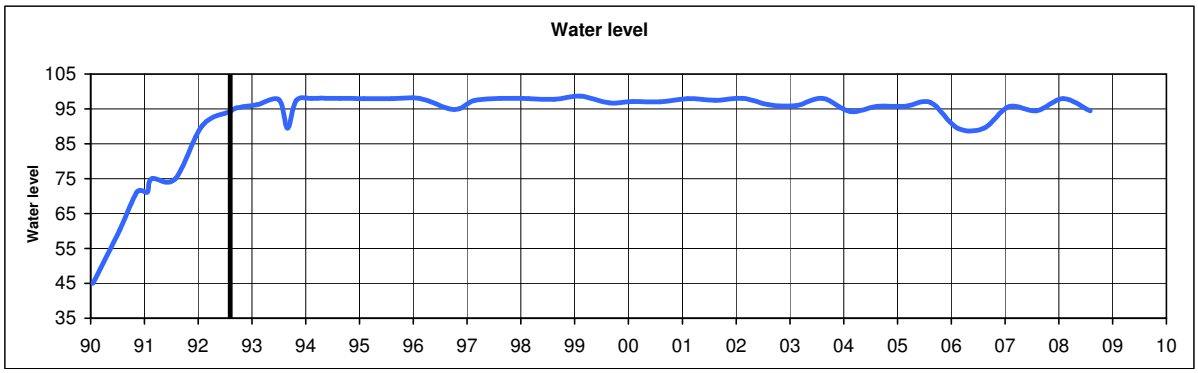
Date	Water Level	E312			E317		E320			E323		
		dy	dx	dz	dy	dx	dy	dx	dz	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	0.3	-0.1	0.6	0.3	0.3	-0.6	0.4	0.3	-0.8	0.3	0.1
03/02/1993	96.22	0.3	0.0	-0.6	0.1	-0.2	0.6	-0.3	-0.4	0.6	-0.2	-0.3
03/07/1993	97.69	0.8	-0.5	0.0	0.6	0.1	0.2	0.2	-0.6	0.3	0.2	-0.6
31/08/1993	89.47	0.5	-0.3	0.4	0.6	0.2	0.2	0.3	0.3	0.4	0.4	0.4
29/10/1993	97.39	0.4	-0.6	1.6	0.4	-0.6	0.0	-0.6	1.0	0.4	-0.2	0.5
09/02/1994	98.07	-0.7	-0.3	0.2	-0.6	0.0	-0.1	-0.2	-0.5	0.7	0.3	-1.3
24/08/1994	98.04	0.5	-0.8	-0.7	0.4	-0.7	0.3	-0.8	-0.2	1.0	-0.2	-0.9
01/02/1995	97.93	1.1	-1.7	-0.5	1.3	-1.2	1.4	-1.0	-0.7	2.2	-0.5	-1.2
09/08/1995	97.90	1.1	-1.7	-0.5	1.3	-1.2	1.4	-1.0	-0.7	2.2	-0.5	-1.2
13/02/1996	98.02	-0.4	-0.4	-1.8	0.0	-0.8	0.2	-0.9	-1.9	1.0	-0.5	-2.4
21/08/1996	95.22	-1.2	0.3	-0.9	-0.6	0.1	-0.6	-0.2	-1.1	0.0	0.3	-1.8
12/11/1996	95.05	-0.8	0.0	-0.8	-0.1	-0.5	-0.4	-0.3	-1.0	0.2	0.2	-1.6
18/02/1997	97.43	-1.3	-1.1	-0.6	-1.2	-1.3	-1.9	-1.0	-1.1	-1.0	-0.6	-1.9
19/08/1997	98.00	-2.2	-0.7	0.3	-1.7	-1.6	-2.1	-1.3	-0.1	-1.0	-0.5	-0.9
26/02/1998	97.92	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
19/08/1998	97.71	-0.5	-0.2	0.8	-0.5	-1.0	-0.9	-0.4	0.3	-0.3	0.1	-0.5
10/02/1999	98.64	0.5	-0.6	-1.2	0.7	-0.7	0.8	-0.2	-1.2	1.7	0.2	-1.9
25/08/1999	96.75	1.4	-1.0	0.7	1.6	-0.3	1.6	-0.1	-0.5	2.1	0.5	-1.1
02/02/2000	97.11	0.8	-1.0	-2.3	0.8	-1.4	0.8	-1.4	-2.3	1.7	-0.9	-2.8
02/08/2000	96.99	0.2	0.4	0.2	0.4	-0.3	0.2	-0.4	0.1	1.0	0.2	-0.5
08/02/2001	97.93	0.1	-0.5	-0.9	0.8	-0.9	0.8	-0.9	-1.6	1.7	-0.4	-2.1
15/08/2001	97.44	1.0	0.1	-0.3	0.9	-0.4	0.3	-0.3	-0.4	0.9	0.3	-1.0
20/02/2002	97.99	1.0	0.1	-2.4	1.4	-0.7	1.4	-0.5	-2.9	2.1	0.1	-3.4
15/08/2002	96.18	0.2	-0.1	-0.1	0.6	-0.5	-0.1	-0.2	-0.7	0.7	0.4	-1.4
13/02/2003	95.93	0.2	-0.1	-2.2	0.3	-1.3	1.1	-1.7	-2.8	2.0	-1.3	-3.2
13/08/2003	98.00	0.8	0.2	-0.2	1.0	-0.7	0.6	-0.4	-0.5	1.3	0.2	-1.3
18/02/2004	94.30	0.5	-2.4	-0.6	0.8	-2.1	1.0	-2.1	-0.9	1.6	-1.7	-1.5
18/08/2004	95.69	0.7	-2.1	-1.1	1.2	-2.7	1.2	-1.9	-1.1	1.7	-1.3	-1.7
23/02/2005	95.69	0.6	-1.6	-1.3	1.2	-2.3	1.2	-1.9	-1.6	2.0	-1.4	-2.2
17/08/2005	96.85	0.7	-1.9	-1.6	1.3	-2.3	0.3	-1.8	-1.7	0.5	-1.3	-2.8
15/02/2006	89.48	0.9	-2.7	-2.3	1.6	-3.3	1.6	-3.3	-2.7	2.6	-2.8	-3.2
16/08/2006	89.48	1.6	-1.4	-0.6	1.3	-2.2	0.6	-1.3	0.0	1.3	-0.6	-0.8
01/02/2007	95.60	1.9	-2.7	-1.0	1.7	-3.4	1.8	-2.4	-0.8	2.8	-1.7	-1.4
08/08/2007	94.48	0.9	-1.2	-0.8	1.0	-1.6	0.8	-0.5	-0.6	1.6	0.2	-1.3
05/02/2008	97.91	1.5	-2.0	-2.1	1.5	-2.8	1.4	-1.8	-1.8	2.3	-1.2	-2.4
06/08/2008	94.48	1.0	-0.8	-0.7	0.4	-0.7	0.4	-0.6	-0.5	1.0	-0.2	-1.2

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Optical Plummet points

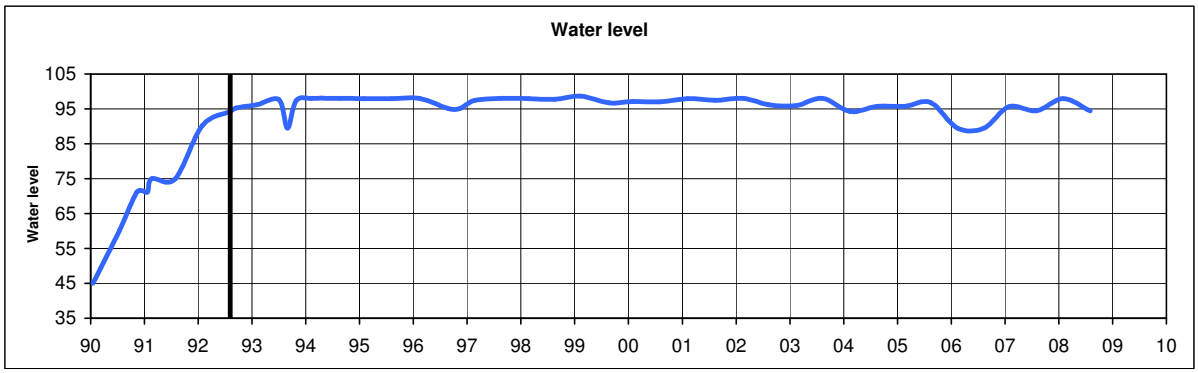
Date	Water Level	E306		E300		
		dy	dx	dy	dx	dz
17/01/1990	45.03	#N/A	#N/A	#N/A	#N/A	#N/A
18/07/1990	60.30	#N/A	#N/A	#N/A	#N/A	#N/A
13/11/1990	71.28	#N/A	#N/A	#N/A	#N/A	#N/A
22/01/1991	71.15	#N/A	#N/A	#N/A	#N/A	#N/A
21/02/1991	74.97	#N/A	#N/A	#N/A	#N/A	#N/A
30/07/1991	74.87	#N/A	#N/A	#N/A	#N/A	#N/A
29/01/1992	90.27	#N/A	#N/A	#N/A	#N/A	#N/A
07/08/1992	94.30	0.0	0.0	0.0	0.0	0.0
17/09/1992	95.23	-0.1	-0.2	0.2	0.2	0.5
03/02/1993	96.22	0.3	0.7	0.7	1.0	-0.3
03/07/1993	97.69	0.3	-0.9	0.1	-0.1	-1.0
31/08/1993	89.47	0.2	-0.8	0.4	0.2	0.6
29/10/1993	97.39	4.1	0.5	-1.6	-3.3	0.7
09/02/1994	98.07	3.9	1.8	-2.0	-3.0	0.6
24/08/1994	98.04	3.3	-0.1	-1.4	-3.9	-1.2
01/02/1995	97.93	4.4	0.1	-0.8	-4.2	0.1
09/08/1995	97.90	4.4	0.1	-0.8	-4.2	0.1
13/02/1996	98.02	3.0	2.7	-1.8	-3.0	-1.1
21/08/1996	95.22	1.4	1.0	-3.0	-3.3	-1.5
12/11/1996	95.05	2.4	1.3	-2.9	-3.0	-1.4
18/02/1997	97.43	2.6	0.6	-3.8	-3.3	-0.7
19/08/1997	98.00	1.1	1.5	-4.1	-3.3	0.0
26/02/1998	97.92	#N/A	#N/A	#N/A	#N/A	#N/A
19/08/1998	97.71	2.7	1.3	-3.3	-3.2	0.3
10/02/1999	98.64	3.5	1.2	-1.9	-2.9	-0.6
25/08/1999	96.75	4.4	-0.3	-1.4	-3.7	0.2
02/02/2000	97.11	4.0	1.9	-1.7	-3.2	-2.3
02/08/2000	96.99	3.6	2.3	-2.5	-2.0	-0.2
08/02/2001	97.93	3.4	1.9	-1.6	-2.9	-0.6
15/08/2001	97.44	4.9	1.8	-1.9	-3.2	-1.3
20/02/2002	97.99	4.9	2.2	-1.5	-1.9	-2.7
15/08/2002	96.18	3.3	1.3	-2.4	-3.1	-1.0
13/02/2003	95.93	4.9	2.8	-2.3	-3.1	-1.4
13/08/2003	98.00	4.5	1.5	-2.1	-2.5	-1.1
18/02/2004	94.30	3.7	-0.8	-2.6	-3.7	-0.2
18/08/2004	95.69	3.3	-1.1	-2.4	-3.8	-1.3
23/02/2005	95.69	4.3	0.2	-1.8	-2.3	-1.2
17/08/2005	96.85	3.0	0.1	-2.2	-3.1	-2.4
15/02/2006	89.48	4.4	-1.2	-2.3	-3.7	-1.2
16/08/2006	89.48	5.5	-0.6	-1.6	-3.7	-1.5
01/02/2007	95.60	5.2	-1.2	-1.0	-0.6	-0.6
08/08/2007	94.48	5.0	-0.3	-1.8	-3.4	-1.2
05/02/2008	97.91	4.7	-0.6	-1.6	-3.2	-1.5
06/08/2008	94.48	5.2	0.2	-2.4	-2.7	-0.1

PRECISE ENGINEERING SURVEYS

DEFORMATION DISPLACEMENTS

WOLWEDANS DAM

Ref: 07/08/1992



Altrimetric wire weight Lower gallery

Date	Water Level	AW300W
		dz
17/01/1990	45.03	#N/A
18/07/1990	60.30	#N/A
13/11/1990	71.28	#N/A
22/01/1991	71.15	#N/A
21/02/1991	74.97	#N/A
30/07/1991	74.87	#N/A
03/07/1993	97.69	-0.7
31/08/1993	89.47	0.3
29/10/1993	97.39	0.9
09/02/1994	98.07	0.6
24/08/1994	98.04	-1.4
01/02/1995	97.93	-0.6
09/08/1995	97.90	-0.6
13/02/1996	98.02	-1.8
21/08/1996	95.22	-1.8
12/11/1996	95.05	-2.1
18/02/1997	97.43	-0.6
19/08/1997	98.00	0.1
26/02/1998	97.92	-1.3
19/08/1998	97.71	0.3
10/02/1999	98.64	-0.7
25/08/1999	96.75	0.2
02/02/2000	97.11	-2.2
02/08/2000	96.99	-0.2
08/02/2001	97.93	-0.6
15/08/2001	97.44	-1.3
20/02/2002	97.99	-2.7
15/08/2002	96.18	-1.0
13/02/2003	95.93	#N/A
13/08/2003	98.00	#N/A
18/02/2004	94.30	#N/A
18/08/2004	95.69	-1.2
23/02/2005	95.69	-0.4
17/08/2005	96.85	25.9
15/02/2006	89.48	27.0
16/08/2006	89.48	-1.4
01/02/2007	95.60	-0.4
08/08/2007	94.48	-1.2
05/02/2008	97.91	-0.7
06/08/2008	94.48	0.8