

Department of Water Affairs and Forestry Directorate: National Water Resource Planning

The Assessment of Water Availability in the Berg Catchment (WMA 19) by means of Water Resource Related Models

Report No. 3 The Assessment of Flow Gauging Stations



FINAL

June 2007

Submitted by: Ninham Shand (Pty) Ltd in Association with Umvoto Africa (Pty) Ltd

NINHAM SHAND

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DEPARTMENT OF WATER AFFAIRS AND FORESTRY

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REPORT No	REPORT TITLE	VOLUME No.	No. VOLUME TITLE					
1	Final Summary Report							
2	Rainfall Data Preparation and MAP Surface							
3	The Assessment of Flow Ga	auging Station	S					
4		Vol 1	Data in Support of Catchment Modelling					
4	Land Use and Water Requirements	Vol 2	Invasive Alien Plant Mapping					
		Vol 3	Water Use and Water Requirements					
		Vol 1	Berg River					
5	Update of Catchment Hydrology	Vol 2	Upper Breede River					
	, ,	Vol 3	Peripheral Rivers					
6		Vol 1	A Literature Review of Water Quality Related Studies in the Berg WMA, 1994 - 2006					
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		Vol 7	TMG Aquifer, Piketberg Model					
		Vol 8	TMG Aquifer, Witzenberg – Nuy Model					
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10	Berg and Mhlathuze Assess	sment Studies	(Refer to Report No.1)					
11	Applicability of the Sami Groundwater Model to the Berg WAAS Area							

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

REPORT No. 3 THE ASSESSMENT OF FLOW GAUGING STATIONS

EXECUTIVE SUMMARY

The Department of Water Affairs and Forestry (DWAF) has invested significantly in the development of a streamflow gauging network within the Western Cape. The primary objective of this network is to develop a historic record of the streamflow conditions within the rivers. Reliable and updated rainfall and streamflow information, as well as an understanding of how surface and groundwater interact, forms the very basis of informed water resource planning decisions. The accuracy and reliability of this information is crucial, in order to allow for surface and groundwater models to be developed and calibrated.

The allocation of adequate resources (financial and technical) is essential to ensure that the existing network can be maintained, and as is recommended in this report, enhanced to improve the quality and availability of streamflow data to support Integrated Water Resource Management (IWRM).

The objective of this task is to document the extent of information available at each flow gauging station which could be considered for catchment calibration purposes, as well as to identify those stations that may warrant reinstatement. Historically, streamflow gauges have been considered as relevant to surface water modelling alone. However, as the low flows in most of the rivers are partially fed by groundwater contributions, the low flow records are relevant for groundwater modelling too. Furthermore, river reaches can be effluent and/or influent at times. It is therefore important to identify those streamflow gauges which may assist in better understanding that interaction.

The scope of this report extends across the whole of the Berg Water Management Area (WMA), as well as the Upper Breede and Riviersonderend Rivers, and the Palmiet River in the Breede WMA. A total of 71 stations were assessed in detail for the purposes of supporting surface water modelling. Of these, 18 were identified as also being important to support the understanding of the surface and groundwater interaction. A further six existing stations (primarily in the Wemmershoek River catchment) were identified as requiring refurbishment, to also support the understanding of the surface and groundwater interaction.

During July 2006, the Department and Ninham Shand undertook a field investigation during which selected flow gauging stations were inspected, their recorders checked and possible extensions to their current discharge tables (DTs), assessed. The practical extension of a DT typically requires current gauging to be undertaken during periods of peak flow. Such conditions may not occur within the timeframe of the hydrology tasks for this study. Nevertheless, where extensions to the existing DTs have been identified as possible, the Department has undertaken preliminary theoretical extensions to develop an order of magnitude understanding of the volume of water which is above the current DT limit.

The following findings and recommendations are made:

The Streamflow Gauging Network from a Surface Water Perspective

The network of available streamflow gauging stations within the study area is to a large extent adequate from a surface-water modelling perspective. Certain stations are fairly new and their records are still too short, whilst some stations have been discontinued and no further data is available from them. It is

important that the new stations as well as those ultimately selected for catchment calibration purposes be maintained to allow continuous recordings to be taken.

The stations on the Upper Breede River are very important due to the potential for the development of water resource infrastructure in this region in the future. The following new streamflow gauging stations are recommended to provide information in support of surface water modelling:

- A new gauging station on the Lower Berg River, particularly for the benefit of monitoring the provision of estuarine flow requirements for the Estuary.
- A new gauging station on the Breede River between Witbrug and Greater Brandvlei Dam.

The existing weirs on the Banhoek (G1H019) and Wolwekloof Rivers (G1H038) require structural attention and modification. This is necessary to limit the impact of boulder accumulation on the diversion into the tunnel, and to enable the diversion to be accurately recorded. The opportunity also exists to undertake remedial work at both weirs, whilst there is a contractor already established on site at the Berg River Dam.

Streamflow gauging on the Lourens River remains problematic despite the construction of the G2H029 weir in 1986 and the new weir (G2H044) in 2004. Whilst the latter is considered accurate, the data available only spans the last two years. It is vitally important that this station be well maintained and a continuous record be established in order that it provides a record against which to calibrate the Lourens River catchment in the future.

Additional Streamflow Gauging to Support Surface Water/Groundwater Interaction

Surface water flow stations can be used to monitor surface water/groundwater interaction. Considering the existing streamflow gauging station network in the Western Cape, several additional sites and sites that can be reinstated have been identified where streamflow data is required in order to be able to accurately model the surface water/groundwater interaction in this study area in the future. In some cases, these stations are no longer active and need to be reinstated in order to collect data suitable for future studies. In addition, some of the existing streamflow stations need to be upgraded and calibrated for accurate "low flow" measurements.

Where possible, the recommendations are focused on reinstatement of existing (yet inactive) stations as opposed to the siting of a new one, so as to reduce the likely capital cost. Providing that their low flow measurement is accurate, the existing streamflow gauging stations tabled hereafter are considered to be well suited to support surface water/groundwater interaction modelling.

Existing Station	River	Place name
G1H002	Vier en Twintig	Driebosch
G1H008	Klein Berg	Nieuwkloof
G1H011	Watervals	Watervalsberge
G1H012	Waterval River	Voëlvlei Mountains
G1H014	Wemmershoek	Tributary
G1H015	Wemmershoek	Tributary
G1H016	Wemmershoek	Tributary
G1H017	Wemmershoek	Tributary
G1H018	Wemmershoek	Tributary
G1H019	Banhoek	Jonkershoek
G1H021	Klein Berg	Mountain View
G1H035	Matjies	Matjiesfontein
G1H066	Klein Berg	Nieuwkloof Pass
G2H005	Jonkershoek	Kleinplaas Dam
G2H008	Jonkershoek	Jonkershoek
G4H030	Palmiet	Krabbefontein
H1H003	Upper Breede	Ceres Golf Club
H1H006	Klein Berg	Michell's Pass
H1H007	Wit River	Drosterskloof
H1H013	Koekedouw	Ceres
H1H018	Molenaars	Hawequas Forest
H2H004	Sanddrif River	Zanddriftskloof
H6H007	Du Toits	Purgatory Outspan
H6H008	Riviersonderend	Nuweberg Forest

In addition to these existing streamflow gauging stations that can be used for groundwater modelling, 11 additional stations are recommended to expand the station network so as to support the surface water groundwater interaction assessment in future studies. These are as tabled below.

Site	Latitude	Longitude	River	Comment
1	-33.84751	19.01585	Berg	At proposed abstraction weir
2	-33.477300	19.175670	Breede	
3	-33.552490	19.220890	Breede	Or reinstating of H1H001
4	-33.589240	19.263540	Breede	
5	-33.318630	19.098090	Klein Berg	
6	-33.397410	19.290110	Breede	
7	-33.314790	19.298780	Skaap	
8	-33.409070	19.443540	Titus	
9	-33.506490	19.493220	Amandel	
10	-33.495940	19.530250	Sanddrif	Or utilising H2H004
11	-33.512220	19.534970	Amandel	

Within this study area, 13 spring locations have been identified during previous studies and initial measurements of temperature and flow have been taken. Natural springs provide a direct indication of the flow of water in the aquifer and it is important that flow stations capable of measuring "low" flow are set up at all springs known to be linked to the aquifer.

There are currently only a handful of springs in the study area that are being monitored. For this reason a full spring hydrocensus is recommended, aimed at locating and identifying all perennial springs in the western portion of the Western Cape, as relevant to this study area. Subsequent field verification will be required as a next phase to determine the validity of the identified potential spring locations and the suitability for installation of automated flow measurements (e.g. weirs, v-notches or flumes) as well as to determine parameters such as their water temperature and flow.

THE ASSESSMENT OF WATER AVAILABILITY IN THE BERG CATCHMENT (WMA 19) BY MEANS OF WATER RESOURCE RELATED MODELS

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ABBREVIATIONS

DT	Discharge Table
DWAF	Department of Water Affairs and Forestry
WAAS	Water Availability Assessment Study
WCRO	Western Cape Regional Office (DWAF)
WCSA	Western Cape System Analysis
WMA	Water Management Area
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model

1. INTRODUCTION

Investigation into the surface water resources of the study area for this Berg Water Availability Assessment Study (WAAS) is based primarily on records of flow in the various rivers within its catchment areas. Whilst reliable and accurate recording is difficult to achieve, previous and ongoing effort is made by the Department of Water Affairs and Forestry (DWAF) to improve estimates of streamflow at gauging stations. This information has been used to support water availability studies undertaken in the past and to introduce ongoing improvements to updated assessments.

During the 1990s, the Western Cape System Analysis (WCSA) was undertaken in which detailed hydrological modelling of the greater Western Cape catchments was undertaken. That study analysed and calibrated the catchments of selected streamflow gauging stations in the Berg River, Riviersonderend (as far downstream as Theewaterskloof Dam), Palmiet, Eerste, Lourens, Steenbras and Diep River Catchments. Stations that were considered useful for hydrological modelling purposes were selected, their calibrations (discharge tables) reviewed, where necessary revised, and their flow records recomputed. The revised flow records were then used to calibrate simulated flow sequences for use in the Water Resource Yield Model (WRYM) and Water Resources Planning Model (WRPM).

Subsequent to the completion of the WCSA, some portions of the Berg and Breede WMAs have been exposed to water resource studies to assess particular development options. These include feasibility studies for the Berg Water Project, Augmentation of Voëlvlei Dam, West Coast Water Supply Options, and various Reserve determination studies. However, a complete update of the hydrology on which the Western Cape Water Supply System (WCWSS) is modelled, and on which important decisions such as the implementation of restrictions and issuing of water use licenses are made, has not been undertaken. It is also important that the 2004/2005 drought experienced in the Western Cape forms part of the re-assessment of water availability from the WCWSS.

The assessment of licence applications by the Regional Office and the potential introduction of compulsory licensing (and possible re-allocation) requires support from an updated and improved system analysis. Since the 1990s, improved estimates of the ecological component of the Reserve and the aquatic requirements of estuaries have become available. These also influence the estimates of water availability, and now need to be taken into account.

Previously, the contribution of groundwater flow to the flow in the rivers has not been modelled via an integrated approach. The incorporation of the Sami Model into the updated WR2000 modelling software attempts to address the surface water / groundwater interaction in a more comprehensive approach. The applicability of this approach in the Berg and Breede WMAs has to be tested in the WAAS. Furthermore an additional 15 years of streamflow and rainfall data has become available at most of the rainstations and flow gauges, providing an opportunity for calibrating over a longer period of time than has previously been possible.

The Department has invested significantly in the development of a streamflow gauging network within the Western Cape. The primary objective of this network is to develop a historic record of the streamflow conditions within the rivers. Reliable and updated rainfall and streamflow information forms the very basis of all informed water resource planning management decisions. The accuracy and reliability of this information is crucial, in order to allow for catchment models to be developed and calibrated. The calibration process involves replicating the measured surface water runoff by means of computer models and then comparing the simulated results with the actual flows measured in the river over a period of time. Model parameters are then adjusted until a suitable match is obtained.

Methodologies have been developed which make use of the calibrated information to generate many statistically similar flow sequences (referred to as stochastic flows). These are then used in complex system modelling software to determine water availability under various development scenarios for planning purposes. The accuracy of these system models is directly related to the information on which they are based. Consequently, rainfall information and streamflow information is critically important to enable informed water resource decision making and develop appropriate operating procedures.

More recently, the concept of Integrated Water Resource Management (IWRM) has placed these models at an even higher level of importance. They are being adapted in order to model the interaction between the surface and groundwater. This requires appropriate monitoring at strategic sites to record, assess and understand the dynamics between surface and groundwater flow. This understanding will need to be developed and improved over time, as the flow records at sites of springs, seeps and at key geological locations become available, processed and understood.

Some of the more important resource management decisions influenced by hydrological models, which in turn are reliant on reliable and updated rainfall and streamflow data include:

- provision of water to meet the Reserve;
- allocation of water to users;
- socio-economic implications of water scarcity and restrictions;
- possible need to re-allocate water through compulsory licensing;
- scenario development and related water resource development options;
- strategic water resource planning purposes.

The allocation of adequate resources (financial and technical) is essential to ensure that the existing network can be maintained, and as is recommended in this report, enhanced to improve the quality and availability of streamflow data to support IWRM.

1.2 OBJECTIVE OF THIS ASSESSMENT

The objective of this task is to document the extent of information available at each flow gauging station which could be considered for catchment calibration purposes. This will provide information to the modelling tasks, during which the flow gauging information will be used. Although the Department has on an ongoing basis, undertaken calibration at priority stations to enhance the quality, reliability and range of flow gauging capacity, certain stations have been closed. A further objective is therefore to identify those stations that may warrant reinstatement.

Historically, streamflow gauges have been considered as relevant to surface water modelling alone. However, as the low flows in most of the rivers are partially fed by groundwater contributions, the low flow records are relevant for groundwater modelling too. Furthermore, river reaches can be effluent and / or influent at times. It is therefore important to identify those streamflow gauges which may assist in better understanding that interaction.

The study footprint area is shown on Figure 1-1. This encompasses the entire Berg WMA, the Upper Breede and Riviersonderend Rivers, as well as the Palmiet River in the Breede WMA. The areas in the Breede WMA are relevant due to the current and potential inter-basin transfers between the two WMAs. The geographical scope of this assessment includes:

- The Berg River
- The Eerste River
- The Diep River
- The Lourens River
- The Steenbras River
- The Palmiet River
- The Upper Breede River
- The Upper Riviersonderend River
- The Hex River (for groundwater modelling only)

It focuses in detail on those flow gauging stations that :

- (a) were used for streamflow calibration during previous studies;
- (b) have been opened subsequently;

It also addresses streamflow gauges that may provide information required to better understand the interaction between surface and groundwater. Recommendations are made on the reinstatement of stations currently not used and additional new stations that may be required.

During July 2006, the Department and Ninham Shand undertook a field investigation during which selected flow gauging stations were inspected, their recorders checked and possible extensions to their current discharge tables (DTs), assessed. The practical extension of a DT typically requires current gauging to be undertaken during periods of peak flow. Such conditions may not occur within the time frame of the hydrology tasks for this study. Nevertheless, where extensions to the existing DTs have been identified as possible, the Department has undertaken preliminary theoretical extensions to develop an order of magnitude understanding of the volume of water which is above the current DT limit. This will help to inform the patching of exceeded data.

Any DTs that are extended in the future by, for example current gaugings or backwater analysis, will be used to fine tune any future hydrological calibrations on investigations typically undertaken as part of the suite of anticipated feasibility studies arising out of the recommendations from the Western Cape Reconciliation Strategy (currently being developed).

Table 1-1 lists the gauges used for catchment calibration in previous studies as well as key stations which have been opened subsequently, and which fall within the footprint of the Berg WAAS. The stations at which physical inspections were undertaken as part of this study are also indicated. The geographical locations of the existing streamflow gauging stations considered to be potentially suitable for surface water catchment calibration are shown in Figure 1-1.

The proposed locations of recommended new stations, either as weirs in streams / rivers or as spring flow installations for providing future information which can be used to interpret the interaction between the surface water and groundwater resources, are described in Sections 9 to 12 of this report.

								-		
STATION	RIVER	PLACE OR DESCRIPTION	LATITUDE	LONGITUDE	CATCHMENT AREA (km ²)	DATE OPENED	DATE RECORDER INSTALLED	DATE CLOSED	RECORD PERIOD HYDROLOGICAL YEARS	STATION INSPECTED DURING WAAS
G1H002	Vier en Twintig	Driebosch	33 08' 02"	19 03' 39"	187	24/04/47	01/05/51	30/09/70	1951 - 1969	
G1H003	Franschhoek	Le Mouillage	33 53' 26"	19 04' 44"	46	01/04/49	16/03/59	-	1949 - 2005	Yes
G1H004	Berg	Bergriviershoek	33 55' 36"	19 03' 41"	70	19/03/49	18/03/59	-	1949 - 2005	Yes
G1h007	Berg	Wellington	33 48' 31"	18 59' 06"	713	01/04/51	01/04/51	28/04/78	1951 - 1976	No
G1H008	Klein Berg	Nieuwkloof	33 18' 41"	19 04' 31"	395	01/05/54	15/05/62	-	1954 - 2004	Yes
G1H011	Watervals	Watervalsberge	33 22' 44"	19 06' 00"	27	30/04/64	29/04/64	-	1964 - 2004	
G1H012	Watervals	Watervalsberge	33 21' 08"	19 06' 04"	36	20/04/64	20/04/64	-	1964 - 1994	
G1H013	Berg	Drieheuvels	33 07' 57"	18 51' 45"	2 934	13/05/64	12/05/64	-	1964 - 2004	Yes
G1H019	Banhoek	Jonkershoek	33 54' 44"	18 56' 36"	25	23/04/68	23/04/68	-	1968 - 2005	
G1H020	Berg	Daljosafat	33 42' 29"	18 59' 29"	609	01/03/66	01/03/66	-	1966 - 2004	Yes
G1H021	Klein Berg	Mountain View	33 11' 05"	19 09' 19"	19	18/03/68	18/03/68	-	1968 - 2004	
G1H028	Vier en Twintig	Driebosch	33 08' 02"	19 03' 39"	183	06/05/72	06/05/72	-	1972 - 2004	
G1H029	Leeu	De Hoek Estates	33 09' 24"	19 03' 08"	36	31/10/72	31/10/72	-	1973 - 2004	
G1H031	Berg	Misverstand	32 59' 49"	18 46' 44"	4 012	15/05/74	15/05/74	-	1974 - 2004	
G1H034	Holle	Moorreesburg Spruit	33 03' 58"	18 45' 35"	134	21/07/76	21/07/76		1976 - 2004	
G1H035	Matjies	Matjiesfontein	33 02' 52"	18 49' 54"	676	17/07/75	17/07/76	24/11/03	1975 - 2002	
G1H036	Berg	Vleesbank	33 26' 06"	18 57' 25"	1 312	03/03/78	03/03/78	-	1978 - 2004	Yes
G1H037	Krom	Wellington	33 37' 39"	18 59' 29"	69	10/05/78	10/05/78	25/05/92	1978 - 1991	
G1H038	Wolwekloof	Ogee : Wolwekloof	33 56' 37"	19 01' 39"	17	16/08/78	16/08/78	-	1978 - 2005	Yes
G1H039	Doring	Grensplaas	33 32' 16"	18 55' 16"	43	14/12/78	14/12/78	-	1978 to 2004	
G1H040	Vis	La Fontaine	33 22' 21"	18 55' 30"	39	16/08/78	16/08/78	-	1979 - 2004	
G1H041	Kompanjies	De Eikeboomen	33 28' 45"	18 58' 41"	121	30/08/79	30/08/79	-	1979 - 2004	
G1H043	Sandspruit	Vrisgewaagd	33 09' 41"	18 53' 35"	152	06/05/80	06/05/80	-	1980 - 2004	
G1H044	Berg	Tunnel Outlet Meters	33 57' 18"	19 04' 22'	N/A	01/02/84	N/A	-	1984 - 2004	
G1H058	Vier en Twintig	Canal from River	33 08' 22"	19 03' 35"	N/A	06/05/72	06/05/72	-	1972 - 2004	
G1H059	Leeu	Canal from River	33 09' 31"	19 03' 13"	N/A	31/10/72	31/10/72	-	1973 - 2004	
G1H060	Wolwekloof	Compensation	33 56' 37"	19 01' 39"	17	16/08/78	16/08/78	-	1978 - 2005	Yes
G1H061	Wolwekloof Shaft	Inlet to Tunnel	33 56' 38"	19 01' 33"	N/A	28/05/82	N/A		1982 - 2005	Yes
								-		

Table 1-1 Gauging Stations Considered for Catchment Model Calibration Purposes (Surface Water)

STATION	RIVER	PLACE OR DESCRIPTION	LATITUDE	LONGITUDE	CATCHMENT AREA (km ²)	DATE OPENED	DATE RECORDER INSTALLED	DATE CLOSED	RECORD PERIOD HYDROLOGICAL YEAR	STATION INSPECTED DURING WAAS
G1H063	Banghoek River	Shaft into Tunnel	33 57' 11"	18 58' 43"	N/A	03/06/82	O3/06/82	-	None (No DT)	
G1H065	Canal to Berg	Voëlvlei outlet canal	33 20' 46"	19 00' 45"	N/A	01/10/51	07/08/72	-	1951 - 2004	
G1H066	Klein Berg	Inlet canal	33 17' 39"	19 03' 27"	N/A	19/06/51	20/02/64	-	1951 - 2004	
G1H067	Vier en Twintig	Inlet canal	33 19' 09"	19 03' 11"	N/A	05/05/71	04/05/72	-	1972 - 2004	
G1H075	Berg	Misverstand	33 01' 26"	18 47' 19"	?	13/07/06	13/07/06	-	2006	
G1R002	Wemmers	Wemmershoek Dam	33 49' 56"	19 05' 05"	86	15/09/69	N/A	-	None (CCT Dam)	
G1R003	Berg River	Misverstand Dam	33 01' 28"	18 42' 18"	3967	12/07/77	12/07/77	-	1977 – 2004	
G2H005	Jonkershoek	Kleinplaas Dam	38 58' 25"	18 56' 17"	31	01/10/40	01/08/47	-	1947 – 2005	Yes
G2H008	Jonkershoek	Jonkershoek	33 59' 11"	18 57' 23"	20	01/06/47	18/04/47	07/04/95	1947 – 1994	
G2H012	Diep	Malmesbury	33 27' 50"	18 44' 25"	244	02/03/65	02/03/65	-	1965 – 2004	Yes
G2H013	Mosselbank	Klipheuwel	33 42' 18"	18 42' 02"	473	06/04/66	06/04/66	27/05/86	1966 – 1985	
G2H014	Diep	Vissershok	33 47' 23"	18 32' 58"	1 360	14/04/67	-	11/11/82	1967 – 1981	
G2H015	Eerste	Faure	34 01' 49"	18 44' 54"	338	21/04/68	20/04/68	25/05/88	1967 – 1978	Yes
G2H016	Lourens	Somerset West	34 05' 13"	18 51' 31"	92	23/04/70	22/04/70	22/04/91	1970 – 1989	
G2H020	Eerste	Stellenbosch	33 56' 58"	18 50' 19"	183	10/05/78	10/05/78	-	1978 – 2005	
G2H029	Lourens	Strand	34 06' 00"	18 49' 22"	107	06/12/86	06/12/86	-	1987 – 2005	Yes
G2H030	Eerste River	Canal to Right Bank	33 56' 35"	18 50' 41"	N/A	11/05/76	11/05/76	-	1976 – 2005	
G2H037	Jonkershoek	Kleinplaas	33 59' 02"	18 57' 11"	21	12/06/89	12/06/89	-	1989 – 2004	Yes
G2H040	Eerste	Klein Welmoed	34 00' 10"	18 45' 47"	?	24/11/98	24/11/98	-	1999 – 2005	Yes
G2H042	Diep	Adderley	33 43' 22"	18 37' 00"	?	14/10/98	14/10/98	-	1999 – 2004	
G2H043	Lourens	Lourens River	34 06' 02"	18 48' 54"	?	20/01/04	20/01/04	-	None	Yes
G2H044	Lourens	Strand	34 05' 46"	18 49' 46"	?	22/06/04	22/06/04	-	2004	Yes
G2R001	Jonkershoek	Kleinplaas Dam	33 58' 45"	18 57' 00"	31	14/01/83	14/01/83	-	1983 – 2004	

STATION	RIVER	PLACE OR DESCRIPTION	LATITUDE	LONGITUDE	CATCHMENT AREA (km ²)	DATE OPENED	DATE RECORDER INSTALLED	DATE CLOSED	RECORD PERIOD HYDROLOGICAL YEAR	STATION INSPECTED DURING WAAS
G4H001	Steenbras	Kogelbaai	34 11' 19"	18 51' 18"	67	Unknown	Unknown	1921	None	
G4H005	Palmiet	Applethwaite	34 11' 49"	18 58' 50"	146	11/03/57	11/03/57	-	1957 – 2005	
G4H007	Palmiet	Welgemoed	34 19' 47"	18 59' 25"	465	30/03/63	30/03/63	-	1963 – 2005	
G4H023	N/A	Rockview Canal	34 11' 24"	18 52' 12"	N/A-	20/01/00	20/01/00	-	2000 - 2005	
G4H030	Palmiet	Krabbefontein	34 16' 06"	19 01' 20"	?	21/07/98	21/07/98	-	1998 – 2005	Yes
G4R001	Steenbras	Lower Steenbras Dam	34 11' 13"	18 51' 10"	66,8	1915	Unknown	-	1989 – 2004	
G4R002	Palmiet	Eikenhof Dam	34 07' 39"	19 02' 10"	63	24/04/78	24/04/78	-	1978 – 2004	
H1H003	Upper Breede	Ceres Golf Club	33 22' 52"	19 18' 10"	657	22/02/23	17/05/62	-	1923 – 2004	
H1H006	Upper Breede	Witbrug	33 25' 18"	19 16' 06"	753	16/04/50	17/05/62	-	1950 – 2004	
H1H007	Wit River	Drosterskloof	33 34' 07"	19 08' 42"	84	10/04/50	17/05/62	-	1949 – 2004	
H1H012	Holsloot	Daschbosch	33 45" 24"	19 19' 50"	146	16/03/63	16/03/63	18/04/86	1963 – 1986	
H1H013	Koekedouw	Ceres	33 26' 05''	19 17' 54"	53	24/02/65	24/02/65	-	1965 – 2004	
H1H018	Molenaars	Hawequas Forestry	33 43' 29"	19 10' 11"	113	26/02/69	26/02/69	-	1969 – 2004	
H1H022	Breede	Witbrug : Diversion	33 25' 20"	19 51' 22"	N/A	16/04/50	N/A	-	1958 - 2004	
H1H033	Elands	Hawequas Forestry	33 44' 12"	19 06' 53"	62	29/04/91	29/04/91	-	1991- 2005	
H4H006	Breede	Lower Brandvlei	33 42' 26"	19 27' 56"	2939	19/04/50	08/02/65	06/08/90	1950 - 1988	
H6H007	Du Toits	Purgatory Outspan	33 56' 19"	19 10' 17"	46	14/03/64	14/03/64	07/09/92	1964 - 1991	
H6H008	Riviersonderend	Nuweberg Forest	33 03' 44''	19 04' 23"	38	18/04/64	18/04/64	07/09/92	1964 - 1991	
H6R001	Riviersonderend	Theewaterskloof Dam	34 03' 29''	19 03' 29"	497	18/03/49	18/03/49	-	1979 - 2004	
H6R002	Elands	Elandskloof Dam	33 57' 53"	19 17' 32"	50	01/07/76	01/07/76	-	1982 - 2004	



Figure 1-1 Locations of Streamflow Gauging Stations in the Study Area

ASSESSMENT OF STREAM FLOW GAUGING STATIONS BERG RIVER CATCHMENT

2. BERG RIVER CATCHMENT

- G1H002 :
- G1H003 :
- G1H004 :
- G1H008 :
- G1H011 :
- G1H012 :
- G1H013 :
- G1H019 & G1H063:
- G1H020 :
- G1H021 :
- G1H028 & G1H058 :
- G1H029 & G1H059 :
- G1H031 :
- G1H034 :
- G1H035 :
- G1H036 :
- G1H037 :
- G1H038, G1H060 & G1H061 :
- G1H040 :
- G1H041 :
- G1H043 :
- G1H044 :
- G1H065 :
- G1H066 :
- G1H067 :
- G1H075 :
- G1R002 :
- G1R003 :

FRANSCHHOEK RIVER AT LE MOUILLAGE BERG RIVER AT BERGRIVIERSHOEK KLEIN BERG RIVER AT NIEUWKLOOF WATERVALS RIVER AT WATERVALSBERGE WATERVALS RIVER AT WATERVALSBERGE BERG RIVER AT DRIEHEUVELS BANHOEK RIVER AT JONKERSHOEK BERG RIVER AT DALJOSAFAT KLEIN BERG RIVER AT MOUNTAIN VIEW TWENTY-FOUR RIVERS AT DRIEBOSCH LEEU RIVER AT DE HOEK ESTATES BERG RIVER AT MISVERSTAND MOORREESBURGSPRUIT AT HOLLE RIVER MATJIES RIVER AT MATJIESFONTEIN BERG RIVER AT VLEESBANK KROM RIVER AT WELLINGTON OGEE WEIR AT WOLWEKLOOF FISH RIVER AT LA FONTAINE KOMPANJIES RIVER AT DE EIKEBOOM SANDSPRUIT AT VRISGEWAAGD TUNNEL OUTLET TO BERG RIVER CANAL FROM VOËLVLEI DAM LITTLE BERG RIVER INLET CANAL TO VOËLVLEI DAM 24 RIVERS INLET CANAL TO VOËLVLEI DAM

TWENTY-FOUR RIVERS AT DRIEBOSCH

- BERG RIVER DOWNSTREAM OF MISVERSTAND
 - WEMMERSHOEK DAM
- MISVERSTAND DAM

Figure 2-1 shows the Upper and Middle Berg River catchment area and the location of the above streamflow gauging stations.



Figure 2-1 Streamflow Gauging Stations in the Berg River Catchment

2.1 G1H002 : TWENTY-FOUR RIVERS AT DRIEBOSCH



Background

This station was opened in 1947 and operated mainly as a flood gauging station. In 1951 a weir was constructed and a recorder installed providing stage-time data on a continuous basis. The original weir consisted of a single, sharp crested notch. It was raised in 1963 and modified into a sharp crested notch and three hydro flumes. The station was closed in 1970 when a diversion weir (G1H028) was constructed immediately upstream to divert water into Voëlvlei Dam.

Data Availability

Stage-time data is available from 1951 to 1970 and two DWAF DTs (DT6 and DT7) are applicable.

The DT No's, their sequence, and periods of relevance are as published on DWAF's information management system, accessed via the DWAF website (<u>www.dwaf.gov.za</u>). The DT No's generally increase from one calibration to the next. However, this appears to be an exception at this station.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
7	1951 to 1963	4,01	705,9
6	1963 to 1970	1,52	67,8

Table 2-1 provides information on the number of days per month during which the limit of the DT was exceeded and the extent of missing data. It shows that for example, no data is available for the periods July 1961 to May 1962.

	Exceedance (No. days per month)												Missing Data (No. days per month)							1)					
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1951	0	0	0	0	0	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	1952	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	1953	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	1956	0	0	0	0	0	0	0	0	25	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	20
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	8	0	0	0	0	0	0	29	30	20	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	21	31	31	30
1961	0	0	0	0	0	0	0	0	0	0	0	0	1961	31	30	31	31	28	31	30	31	6	0	0	0
1962	0	0	0	0	0	0	0	0	1	2	2	2	1962	4	0	0	0	0	0	0	0	0	0	0	0
1963	0	2	0	0	0	0	0	1	2	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	1	0	1	0	0	1	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	2	3	1	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	3	1	2	0	1966	0	0	0	0	0	0	11	0	0	9	0	6
1967	1	0	0	0	0	0	0	3	2	1	0	0	1967	5	0	0	0	0	0	0	0	0	8	0	0
1968	2	0	0	0	0	0	0	0	0	0	0	1	1968	0	0	0	7	19	0	0	0	0	0	0	3
1969	0	0	0	0	0	0	0	0	3	3	3	1	1969	8	0	0	0	0	0	2	31	22	3	1	3

Table 2-1 Summary of Exceeded and Missing Data at G1H002

Recommendations

From Table 2-1 it is evident that considerable patching of the observed record would be required due to the extent of exceeded and missing data. The catchment calibration undertaken during the WCSA was based on the observed record between 1951 and 1969. Due to the fact that the station was closed in 1970, any extension to the WCSA hydrology would be dependent on the record available from G1H028. That station measures flow in the river and has data available from 1972 (see Section 2.11).

An Approach to Patching

Based on local knowledge of the specific conditions and characteristics at selected gauging stations, DWAF has extrapolated the DTs to estimate the incremental flow volumes, above the DT limit, for those days during which the limit was exceeded. This information will serve as a tool for patching the exceeded data on a monthly volume basis during the catchment hydrology task.

However, it is recognised that the accuracy of these extrapolations is not known and as such a cautionary approach should be adopted to the use thereof. It is recommended that patching of monthly values based on this information be limited to months with five or less days in which exceeded data occur. In those months where the extent of exceedence is greater than this, the simulated monthly flow volumes will be used to patch the observed flows.

The patching approach will be described in more detail under the hydrology task. Mention will be made in this report of those gauging stations at which theorectical extensions of the DTs have been undertaken by DWAF.

2.2 G1H003 : FRANSCHHOEK RIVER AT LE MOUILLAGE



Background

The station was initially established in 1949 and used as a flood-run section with two surveyed cross sections. In 1959, a sharp crested weir was constructed and a recorder installed. The weir was raised in 1966 by about 0,3m. Current gauging and float gauging have been undertaken on many occasions in the past to support calibration improvements at this gauge. Submergence information has only been available since 1966, and as such it is the subsequent period of record that is considered the most reliable.

The post-1966 DT limit is 1,37m and the limit of the sharp crested weir is 0,3m. For the DT to be increased so as to bring more of the flood peaks within the calibrated limit, new survey information is necessary. During the inspection, it was estimated that a potential increase in the DT limit to 1,7m could be obtained. Siltation and boulder accumulation upstream of the weir impacts on the flow depth and approach velocity. This accumulation occurs rapidly, as can be seen in the photograph, which was taken only a few months after the pool had been cleaned. The result of the shallow upstream pool is a high approach velocity which is not suited to accurate measurement at sharp crested weirs. It was furthermore observed that if the structure is treated as a canal for high flows, it may produce improved flow estimates.

Data Availability

Stage-time data is available from 1949 to date. Four DWAF DTs (DT6, 9, 10 and 11) are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DTLIMIT (m)	FLOW LIMIT (m³/s)
11	1949 to 1955	0,95	19,6
6	1955 to 1959	1,53	27,1
9	1959 to 1966	0,69	4,6
10	1966 to date	1,37	22,1

The DT No's, their sequence, and periods of relevance are as published on DWAF's information management system, accessed via the DWAF website (<u>www.dwaf.gov.za</u>). The DT No's generally increase from one calibration to the next. However, this appears to be an exception at this station.

Suitability for Catchment Calibration

Table 2-2 provides information on the number of days per month during which the DT was exceeded and the extent of missing data.

V	Exceedance (No. days per month)								V			N	lissin	g Dat	a (No	. days	s per r	nonth)						
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1949	0	1	0	0	0	0	2	0	0	2	0	0	1949	0	0	0	0	0	0	0	0	0	0	0	0
1950	0	0	0	0	0	0	1	0	0	1	0	0	1950	0	0	0	0	0	0	0	2	30	22	0	0
1951	0	0	0	0	0	0	0	1	0	0	0	0	1951	0	0	0	0	0	0	0	1	30	31	31	30
1952	0	0	0	0	0	0	0	0	0	0	0	0	1952	31	30	31	31	28	31	30	31	30	31	31	30
1953	0	0	0	0	0	0	0	0	1	9	4	0	1953	31	30	31	31	28	31	30	31	0	0	0	0
1954	0	0	0	0	2	0	0	0	0	0	1	0	1954	0	0	0	0	0	0	0	0	0	19	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	1	30	31	30	31	31	30
1956	0	0	0	0	0	0	0	0	2	1	0	0	1956	31	30	31	31	28	20	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	1	11	2	0	2	0	1958	0	0	1	12	25	31	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	2	8	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	1	5	0	3	6	1960	0	0	0	0	0	0	0	0	0	0	0	0
1901	5	1	0	0	0	0	0	0	10	5	14	1	1901	0	0	0	0	0	0	0	0	0	0	0	0
1902	5	0	0	0	1	0	0	2	2	2	2	0	1902	0	0	0	0	0	0	0	0	0	0	0	0
1903	0	0	0	0	0	0	0	3	1	2	3	0	1064	0	0	0	4	0	0	0	0	0	0	0	0
1065	0	1	0	0	0	0	0	0	0	2	4	1	1065	0	0	0	-	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1967	n	ñ	0	ñ	ñ	n	ñ	1	0	0	0	n	1967	0	n	ñ	n	0	0	ñ	4	3	0	0	0
1968	ñ	ñ	0	ñ	ñ	ñ	ñ	0	0	0 0	0 0	1	1968	õ	7	ñ	ñ	0 0	0 0	ñ	0	0	0 0	0 0	0
1969	0	õ	0	0	0	õ	õ	0	0	0	0	0	1969	0	0	õ	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	30	1	0
1973	0	0	0	0	0	0	0	0	0	0	3	0	1973	0	0	15	0	0	0	0	12	10	0	0	0
1974	0	0	0	0	0	0	0	0	0	1	0	0	1974	0	0	0	0	0	15	24	6	0	0	0	2
1975	0	0	0	0	0	0	0	0	2	2	0	0	1975	16	0	0	0	0	0	0	0	0	0	0	0
1976	0	1	0	0	0	0	0	1	2	0	3	0	1976	0	0	0	0	0	0	0	0	0	0	0	6
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	1	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	24	21	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	1	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	1	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1903	0	0	0	0	0	0	0	2	1	0	0	0	1003	0	0	0	0	0	0	0	0	10	21	21	26
1985	0	0	0	0	0	0	0	0	0	0	0	0	1085	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	21	22	10	10	8	2	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	4	1
1988	0	0	0	0	Ő	Ő	0	0	0	0	1	0	1988	0	0	0	0	0	0	0	Ő	Õ	0	0	0
1989	0	0	0	0	0	0	0	0	0	1	0	0	1989	0	0	0	9	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	1	0	1	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	3	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	3	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	3	1	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	3	0	0	0	1995	12	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	1	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	Û	0	0	0
2000	0	0	U	U	0	0	0	U	U	0	0	U	2000	U	0	0	U	U	0	0	U	U	U	0	U
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	U E	30	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	3U 0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	1	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2005	n	0	0	0	0	n	n	0	0	0	0	n	2005	0	n	0	n	0	0	n	0	0	0	0	0

Table 2-2 Summary of Exceeded and Missing Data at G1H003

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 2-2. The limits of the four DTs are also indicated.



Figure 2-2 Primary data plot for G1H003

The DTs for this station have been extrapolated by DWAF to estimate incremental flows and associated flow volumes, above their upper limit, for those days during which the limit was exceeded. This information will prove useful for selective patching of the exceeded data on a monthly volume basis, during the catchment hydrology task.

Recommendations

Prior to 1959, the extent of missing data is significant. During the WCSA, hydrological calibration was undertaken for the period 1959 to 1989. The post-1989 record period contains very little missing or exceeded data. As such, this now offers a further 15 years of observed record against which to calibrate. The observed record is complete up to the end of the 2005/06 hydrological year (September 2006).

2.3 G1H004 : BERG RIVER AT BERGRIVIERSHOEK



Background

G1H004 has been functioning since 1949. It is located on the Upper Berg River, about 1km upstream of the Berg River Dam wall which is presently under construction. Between 1949 and 1959 it was a surveyed section only. In 1959, a sharp crested weir was constructed and this operated until 1979. The station was converted to a crump weir in 1980 in an attempt to reduce the extent of siltation and submergence problems experienced at the site. It lies within the impoundment area of the Berg River Dam and will be submerged when the dam fills.

During the site inspection it was noted that siltation from boulders in the upstream pool remains evident, creating reduced upstream depth and associated higher approach velocities that are not desirable for a weir of this type. Current gauging has been attempted in an effort to try and extend the limit of the DT at this station. However, the high flow velocities have rendered this unsuccessful.

The weir has a structure limit of 0,3m and the DT limit is 1,51m. The further extension of the DT may be possible although local disturbances caused by the activities associated with borrowing of material for the construction of the dam wall, as is evident in the photographs, may be a limiting factor.

Data Availability

Stage-time data is available from 1949 to date. Three DWAF DTs (DT 7, 8 and 9) are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
9	1949 to- 1959	1,86	110,3
7	1959 to Dec 1978	2,50	313,6
Zero Rating	Jan 1979 to Mar 1980	None	None
8	Apr 1980 to date	1,51	85,6

Between January 1979 and March 1980, there was no DT available (reason unknown) and as such a zero rating is shown on Figure 2-3 for that period, with corresponding missing data as indicated in Table 2-3.

Voor	Exceedance (No. days per month)									Missing Data (No. days per month)															
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1949	0	1	0	0	0	0	3	0	3	7	0	2	1949	0	0	0	0	0	0	0	0	0	0	0	0
1950	0	2	0	0	0	0	4	7	12	3	2	1	1950	0	0	0	0	28	1	0	0	0	0	0	0
1951	2	3	0	0	0	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	1	30	31	31	30
1052	0	0	ñ	0	0	0	0	ñ	0	ñ	ñ	õ	1052	31	30	31	21	28	31	30	31	30	31	31	30
1052	0	0	0	0	0	0	0	0	0	7	5	2	1052	24	20	24	24	20	24	20	24	20	1	0	0
1955	0	0	0	0	0	0	0	0	0	1	5	2	1955	31	30	31	31	20	31	30	31	30	1	0	0
1954	0	0	0	0	0	0	0	0	0	0	3	1	1954	0	0	0	0	0	0	0	1	30	31	20	0
1955	0	1	0	0	0	0	0	2	1	4	4	3	1955	0	0	0	0	0	0	0	0	0	0	11	0
1956	0	0	0	0	0	0	0	0	0	8	11	0	1956	0	0	0	1	28	1	0	0	0	0	0	0
1957	0	0	0	0	0	1	0	0	2	0	3	1	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	1	0	0	0	0	1958	0	0	0	0	0	6	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	1	1	1960	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	2	0	1	0	1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	2	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	1	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	2	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	1	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0 0	Ő	0	0	Ő	ő	Ő	1	0	1	0	ő	1967	Ő	0	0	Ő	ő	ő	0	0	0	0	0	ő
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	0	0	1	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
1909	0	0	0	0	0	0	0	0	0	2	0	0	1909	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	3	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	3	0	0	1972	0	0	0	0	0	0	0	4	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	1	0	1	0	0	1974	0	0	0	0	0	0	0	8	0	0	0	0
1975	0	0	0	0	0	0	0	0	4	3	0	0	1975	0	8	8	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	1	0	0	0	2	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	20	28	31	30	31	30	31	31	30
1979	0	0	0	0	0	0	0	2	1	0	0	0	1979	31	30	31	31	29	31	3	0	0	21	31	30
1980	0	0	0	1	0	0	0	0	0	1	0	1	1980	31	30	3	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	1	0	0	1	0	1981	0	0	0	0	0	0	0	0	0	0	0	13
1982	0	0	0	0	0	0	0	3	3	2	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	3	1	2	1	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	3	2	2	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	Ő	0	Ő	0	0	1	2	1	Ő	1985	Õ	Ő	õ	0	0	õ	Õ	0	4	0	õ	8
1986	0	0	0	0	0	Ő	0	4	1	2	3	1	1986	Õ	0	Ő	0	0	Ő	Ő	0	0	2	6	0
1097	0	0	0	0	0	0	0	1	0	0	2	0	1087	0	0	0	0	0	0	0	8	0	0	0	õ
1088	0	0	0	0	0	0	0	0	0	0	2	0	1099	0	0	0	0	0	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	2	2	1	2	2	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
1909	0	0	0	0	0	0	2	2	1	3	2	0	1909	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	3	2	1	0	3	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	2	0	4	2	0	1	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	4	0	0	0	0	0	0	0	2	6	1	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	6	2	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	5	17	0
1995	1	0	0	0	0	0	0	0	5	1	2	2	1995	0	0	0	0	0	0	0	15	0	0	0	0
1996	1	0	0	0	0	0	0	0	5	0	0	0	1996	0	0	0	0	0	0	0	0	0	1	7	0
1997	0	0	0	0	0	0	0	2	0	2	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	3	1	1	1	1998	0	0	0	0	0	0	0	0	3	8	0	0
1999	0	0	0	0	0	0	0	2	0	1	0	1	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	1	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	1	0	5	2	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	ñ	ñ	0 0	0 0	ñ	ñ	ñ	0	ñ	n n	2	1	2002	0 0	0 0	ñ	ñ	ñ	ñ	0 0	õ	õ	ñ	õ	ñ
2003	õ	õ	õ	õ	õ	0	õ	õ	1	1	2	0	2003	õ	õ	0	õ	õ	õ	õ	õ	õ	õ	õ	õ
2003	0	0	0	0	0	0	0	0	2	1	2	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	1	4	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	υ	U	U	U	U	U	U	U	U	1	1	U	2005	U	U	U	U	U	U	U	υ	υ	υ	U	U

Table 2-3	Summary of Exceeded and Missing Data at G1H004
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A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 2-3, and the limits of the three DTs are also indicated.



Figure 2-3 Primary data plot for G1H004

The DTs have been extrapolated to estimate the incremental flows and associated flow volumes, above the upper limit during periods of exceedence.

Recommendations

During the WCSA, it was concluded that the period of record corresponding to that of the crump weir (from 1980 onwards) was suitable for calibration purposes. Considering the record period from 1980 to date, the weir is exceeded for a few days in every year, except for 1994. The extent of missing data is not considered to be significant. With informed decisions to support patching, it should be possible to utilise the full extent of the record from 1980 to date, providing 15 additional years of additional observed record against which to calibrate.





Background

The station is located on the Klein Berg River, upstream of the diversion into the feeder canal to Voëlvlei Dam. It has been operating since 1954 and an automatic recorder was installed in 1962. It consists of four sharp crested notches, separated by a pier. The longer of the two weir sections has a centrally located low flow section. This is considered to be a reliable gauging station for both low and high flows. The upstream pool is relatively deep and has a low approach velocity at low flows, which is desirable.

The downstream submergence plate is located closer to the weir (see photograph) than would normally be recommended. However it is in a relatively well protected zone (behind the weir abutment wall) and the accuracy of submergence readings should therefore not be adversely affected.

Data Availability

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1954 to date	3,00	267,0

The DT has previously been extended from 1,6m to 3,0m using a slope-area calculation. The structure limit is 1,3m. The DT limit of 3,0m has rarely been exceeded, as shown in Table 2-4.

			E	xcee	dance	e (No.	davs	per m	onth)					<u> </u>		N	lissin	a Dat	a (No.	davs	per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aua	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aua	Sep
1954	0	0	0	0	0	0	0	0	0	0	0	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	1956	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	31	31	30
1961	0	0	0	0	0	0	0	0	1	0	0	0	1961	31	30	7	20	28	31	30	15	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	1	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	7	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	1	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	
1909	0	0	0	0	0	0	0	0	0	0	0	0	1909	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	õ
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	2
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	17	31	31	28	31	30	31	30	31	31	30
1975	0	Õ	0	0	Õ	0	0	Ő	0	0	Õ	Ő	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	8	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	12	4	22	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	10	0	0	0	0	0	0	0	8	0	0
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	2	0	0	0	2	1	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	3	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	4	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	9	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	0	0	0	0	1	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1001	0	0	0	4	3	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	Ő	Ő	0	0	0	0	0	0	0	0	õ
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	õ
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	10	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0					

 Table 2-4
 Summary of Exceeded and Missing Data at G1H008

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 2-4. This also shows the limit of the DT and the few occasions on which the gauge has been exceeded. A theoretical extrapolation of the DT has been undertaken and will be used to inform the patching process.



Figure 2-4 Primary data plot for G1H008

Recommendations

This station was used for catchment calibration purposes during the WCSA. That study concluded that the period of record corresponding to the automated recordings was best suited for calibration purposes. At that time, the available record was up to the 1988/89 hydrological year. An additional 16 years of observed record is available against which to calibrate. Missing data is most prevalent during the 1974/75 hydrological year. These months as well as sporadic others could be patched using simulated flows. It is recommended however that the calibration results be verified over the period 1975 to 2004, so as to confirm that the patching of the 1974 data has not unreasonably skewed the resulting parameter set.

2.5 G1H011 : WATERVALS RIVER AT WATERVALSBERGE



Background

This is one of two streamflow gauging stations in close proximity to one another on the Watervals River, a tributary of the Klein Berg River. The gauge is located above the waterfall and has a catchment area of 27km². It is a sharp crested weir consisting of a low flow central section and a v-notch. Structurally, the gauge remains unchanged from its original configuration, as constructed in 1964, at which stage an automatic recorder was also installed.

During the WCSA it was found that the calibrated parameters for the G1H011 catchment were noticeably different from surrounding and similar catchments, and that these parameters produced a much higher runoff coefficient than seemed reasonable. Consequently, the catchment area of this station was incorporated as part of the calibration undertaken at the G1H008 station, downstream. This type of anomaly may have been due to the rainfall surface and/or flow gauging inaccuracies at the gauge itself.

Data Availability

Stage-time data is available from 1964 to date. There is only one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1964 to date	2,50	85,4

As shown in Table 2-5, the station's DT has never been exceeded and there is relatively little missing data.
			E	Excee	dance	e (No.	days	per m	onth)						N	lissin	g Dat	a (No	. days	s per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Ňar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Ňar	Apr	May	Jun	Jul	Aug	Sep
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	3	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	8	9	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	10	5	8	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	8	0	0	0	0	0	0	0
19/9	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1902	0	0	0	0	0	0	0	0	0	0	0	0	1902	0	0	0	0	0	0	0	0	0	1	2	0
1903	0	0	0	0	0	0	0	0	0	0	0	0	1903	0	0	0	0	0	0	0	0	0	0	2	0
1085	0	0	0	0	0	0	0	0	0	0	0	0	1085	4	0	1	2	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	-	0	-	0	0	0	0	0	0	0	a	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	16	0	0	0	0	0	0	õ
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	õ
1990	0	0	0	0	0	Õ	Ő	0	Õ	õ	Õ	Ő	1990	0	Ő	Õ	Õ	Õ	Õ	Ő	0	Õ	0	Ő	õ
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	1	31	11	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	5	24	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	2	2	31	10	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-5 Summary of Exceeded and Missing Data at G1H011

0

0 0

0 0 0

2004 0 0 0 0 0 0 0 0 0 0 0 0 0

2005 0

Whilst this station was not used for catchment calibration purposes during the WCSA, the reasons for this should be reassessed. This must take the extended available flow record into consideration as well as the fact that the rainfall surface used in this Berg WAAS is an improved estimate for the high rainfall areas, from that used in the WCSA. The hydrology task must assess if there is benefit in calibrating at this gauge or at G1H012 downstream, or alternatively, if it should (as was done previously) be incorporated into the greater catchment area of the G1H008 station.

2004 0

2005 0 0 0

0 0 0 0 0 0 0 0

0 0 0

0

0 0

0

2.6 G1H012 : WATERVALS RIVER AT WATERVALSBERGE

Background

G1H012 lies below the waterfall on the Watervals River, downstream of G1H011. It has a total catchment area of 36km². The weir consists of compound multiple notches with a low v-notch. It has remained structurally unchanged from its original configuration, as constructed in 1964. At that time an automatic recorder was also installed. Recordings were discontinued in 1996 due to low reliability of the low flow record. The upstream gauge (G1H011) has a low notch, records low flows accurately and the operation of two gauges in such close proximity to one another was not considered necessary.

The WCSA reported that at the time of that study, no DT was available from which to process the primary data for this station. In the interim however, DWAF have subsequently developed a DT and as such this gauge can now be considered for catchment calibration. This is of importance to the Klein Berg catchment hydrology, in which it had been necessary during the WCSA to exclude both this station and G1H011 (described in previous paragraph), and to model the whole of the Klein Berg catchment on the flow record at G1H008 alone.

Data Availability

Stage-time data is available from 1964 to 1996. There is only one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1964 to 1996	1,10	27,2

As shown in Table 2-6 the gauge has never been exceeded. Although there are sporadic months of missing information between 1974 and 1977, these could be patched using simulated flows correlated against the flow record at the upstream station (G1H011).

Table 2-6	Summary of Exce	eded and Missing Data at G1H012
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			E	Excee	dance	e (No.	davs	per n	nonth)						N	lissin	a Dat	a (No	. davs	s per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	, Jul	Aua	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aua	Sep
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	8	7	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	15	0	6
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	5	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	11	25	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	8	14	0	0	0	0	0	24	30
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	18	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	2	1	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0					1995	0	0	0	0	0	0	0	0				

Either this station or G1H011 should be reconsidered for catchment calibration purposes on the Watervals River.

2.7 G1H013 : BERG RIVER AT DRIEHEUVELS



Background

The weir is located on the lower reaches of the Berg River just upstream of Misverstand Dam, but beyond the backwater effect of the dam. The gauge has a catchment area of $2\,934 \text{ km}^2$. It consists of four sharp notch sections and a hydro flume, for measuring low flows . The crest level of the hydro flume is set at about 0,45m lower than the crest of the lowest of the four weir sections. It has been operational with an automatic recorder since 1964.

Many current gaugings have been taken at this station, of which the most recent work was undertaken in 2002. The DT limit has been extended to 5,86m (equivalent to 978 m³/s). As a result, this station is now capable of recording major flood events. DT 9 extends to the new upper limit and is applicable from 1965. During the inspection a manual flow depth reading was taken as 0,705m. This compared favourably with the recorder which read 0,710m, indicating correct functioning of the recorder at that time.

Data Availability

During the WCSA it was identified that the available flow information for this station prior to February 1965 should be used with caution. Consequently, the observed record from the 1965/66 hydrological year to the end of the 2004/05 hydrological year could be considered for calibration purposes. It is likely that this catchment will be calibrated on an incremental basis. This involves subtracting the observed inflow records of those gauging stations lying upstream of this one, from its observed record. In the WCSA, the resulting incremental flow record for calibration spanned the period 1982 to 1988. An extension to the calibration period will be governed by the length of the records from the upstream gauges, to be subtracted from the cumulative observed record at G1H013.

There is one DT applicable for the period February 1965 to date.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
8	Nov 1964 to Feb 1965	0,82	28,6
9	Feb 1965 to date	5,86	978,3

The extent of missing and exceeded data at this station is indicated in Table 2-7.

i1H013

			E	xcee	danc	e (No.	days	per n	nonth)						N	lissin	g Dat	a (No	. days	s per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Nar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Nar	Apr	May	Jun	Jul	Aug	Sep
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	31	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	8	0	4	2	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	3	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	9	13	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	16	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
19/1	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	8	0
19/2	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	7	0	0	4	1	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	2	0	0	0	4	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	2	0	0	0	0	0	23
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	31	8	0	0	0	0	0	0	0	0	8	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	Ő	0	Ő	0	õ	0	0	õ	0	õ	1979	0	0	0	0	0	0	õ	õ	0	0	0	õ
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	7
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	3	0	4	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	8	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	8	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1994	8	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	Ő	0	0	Ő	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	Õ	Ő	0	0	0	Ő	0	0	Õ	0	Ő	0	1998	Ő	0	0	Ő	0	Õ	0	0	0	Ő	Õ	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	8	28	6	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0	0				

As shown in the above table and on Figure 2-5, the very high DT limit (5,86m) for the post-1964 period results in the gauge not having been exceeded. The extent of missing data is not significant.



Figure 2-5 Primary data plot for G1H013

The period of record from the 1965/66 hydrological year up to the latest year in which there is commonality across the other upstream gauging stations, should be considered for incremental catchment calibration purposes. The extent of missing data is not significant.

2.8 G1H019 AND G1H063: BANHOEK RIVER AT JONKERSHOEK



Background

G1H019 is located on the Banhoek River which is a tributary of the Berg River and drains the valley between the Jonkershoek and Groot Drakenstein Mountains. The station opened in 1968 with automated recordings from then. The structure consists of sharp crested notches with a low flow section offset to one side.

Two other stations are found upstream of this one, namely G1H033 and G1H042. The former has a catchment area of only 11 km and no available flow record. G1H042 only has data from 1983 to 1989. At G1H019, flows can be diverted into the Theewaterskloof Tunnel where the intention has been to gauge them at G1H063. There is however no available DT to apply at G1H063, and as is the case at Wolwekloof (the other vertical inlet shaft to the tunnel), the diversions into the tunnel are not quantified.

Data Availability

Data for this station is available from 1968 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
3	1968 to date	1,62	20,4

The extent of missing and exceeded data at this station is indicated in Table 2-8.

			E	Excee	danc	e (No.	days	per n	nonth)						N	lissir	ng Dat	a (No	. days	speri	month	1)		
Year	Oct	Nov	Dec	Jan	Feb	Nar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Ňar	Apr	May	Jun	Jul	Aug	Sep
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	8	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	10	27	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	8	30	31	31	22	8	19	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	29	14	0	0	2	18	0	7	0
1974	0	0	0	0	0	0	0	0	0	1	0	0	1974	0	0	4	31	13	0	6	31	6	0	0	0
1975	0	0	0	0	0	0	0	0	2	2	0	0	1975	0	8	0	9	6	0	17	0	0	0	0	1
1976	0	1	0	0	0	0	1	0	4	0	0	0	1976	17	16	3	24	19	10	12	0	0	0	0	12
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	1	13	15	8	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	1	1	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	27	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	3	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	3	2	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	3	0	1	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	3	1	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	8	0	0
1986	0	0	0	0	0	0	0	0	0	0	2	0	1980	0	0	0	0	0	0	8	0	0	0	0	0
1907	0	0	0	0	0	0	0	0	0	0	0	0	1907	0	0	0	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	1	0	1	1	0	0	1080	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	1	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	1	0	0	Ő	1991	0	Ő	0	Ő	Ő	õ	0	0	0	0	0	8
1992	0	0	0	0	0	0	0	0	1	2	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	2	0	0	0	1993	0	0	0	0	19	17	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	1	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	1	0	0	0	0	0	0	0	1	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	6	30	31	30	31	31	30
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	31	30	31	31	28	31	30	31	30	31	31	30
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	31	30	6	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	2	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	1	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

During the WCSA, the record period between 1977 and 1988 was used for calibrating this catchment. Since that study, a further 16 years of data has been recorded. Whilst the gauge does experience a degree of exceedence (see Figure 2-6), it is the missing data that is of greater consequence. This not only influences the pre-1977 period but may also influence the post-1997 period. As can be seen in the above table and on the following figure, there are 20 consecutive months during the 1997 – 1999 period during which no data is available at all. From January 2000 to date, the record is again complete.



Figure 2-6 Primary data plot for G1H019

The period of record from the 1977/78 hydrological year to the end of the 1996/97 hydrological year should be considered for catchment calibration purposes. The extent of missing data between 1997 and 1999 would require extensive patching which may influence the reliability of a catchment calibration up to 2004/05.

As is the case at the Wolwekloof inlet shaft to the tunnel, the gauging of the inflows into the tunnel at G1H042 is important. Consideration should be given to upgrading this inlet and ensuring that the diversions are measured as these are important to quantify in terms of the operation of the system as a whole.

2.9 G1H020 : BERG RIVER AT DALJOSAFAT



Background

On the Berg River, to the northern side of the town of Paarl, lies the Daljosafat weir (G1H020). This gauging station has a catchment area of 609 km^2 . The weir originally consisted of two sharp crested notches (1966), separated by a central pier, and a hydro flume. Automatic recordings have been taken since 1966. The central pier was removed in 1995 and as such, the latest DT is applicable from then to date. When the upstream water level approaches about 1m depth, then bypassing of the weir occurs via a storm water channel situated on the left bank.

Hydrodynamic modelling has been undertaken by Stellenbosch University. This found that the observed flows seem to be too high during flood periods. This could be due to the damming effect caused by the bridge piers situated just downstream of the weir. At the site inspection, a manual reading of 0,50m was taken at the gauge plate. This compared to a reading of 0,51m on the chart and it is concluded therefore that the gauge was recording accurately at the time of the inspection.

Data Availability

Data for this station is available from 1966 to date. DWAF have undertaken current gauging and slope-area calculations, and adapted each of the DT's to allow for the bypassing effect at high flows. Their most recent work in this regard was undertaken in 2002. The upper limit for each DT has been increased to 4,5m, from the previous DT limit of 1,94m.

The observed record from the 1966/67 hydrological year to the end of the 2004/05 hydrological year could be considered for calibration purposes, subject to the availability of information on the upstream gauging stations, as this catchment calibration is likely to be undertaken on an incremental basis.

During the WCSA, the resulting incremental flow record for calibration spanned the period 1980 to 1988.

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DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1966 to1977	4,5	708,5
6	1977 to1983	4,5	708,5
7	1983 to 1995	4,5	705,2
8	1995 to date	4,5	713,5

The extent of missing and exceeded data at this station is indicated in Table 2-9 and on Figure 2-7.

Table 2-9	Summary of I	Exceeded and	Missing Data	at G1H020
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	Exceedance (No. days per month)									Year Oct Nov Doc Ion Ech Mar An May Jun															
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	9	0	0	15	9	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	5	1	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1079	0	0	0	0	0	0	0	0	0	0	0	0	1070	0	0	0	0	0	0	0	0	0	0	0	0
1070	0	0	0	0	0	0	0	0	0	0	0	0	1070	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	1	7	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	Ő	Ő	0	0 0	0	Ő	0 0	1981	0	0 0	0	0	0	0	0	0	Ő	0	0	0 0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	3	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	4	4	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	6
1009	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	9	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	õ	0	õ	õ	õ	õ	õ	0	õ	0	õ	õ	2003	õ	0	õ	õ	0	õ	õ	0	õ	õ	0	õ
2004	õ	õ	0	õ	õ	õ	õ	õ	õ	0	õ	õ	2004	0	0	õ	õ	0	0	õ	0	õ	õ	0	õ
2005	0	0	0	0	0	0	0	-	-	-	-	-	2005	0	0	0	0	0	0	0	-	-	-	-	-



The very high DT limit (4,5m) results in the gauge not having been exceeded. The extent of missing data is not significant.

Primary data plot for G1H020 Figure 2-7

Recommendations

The period of record from the 1966/67 hydrological year to date should be considered for catchment calibration purposes. Sporadic months in which missing data occurs can be patched with simulated values. The actual period on which the incremental G1H020 catchment could be calibrated will be influenced by the data availability from gauging stations lying upstream of it. This is due to the fact that the incremental observed record is determined by subtracting the upstream observed records from the observed record at G1H020, over the period of overlapping data. During catchment modelling cognizance should be taken of the fact that the observed flows during flood periods may be too high.

2.10 G1H021 : KLEIN BERG RIVER AT MOUNTAIN VIEW



Background

This station was opened in 1968 and an automatic recorder installed at the same time. As can be seen it is a very low structure and submergence begins at only 0,17 m. It was identified during the WCSA that severe problems with siltation are experienced in the upstream pool. This impacts on approach velocities and depth, and as a result, the station is regularly exceeded.

Data Availability

Stage-time data is available from 1968. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1968 to date	0,9	6,5

The extent of missing and exceeded data at this station is fairly significant, and the station is exceeded for a few days in almost every year. The period prior to 1975 is of little use due to the extent of missing data. During the WCSA, this catchment area was included in the calibration undertaken further downstream at G1H008. The reason for that decision was that it was considered that the only reliable period of the record at G1H021 was between 1984 and 1988. Although there are now an additional 16 years of observed record available, the DT is still regularly exceeded.

Veer	Exceedance (No. days per month)								Year Missing Data (No. days per month)																
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1968	4	0	0	0	0	0	0	0	0	0	0	2	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	1	0	0	0	0	0	0	0	0	0	0	0	1969	0	15	0	1	0	0	0	0	0	15	16	17
1970	0	0	0	0	0	0	0	0	0	2	0	0	1970	15	0	0	0	9	0	22	7	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	8	0	0	4	18	8
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	21	25	31	28	31	30	31	30	31	31	30
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	31	30	31	31	28	31	30	31	30	31	31	30
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	31	30	31	31	28	31	30	31	30	31	31	30
1975	0	0	0	0	0	0	0	0	3	1	0	0	1975	10	0	0	0	0	0	0	0	0	0	0	0
1976	0	2	2	0	0	0	0	5	5	1	3	0	1976	0	0	0	0	0	0	0	0	0	1	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	1	1977	0	0	0	0	0	0	0	8	3	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	1	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	2	0	0	0	0	0	0	0	1	0	0	0	1979	0	4	31	8	0	0	0	0	0	0	0	0
1980	0	1	0	0	0	0	0	0	0	0	0	2	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	8	0	0
1982	0	0	0	0	0	0	0	1	3	5	0	0	1982	11	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	3	0	2	2	2	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	1	0	1	3	5	2	0	1984	6	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	1	4	3	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	1	1	1	1	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	2	0	0	0	1987	0	8	8	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	1	1	0	2	2	1900	0	0	0	0	0	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	0	1	ו 2	2 1	0	1	1000	0	0	0	0	0	0	0	0	0	0	0	0
1001	0	0	0	0	0	0	0	2	2	0	0	0	1001	0	0	0	0	0	0	0	0	0	0	0	0
1002	1	0	0	0	0	0	0	2	0	6	0	0	1002	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	4	2	0	1	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	1	0	0	0	0	1994	0	0	Ő	0	0	0	0	0	0	0	0	0
1995	2	0	0	0	0	0	0	0	4	1	1	3	1995	0	0	Ő	0	0	0	0	0	0	0	0	0
1996	0	1	0	0	0	0	0	0	3	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	1	1	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	1	0	0	0	0	0	0	0	1	1	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	1	1	0	2	1999	1	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	1	0	3	0	2	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	2	0	3	1	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	1	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	1	1	1	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0					

 Table 2-10
 Summary of Exceeded and Missing Data at G1H021

In view of the fact that there are now an additional 16 years of observed record available, consideration should be given to attempt a hydrological catchment calibration at this station. However, in doing so cognisance must be taken of the extent of exceedence, the amount of patching that would be required, and the resulting impact on the calibrated parameter set.

2.11 G1H028 AND G1H058: TWENTY FOUR RIVERS AT DRIEBOSCH



Background

This station is located on the Twenty Four Rivers and has been in operation since 1972. The weir consists of a single ogee section. There is no downstream gauge plate for submergence recording. However, the drop to bed level downstream of the ogee is about 7,5m and therefore submergence can be assumed to be insignificant.

The weir also acts as a diversion structure, lying upstream of G1H002, which was closed in 1970. The diversion feeds the canal system which leads water into Voëlvlei Dam. The flow record that would be used for catchment calibration purposes is therefore a composite one, consisting of:

- G1H002 (1959 to 1970);
- G1H028 (1972 to date)

Data Availability

There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
2	1972 to date	4,40	1273

The extent of missing and exceeded data at this station is indicated in Table 2-11. Because of the high upper limit of the DT this station has never been exceeded. The flow in the river is the remaining flow after the diversion into the canal. The flow into the canal is gauged at G1H058 (see picture above). The WCSA however reported a very low accuracy rating at the measuring point. Furthermore, between the point of diversion and the measuring point, a large portion of the diverted flow has been known to spill from the canal at a silt trap, during periods of high flow. When spilling takes place, this component of the diverted flow is therefore not measured, making it impossible to accurately determine the river flow by means of a mass balance.

Voor	Exceedance (No. days per month)											Voor			N	lissin	g Dat	a (No	. days	s per r	nonth)			
Tear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	3	13	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	15	1	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	8
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	8	0	0	0	0
19//	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	5	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
19/9	0	0	0	0	0	0	0	0	0	0	0	0	19/9	0	0	0	0	0	0	0	0	17	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	20	21	0	0	7	20
1092	0	0	0	0	0	0	0	0	0	0	0	0	1082	21	30	28	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	Ő	0	0	0	8	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	7	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	U	U	U	U	U	2005	0	0	0	0	0	0	0	U	U	U	0	U
2000	U	0	0	U	U	0	U						2000	U	0	0	U	U	U	U					

 Table 2-11
 Summary of Exceeded and Missing Data at G1H028

Due to the low accuracy rating given to the measurement of the diversion, and the fact that the spills from the diversion canal are not measured, a mass balance to develop a record of flow remaining in the river is not possible. Consequently, it is likely that the period of record available for calibration will be as used in the WCSA, namely that of G1H002, between 1951 and 1969 with considerable patching required due to the extent of missing data, primarily in 1960 and 1961.

The extent at which spills from the canal take place should be investigated by the RO.

2.12 G1H029 AND G1H059: LEEU RIVER AT DE HOEK ESTATES



Background

G1H029 is located on the Leeu River, a tributary of the Twenty Four Rivers. It has been in operation with an automatic flow depth recorder since 1972. It also acts as a diversion weir, feeding the canal system which diverts water out of the Leeu River and into Voëlvlei Dam. A second measurement point (G1H059) records the inflow to the canal. The sum of these two records over a period of commonality, represents the total flow record for this catchment. It is this amalgamated record that can be used for catchment calibration purposes.

Data Availability

Stage-time data is available as follows:

• G1H029 : from 1972 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
3	1972 to date	0,89	120,3

• G1H059 : from 1972 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
2	1973 to date	0,50	3,95

The common period of overlap is therefore from 1973 to date.

Table 2-12 provides an indication of the extent of missing and exceeded data for these two stations, from 1973 to date.

Table 2-12	Summary	of Exceeded a	nd Missing	Data at G1H029

												<u>G1</u>	1029												
Year	_			Excee	danc	e (No.	days	s per n	nonth)		_	Year	_		N	lissin	g Dat	a (No	. days	s per i	nonth	1)		_
1070	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	1070	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	9	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	15	0	0	2	28	31	30	31	30	31	31	30
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	a	15	3	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	õ	õ	õ	õ	õ	õ	0	Ő	0	Ő	0	õ	1978	õ	õ	0	õ	õ	õ	0	0	õ	Ő	õ	õ
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	17
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	30	23	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	22	0	20
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	2	0	0	0	0	0	0	0	0	2	21	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	9	30	17	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	28	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	Ő	0	ő	0	0	0	0	0	Ő	0	0	1991	0	0	0	0	0	0	0	0	ő	0	0	0
1992	Ő	Ő	õ	õ	0	Ő	Ő	Ő	Ő	0	õ	Ő	1992	Ő	Ő	õ	Ő	Ő	Ő	Ő	Ő	õ	0	Ő	Ő
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	õ	0	0	Ő	Ő	0	0	Ő	0	2004	0	õ	Ő	õ	0	0	0	0	õ	0	Ő	Ő
2005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0					-
												<u>G1</u>	1059	-					-						
Vear			E	Excee	dance	e (No.	days	per n	nonth)		<u>G1</u>	1059 Vear	-		N	lissin	g Dat	a (No.	. days	per r	nonth	1)		
Year	Oct	Nov	l Dec	Excee Jan	dance Feb	e (No. Mar	days Apr	per n May	nonth Jun) Jul	Aug	<u>G1H</u> Sep	1059 Year	Oct	Nov	N Dec	lissin Jan	g Dat Feb	a (No. Mar	. days Apr	per r May	nonth Jun	i) Jul	Aug	Sep
Year 1973	Oct	Nov	0	Excee Jan 0	dance Feb	e (No. Mar 0	days Apr 0	per n May 2	nonth Jun 8) Jul 0	Aug 9	<u>G1H</u> Sep	1059 Year 1973	0 0	Nov	N Dec	lissin Jan 0	g Dat Feb	a (No. Mar	. days Apr 0	perr May	nonth Jun 0	i) Jul 0	Aug	Sep
Year 1973 1974	Oct 0 0	Nov 0 0	0 0	Excee Jan 0 0	dance Feb	e (No. Mar 0 0	days Apr 0 0	pern May 2 4	nonth Jun 8 2) Jul 0 1	Aug 9 0	<u>G1H</u> Sep 0 0	1973 1974	0 0 0	Nov 0 0	0 0	lissin Jan 0 0	g Data	a (No. Mar 0 0	days	per r May	nonth Jun 0) Jul 0	Aug 0 0	Sep 0 0
Year 1973 1974 1975	0 0 1	Nov 0 0 0	0 0 0 0	Excee Jan 0 0 0	dance Feb 0 0 0	e (No. Mar 0 0 0	days Apr 0 0 0	pern May 2 4 0	nonth Jun 8 2 9) Jul 0 1 2	Aug 9 0 0	<u>G1H</u> Sep 0 0 0	1973 1974 1975	0 0 0 0	Nov 0 0 0	0 0 0 0	lissin Jan 0 0 0	g Dat Feb 0 0	a (No. Mar 0 0	. days Apr 0 0 0	per r May 0 0	nonth Jun 0 0	i) Jul 0 0	Aug 0 0 0	Sep 0 0 0
Year 1973 1974 1975 1976 1977	0 0 1 0	Nov 0 0 3	Dec 0 0 0 0	Excee Jan 0 0 0 0	dance Feb 0 0 0 0	e (No. <u>Mar</u> 0 0 0 0	days Apr 0 0 0 0	2 4 0 0	nonth Jun 8 2 9 0) Jul 0 1 2 0	Aug 9 0 0 0	<u>G1H</u> Sep 0 0 0 0 0	1973 1973 1974 1975 1976 1977	0 0 0 0 0	Nov 0 0 0	Dec 0 0 0 0	lissin Jan 0 0 0 0	g Dat Feb 0 0 0 0	a (No . <u>Mar</u> 0 0 0	. days Apr 0 0 0 0	b per r May 0 0 0 0	nonth Jun 0 0 0 0) Jul 0 0 0	Aug 0 0 0 0	Sep 0 0 0 0
Year 1973 1974 1975 1976 1977 1978	0 0 1 0 0 0	Nov 0 0 0 3 0 0	Dec 0 0 0 0 0 0 0	Excee Jan 0 0 0 0 0 0 0	dance Feb 0 0 0 0 0 0	e (No. <u>Mar</u> 0 0 0 0 0	days Apr 0 0 0 0 0 0	per n May 2 4 0 0 0 2	Jun 8 2 9 0 0 7) 0 1 2 0 0	Aug 9 0 0 0 4 1	<u>G1H</u> Sep 0 0 0 0 4 1	1973 1973 1974 1975 1976 1977 1978	0 0 0 0 0 0 0 0 0	Nov 0 0 0 0 0	Dec 0 0 0 0 0 0 0	lissin Jan 0 0 0 0 0 0	g Dat Feb 0 0 0 0 0 0	a (No. <u>Mar</u> 0 0 0 0 0	. days Apr 0 0 0 0 0 0	per r May 0 0 0 0 0 0 0	nonth Jun 0 0 0 0 0 0	1) Jul 0 0 0 0 0	Aug 0 0 0 0 0 0	Sep 0 0 0 0 0 0 0
Year 1973 1974 1975 1976 1977 1978 1979	Oct 0 1 0 0 0 3	Nov 0 0 3 0 0 0	Dec 0 0 0 0 0 0 0 0 0	Excee Jan 0 0 0 0 0 0 1	dance Feb 0 0 0 0 0 0 0 0 0	e (No. Mar 0 0 0 0 0 0 0 0 0	days Apr 0 0 0 0 0 0 0 0	per n May 2 4 0 0 0 2 2 2	Jun 8 2 9 0 0 7 2) Jul 0 1 2 0 0 1 0	Aug 9 0 0 4 1 2	<u>G1H</u> Sep 0 0 0 0 4 1 0	059 Year 1973 1974 1975 1976 1977 1978 1979	0 0 0 0 0 0 0 0 0 0	Nov 0 0 0 0 0 0 0 0	M Dec 0 0 0 0 0 0 0 0 0	lissin Jan 0 0 0 0 0 0 0 0	g Dat Feb 0 0 0 0 0 0 0 0 0 0	a (No. <u>Mar</u> 0 0 0 0 0 0 0	. days Apr 0 0 0 0 0 0 0 0 0	ber r May 0 0 0 0 0 0 0 0 0 0 0 0 0	nonth Jun 0 0 0 0 0 0 0 0) Jul 0 0 0 0 0 0 0	Aug 0 0 0 0 0 0 0 0	Sep 0 0 0 0 0 0 0 0
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Due to the extent of missing data in the G1H029 record during the 1974 hydrological year, the period between 1975 and 2004 would be suitable for catchment calibration purposes. This would require sporadic patching of missing data in both records, and of exceedences in G1H059.

2.13 G1H031 : BERG RIVER AT MISVERSTAND

Background

This gauging station is at a bridge across the Berg River, approximately 15 km downstream of G1H013 (which to date is the most downstream gauge on the Berg River at which catchment calibration has been possible). The station lies downstream of Misverstand Dam. No weir has been constructed at this site but DWAF have developed DTs for the section based on calibrations using current gaugings. This station was not used for calibration purposes during the WCSA. G1H031 has previously been assigned a low accuracy rating. An automatic recorder was installed at the section in 1972.

A new weir (G1H075) has been constructed downstream of G1H031 and has been operational since July 2006.

Data Availability

Stage-time data is available from 1974 to date. There are three DTs applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1974 to 1977	6,99	1005
6	1977 to 1982	6,99	920,6
7	1982 to date	6,99	979,9

The extent of missing and exceeded data at this station is indicated in Table 2-13 and Figure 2-8.

Iber Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Iber Oct Nov Dec Jan Feb Mar Apr May Jul 1975 0	r		Exceedance (No. days per month)											Voor			N	lissin	g Dat	a (No	. days	s per i	nonth	ı)		
1974 0 0 0 0 0 0 0 1974 0 </th <th>ear</th> <th>Oct</th> <th>Nov</th> <th>Dec</th> <th>Jan</th> <th>Feb</th> <th>Mar</th> <th>Apr</th> <th>May</th> <th>Jun</th> <th>Jul</th> <th>Aug</th> <th>Sep</th> <th>rear</th> <th>Oct</th> <th>Nov</th> <th>Dec</th> <th>Jan</th> <th>Feb</th> <th>Mar</th> <th>Apr</th> <th>May</th> <th>Jun</th> <th>Jul</th> <th>Aug</th> <th>Sep</th>	ear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975 0	974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1976 0	975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1977 0	976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1978 0 0 0 0 0 0 0 1979 0 0 0 0 0 1979 9 0	977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	2	28	0	0	0	0	0	0	0
1979 0 0 0 0 0 0 0 1979 9 0 </th <th>978</th> <th>0</th> <th>1978</th> <th>0</th> <th>8</th> <th>28</th> <th>8</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>27</th>	978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	8	28	8	0	0	0	0	0	0	0	27
1980 0	979	0	0	0	0	0	0	0	0	0	0	0	0	1979	9	0	0	0	0	0	0	0	0	0	0	0
1981 0	980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1982 0	981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1983 0 0 0 0 0 0 0 1984 0 0 0 0 0 1984 0 0 0 0 0 0 1984 0 <	982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	8	0	0
1984 0	983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	8	0	0	0	0	0	0	0	0	0	0
1985 0	984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1986 0 0 0 0 0 0 0 1987 0 </th <th>985</th> <th>0</th> <th>1985</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>5</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th>	985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	5	0	0	0	0	0
1987 0	986	0	0	0	0	0	0	0	0	0	0	0	0	1986	3	4	0	0	0	0	0	8	0	0	0	0
1988 0	987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	6	0	0	0	0
1989 0	988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	8	0	0
1990 0	989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	8	30	30	31	1	0
1991 0	990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1992 0 0 0 0 0 0 0 1992 0 </th <th>991</th> <th>0</th> <th>1991</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>0</th> <th>8</th> <th>31</th> <th>31</th> <th>8</th>	991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	8	31	31	8
1993 0	992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	7	0	0
1994 0	993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1995 0	994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	27	31	30	4	0	0
1996 0 0 0 0 0 0 1996 0 </th <th>995</th> <th>0</th> <th>1995</th> <th>0</th>	995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1997 0 0 0 0 0 0 0 1997 0 </th <th>996</th> <th>0</th> <th>1996</th> <th>0</th>	996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1998 0	997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1999 0 0 0 0 0 0 0 0 0 0 0 0 0 1999 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
 2000 0 0 0 0 0 0 0 0 0 0 0 0 0 2000 0 0 0 0 0 0 0 0 0 0 0	999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
	000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001 0 0 0 0 0 0 0 0 0 0 0 0 0 2001 0 0 0 0 0 0 0 0 0	001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002 U U U U O O O O O O O O 2002 O O O O O O O O O	002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2003 0 0 0 0 0 0 0 0 0 0	003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
	004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005 0 0 0 0 0 0 0 0 2005 0 0 0 0 0 0 0	005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0					

Table 2-13 Summary of Exceeded and Missing Data at G1H031



Figure 2-8 Primary data plot for G1H031

As shown above, the DT is never exceeded, although sporadic missing data occurs throughout the record.

Recommendations

The station's low accuracy rating is attributed to the fact that it is a rated section only and not a formal measuring structure. As such it is not recommended that this station's record be used for catchment calibration purposes. It can however serve as a cross check for those months in which the record at G1H013 is either exceeded or contains missing data and requires patching.

G1H031 should continue to be operated in conjunction with the new weir G1H075 in order to establish a suitably long enough overlap period, from which to develop a correlation between the two records. This can then be used to attempt an improvement to the available record from G1H031.



Background

The weir is located on the Moorreesburgspruit at Holle River. It is a broad crested structure with a centrally located rectangular low flow section. This station was not used for calibration purposes during the WCSA. No reason for its exclusion was provided during that study. At that time the decision was taken to include it as part of the incremental catchment of Misverstand Dam, for which a transferred parameter set was used to generate the surface water runoff.

Data Availability

Stage-time data is available from 1976 to date. There are two DTs applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
4	1976 to 1977	0,37	1,1
5	1977 to date	0,49	1,9

The extent of missing and exceeded data at this station is indicated in Table 2-14.

Table 2-14	Summary	of Exceeded and Missin	g Data at G1H034
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Veer			E	Excee	danc	e (No.	. days	per n	nonth)			Veer			N	lissin	ig Dat	a (No	. days	s per r	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	0	3	0	0	0	0	0	6	12	13	4	2	1976	0	0	0	28	28	0	0	0	0	0	8	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	7	2	0	15	14	0	0	16	14	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	22	31	30
1979	0	0	0	0	0	0	0	0	1	0	0	0	1979	31	6	0	0	0	0	0	0	0	0	0	0
1980	0	1	1	0	0	0	0	0	0	1	2	4	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	1	2	0	0	2	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	2	4	4	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	6	0	1	1	2	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	1	0	0	0	0	0	0	0	5	5	0	0	1984	0	0	0	0	0	0	0	0	0	5	13	0
1985	0	0	0	0	0	0	0	0	0	0	4	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	1	3	4	4	0	1986	0	0	0	0	0	0	3	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	2	1	4	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	3	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	1	4	3	1	1	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	2	8	2	4	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	2	3	2	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1003	0	0	0	0	0	0	0	0	2	4	2	1	1003	0	0	0	0	0	0	0	0	0	0	0	0
1004	0	0	0	0	0	0	0	0	0	0	0	0	1004	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	5	2	3	1995	0	0	0	0	0	0	0	0	0	1	7	0
1996	0	0	0	0	0	0	0	Ő	0	0	0	0	1996	0	0	0	Ő	Ő	0	0	0	8	0	0	Ő
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	Ő	0	0	0	0	0	0	Ő
1998	0	0	2	0	0	0	0	0	0	0	0	2	1998	0	0	0	0	0	0	0	0	0	0	0	2
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	4	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	3	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	1	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	2	0	0			2005	0	0	0	0	0	0	0	0	0	0		

As would be expected with a DT limit of only 0,5m, the streamflow record at this station contains numerous winter months in which the DT is exceeded and in which patching would be required.

The period from 1994 to 2004 appears to be the more reliable, containing fewer months of exceedence than the earlier part of the record. Whilst is may be possible (with significant patching) to obtain a calibration over the full period, the resulting parameter set is likely to be skewed due to the extent of patching. It is therefore recommended that such a calibration attempt be verified against the shorter (but more complete) post-1993 record period.





Background

G1H035 is located on the Matjies River, which is a tributary of the Berg River. It has a catchment area of 671 km². Automatic water depth recordings have taken place since 1976. The weir is a fairly low structure and has submergence problems associated with the following downstream conditions:

- When Misverstand Dam is full and when periods of high inflow to the dam occur, the dam's tail waters push back up to G1H035, depositing silt at the downstream side of the weir, which creates a submergence problem.
- The weir foundation is poorly founded with flow paths having developed underneath it.
- A downstream causeway has been upgraded to a formal culvert which now causes a backwater effect at the weir during periods of high flow.

Data Availability

Stage-time data is available from 1975 to 2002. There are two DTs applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
4	1975 to 1981	1,89	182,9
5	1981 to 2002	1,30	171,4

The extent of missing and exceeded data at this station is indicted in Table 2.15 and Figure 2.9. The station was closed in 2002 due to the unreliability of the data.

			E	xcee	danc	e (No.	days	per r	nonth)						N	lissin	g Dat	a (No	. days	s per r	nonth	ı)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	31	31	10	
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	28	31	30	31	30	31	31	24	
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1983	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1984	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1989	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1990	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
1991	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	
1992	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1994	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	6	0	0	0	
1995	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	5	0	0	
1996	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1998	0	0	2	0	0	0	0	0	1	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	
1999	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
2000	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
2001	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
2002	0	U	0	0	U	0	0	0	U	U	I.	0	0	U	U	U	U	U	U	U	U	0	U	0	
2003	U												0												

Table 2-15 Summary of Exceeded and Missing Data at G1H035



Figure 2-9 Primary data plot for G1H035

The station is fairly regularly exceeded during the winter months, particularly in the post-1995 period.

Recommendations

During the WCSA, the record period from 1975 to 1988 was used for catchment calibration purposes. There are now an additional 14 years of observed record available for calibration. Sporadic patching will also be required in months of missing and exceeded data. The reliability of the data is considered to be low and this must be taken into account when used.

2.16 G1H036 : BERG RIVER AT VLEESBANK



Background

G1H036 was originally operated to gauge floods upstream of the bridge at Hermon. It has been in place since 1975, with automated recordings from 1976. In 1985, a weir consisting of several stepped crump weirs was constructed between the bridge piers. This was primarily implemented to give accurate flow measurement of low flows, for DWAF's operational requirements. As shown in the photographs, an erosion channel between the right most bridge pier and the river embankment occurs. When the upstream water level approaches a depth of about 1m, the weir becomes bypassed. Consequently flows corresponding to depths greater than 1m should be used with caution as they are likely to be overestimated due to the effect of submergence.

During the WCSA, the catchment area of G1H036 was calibrated incrementally. This approach was adopted due to the numerous upstream gauges discharging into the catchment area of this gauge. During the hydrology task of this study, motivation will be provided in relation to the best approach to now adopt for calibrating this catchment. That decision will be influenced by the extent of additional data now available at each gauge upstream of G1H036, and the reliability of the information. The most pertinent aspects to be considered at each upstream gauge are:

- G1H007 (on Berg River)
 - o very poor accuracy
 - o unreliable station
 - o closed in 1977
 - o record available (1951 to 1977)
 - o no catchment calibration possible during WCSA
- G1H037 (on Krom River at Wellington)
 - o gauge demolished in 1992
 - o record available (1978 to 1992)
 - o catchment calibrated during WCSA (1981 to 1988)
 - o refer to Section 2.17 for detail.

- G1H039 (on Doring River)
 - very regularly exceeded (see Figure 2-11)
 - o requires extensive patching
 - o record available (1978 to date)
 - o no catchment calibration possible during WCSA (no DT available at that time)
 - o DT now available
- G1H041 (on Kompanjies River)
 - o gauge still open
 - o requires very little patching
 - o record available (1979 to date)
 - o catchment calibrated during WCSA (1979 to 1988)
 - o refer to Section 2.20 for detail.
- G1H020 (Daljosafat weir at Paarl
 - o gauge still open
 - requires very little patching
 - o record available (1966 to date)
 - o catchment calibrated incrementally during WCSA (1980 to 1988)
 - o refer to Section 2.9 for detail.

Data Availability

Stage-time data for G1H036 is available from 1978. There are two DTs applicable. These are shown below, and are numbered as found on the DWAF website.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
5	1978 to 1985	7,41	328,1
4	1985 to date	6,44	310,5

Based on current gaugings undertaken by DWAF, the DT limit for the station was reduced in 1985 from 7,41m to 6,44m. However, the structure limit is only 0,75m and submergence occurs easily (90% submerged at an upstream water level of 0,80m).

The extent of missing and exceeded data at this station is indicated in Table 2-16 and Figure 2-10.

Veen			E	xcee	dance	e (No.	days	per n	nonth)			Veer			N	lissir	g Dat	a (No	. days	s per r	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	31	30	31	31	28	31	30	31	30	31	31	30
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	31	30	6	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	14	31	12	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	1	0	1985	0	0	0	7	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	3	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	2	0	1	0	1990	0	0	0	0	0	0	0	0	0	0	0	8
1991	0	0	0	0	0	0	0	0	4	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	3	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	3	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	28	31	30
1995	0	0	0	0	0	0	0	0	2	0	0	0	1006	20	30	21	30 24	20	21	0	14	0	15	0	0
1007	0	0	0	0	0	0	0	0	0	0	0	0	1007	3U 0	3U 0	0	0	20	0	0	0	0	0	0	0
1008	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0 0	0	Ő	0	0	0 0	Ő	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	17	0	0
2003	õ	0	0	0	õ	0	õ	õ	õ	õ	0	õ	2003	õ	0	0	0	0	0	õ	0	0	0	0	õ
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0						2005	0	0	0	0	0	0	0					-

 Table 2-16
 Summary of Exceeded and Missing Data at G1H036



Figure 2-10 Primary data plot for G1H036

This station has 16 additional years of observed flow record. Consecutive months of missing data during the period 1995 to 1997 would require patching.

During the WCSA, the catchment of G1H039 was not calibrated as no DT was available. Although a DT for that gauge is now available, it is exceeded in almost every winter and will require significant patching. As such it is not likely to support a catchment calibration within its own catchment area. If an incremental catchment calibration for G1H036 is undertaken, then the catchment areas of G1H039 and G1H007 could be grouped together as part of the incremental catchment of G1H036.



Figure 2-11 Primary data plot for G1H039

2.17 G1H037 : KROM RIVER AT WELLINGTON



Background

This station lies downstream of G1H030 for which there is no flow data available (Ref: DWAF website). G1H037 lies on the Krom River near Wellington and has a catchment area of 71 km². It is located 20 m downstream of a road bridge and consists of a single crump weir. It was constructed in 1978 and has had automatic recordings since May of that year. Between 1978 and 1983, the upstream recorder pipe was located close to the weir and discharges

were underestimated. In 1983, the recorder pipe was moved upstream by a distance of four times the design height of the weir to improve the accuracy of the upstream water level recordings.

Data Availability

Stage-time data is available from 1978 to 1992. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
3	1978 to 1992	1,22	22,4

In 1992, the weir was demolished due to localised flooding caused by it to adjacent private agricultural property and embankment undermining at an adjacent industrial property.

Figure 2-12 and Table 2-17 show the extent of exceeded and missing data at this station.

Vaar			E	xcee	danc	e (No.	days	per n	nonth)			Vaar			N	lissin	g Dat	a (No	. days	s per r	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	9	1	0	0	0	0	0	0	13	16	2	24
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	19	31	31	28	31	30	31	30	31	19	4
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	6	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	3	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	2	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	2	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	1	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	1	0	2	1	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	2	1	0	1	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0						1992	0	0	0	0	0	0	0					

Table 2-17 Summary of Exceeded and Missing Data at G1H037



Figure 2-12 Primary data plot for G1H037

During the WCSA, the catchment was calibrated using the period 1981 to 1988. There is now an additional three years of data available for catchment calibration. As was the case during the WCSA, the period before 1981 should not be used, due to the extent of missing data. Sporadic patching will be required to address those months in which the DT has been exceeded.

2.18 G1H038, G1H060 & G1H061 : OGEE WEIR AT WOLWEKLOOF



Background

This weir forms part of a complex structure, which includes the intake to the vertical shaft (G1H061) which transfers water from the Wolwekloof River into the Theewaterskloof tunnel, a small weir measuring compensation releases (G1H060) into the Wolwekloof River, and an ogee weir (G1H038) measuring surplus water flowing down the Wolwekloof River. It was constructed in 1978 and an automatic recorder has been in operation since then. An abstraction from upstream of the weir supplies water to the Robertsvlei community but this is not measured. Water diverted into the tunnel is recorded but this data has previously been described as being of poor quality (Ref: WCSA).

The pool upstream of the ogee structure regularly experiences significant accumulation of boulders and requires clearing to reduce obstruction to the intake of the tunnel shaft. The photographs above represent a partially cleared condition.

Data Availability

Flow records for G1H038 are available from 1978 to date. As shown on Figure 2-13 Primary data plot for G1H038 the period before 1983 contained a data error in the primary data record which resulted in gross overestimation of the flows over the weir. This has now been corrected by DWAF. Table 2-18 shows that there are 36 consecutive months of missing data during the 1997 to 1999 hydrological period.

COMPONENT	DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
G1H038	1	1978 to date	3,19	249
G1H060	1	1978 to date	1,52	9,3
G1H061	None	1982 to date	n/a	n/a

The stage-time data is summarised as follows:

0 0 0 0

> 0 0

Table 2-18	Summary of	Exceeded	and Missing	Data at	G1H038	and	G1H060
------------	------------	----------	-------------	---------	--------	-----	--------

												G1F	1038												
Year			E	xcee	dance	e (No.	days	per r	nonth)				Year			N	lissin	ng Dat	a (No	. days	s per i	month	ı)		
1020	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	1020	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	6	0	0	0 14	0	0	0	0	6	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	4	4	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	4
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	6	31	6
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	U O	0	0	0	0	0	0	0	0	0	0	1996	U 31	30 20	U 31	0 21	0 29	U 31	30 U	U 31	30 20	29	31 31	30 30
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	31	30	31	31	28	31	30	31	30	31	31	30
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	31	30	31	31	29	31	30	31	8	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0
												G1F	1060												
Year	0.04	Nev	E	xcee	dance	e (No.	days	per r	nonth)		A	Com	Year	0.04	Nev	N Dee	/lissin	ng Dat	a (No	. days	s per i	month	ı) i	A	6 an
1972	001	NOV	0	0	0	0	0	0	0	0	0	0 0	1972	001	NOV	0	0	8	0	0	0	0	0	0	0 0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	7	1	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	8	0	0	0 8	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	22	0	8	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	8
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	28	0 30	0 31	0 31	0 30
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	31	30	31	18	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	1	0	0	0	1996	0	0	0	0	0	0	0	0	0	29	31	30
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	31	30	31	31	28	31	30	31	30	31	31	30
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	31	30	31	31	28	31	30	31	30	31	31	30
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	31 0	30 0	31 0	31 0	29	31	30 0	31 0	8 N	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	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

2004

 0 0

0 0

0 0 0 0 0 0

0

0 0

0 0

0 0



Figure 2-13 Primary data plot for G1H038

Flow records for G1H060 are also available from 1978 to date. That record contains 9 consecutive months of missing data during 1988/89 and 36 consecutive months of missing data between 1997 and 1999 (see Table 2-18). The record at G1H061 extends from 1982 to date but as mentioned above, is not considered reliable. It has no DT and the recorder measures stage heights even if the gates to the inlet are closed. Effectively this record is therefore of no use.

Recommendations

In terms of use of the data, the WCSA calibration was carried out between 1983 and 1988. As shown in Table 2-18, the records at both stations are currently ongoing. However, the extent of missing data at G1H038 between 1997 and 1999, is likely to limit the period of usable record to 1996. Although data is also missing for 9 months in 1988/89, in the G1H060 record, the magnitude of the compensation releases are small in relation to the overflow at G1H038. Consequently it would be reasonable to assume that these missing months could be patched with monthly averages. In so doing, the potential calibration period need not be further limited.

Due to its strategic importance as a measuring station within the WCWSS, and taking into account that the resources are currently available on site at the Berg Water Project, it is recommended that the entire structure be redesigned, with particular emphasis on reducing boulder accumulation, most notably at the inlet to the shaft.

2.19 G1H040 : FISH RIVER AT LA FONTAINE



Background

The Fish River is a tributary of the Berg River and the streamflow gauging station, G1H040, is located approximately 5km east of Riebeeck-West. It was constructed in 1979 with automatic recordings having taken place since then. The cross section is particularly flat, making it very difficult to obtain any calibration of a DT above the limit of the weir structure itself (0,79m). However, based on flood events during and subsequent to 1983, slope area calculations have been carried

out by DWAF, enabling the limit of the DT to be extended to 1,8m.

Data Availability

Stage-time data is available from 1979 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)				
4	1979 to date	1,80	59,1				

Table 2-19 and Figure 2-14 and show the extent of exceeded and missing data at this station.

V		Exceedance (No. days per month)													Missing Data (No. days per month)											
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0	
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0	
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0	
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	8	31	31	30	
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	6	0	0	0	0	0	0	0	0	0	0	0	
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0	
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0	
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0	
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0	
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0	
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0	
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0	
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0	
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0	
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0	
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0	
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0	
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0	
1008	0	0	0	0	0	0	0	0	0	0	0	0	1008	0	0	0	0	0	0	0	0	0	0	0	0	
1000	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0	
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0	
2002	0	Ő	õ	Ő	Ő	Ő	0	0	0	0	0	0	2002	Ő	Ő	õ	0	Ő	Ő	Ő	0	õ	Ő	0	0	
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0	
2004	0	0	0	0	0	0	Ő	0	0	Ő	0	Ő	2004	0	0	0	0	0	0	0	Ő	0	0	0	0	
2005	0	0	0	0	0	0	0	-	-		•		2005	0	0	0	0	0	0	0	•	-	-	-	-	



Figure 2-14 Primary data plot for G1H040

No flows exceed the DT limit and with the exception of four months in 1983, there is no missing data.

This flow record was used for catchment calibration purposes for the period between 1979 and 1988 during the WCSA. There are now an additional 16 years of information against which to calibrate. Patching will again be required during the period June to October of 1983, due to missing data.
2.20 G1H041 : KOMPANJIES RIVER AT DE EIKEBOOM



Background

The gauge is located on the Kompanjies River and has a catchment area of 121 km², including the high rainfall area in the east, which lies in the Limietberg Mountains. It consists of a crump weir which was established in 1979, at which time automated recordings also commenced. Between 1981 and 1985, the original upstream recorder pipe was moved to a more appropriate upstream location. The record between 1979 and 1988 was used to calibrate this catchment during

the WCSA.

Data Availability

Stage-time data is available from 1979 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
3	1979 to date	1,80	52,4

The extent of missing and exceeded data is shown in Table 2-20.

Table 2-20	Summary	of Exceeded and Missin	ig Data at G1H041
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Vaar			E	Excee	dance	e (No.	days	per n	nonth)			Vaar			N	lissin	g Dat	a (No	. days	s per i	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	8	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	1	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	8	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	1	1	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0			2005	0	0	0	0	0	0	0	0	0	0		

There are an additional 16 years of data against which to calibrate this catchment, with very little patching required.

2.21 G1H043 : SANDSPRUIT AT VRISGEWAAGD



Background

G1H043 consists of two crump weirs and was constructed on the Sandspruit during 1980. The weir is located at a site which has a much higher upstream level than downstream, and localised submergence would therefore not be expected. However, the Berg River itself causes a backup of water and damming in the Sandspruit, which results in high downstream water levels and submergence. The accumulation of sand in the upstream pool has historically caused severe siltation problems.

Data Availability

Stage-time data is available from 1980 to date. There is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
1	1980 to date	1,19	31,31

Table 2-21 shows the extent of exceeded and missing data at this station. It can be seen that the gauge is sometimes exceeded during the winter months, due to the back-up effect of the main stem Berg River and from the impact of siltation in the upstream pool.

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С)∠	<u> </u>

			E	xcee	danc	e (No.	days	per n	nonth)			V			M	lissin	g Dat	a (No	. days	s per r	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Νον	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	25	5	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	1	0	0	0	1982	0	0	0	8	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	1	1	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	2	1	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	2	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	2	0	0	1992	8	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	2	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	1	1	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	1	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0			2005	0	0	0	0	0	0	0	0	0	0		

 Table 2-21
 Summary of Exceeded and Missing Data at G1H043

During the WCSA, it was recommended that the weir be raised or moved further upstream, but this has not been implemented. As such, the average accuracy rating assigned to this station during that study remains and it should be cautiously used, if at all, for catchment calibration purposes.

2.22 G1H044 : TUNNEL OUTLET TO BERG RIVER

Background

This is not a streamflow gauging station but rather a metering point which measures the releases made from the Theewaterskloof Tunnel into the Berg River via the outlet at the West Portal. There are two meters, one measuring small-scale and the other large-scale flow releases.

Data Availability

Stage-time data is available from 1983 to date. The extent of missing data at both the small and large release water meters is indicated in Table 2-22.

				G1H	044 (N	/101 - I	arge	Relea	ases)								G1H	044 (N	/102 - \$	Small	Relea	ases)			
Year					Ν	lissin	g Dat	a					Year					N	lissin	g Dat	a				
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	1	31	30	31	30	31	31	30	1993	0	0	0	0	1	31	30	31	30	31	31	30
1994	31	30	31	31	28	31	30	31	30	31	31	30	1994	31	30	31	1	0	0	0	0	0	0	0	0
1995	31	30	1	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-22 Summary of Missing Data at G1H044

Recommendations

This record provides an indication of the volumes of water released into the Berg River from the Theewaterskloof tunnel. These releases are primarily for uptake by the irrigators along the Berg River.

2.23 G1H065 : CANAL FROM VOËLVLEI DAM



Background

This station consists of a hydro flume located inside the outlet canal from Voëlvlei Dam. The canal delivers water to the Swartland Water Treatment Works which abstracts from the canal, just upstream of the flume. The balance of the water is returned to the Berg River via the canal, for storage in Misverstand Dam, from where the Withoogte Water Treatment Works abstracts raw water.

Data Availability

Stage-time data is available from 1951 to date. As indicated in Table 2-23, there is no exceedence and very little missing data.

				Excee	danc	e (No	davs	nern	nonth)						м	issin	n Dat	a (No	davs	s ner r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aua	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aua	Sep
1951	0	0	0	0	0	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1952	0	0	Ó	0	0	Ó	Ó	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	1953	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	1956	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1966	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1967	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1967	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1969	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1971	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1973	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1974	0	0	Ó	Ó	Ó	Ó	0	0	0	Ó	0	0	1974	0	0	Ó	0	0	Ó	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	1
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	14	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0			2005	0	0	0	0	0	0	0	0	0	0		

Table 2-23 Summary of Exceeded and Missing Data at G1H065

This record provides an indication of the volumes of water released from Voëlvlei Dam for the Swartland and Saldanha Regional Water Supply Schemes and for irrigation along the Berg River.

2.24 G1H066 : LITTLE BERG RIVER INLET CANAL TO VOËLVLEI DAM



Background

This measuring station consists of a hydro flume located in the canal which diverts water from just downstream of the G1H008 streamflow gauging station on the Klein Berg River into Voëlvlei Dam.

Data Availability

Stage-time data is available from 1951 to date. As indicated in Table 2-24, there are only a few days of exceeded data in the 1973 hydrological year and a few sporadic months from 1993 to date where there is missing data.

Table 2-24 Summary of Exceeded and Missing Data at G1H066

				Excee	danc	e (No	. davs	pern	nonth)						м	issin	g Dat	ta (No	. davs	perr	nonth	1)		
Year	Oct	Νον	Dec	.lan	Feb	Mar	Δnr	Mav	Jun	, .lul	Aug	Sen	Year	Oct	Nov	Dec	.lan	Feb	Mar	Δnr	Mav	Jun	., 	Aua	Sen
1951	0	0	0	0	0	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	1952	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	1953	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1056	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1057	0	0	0	0	0	0	0	0	0	0	0	0	1057	0	0	0	0	0	0	0	0	0	0	0	0
1059	0	0	0	0	0	0	0	0	0	0	0	0	1059	0	0	0	0	0	0	0	0	0	0	0	0
1050	0	0	0	0	0	0	0	0	0	0	0	0	1050	0	0	0	0	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0	0	0	0	0	1060	0	0	0	0	0	0	0	0	0	0	0	0
1061	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	0	0	0
1062	0	0	0	0	0	0	0	0	0	0	0	0	1901	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	1902	0	0	0	0	0	0	0	0	0	0	0	0
1903	0	0	0	0	0	0	0	0	0	0	0	0	1903	0	0	0	0	0	0	0	0	0	0	0	0
1904	0	0	0	0	0	0	0	0	0	0	0	0	1904	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0	1900	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
19/1	0	0	0	0	0	0	0	0	0	0	0	0	19/1	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	2	0	2	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	3	30	10	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	29	14	0	0	0	8	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	3	23	3	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	4	4	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	1	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
1 2005	0	0	0	0	0	0	0	0	0	0			2005	0	0	0	0	0	0	0	0	0	0		

Recommendations

None.

2.25 G1H067 : TWENTY FOUR RIVERS INLET CANAL TO VOËLVLEI DAM



Background

This measuring station consists of a hydroflume located in the canal transferring water diverted from the Twenty Four Rivers into Voëlvlei Dam.

Data Availability

Stage-time data is available from 1972 to date. As indicated in Table 2-25, there is only one day in the entire record during which data is missing, namely in December of 1987. There are no exceedences in the record.

Table 2-25 Summary of Exceeded and Missing Data at G1H067

Vaar			E	xcee	danc	e (No.	days	per n	nonth)			Veer			Μ	issin	g Dat	a (No	. days	s per r	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	1	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0	1900	0	0	0	0	0	0	0	0	0	0	0	0
1909	0	0	0	0	0	0	0	0	0	0	0	0	1909	0	0	0	0	0	0	0	0	0	0	0	0
1001	0	0	0	0	0	0	0	0	0	0	0	0	1001	0	0	0	0	0	0	0	0	0	0	0	0
1002	0	0	0	0	0	0	0	0	0	0	0	0	1002	0	0	0	0	0	0	0	0	0	0	0	0
1003	0	0	0	0	0	0	0	0	0	0	0	0	1003	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	Ő	0	0	0	0	0	0	0	0	0	0	1996	0	Ő	0	0	0	0	0	0	0	0	0	0
1997	0	õ	0	0	0	0	õ	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	9	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0			2005	0	0	0	0	0	0	0	0	0	0		

Recommendations

None

2.26 G1H075 : BERG RIVER DOWNSTREAM OF MISVERSTAND DAM



which to extend the record at either gauge.

Background

This gauge is a new station located downstream of G1H031 on the Berg River. It was only opened in July 2006 and to date there is no flow record yet available for it on the DWAF website. The gauge measures spills and releases from the dam.

Recommendations

A suitably long overlap period between G1H031 and G1H075 should be established to enable a reasonable correlation between the two from



Background

The Wemmershoek Dam lies on the Upper reaches of the Wemmers River, a tributary of the Berg River. The dam has a catchment area of 88 km² and receives runoff from the Drakenstein Mountains. The dam is owned and operated by the City of Cape Town and provides water for urban consumption to Cape Town, Paarl and Wellington.

Data Availability

There is no recorded inflow data available on the DWAF website. Information will be made available from the CCT. This will take the form of a monthly reservoir record, which is based on a mass balance calculation, taking into account changes in storage, evaporation, releases and rainfall on the reservoir surface. From this information monthly inflow volumes are calculated. It is anticipated that an inflow record from 1957 to date is available. During the WCSA, the period prior to 1973 was found to contain certain anomalies and the calibration in that study had been conducted over the 1973 to 1988 period.

It is therefore likely that the updated calibration to be undertaken during this study will be on the record period from 1973 to the end of the latest complete hydrological year, namely 2004/05.



Background

The inflow to Misverstand Dam is poorly gauged, due to the low accuracy associated with the closest upstream gauging station (G1H031).

Furthermore, the spillway configuration at the dam itself is not suited to accurately measure the spills (G1R003).

Consequently it is not possible to develop a reliable

enough inflow record to support a calibration of the incremental Berg River between G1H013 and Misverstand Dam. G1H013 is the most reliable gauging station in close proximity to the dam itself (approximately 15km upstream) and is above the tail water influence.

Recommendation

Catchment calibrations should be attempted at G1H013, at G1H034 (Moorreesburg Spruit) and at G1H035 (Matjies River). Based on these results, a decision will then be motivated for the transfer of parameters into the incremental Berg River catchment in order to simulate long-term flow sequences into Misverstand Dam.

ASSESSMENT OF STREAMFLOW GAUGING STATIONS STEENBRAS AND PALMIET RIVER CATCHMENTS

3. STEENBRAS AND PALMIET RIVER CATCHMENTS

- G4H001 : STEENBRAS RIVER AT KOGELBAAI
- G4H005 : PALMIET RIVER AT APPLETHWAITE
- G4H007 : PALMIET RIVER AT WELGEMOED
- G4H023 : ROCKVIEW CANAL
- G4H030 : PALMIET RIVER AT CAMPANULA
- G4R001 : STEENBRAS RIVER AT LOWER STEENBRAS DAM
- G4R002 : PALMIET RIVER AT EIKENHOF DAM

Figure 3-1 shows the Upper and Middle Berg River catchment area and the location of the above streamflow gauging stations.



Figure 3-1 Streamflow Gauging Stations in the Steenbras and Palmiet River Catchments

3.1 G4H001: STEENBRAS RIVER AT KOGELBAAI

Background

This station was situated near the Lower Steenbras Dam and was closed in 1921. There is no information available and no record on which to calibrate.

3.2 G4H005 : PALMIET RIVER AT APPLETHWAITE





Background

G4h005 was opened in 1957 and is gauged by a slightly curved, broad-crested weir on the spillway of the Applethwaite farm dam. The broad crested weir is only 300 mm high therefore submergence and high approach velocities influence the reliability of the flow record at the spillway. There is a freeboard of 1,45m between the weir crest and the dam wall, but the calibration limit of the spillway is less than the freeboard due to the influence of submergence. The dam owners open a 300 mm dia. scour valve in the dam wall during winter which releases approximately 32 l/s. However, there is no record of the periods during which this valve has been opened. The gauging station at the spillway tends to be inaccurate during low flows, due to the length of the sill.

Data Availability

Stage-time data is available from 1957 to date and one DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
3	1957 to date	1,45	123,4

This station was used for catchment calibration purposes during the WCSA, using the observed spill record between 1965 and 1987 and calibrating on an incremental catchment basis. The spill component has a low accuracy rating and a gauge plate correction factor of approximately 30 mm was applied between 1968 and 1973.

Suitability for Catchment Model Calibration

 Table 3-1 provides information on the number of days per month during which the limit of the DT was exceeded and the extent of missing data.

¥				Excee	danc	e (No	. days	s per r	nonth)			V			N	lissir	ng Dat	ta (No	. day	s per i	month	1)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	1	0	1961	0	0	0	0	0	0	0	0	4	0	4	0
1962	0	0	0	0	0	0	0	0	0	0	1	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	11	31	29	31	30	4	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	3	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1076	0	0	0	0	0	0	0	0	0	0	0	0	1076	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	ñ	0	0	0	1978	0	0 0	0	0	0	0	0	0	0 0	0 0	0	0
1979	0	Ő	0	0	0	0	0	0	Ő	0	Ő	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	Ő	0	0	0	0	0	0	Ő	0	Ő	0	1980	0	0	0	0	0	õ	0	0	0	0	0	Ő
1981	Ő	Ő	0	Ő	0	Ő	0	Ő	Ő	0	Ő	Ő	1981	0	0	Ő	0	Ő	Ő	Ő	Ő	0	0	Ő	Ő
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	7	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	1	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	õ	0	0	0	0	0	0
2004	0	õ	õ	0	0	0	0	0	õ	õ	õ	0	2004	0 0	0 0	0	õ	0	õ	0	õ	0	0	õ	õ
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-1 Summary of Exceeded and Missing Data at G4H005



A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 3-2.

Figure 3-2 Primary data plot for G4H005

As a result of its low level, the station is influenced by downstream water levels when submergence exceeds 70%. However, DWAF has calibrated this gauging station to take into account the influence of submergence.

Recommendations

An additional 18 years of observed record is now available against which to calibrate, if the inflow records entering this catchment from upstream are also available over the same period. Missing data is most prevalent during the 1971/72 hydrological year and these will require patching. The extent of exceedence is negligible but where it does occur, these monthly values will also be patched.





Background

G4H007 was opened in 1963. It consists of five sharp crested weirs, separated by divider walls. Historically, problems with Palmiet reed in the upstream pool have been experienced causing the main river flow to be diverted away from the low notch. The upstream pool has been cleaned and continues to be maintained. In 1967 and 1968, the right notch length was changed, decreasing its length to 5,99 m and 5,85 m respectively. A comparison between the DTs undertaken previously resulted in differences of less than 1%. As a result, only one DT has been calculated and a notch length of 5,85 m is assumed to be valid for the total record period.

The submergence gauge plate is considered to be correctly placed. The limit of the DT is at 2,00m and it has only been exceeded during three flood events within the 43-year record period (1963 to date). During the WCSA this gauging station was assigned a low accuracy rating due to the position of the upstream gauge plate potentially leading to an underestimation of the flow.

DWAF considered the above recommendation but no change to the gauge plate position was made due to the fact that:

- DWAF has an operational procedure which does not allow for automatic recorders to be adjusted on the basis of gauge plate readings taken during periods of high flow.
- During periods of low flow, the gauge plate readings are considered to be correct.
- The inlet pipe to the automatic recorder is correctly located, and as such only the manual control reading would be faulty.

Data Availability

Stage-time data is available from 1963 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
5	1963 to date	2,00	189,1

Table 3-2 provides information on the number of days per month during which the DT was exceeded and the extent of missing data. There are no extended periods of missing or exceeded data, and for the few instances where it does occur, these monthly flows can be patched.

Veer	Exceedance (No. days per month) Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug												Veer			N	lissin	g Dat	a (No	. days	s per i	month	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	6	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	1	7	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	19/1	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	1	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1075	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	1	0	1976	0	0	0	0	0	0	0	0	17	12	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	õ	0	0	0	0	1978	0	0	0	õ	0	0	0	õ	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	2	28	6	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	2	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	2	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1007	0	0	0	0	0	0	0	0	0	0	0	0
1008	0	0	0	0	0	0	0	0	0	0	0	0	1008	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	õ	õ	0	õ	0	0	0	0	õ	õ	0	0	2001	õ	0	õ	õ	õ	0	õ	õ	0	õ	0	õ
2002	õ	õ	õ	õ	0	õ	õ	0	õ	õ	0	õ	2002	õ	õ	0	õ	õ	0	õ	õ	0	õ	0	õ
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

 Table 3-2
 Summary of Exceeded and Missing Data at G4H007

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 3-3.



Figure 3-3 Primary data plot for G4H007

The record post-1985 contains no missing data and very little exceeded data. Therefore, a further 19 years of observed record is now available against which to calibrate.

3.4 G4H023 : ROCKVIEW CANAL



Background

This gauging station was opened in 2000 and consists of a crump weir constructed in the canal which transfers water from Rockview Dam into Upper Steenbras Dam. The DT is applicable from 2000 to date.

Data Availability

Stage-time data is available from 2000 to date.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
2	2000 to date	2,00	18,86

Table 3-3 shows the extent of missing data. The gauge has not been exceeded.

Table 3-3 Summary	of Exceeded and Missing Data at G4	H023
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Veer			E	Excee	danc	e (No.	days	s per n	nonth)			Veer			Ν	/lissir	g Dat	a (No	. day	s per i	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1999					0	0	0	0	0	0	0	0	1999				20	28	31	30	31	13	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0					2006	0	0	0	0	0	0	0	0				

Recommendations

None

3.5 G4H030 : PALMIET RIVER AT CAMPANULA



Background

This gauging station is relatively new, having been in operation since 1998. It consists of a horizontal crump weir on two levels and is in excellent condition. The approach pool is deep and hence the flow velocities are low. Furthermore it is unlikely to experience any submergence due to the steeply sloping river bed level and the difference in river bed elevation between the upstream and downstream pools.

The station has a DT limit of 2.25m and a record period of only 8 years. It was noted during inspection that DWAF need to check the calculation of the DT to confirm whether it is relevant only to the section across the crump weir, or if it also includes any overtopping of the guide walls. A reading taken at the gauge plate showed 0,169m which compared to a reading of 0,163m in the thalimedes shaft, indicating that the station is accurately recording the water levels.

Data Availability

Stage-time data is available from 1998 to date. One DWAF DT (DT1) is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1998 to date	2,25	109,0

Table 3-4 provides information on the number of days per month during which the DT was exceeded and the extent of missing data.

	Table 3-4	Summary	/ of Exceeded and Missing Data at G4H	1030
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Veer	Exceedance (No. days per month)												Veer			N	lissin	g Dat	a (No	. days	s per r	nonth	1)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	15	31	5	0	0	0	0	4	31	22	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	15	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

Although this gauging station has a complete record length of only 7 years, it provides information to this study which was not available during the WCSA. There is no exceeded data and the missing data in the 1999/00 hydrological year could be patched, using simulated flows. A catchment calibration over the period 1998 to 2004 should be attempted.

3.6 G4R001 : STEENBRAS RIVER AT LOWER STEENBRAS DAM



Background

The Lower Steenbras Dam was constructed in 1915. It is owned, operated and maintained by the City of Cape Town (CCT). Two recorders have been installed, one at the spillway (G4R001) and a meter (G4H038) at the water supply outlet pipe. The dam wall and spillway have been raised twice since its initial construction.

Data Availability

The DWAF website contains monthly flow records at the following locations:

G4R001 (Spills) :	1989 to date
G4R028 (Metered releases via outlet pipe) :	1924 to 1958
	1963 to 1964
	1981 to 1991

Both the CCT and DWAF have calculated the gross monthly inflows to the dam. The CCT's record extends back to 1904 and that of DWAF to 1921. These records do not correspond exactly due to the use of slightly different area / capacity tables by the two institutions.

During the WCSA, an approach was successfully adopted to develop an inflow record to the dam based on concatenating (joining) the most reliable periods of record from DWAF and CCT, to produce an inflow record between 1927 and 1987. The construction of Steenbras Upper Dam and the raising of the Lower Dam were also taken into account. Rainfall on the dam surface was also allowed for using the raingauge at Steenbras Dam, so as to develop a net inflow record. That record was patched in the months where data was not available and a successful catchment calibration was undertaken.

Recommendations

It is proposed that the same approach be adopted to extend the net inflow record used in the WCSA from 1987 to the end of the 2004/05 hydrological year. In developing this record, cognisance must also be taken of the inter-basin transfer into the Upper Steenbras Dam from the Palmiet River via the Palmiet Pumped Storage Scheme.



Background

This gauge replaced gauging station G4H011 which is now submerged in the dam basin. In 1988, the dam wall was raised and the spillway configuration changed. In 1999, the dam was raised a second time and major alterations were made to both the main spillway and service spillway. The main spillway was converted into a labyrinth structure and fusegates were installed on the auxiliary spillway.

The dam is owned and operated by the former Groenland Irrigation Board, which is transforming to the Palmiet Water User Association (WUA).

Data Availability

Stage-time data at the spillway is available from 1978 to date. The following three DTs are listed on the DWAF website.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
3	1978 to 1988	3,59	314,8
4	1988 to 1999	3,54	363,2
5	1999 to date	2,79	250,3

Table 3-5 provides information on the number of days per month during which data was missing. There are no exceedences. During the WCSA, an inflow record to the dam was developed and used for calibrating the inflows between 1978 and 1987.

Table 3-5 Summary of Exceeded and Missing Data)ata at G4R002 (Spills)
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			E	xcee	danc	e (No.	days	per n	nonth)						N	lissin	g Dat	a (No	. days	s per i	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Nar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977								0	0	0	0	0	1977								0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	1	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	8	15	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	8	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	3	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	3	30	31	17	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	14	1	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	6	1	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0					2005	0	0	0	0	0	0	0	0				

The same approach as previously adopted, namely the development of an inflow record by means of a reservoir balance calculation is proposed for this study.

ASSESSMENT OF STREAM FLOW GAUGING STATIONS UPPER BREEDE RIVER CATCHMENTS

4. UPPER BREEDE RIVER CATCHMENT

- H1H003 : UPPER BREEDE RIVER AT CERES GOLF CLUB
- H1H006 & H1H022 : UPPER BREEDE RIVER AT WITBRUG
- H1H007 : WIT RIVER AT DROSTERSKLOOF
- H1H012 : HOLSLOOT RIVER AT DASCHBOSCH
- H1H013 : KOEKEDOUW RIVER AT CERES
- H1H018 : MOLENAARS RIVER AT HAWEQUAS FORESTRY
- H1H033 : ELANDS AT HAWEQUAS FORESTRY
- H4H006 : BREEDE RIVER AT LOWER BRANDVLEI

Figure 4-1 shows the Upper Breede River catchment area and the location of the above streamflow gauging stations.



Figure 4-1 Streamflow Gauging Stations in the Upper Breede River Catchment

4.1 H1H003 : UPPER BREEDE RIVER AT CERES GOLF CLUB





Background

This station consists of a sharp crested weir and has stage-time data extending back to 1923. Since 1962, an automatic recorder has been in place. The observed record was recently used for catchment calibration during the Breede River Basin Study (BRBS) of 2003.

The DT limit was originally 1,08m. Since 1997, submergence data has been collected and the DT limit has subsequently been extended to 2,20m using submergence correction data. The DT is however still exceeded during periods of high flow. DWAF have proposed that a back water calculation be undertaken to try and extend the DT to 4,5m. This will entail a survey of a selected downstream control section (during summer) and theoretical depth calculations to correlate the depth and flow at the control section, with the flow depth at the weir. This is not likely to be undertaken in time for use in this modelling study. However, it is an important aspect to address and will need to be available in time for the feasibility studies that are likely to be implemented for the potential transfer of water from the Upper Breede River into the Berg WMA.

Data Availability

Stage-time data is available from 1923 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
6	1923 to date	2,20	65,6

Table 4-1 provides information on the number of days per month during which the DT was exceeded and the extent of missing data. A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 4-2.

Voor	Exceedance (No. days per month)										Year Missing Data (No. days per month)														
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	~	~	~	~	0	0	0	0	3	0	0	0	1922	~	~	~	~	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	6	1	0	0	1923	0	0	0	0	0	0	0	0	0	0	0	0
1925	õ	õ	ō	ō	ō	ō	ō	o	õ	2	ō	õ	1925	o	ō	õ	õ	o	ō	õ	õ	ō	ō	õ	0
1926	0	0	0	0	0	0	0	0	0	0	1	0	1926	0	0	0	0	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	1	0	0	0	1927	0	0	0	0	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	2	0	0	1928	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	2	0	0	3	2	1929	0	0	0	0	0	0	0	0	0	0	0	0
1931	õ	ō	ō	ō	1	ō	ō	0	õ	1	0	õ	1931	o	ō	õ	õ	o	ō	õ	õ	ō	ō	õ	0
1932	0	0	0	0	0	0	0	0	0	3	0	0	1932	0	0	0	0	0	0	0	17	0	0	0	1
1933	0	0	0	0	0	0	0	0	0	0	0	1	1933	31	30	31	31	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	1934	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	1	4	0	2	1935	0	0	0	0	0	0	0	0	0	0	0	0
1937	õ	õ	õ	õ	õ	õ	õ	õ	o	0	õ	õ	1937	õ	õ	õ	õ	õ	o	õ	õ	õ	õ	õ	õ
1938	0	0	0	0	0	0	0	1	0	0	0	0	1938	0	0	0	0	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0	0	1939	0	0	0	0	0	0	0	0	0	0	0	0
1940	0	0	0	0	0	0	0	4	7	1	2	4	1940	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	0	0	0	0	0	0	2	0	3	4	0	1941	0	0	0	0	0	0	0	0	0	0	0	0
1943	õ	õ	õ	õ	õ	õ	õ	õ	õ	0	2	õ	1943	õ	õ	õ	õ	1	31	30	31	30	31	õ	0
1944	0	0	0	0	0	0	0	2	5	4	0	0	1944	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	2	1945	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	2	0	0	1946	0	0	0	26	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	0	0	0	2	0	2	1947	0	0	0	0	0	0	0	0	0	0	0	0
1949	õ	1	o	ō	ō	ō	1	õ	õ	õ	ō	õ	1949	o	ō	õ	õ	õ	ō	õ	õ	ō	ō	õ	0
1950	0	0	0	0	0	0	0	0	1	1	0	0	1950	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	2	0	1951	0	0	0	0	0	0	0	0	0	0	0	1
1952	0	0	0	0	0	0	0	0	0	4	0	0	1952	31	30	31	31	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	3	0	11	4	1	1953	0	0	0	0	0	0	0	0	0	0	0	0
1955	õ	õ	0	0	0	õ	0	0	1	0	1	0	1955	0	õ	1	31	29	31	30	õ	õ	õ	0	0
1956	0	0	0	0	0	0	0	0	2	0	3	0	1956	0	0	0	0	0	0	0	0	24	31	0	0
1957	2	0	0	0	0	0	0	0	0	0	0	0	1957	1	30	31	31	10	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	1	0	0	1	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	1	1959	0	0	0	0	0	0	0	0	0	0	0	0
1961	õ	0	ō	0	0	0	0	ō	2	2	3	0	1961	ō	0	0	0	0	ō	0	0	0	0	0	0
1962	з	0	0	0	0	0	0	0	0	1	3	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	1	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	1	1	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	1	o	0	0	1966	0	0	0	0	0	0	0	0	22	31	31	30
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	31	30	31	10	8	0	0	10	8	8	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	1	4	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1972	õ	0	ō	0	0	0	0	ō	0	1	0	0	1972	ō	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	7	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	2	0	0	0	0	0	2	2	3	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1977	õ	0	o	o	ō	ō	ō	0	ō	o	0	õ	1977	o	ō	õ	õ	õ	ō	õ	õ	ō	õ	õ	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	5
1980	0	0	0	1	0	0	0	0	0	0	1	0	1980	0	0	0	0	0	0	0	0	0	0	0	8
1982	0	0	0	0	0	0	0	0	5	2	0	0	1982	0	2 0	0	0	0	0	0	0	0	15	5	6
1983	0	0	0	0	0	0	0	4	0	1	0	3	1983	Ō	0	8	0	0	0	0	0	0	0	0	Ó
1984	0	0	0	0	0	0	0	0	2	2	3	0	1984	0	0	1	14	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	4	0	1985	0	5	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	1	1	0	0	0	1986	0	0	0	0	0	0	U A	0	0	0	0	0
1988	õ	õ	0	0	o	õ	o	õ	o	õ	õ	2	1988	õ	õ	õ	0	0	0	õ	õ	õ	0	0	õ
1989	0	0	0	0	0	0	0	1	1	2	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	1	1	1	1	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	1	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	1 0	2	о 1	0	0	1992	0	0	0	0	0	0	0 n	0	0	0	0	0
1994	õ	õ	õ	õ	õ	õ	õ	õ	ō	0	õ	õ	1994	õ	õ	õ	õ	õ	õ	ō	õ	õ	õ	õ	õ
1995	0	0	0	0	0	0	0	0	2	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	2	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	1	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	U A	0	0	0	0	0	0	0	0	U A	0	0	1998	0	0	0	U n	U A	0	0	0	0	U n	0	0
2000	0	0	0	0	0	0	0	0	0	1	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	õ	õ	õ	õ	õ	õ	õ	õ	1	õ	õ	2001	õ	õ	õ	0	0	õ	õ	õ	õ	0	0	õ
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	υ	1	υ	0	2004	0	0	0	0	0	0	0	0	υ	0	0	U

 Table 4-1
 Summary of Exceeded and Missing Data at H1H003



Figure 4-2 Primary data plot for H1H003

There are 7 years in which there are four or more months missing. These values could be patched using simulated data. This gauge should be used for catchment calibration from 1962 to 2004 with patching required primarily to address the exceedences that occur.

4.2 H1H006 & H1H022: UPPER BREEDE RIVER AT WITBRUG





Background

The weir at Witbrug is a broad crested weir, located just downstream of the confluence of the Breede River and the ungauged Witels River tributary. The structure also consists of an intake on the left bank which feeds the Artois canal supplying water to across the catchment divide to farmers in the Klein Berg River catchment, and from which the town of Wolseley has an allocation.

The flow in the canal is measured at H1H022 and must be added to the flow record at the weir in order to determine the total streamflow. Observed flow data is available from 1950 and an automatic recorder was installed in 1962. The weir is a very low structure (structure limit is 0,35m), submerges easily and has a current DT limit of 2,07m. Many peak flows exceed the limit of the DT. The station experiences problems with high approach velocities (shallow water depth) often exacerbated by the accumulation of sediment in the upstream pool, forming an island.

This gauging station was used for catchment calibration in the Breede River Basin Study (BRBS, 2003) for the period 1964 to 1990. Base flows should be cautiously used and must allow for the diversion of water into the intake structure upstream of the weir. H1H006 is situated in an important location from a potential water resource development perspective, and associated hydrological studies.

Data Availability

Stage-time data is available from 1950 to date. Three DTs are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
8	1950 to 1959	2,44	139,5
9	1959 to 1982	2,04	224,9
10	1982 to date	2,07	290,2

Table 4-2 provides information on the number of days per month during which the DT was exceeded and the extent of missing data. The 1960/61 and 1981/82 hydrological years are missing but apart from these, there is relatively little missing data. The flow gauge is frequently exceeded during winter months and these values could be patched using the appropriate methodology.

Voar	Exceedance (No. days per month)												Year Missing Data (No. days per month))					
Tear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Teal	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
1949							1	0	0	3	0	0	1949							0	0	0	0	0	0			
1950	0	0	0	0	0	0	0	0	2	1	0	0	1950	0	0	0	0	0	0	0	0	0	0	0	0			
1951	0	0	0	0	0	0	0	1	0	0	3	0	1951	0	0	0	0	0	0	0	0	0	0	0	0			
1952	0	0	0	0	0	0	2	1	0	2	0	0	1952	0	0	0	0	0	0	0	0	0	0	0	0			
1953	0	0	0	0	0	0	1	6	1	6	3	0	1953	0	0	0	0	0	0	0	0	0	0	0	0			
1954	0	0	0	0	0	0	0	0	0	3	6	0	1954	0	0	0	0	0	0	0	0	0	0	0	0			
1955	1	0	0	0	0	0	0	0	1	3	2	0	1955	0	7	0	0	0	0	0	0	0	0	0	0			
1956	0	0	0	0	1	0	0	1	6	4	3	0	1956	0	0	0	0	0	0	0	0	0	0	0	0			
1957	2	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	29	30	31	31	30			
1958	0	0	0	0	0	0	0	2	0	0	0	0	1958	31	0	0	0	0	0	0	0	0	0	0	0			
1959	0	0	0	0	0	0	0	0	1	0	0	0	1959	0	20	21	21	0	21	20	0	20	0	0	20			
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	30	0	0	20	0	30	0	30	0	0	30			
1062	2	0	0	0	0	0	0	0	0	1	3	0	1062	0	0	0	0	0	0	0	0	0	0	0	0			
1963	0	0	0	0	0	0	0	0	1	0	0	0	1962	0	0	0	0	0	0	0	0	0	0	0	0			
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0			
1965	0	0	0	0	0	0	0	0	1	2	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0			
1966	0	0	0	0	0	Ő	0	0	2	0	0	Ő	1966	Ő	0	0	0	Ő	0	0	0	0	0	0	0			
1967	0	0	0	0	0	0	0	3	0	0	0	0	1967	0	0	0	0	0	õ	0	0	0	0	0	0			
1968	0	0	0	0	0	0	0	0	0	0	õ	0	1968	2	0	0	0	0	õ	0	0	0	0	õ	0			
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0			
1970	0	0	0	0	0	0	0	0	0	1	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0			
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0			
1972	0	0	0	0	0	0	0	0	0	1	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0			
1973	0	0	0	0	0	0	0	0	0	0	4	0	1973	0	0	0	0	0	0	0	0	0	0	2	0			
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0			
1975	0	0	0	0	0	0	0	0	2	1	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0			
1976	0	2	0	0	0	0	0	3	1	3	3	0	1976	0	0	0	0	0	0	0	0	0	0	0	0			
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0			
1978	0	0	0	0	0	0	0	0	1	0	0	1	1978	0	0	0	0	0	0	0	0	0	0	0	0			
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0			
1980	0	0	0	0	0	0	0	0	0	0	0	1	1980	0	0	0	0	0	0	0	0	0	0	0	0			
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	1	31	31	28	31	30	31	30	31	31	30			
1902	0	0	0	0	0	0	0	2	5	4	0	2	1902	0	30	0	0	0	0	0	2	0	0	0	0			
1084	0	0	0	0	0	0	0	2	2	1	3	2	1003	0	0	0	0	0	0	0	2	0	0	0	0			
1085	0	0	0	0	0	0	0	0	0	0	3	0	1085	0	0	0	0	0	0	0	0	0	0	0	0			
1986	0	0	0	0	0	Ő	0	1	1	0	0	0	1986	Ő	0	0	0	0	0	0	0	0	0	0	0			
1987	0	0	0	0	0	0	0	0	1	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0			
1988	0	0	0	0	0	0	0	0	0	0	0	2	1988	0	0	0	0	0	0	0	0	0	0	0	0			
1989	0	0	0	0	0	0	1	1	1	2	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0			
1990	0	0	0	0	0	0	0	0	2	1	1	0	1990	0	0	0	0	0	0	0	0	0	0	0	0			
1991	0	0	0	0	0	0	0	0	2	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0			
1992	0	0	0	0	0	0	0	0	0	3	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0			
1993	0	0	0	0	0	0	0	0	1	2	0	0	1993	0	0	0	0	0	0	0	0	9	0	0	0			
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0			
1995	0	0	0	0	0	0	0	0	3	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0			
1996	0	0	0	0	0	0	0	0	2	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0			
1997	0	0	0	0	0	0	0	1	0	0	0	0	1997	0	0	0	10	12	0	0	0	0	0	0	0			
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0			
1999	0	U	0	0	0	0	0	U	U	0	U	U	1999	U	U	0	U	0	U	0	0	U	U	U	U			
2000	0	0	0	0	0	0	0	0	0	ן א	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0			
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0			
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0			
2003	n	0	0	n	n	n	n	0	0	1	0	n	2004	0	0	0	0	n	0 0	n	0	0 0	0	0	0			
2005	0	0	0	0	0	õ	õ	0	5		5	5	2005	0	0	0	0	0	õ	0	0	5	5	5	5			

 Table 4-2
 Summary of Exceeded and Missing Data at H1H006



A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 4-3.

Figure 4-3 Primary data plot for H1H006

Recommendations

This gauging station should be used for catchment calibration purposes but significant patching will be required. Data is available to the end of the 2004/05 hydrological year. In view of its future strategic importance with respect to the assessment of the potential inter-basin transfer schemes, DWAF should investigate the opportunity to further increase the DT limit to at least 3,0m and to ensure regular maintenance of the upstream pool.

4.3 H1H007 : WIT RIVER AT DROSTERSKLOOF



Background

The Wit River is a tributary of the Breede River and drains the catchment in which the Bain's Kloof Pass is located. The weir was established in 1935 but flow information is only available from 1950, and automated data from 1961 onwards. The weir consists of three low flow, sharp crested notch sections and is easily submerged.

Many current gaugings have been undertaken to date and it has been possible to calibrate this section to an upper DT limit of 2,26m. A number of peak flow events still exceed the DT limit and as such, DWAF are proposing that current gauging be undertaken to calibrate the section and extend the DT limit to about 3,0m. This will need to be undertaken when the water levels in the river next exceed the existing DT limit.

Data Availability

Stage-time data is available from 1950 to date. Two DTs are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
8	1950 to 1973	2,26	150,1
11	1973 to date	2,26	154,6

Table 4-3 provides information on the number of days per month during which the DT was exceeded and the extent of missing data in the record.

Table 4-3	Summary of Exceeded and Missing Data at H1H007
-----------	--

~			I	Excee	danc	e (No	. days	per r	nonth)							N	lissin	g Dat	a (No	. days	per i	month)		
Year	Oct	Nov	Dec	Jan	Feb	Ňаг	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1949	0	0	0	0	0	0	1	0	0	1	0	0	1949	31	30	31	31	28	31	9	0	0	0	0	0
1950	0	0	0	0	0	0	1	0	0	0	0	0	1950	0	0	0	0	0	0	0	0	0	0	0	0
1951	1	0	0	0	0	0	2	1	0	2	1	0	1952	0	0	0	0	0	0	0	0	0	0	3	11
1953	0	0	0	0	0	0	0	0	0	1	0	0	1953	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	1	1	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	1	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	1956	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	1	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	1	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	5	3	0	0	0	0	26	30	31	31	30
1961	0	0	0	0	0	0	0	0	2	2	0	0	1961	31	30	31	31	28	31	30	16	0	0	0	0
1962	1	0	0	0	0	0	0	0	0	1	2	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	1	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	4	4
1965	0	0	0	0	0	0	0	0	1	2	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	2	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	1	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	1	0	1	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	5	2	0	0	0
1972	0	0	0	0	0	0	0	0	0	3	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	3	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	1	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	3	2	0	0	1975	0	0	0	0	0	0	0	0	0	0	20	2
1976	0	0	0	0	0	0	1	0	0	0	2	0	1976	0	20	2	0	0	0	0	5 0	0	0	0	0
1978	0	0	0	0	0	0	0	1	1	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	2	2	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	1	0	0	0	0	0	1	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	10	12	0	0	0	0	0
1983	0	0	0	0	0	0	0	2	2	0	1	0	1983	0	0	0	0	0	0	0	0	3	13	0	8
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	1	7	13	23	26	31	28	15
1985	0	0	0	0	0	0	0	0	0	2	3	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	1	0	0	1986	0	0	0	0	0	15	8	0	0	0	0	0
1987	0	0	0	0	0	0	0	1	1	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	1	0	1	2	2	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	2	2	2	0	1	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	2	5	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	1	1	1	3	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	4	1	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	0	0	0	0	0	0	0	4	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	1	0	0	0	0	0	0	2	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	3	1	1	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	1	0	0	0	0	0	0	0	1	0	1	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	1	0	1	0	1	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	1 1	0	2	2	1 0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	2	1	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	õ	õ	õ	1	0	1	0	2003	0	0	õ	0	0	õ	õ	0	õ	0	0	0
2004	0	0	0	0	0	0	0	0	2	1	1	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	1					2005	0	0	0	0	0	0	0	0				

A plot of the primary data recorded at the weir for the full duration of the available record is shown in Figure 4-4. The limit of the DT is also indicated.


Figure 4-4 Primary data plot for H1H007

This gauge was used for catchment model calibration in the BRBS (2002) for the period 1961 to 1990. An additional 14 years of data is now available against which to calibrate. There is some missing and exceeded data that will require patching. Current gaugings should be undertaken when the water levels next exceed the existing DT limit. Backwater calculations can also be attempted if a proper flood survey is done and flood water levels are recorded. However, high water velocities may limit the success of a backwater calculation.

4.4 H1H012 : HOLSLOOT RIVER AT DASCHBOSCH

Background

This station is located on the Holsloot River at Daschbosch, where a diversion structure diverts water into the Holsloot Canal.

Data Availability

Stage-time data is available from 1963 to 1986, when recordings were discontinued and the station was closed. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
5	1963 to 1986	3,54	1017

Suitability for Catchment Calibration

Table 4-5 provides information on the number of days per month during which the DT was exceeded and the extent of missing data.

Vaar	Exceedance (No. days per month)												Vaar			N	lissin	g Dat	a (No	. days	s per r	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	6	2	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	8	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	8	8	25	31	30
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	31	30	31	31	28	31	30	31	30	31	31	30
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	31	30	31	31	28	31	30	31	30	31	31	30
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	31	30	31	31	28	31	30	31	30	31	31	30
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	31	30	31	31	29	31	30	31	30	31	31	25
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	6	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	17	30	31	31	29	31	30	17	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	17	17	17	17	17	17	17
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	17	17	17	17	17	17	17	17	17	17	17	17

Recommendations

This gauge was not used for catchment model calibration purposes during the BRBS (2002). Although that report did not indicate the reason for its exclusion, it is apparent from the extent of missing data and the fact that this station was discontinued in 1986, that the record may not be reliable. If a calibration is attempted for the period between 1963 and 1974, then the results should be considered in light of this.



Background

This gauging station is located on the Koekedouw River near Ceres and has a catchment area of 53km². It was used for catchment calibration purposes during the BRBS of 2002, for the period 1964 to 1990. That study reported that the flow data was considered to be accurate. The gauge lies downstream of the Koekedouw Dam (13,7 million m³) which was completed in 1998, at the same site of the former Ceres Dam which was only of 0,3 million m³ capacity.

Data Availability

Stage-time data is available from 1964 to date. Three DTs are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
5	1965 to 1967	1,50	27,7
6	1967	0,85	8,3
0	1967 to 1968	-	-
8	1968 to date	2,00	65,1

Table 4-5 provides information on the number of days per month during which the DT was exceeded and the extent of missing data.

Table 4-5	Summary of Exceeded and Missing Data at H1H013
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Veer		Exceedance (No. days per month)								Veer			M	lissin	g Dat	a (No	. days	s per r	nonth	ı)					
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1964					0	0	0	0	0	0	0	0	1964					0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	12	2	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	30
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	31	30	31	31	29	31	4	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	8	0	0	0	0	0	0	0	2
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	11	0	0	0	0	0	4	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	1	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	1	11	11	0	0	0	0	0	0	2	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	25	30
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	31	30	31	0	0	0	0	0	0	0	0	0
1976	0	2	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	5	5	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	12
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	5	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	1	0	0	0	1984	0	0	0	0	0	0	4	20	0	0	0	8
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	5	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	5	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1006	0	0	0	0	0	0	0	0	0	0	0	5
1007	0	0	0	0	0	0	0	0	0	0	0	0	1007	0	0	0	0	0	0	0	0	0	0	0	0
1008	0	0	0	0	0	0	0	0	0	0	0	0	1008	0	0	0	0	0	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	õ	õ	0	õ	0	0	õ	0	2002	0	0	õ	0	0	0	0	0	0	0	õ	õ
2003	õ	õ	õ	õ	õ	õ	0	õ	õ	0	õ	õ	2003	0	õ	õ	õ	0	õ	0	õ	0	0	õ	0
2004	õ	0	Ő	õ	õ	õ	0	õ	0	0	õ	Ő	2004	0	õ	õ	õ	0	0	0	0	0	0	õ	0
2005	0	0	0	0	0	Õ	0	Ő	0	0	ÿ	ÿ	2005	0	0	õ	õ	0	0	0	0	0	0	č	Ũ

A plot of recorded primary data for the full duration of the available record is shown in Figure 4-5. The limit of the DTs are also indicated.



Figure 4-5 Primary data plot for H1H013

This gauging station should be used for catchment model calibration, taking advantage of the additional 14 years of data that is now available to the end of the 2004/05 hydrological year. There is relatively little exceeded and missing data to be patched.



Background

This gauging station was opened in February 1969. It consists of a sharp crested weir. The weir's upstream pool is severely affected by siltation as a result of large boulders. The pool has to be closed at least once a year in order for it to be cleaned. The upstream depth of the cleaned pool is 0,40m resulting in high approach velocities due to the shallow depth.

Submergence data indicates that the gauge plates at this weir have been moved several

times, firstly in 1969, then again prior to 1980 (date uncertain), and finally in 1983 to its present location. The upstream gauge plate was originally fitted to the weir but was moved upstream in 1983 to where the recorder pipe is situated. It is still in this location.

DWAF have undertaken numerous current gauging exercises and submergence data evaluations, to support the development in an increased DT above the current stage limit.

Data Availability

Stage-time data is available from 1969 to date. Two DTs are applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
4	1969 to 1994	3,16	717,8
5	1994 to date	2,82	559,6

Table 4-6 provides information on the number of days per month during which the DT was exceeded and the extent of missing data. There is no exceeded data and that which is missing can be patched.

Table 4-6 S	ummary of Exceeded	and Missing Data at H1H018
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	Exceedance (No. days per month) Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug S												v			N	lissin	g Dat	a (No	. days	s per r	nonth)		<u> </u>
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1968					0	0	0	0	0	0	0	0	1968					0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	9	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	19/0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	19//	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	12	3	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	õ	0	0	0	0	0	0	0	0	0	1981	0	0	0	14	1	õ	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	5	0	0	0	0	4	30	2	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	3	5	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	7	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	16	30	4	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	õ	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	õ	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0					2005	0	0	0	0	0	0	0	0				

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 4-6.



Figure 4-6 Primary data plot for H1H018

This gauge was used for catchment model calibration in the BRBS (2002) for the period from 1968 to 1990. An additional 14 years of data is now available against which to calibrate.

DWAF to confirm if the current gauging and submergence data assessments have been incorporated into the DT's, and if not, to do so.

4.7 H1H033 : ELANDS RIVER AT HAWEQUAS FORESTRY RESERVE



Background

The Elands River is a tributary of the Molenaars River with its confluence at the Worcester side of the Du Toits Kloof Tunnel. There are two gauging sites on the Elands River, located in close proximity to one another, namely H1H017 and H1H033. The latter was opened in April 1991 as a replacement to H1H017, which was considered to be unreliable and was closed in June 1992.

During the Breede River Basin Study (2003), a

strategic decision was taken not to calibrate the Elands River catchment. The previous attempt to do so had been during the Breede River Hydrology Study (1990), during which it had not been possible to calibrate on the record available at H1H017, and the record at H1H033 was too short at that time

H1H033 had originally been a diversion weir, supplying water to the construction of the Du Toits Kloof Tunnel. This was subsequently modified into a fully operational gauging station in 1991.

Data Availability

As shown in **Table 4-7** there are now 15 years of record against which to calibrate. The record is considered to be reliable.

Vaar	Exceedance (No. days per month)												Vaar			Ν	lissin	g Dat	ta (No	. days	s per i	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	2	22	0	0	0	0	0	6	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	6	0	0	0	0	0	0	6	6	6	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-7 Summary of Exceeded and Missing Data at H1H033

Recommendations

This record should be used to calibrate the Elands River catchment. A correlation should be attempted based on the overlapping period of 14 months between the two gauges.

4.8 H4H006 : BREEDE RIVER AT LOWER BRANDVLEI



Background

H4H006 is located on the Breede River, just below the Greater Brandvlei off-channel storage Dam. Prior to the Breede River Basin Study (2003), the Breede River Hydrology Study (1990) had identified this station as being unreliable, and a gauging station (H4H017) further downstream at Le Chasseur, was constructed in 1980. H4H017 falls outside of the geographical scope of this study.

The river reach between Witbrug and that adjacent to Greater Brandvlei Dam does not have adequate gauging sites and it is with this in mind that an attempted catchment calibration at this station is considered worthwhile.

Data Availability

Stage-time data is available from 1950 to 1989, when the station was closed due to its poor record. The available DTs are only applicable from 1955. Automatic recordings started in 1965 and were continued until 1989.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
6	1955 to 1979	4,03	1011,0
7	1979 to 1989	3,81	916,4

Suitability for Catchment Calibration

Table 4-8 provides information on the number of days per month during which the DT was exceeded and the extent of missing data.

Table 4-8	Summary of Exceeded and	Missing Data at H4H006
-----------	-------------------------	------------------------

V			E	xcee	danc	e (No.	days	per n	nonth)			V			N	lissin	g Dat	a (No	. day	s per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1950	0	0	0	0	0	0	0	0	0	0	0	0	1950	31	30	31	31	28	31	30	31	30	31	31	30
1951	0	0	0	0	0	0	0	0	0	0	0	0	1951	31	30	31	31	29	31	30	31	30	31	31	30
1952	0	0	0	0	0	0	0	0	0	0	0	0	1952	31	30	31	31	28	31	30	31	30	31	31	30
1953	0	0	0	0	0	0	0	0	0	0	0	0	1953	31	30	31	31	28	31	30	31	30	31	31	30
1954	0	0	0	0	0	0	0	0	0	0	0	0	1954	31	30	31	31	28	31	0	0	0	0	6	2
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1950	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	0	0	6
1961	0	0	0	0	0	0	0	0	0	0	0	0	1961	0	0	0	0	0	0	0	0	0	0	8	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	1962	0	0	0	0	14	1	0	0	10	31	24	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	7	2	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	9	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	24	6	0	4	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	3	3	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	4	0	0	0	0	0	0	0	0	0	0	4
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	15	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	8	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	5	23	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	1	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	õ	0	0	0	0	0	0	1974	0	0	0	0	Ő	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	1	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	1	0	0	0	0	0	0	0	0	2	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	8	0	0	8	8	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	8	0	0	0	0	8	0	24	17	11	0	0
1983	0	0	0	0	0	0	0	2	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	4	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	4
190/	0	0	0	0	0	0	0	0	0	0	0	0	190/	0	0	0	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0	1080	0	0	0	0	0	0	0	0	0	0	0	0
1909	0	0	0	0	0	0	0	0	0	0	0	0	1909	0	0	0	0	0	0	0	0	0	0	0	0
1330	U	U	U	U	U	U	U	U	U	U	U	U	1330	U	U	U	U	U	U	U	U	U	U	U	U

The period prior to 1966 should be not be used for catchment calibration purposes, due to the missing data within the first five years and the fact that automated recordings only commenced during 1965. Patching of sporadic missing data would be necessary for the period 1966 to 1990.

ASSESSMENT OF STREAM FLOW GAUGING STATIONS UPPER RIVIERSONDEREND RIVER CATCHMENT

5. UPPER RIVIERSONDEREND RIVER CATCHMENT

- H6H007 : DU TOIT'S RIVER AT PURGATORY UITSPAN
- H6H008 : RIVIERSONDEREND AT NUWEBERG FOREST
- H6R001 : RIVIERSONDEREND AT THEEWATERSKLOOF DAM
- H62002 : ELANDS RIVER AT ELANDSKLOOF DAM

It should be noted that during the Breede River Basin Study, the only catchment calibration undertaken on the main stem Riviersonderend River was at the Reenen streamflow gauging station (H6H009). This was done by adding the spills and releases from Theewaterskloof dam as an inflow to the H6H009 catchment and calibrating up to the end of the 1997/98 hydrological year. As part of that study, no calibration was therefore undertaken on the inflow to Theewaterskloof Dam or on any of the gauged sub-catchments within the Theewaterskloof Dam catchment. Figure 5-1 shows the Upper Riviersonderend River catchment area and the location of the above gauging stations.



Figure 5-1 Streamflow Gauging Stations in the Upper Riviersonderend River Catchment

5.1 H6H007 : DU TOIT'S RIVER AT PURGATORY UITSPAN



Backround

This gauging station was used for catchment calibration in the WCSA study for the period from 1964 to 1988. It has a low accuracy rating despite relatively little missing and exceeded data. The upstream pool at this gauging station became silted up every winter.

An island of boulders that extended approximately 1m above the low notch of the weir was common. As a result, the main flow of water across the weir was not through the low notch.

The recorder inlet pipe was situated opposite the low notch therefore, underestimated the actual flows at this weir. This station was closed in 1992 due to the high maintenance requirements and extremely difficult access (steep terrain).

Data Availability

Stage-time data is available from 1964 to 1992. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m ³ /s)
3	1964 to 1992	2,10	73,7

Table 5-1 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

Veer			E	xcee	dance	e (No.	days	per n	nonth)			Veer			N	lissin	g Dat	a (No	. days	s per r	nonth	I)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1963						0	0	0	0	0	0	0	1963						0	20	8	0	8	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	2	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	1	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	10	0	0
1903	0	0	0	0	0	0	0	0	2	1	0	0	1903	0	0	0	0	0	0	0	0	0	0	0	0
1004	0	0	0	0	0	0	0	0	2	0	0	0	1904	0	0	0	11	11	0	0	0	0	0	0	0
1086	0	0	0	0	0	0	0	0	0	0	0	0	1086	0	0	0	0	0	0	0	0	0	0	0	0
1087	0	0	0	0	0	0	0	0	0	0	0	0	1900	0	0	0	0	0	0	0	0	1	0	0	0
1088	0	0	0	0	0	0	0	0	0	0	0	0	1088	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	29	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	1	0	0	0	1990	0	0	0	0	0	0	0	19	17	0	0	0
1991	0	0	0	0	0	0	0	0	1	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0

Table 5-1 Summary of Exceeded and Missing Data at H6H007

There is very little missing and exceeded data in the record requiring patching. Only 3 years of additional record are available from that which was calibrated during the WCSA. The catchment has remained relatively undeveloped and it should be possible to calibrate on the historical record up to the end of the 1991/92 hydrological year.

Reinstatement of this station would require refurbishment. As a result of the access difficulties (particularly in relation to mechanical equipment), is likely to be prohibitively expensive.

5.2 H6H008 : RIVIERSONDEREND AT NUWEBERG FOREST

Background

This station is located very high up in the Upper Riviersonderend catchment and has a catchment area of 38km². During the WCSA, this gauging station was used for catchment model calibration in the upper catchment of the Theewaterskloof Dam for the period 1964 to 1988. The gauge was assigned an accuracy rating of 4 during that study.

In 1992 it was closed due to siltation problems. The DT limit was frequently exceeded in the winter months and patching was undertaken to resolve this. DWAF are currently considering reinstating this gauge but anticipate this having a fairly significant capital cost.

Data Availability

Stage-time data is available from 1964 to 1992. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
4	1964 to 1992	1,90	41,41

Suitability for Catchment Calibration

Table 5-2 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

|--|

Vee			E	xcee	danc	e (No	. days	s per n	nonth)			Vee			N	lissin	ig Dat	a (No	. day	s per i	month	ו)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1963							0	1	3	1	1	0	1963							0	8	0	0	0	0
1964	0	0	0	0	0	0	0	2	0	0	2	0	1964	0	0	0	0	0	0	10	0	0	0	0	0
1965	0	0	0	0	0	0	2	0	1	3	0	1	1965	0	0	0	0	0	0	0	0	0	3	0	0
1966	0	0	0	0	0	0	0	0	0	0	1	0	1966	0	0	0	0	0	0	0	0	0	8	0	0
1967	1	0	0	0	0	0	0	3	2	2	0	0	1967	0	0	0	0	0	0	0	0	8	0	0	0
1968	0	0	0	0	0	0	0	0	0	1	0	0	1968	0	0	0	0	0	0	0	0	8	0	10	12
1969	0	0	0	0	0	0	0	1	2	1	1	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	4	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	1	1	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	3	1	0	1972	0	0	0	0	0	0	0	0	0	0	0	7
1973	0	0	0	0	0	0	0	0	1	0	1	0	1973	1	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	2	1	0	1974	0	0	0	8	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	2	3	0	0	1975	0	0	0	0	0	0	0	0	6	0	0	0
1976	0	1	3	0	0	0	2	2	7	2	2	0	1976	0	0	1	3	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	1	1	1	1977	0	0	8	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	2	1	0	0	1	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	2	2	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	1	0	0	0	0	0	2	0	2	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	1	0	1981	0	0	4	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	2	2	1	0	0	1982	0	0	0	0	0	8	20	0	0	0	0	0
1983	0	0	0	0	0	0	0	4	1	3	1	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	1	0	0	0	0	1	0	0	2	3	1	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	1	1	2	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	1	0	1	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	1	1	0	1	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	2	1	2	0	1	1	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	1	0	2	2	1	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	1	2	2	0	3	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	1	1	3	1	0	0	1991	7	0	0	0	0	0	0	0	0	0	0	0

Patching of missing and exceeded data would be required for this record. Data is now available to the end of the 1991/92 hydrological year and this could be used to extend the previous calibration period by three years.

Reinstatement costs should be estimated and these considered in light of the importance of the data from this station.

5.3 H6R001 : RIVIERSONDEREND AT THEEWATERSKLOOF DAM



Background

Theewaterskloof Dam is located in the upper catchment of the Riviersonderend River. The dam was completed in 1975. There are four gauged sub-catchments within its catchment area, namely:

- H6H010 (Waterkloof River);
- H6H008 (Nuweberg);
- H6H007 (Du Toits River) and
- H6R002 (Elandskloof Dam)

Data Availability

In order to assess the data availability, it is necessary to first identify the approach that is likely to be adopted to model the inflow to the dam. The most recent calibration for the incremental catchment of the dam was undertaken during the feasibility study for the Berg River Dam (formerly Skuifraam Dam), dated 1997, for which the hydrology extended to the end of the 1993/94 hydrological year. The approach adopted proved to be successful and produced a good calibration. The same approach will be adopted for this study and will involve concatenating (joining) three observed flow records into one, taking into account:

- the period before the dam was constructed;
- the period after construction but before releases into the Theewaterskloof tunnel; and
- the period thereafter.

The proposed development of the observed inflow record to Theewaterskloof Dam is briefly described as follows:

October 1967 to May 1974:

Gauge H6H003 provides the portion of record before construction activities at the dam influenced the reliability of this station. The period prior to 1967 will be excluded as this has previously been identified as being of lower reliability than the remainder. This gauge eventually became submerged when the dam was completed.

June 1974 to December 1979

Gauge H6H012 which was constructed downstream of the dam to measure spills and releases into the Riviersonderend River will provide the flow record for the period prior to impoundment.

January 1980 to date

Gauge H6R001 which comprises the calculated inflow record to Theewaterskloof Dam, will provide the remaining portion of the inflow record, and will be provided by DWAF in the form of a reservoir balance sheet.

It is proposed that the previous composite record be further extended from 1993 to the end of the 2004/05 hydrological year, effectively providing an additional 11 years of record against which to calibrate. Particular caution should be paid to the period between January 1980 and June 1984, which has previously been identified as being less reliable than the rest of the record.

5.4 H6R002 : ELANDS RIVER AT ELANDSKLOOF DAM



Background

Elandskloof Dam is located on the Elands River, a tributary of the Riviersondered River and is situated upstream of Theewaterskloof Dam.

Data Availability

Observed inflow data is available at Elandskloof Dam from 1982, when it began operating. This information is not available on the DWAF website and has been requested from the Department in the form of a reservoir

balance sheet against which to calibrate the runoff from this catchment.

ASSESSMENT OF STREAMFLOW GAUGING STATIONS EERSTE AND LOURENS RIVER CATCHMENTS

6. EERSTE AND LOURENS RIVER CATCHMENTS

- G2R001 : JONKERSHOEK RIVER AT KLEINPLAAS DAM
- G2H005 : JONKERSHOEK RIVER AT JONKERSHOEK
- G2H008 : JONKERSHOEK RIVER AT JONKERSHOEK
- G2H015 : EERSTE RIVER AT FAURE
- G2H016 : LOURENS RIVER AT SOMERSET WEST
- G2H020 : EERSTE RIVER AT FLEURBAAI
- G2H029 : LOURENS RIVER AT STRAND
- G2H030 : RIGHT BANK CANAL FROM EERSTE RIVER AT STELLENBOSCH
- G2H037 : JONKERSHOEK RIVER AT KLEINPLAAS
- G2H040 : EERSTE RIVER AT KLEIN WELMOED
- G2H043 : LOURENS RIVER AT ESTUARY
- G2H044 : LOURENS RIVER AT STRAND

Figure 6-1 shows the Lourens and Eerste River catchment areas and the location of the above streamflow gauging stations.



Figure 6-1 Streamflow Gauging Stations in the Eerste and Lourens River Catchments

6.1 G2R001 : JONKERSHOEK RIVER AT KLEINPLAAS DAM

Background

This gauging station was opened in 1983. It was not used for catchment calibration in the WCSA due to the rapid variations in water stored in the dam as a result of the transfer scheme. The spillway of the dam consists of an ogee crest and it acts as a balancing dam for the intercatchment transfer of water from the Theewaterskloof Dam to the Cape Town basin. Gauging station G2H005 is located approximately 500m downstream of the dam wall and measures spills and compensation releases from the dam.

Data Availability

Stage-time data is available from 1983 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1983 to date	3,00	410,9

Suitability for Catchment Calibration

Table 6-1 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. The extent of missing data between 1993 and 1999 limits the use of this record for catchment calibration purposes.

Table 6-1	Summary	of Exceeded and	Missing	Data at	G2R001
-----------	---------	-----------------	---------	---------	--------

Veen			E	xcee	danc	e (No.	days	per n	nonth)		A Sen Year Missing Data (No. days per month)													
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1982				0	0	0	0	0	0	0	0	0	1982				0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	1	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	11	31	30
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	31	30	31	31	28	31	30	31	30	31	31	30
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	31	30	31	31	29	31	30	31	30	31	31	30
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	31	30	31	31	28	31	30	31	30	31	31	30
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	31	30	31	31	28	31	30	31	30	31	31	30
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	31	30	31	31	24	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	9	12	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0					2005	0	0	0	0	0	0	0	0				

Recommendations

It is recommended that the monthly inflow to this dam from its own incremental catchment be calibrated. This will be based on the use of the reservoir balance sheet and will effectively assume that the volumes transferred in and out of the dam are in balance. This approach will be dependent on the availability and quality of the information available in the reservoir balance sheet.

6.2 G2H005 : JONKERSHOEK RIVER AT JONKERSHOEK



Background

This gauging station is located on the Jonkershoek River, downstream of both G2H008 and G2H037. It was used for catchment model calibration in the WCSA study for the period before the construction of Kleinplaas Dam (1947 to 1974). The gauge was opened in 1940 and the following flow data is available:

- 1947 to 1957: flow in cusecs on a daily basis or whenever readings were taken
- 1960 to 1976: daily flows volumes (m³)
- 1981 to date: primary stage data

Data Availability

Stage-time data is available from 1947 to date and one DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
4	1947 to date	2,40	61,83

Table 6-2 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

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Table 6-2	Summary	f Exceeded and Missing	Data at G2H005
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				Excee	danc	e (No.	davs	per n	nonth)						Ν	<i>l</i> issir	ng Dat	a (No	. dav	s per r	nonth)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Anr	Mav	Jun	, Jul	Αυα	Sen	Year	Oct	Nov	Dec	Jan	Feb	Mar	Anr	Mav	Jun	Jul	Αυα	Sen
1947	0	0	0	0	0	0	0	0	0	0	0	0	1947	0	0	31	31	29	31	30	31	30	31	31	30
1948	Õ	0	Ő	Ő	0	Õ	0	0	0	0	0	0	1948	31	30	31	0	0	0	0	0	0	0	0	0
1949	0 0	0 0	0	0	0	0 0	0 0	0	0	0	0	0	1949	0	0	0	0	0 0	0	0	0	0	0 0	0	0
1950	Ő	0 0	0	0	0	0	Ő	ñ	ñ	0	Ő	ñ	1950	0 0	Ő	Ő	0	0 0	Ő	0	0	0 0	Ő	0	ñ
1951	0	0	0	0	0	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	0	0	0	0	15
1052	0	0	0	0	0	0	0	0	0	0	0	0	1052	0	0	0	0	0	0	0	0	0	0	0	0
1052	0	0	0	0	0	0	0	0	0	0	0	0	1052	0	0	0	0	0	0	0	0	0	0	0	0
105/	0	0	0	0	0	0	0	0	0	0	0	0	105/	0	0	0	0	0	0	0	0	0	0	0	0
1055	0	0	0	0	0	0	0	0	0	0	0	0	1055	0	0	0	0	0	0	0	0	0	0	0	0
1056	0	0	0	0	0	0	0	0	0	0	0	0	1056	0	0	0	0	0	0	0	0	0	0	0	16
1950	0	0	0	0	0	0	0	0	0	0	0	0	1950	0	20	0	24	20	0	20	0	20	0	0	10
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	31	30	31	31	28	31	30	31	30	31	31	30
1950	0	0	0	0	0	0	0	0	0	0	0	0	1950	31	30	31	31	28	31	30	31	30	31	31	30
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	31	30	31	31	29	31	0	5	30	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1964	8	0	0	0	0	0	2	5	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	0	14	31	11	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	5	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	5	1	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	5	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	7	0	0	0	0	0	0	5	0	3	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	5	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	5	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	3	0	0	1	30	31	30	31	31	30
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	31	30	31	31	28	31	30	31	30	31	31	30
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	31	30	31	31	28	31	30	31	30	31	31	30
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	31	30	31	31	28	31	30	31	30	31	31	30
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	31	30	31	31	29	31	30	31	30	31	31	30
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	31	30	31	31	28	31	30	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	1	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	Ő	0	0	0	0	0	Ő	Ő	0	0	õ	Ő	2005	0	0	0	0	Ő	Ő	Ő	0	0	0	0	0



A plot of the water levels across the weir for the full duration of the available record is shown in Figure 6-2. This also shows the period when the Kleinplaas Dam was being constructed.

Figure 6-2 Primary data plot for G2H005

Recommendations

This station was used for catchment calibration purposes in the WCSA for the period prior to the construction of the dam (1948 to 1974). The spill record from the dam is available from 1981 to date and provides an additional 24 years of observed record, which can be used in the reservoir balance calculation to determine the net incremental inflow into Kleinplaas Dam from 1981 to date.

6.3 G2H008 : JONKERSHOEK RIVER AT JONKERSHOEK



Background

This gauging station was opened in 1947 and consists of a broad crested weir that is considered to be relatively accurate for high flows but less accurate under low flow conditions. Stellenbosch Municipality abstracts water upstream of the station via a pipeline in the upstream pool. The upstream pool tends to silt up but this has been taken into account in the DT. In May 1989, a crump weir was opened (G2H037) about 500m downstream of the gauge and measures low

flows more accurately. The correlation between these two stations is good. G2H008 was closed in 1995, after G2H037 had been recording information over a six-year correlation period.

Data Availability

Stage-time data is available from 1947 to 1995 and one DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
7	1947 to 1995	1,55	46,7

Table 6-3 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

			E	Excee	danc	e (No	. days	s per r	nonth)						N	lissir	g Dat	ta (No	. day	s per i	month	n)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1946									0	0	0	0	1946									0	0	0	0
1947	0	0	0	0	0	0	0	0	0	0	0	0	1947	0	0	0	0	0	0	0	0	0	0	0	0
1948	0	0	0	0	0	0	0	0	0	0	0	0	1948	0	0	0	0	0	0	0	0	0	0	0	0
1949	0	0	0	0	0	0	1	0	0	0	0	0	1949	0	0	0	0	0	0	0	0	0	0	0	0
1950	0	0	0	0	0	0	0	0	0	0	0	0	1950	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	2	0	0	0	0	0	0	0	1951	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	1952	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	1953	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	1	0	0	0	0	0	0	0	1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	1956	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	1959	0	0	0	0	0	2	5	0	6	6	31	30
1960	0	0	0	0	0	0	0	0	0	0	0	0	1960	12	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	1961	0	0	0	0	0	0	0	0	0	0	0	6
1902	0	0	0	0	0	0	0	0	0	0	0	0	1062	2	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	1064	0	0	0	0	8	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	1965	8	15	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	8	0
1967	Ő	0	õ	0	0	0	0	0	õ	0	0	0	1967	0	õ	0	0	16	õ	3	0	õ	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	5	3	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	7	1	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	3	5	20	16	4	5	8	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	8	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	15	0	8	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0	1900	0	0	0	0	15	0	0	0	0	0	0	0
1092	0	0	0	0	0	0	0	0	0	0	0	0	10901	0	0	0	0	0	0	0	0	5	1	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	6	2	0	0	0	15	30	13
1984	Ő	0	0	0	0	0	0	0	0	0	0	0	1984	0	10	31	17	0	1	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	8	8	9	8	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	1	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	1	4	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	8	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	4	4	8	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	7	0	0
1994	0	0	0	0	0	0	0						1994	0	0	0	0	0	0	0					

Table 6-3 Summary of Exceeded and Missing Data at G2H008

Recommendations

This station was used for catchment calibration purposes in the WCSA for the period 1947 to 1988. An additional 5 years of observed record is available against which to calibrate. However, calibration of this gauging station has previously proved difficult due to discrepancies in the rainfall isohyets. This aspect is being addressed as part of this Berg WAAS. The extent of missing and exceeded data is relatively small and these monthly values could be patched.





Background

G2H015 was used for catchment calibration in the WCSA for the period between 1968 and 1980. It is a rated cross-section near the road bridge. It was opened in 1968 and closed in 1980 due to the water level measurements being taken at an unstable location, where significant sedimentation problems were being experienced. It is located on a bend in the river which is the primary reason for the sedimentation. The station was however unofficially reopened in 2002 in order to correlate the measured flows at the newer station (G2H040) that had been constructed upstream and was opened in 1999. Once the correlation has been completed, it is likely that the station will again be closed.

Data Availability

Stage-time data is available from 1968 to 1980 and again from 2002 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
3	1968 to 1980	3 99	49 1
	2002 to date	5,55	10,1
Т	•	·	·

able 6-4 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. The gauge is often exceeded during winter months and there is some missing data which could be patched in the useable portion of the record (1968 to 1980). DT 3 will remain unchanged until it can be improved by correlation with G2h040.

Veer			E	xcee	dance	e (No.	days	per n	nonth)			Veer			N	lissin	g Dat	a (No	. days	s per i	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep
1967							0	0	0	0	0	0	1967							0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	1	7	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	2	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	9	0	0	0	0	0	0	9	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	18	30	31	31	30
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	31	30	31	31	28	31	30	31	30	31	31	30
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	31	30	31	31	28	31	30	31	30	31	31	30
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	31	30	31	31	28	31	30	31	30	31	31	30
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	31	30	31	31	29	31	30	31	30	31	31	30
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	31	30	31	31	28	31	30	31	30	31	31	30
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	31	30	31	31	28	31	30	31	30	31	31	30
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	31	30	31	31	28	31	30	31	30	31	31	30
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	31	30	31	31	29	31	30	31	30	31	31	30
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	31	30	31	31	28	31	30	31	30	31	31	30
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	31	30	31	31	28	31	30	31	30	31	31	30
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	31	30	31	31	28	31	30	31	30	31	31	30
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	31	30	31	31	29	31	30	31	30	31	31	30
1992	0	0	0	0	0	0	0	0	0	0	0	0	1992	31	30	31	31	28	31	30	31	30	31	31	30
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	31	30	31	31	28	31	30	31	30	31	31	30
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	31	30	31	31	28	31	30	31	30	31	31	30
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	21	30	21	21	29	21	30	21	30	21	21	30
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	21	30	21	21	20	21	30	21	30	21	21	30
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	21	30	21	21	20	21	30	21	30	21	21	30
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	21	20	21	21	20	21	20	21	20	21	21	20
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	21	30	21	21	29	21	30	21	30	21	21	30
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	31	30	31	31 22	20	0	0	0	0	0	0	30
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	30 12	31 31	20 30	11	23	30	20	0	10	31	a
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	16	0	0	0	0	23	24	20 31	30	20	26	q
2004	0	0	0	0	0	0	0	0	0	1	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	ő
2004	0	0	0	0	0	U	U	U	0	'	U	U	2004	0	0	0	0	0	U	U	U	U	0	U	0
2003	U	U	U	U	U								2003	U	U	U	U	U							

Table 6-4	Summary of Exceeded	and Missing Data	at G2H015
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A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 6-3. The limit of the DT is also indicated.



Figure 6-3 Primary data plot for G2H015

This gauging station was used in the WCSA for catchment calibration for the period 1968 to 1976. There is no additional data on which to calibrate in the current study because the station was closed in 1980. Therefore, calibration would have to be made on the same time period as in the previous study, with improved land-use information and rainfall surface data.





Background

This gauging station was opened in 1970 and closed in 1991. It is situated upstream of an old historical bridge in Somerset West and it has experienced some significant flow measuring problems. The bridge openings were often blocked with debris during floods, causing the weir upstream to be drowned. The upstream pool, although regularly cleaned and maintained, would again quickly become exposed to boulder accumulation. Leaks below the weir could not be repaired and the recorder pipe was regularly blocked as a result of siltation in the upstream pool. It was recognised during the WCSA, that this station was by far the worst in terms of exposure to boulder accumulation than any other in the study area.

Data Availability

Stage-time data is available from 1970 to 1991. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
3	1970 to 1991	0,94	18,1

Table 6-5 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

JUNE	2007
00112	2001

			E	xcee	danc	e (No	days	per r	nonth)						N	lissin	g Dat	a (No	. days	s per i	nonth	ı)		
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1969							0	0	0	0	1	0	1969							0	16	6	0	0	0
1970	0	0	0	0	0	0	0	0	0	2	0	0	1970	0	0	0	0	0	29	17	8	12	9	21	0
1971	0	0	0	0	0	0	0	1	0	0	0	1	1971	0	0	0	0	0	0	0	0	8	8	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	1	0	1973	8	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	4	2	0	1	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	2	0	0	0	0	0	0	6	1	2	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	1	0	1977	0	9	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	2	1	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	2	0	0	0	0	0	1	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	1	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	2	0	0	0	0	1983	0	0	0	0	0	0	0	9	0	0	0	0
1984	0	0	0	0	0	0	0	0	2	1	0	0	1984	0	16	6	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	2	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	3	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	3	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	1	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0						1990	0	0	0	0	0	0	0					

Table 6-5 Summary of Exceeded and Missing Data at G2H016

Recommendations

The period from 1974 to 1988 was used for catchment calibration in the WCSA. Only 2 additional years of observed record is now available for calibration before the station was closed. A new station (G2H029) was opened downstream of G2H016 in 1986.

Owing to the problems with the record and the difficulty experienced during the calibration in the previous study, it would be preferable to select an alternative station such as G2H029 to calibrate this catchment. However, G2H029 itself is problematic due to the accumulation of silt resulting in altering river-bed conditions, exposure to vandalism and tidal influence. In 2000, a rated cross section (G2H043) was established at the estuary to measure the effects of tidal influence at G2H029. However, the DWAF database contains no rating curve nor flow data and as such this is of no use.

The new gauging station (G2H044) located between G2H016 and G2H029, will in the long term provide the most reliable record for calibrating this catchment. It currently however only has a record length of 2 years and as such is not suitable for calibration as this stage.

It is therefore recommended that a calibration be attempted at G2H029, which at the time of the WCSA only contained two years of available data. If unsuccessful, then the regional parameters (WR2005) may need to be accepted for the Lourens River catchment. The importance of establishing a continuous streamflow record at the new station (G2H044) is vital for future calibrations of this catchment.



Background

G2H020 has been in operation since 1978. It consists of a crump weir that has previously been assigned a good accuracy rating up to 1,38 m. It has a record period from 1978 to date and was used for catchment calibration purposes during the WCSA. The theoretically developed DT has been correlated during flood events by means of current gauging downstream. During very large floods, a narrowing in the river channel some 70 m downstream results in submergence problems at the weir. Submergence data that has been obtained from a downstream weir correlates well with upstream water levels. The upstream pool has experienced siltation up to the notch level in the past. The backwater effect consequently produces higher water levels, which in turn results in an overestimation of the larger flood events. It may be possible to extend the limit of the DT from its current limit of 1,38 m to about 1,6 m. This would allow for most of the peak flows to be included within the DT limit.

Data Availability

Stage-time data is available from 1978 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1978 to date	1,38	44,9

Table 6-6 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. The gauge is regularly exceeded during winter months and missing data occurs sporadically, with consecutive months primarily in the middle period of the record (1988 to 1995). Patching would be required.

Voor			E	Excee	danc	e (No.	. days	s per n	nonth)			Voor			Ν	lissin	g Dat	a (No	. day	s per i	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977								0	0	0	0	0	1977								0	0	0	0	0
1978	0	0	0	0	0	0	0	0	1	0	0	0	1978	8	0	8	0	0	0	0	0	7	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	1	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	2	1	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	2	6	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	1	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	5	16	4	4	0	0
1989	0	0	0	0	0	0	1	0	1	1	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	13	18	31	30

Table 6-6 Summary of Exceeded and Missing Data at G2H020

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 6-4.



Figure 6-4 Primary data plot for G2H020

A further 18 years of observed record is potentially available against which to calibrate, compared with what was available at the time of the WCSA. If the catchment is to be calibrated on an incremental basis then the record length will depend on the observed inflow records from the flow gauging stations upstream which discharge into the incremental catchment of G1H020. The observed record for G1H020 is complete up to the end of the 2004/05 hydrological year.

6.7 G2H029 : LOURENS RIVER AT STRAND





Background

G2H029 was opened in 1986 and was calibrated by DWAF using current gauging. It is a rated cross-section, with an automatic recorder. The cross section has been equipped with a cable for current gauging purposes. About 10 years ago it was observed that tidal submergence has an influence at the station. Consequently a rated cross section was established (G2H043) downstream to record water levels and attempt to allow for the influence of submergence to be accounted for during the flow calculation at G2H029.

This station has encountered significant sedimentation problems (see island upstream of cable section), and continues to be exposed to vandalism and submergence. Three years ago DWAF decided to close the station and build a new one (G2H044). Water quality and automatic water levels continue to be measured here but there are no more rating curve adjustments or improvements undertaken. The station is considered to be of low reliability, except where actual stream gauging values may be available (from the regional office). This station was excluded from the catchment calibration hydrology undertaken during the WCSA.

Data Availability

Stage-time data is available from 1986 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
2	1986 to date	0,97	10,5

Suitability for Catchment Calibration

Table 6-7 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.
2003 0 0 0 0 0 0 2 0

2004 3 0 0 0 0 0

2005

0 0 0 0 0 0

Voor			E	Excee	danc	e (No.	days	s per n	nonth)			Voor			Ν	lissin	g Dat	a (No	. days	s per r	nonth)	
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1986			0	0	0	0	0	0	1	1	4	0	1986			0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	2	3	0	1987	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	1	1	1	1	0	3	1	1988	0	0	0	0	15	0	0	0	0	0	0
1989	0	0	0	0	0	0	1	2	3	6	2	0	1989	0	0	0	8	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	6	31	31
1991	0	0	0	0	0	0	2	1	7	1	1	1	1991	31	11	0	0	6	0	0	0	0	0	0
1992	0	0	0	0	0	0	2	0	0	3	1	0	1992	0	0	0	0	0	0	0	0	3	12	0
1993	0	0	0	0	0	0	0	0	8	2	0	0	1993	0	0	0	0	3	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	2	0	2	3	0	1994	0	0	0	0	0	0	0	0	0	0	0
1995	3	0	0	0	0	0	0	0	5	2	1	1	1995	0	0	0	0	0	10	2	13	0	0	0
1996	4	1	1	0	0	0	0	1	7	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0
1997	0	1	0	0	0	0	0	6	0	3	1	0	1997	0	0	2	6	0	0	8	0	0	0	0
1998	0	1	0	0	0	0	1	0	1	2	5	3	1998	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	1	2	0	1	4	1999	0	0	0	9	0	0	0	0	0	20	21
2000	0	0	0	0	0	0	0	2	1	9	11	7	2000	0	0	0	0	0	0	0	0	0	0	0
2001	1	0	0	3	0	0	0	1	2	4	3	0	2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	1	0	0	0	0	5	2	2002	0	0	0	0	0	0	0	0	0	0	0

 Table 6-7
 Summary of Exceeded and Missing Data at G2H029

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 6-5. The limit of the DT is also indicated.

0 2005

0 0 0 0 0 0 0

4 0 **2003** 0 0 0

5 0 2004 0 0 0 0 0 0 0 0 0 0 0 0

1 1

6

1 1



Figure 6-5 Primary data plot for G2H029

Sep 0 0

0 0 0 0 0 0

0

0

0

0 0

0 0

This gauging station was not used for catchment calibration during the WCSA. At that time only two years of data was available. The DT is frequently exceeded and there is also a fair degree of missing data. Considering the unreliable nature of the gauging station upstream (G2H016), it would be desirable to undertake a calibration at this station. However, significant patching would be necessary, which may not lend confidence to the calibrated parameter set. Furthermore, there is tidal influence at this station with no information available from G2H043 downstream, which had been established to provide this.

G2H029 currently represents the only option, other than G2H016 for attempting a calibration of the Lourens River catchment. The problems associated with the latter have been described previously. It is therefore recommended that a catchment calibration be attempted at G2H029. If this is not successful, then it may not be possible to improve on the parameter set derived for G1H016 during the WCSA.

Ultimately G1H044 will serve as the record for calibrating this catchment but only 2 years of data have been collected to date.

6.8 G2H030 : RIGHT BANK CANAL FROM EERSTE RIVER AT STELLENBOSCH

Background

This station is a parshall flume located in the right bank canal which delivers water from the Eerste River to irrigators. It was opened in 1976, an automatic recorder installed at the same time, and it is still in operation. The gauge has experienced problems during operation which were reported in the WCSA as:

- the flow approach is not straight but around a bend in the canal;
- the canal section downstream of the flume is exposed to debris accumulation, causing the structure to become drowned;
- The recorder pipe often becomes blocked with sand.

DWAF have undertaken several current gaugings which together with theoretical calibrations have allowed for a DT to be determined.

Data Availability

Stage-time data is available from 1976 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1976 to date	0,60	0,64

Table 6-9 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. This station was given a low accuracy rating during the WCSA assessment.

Table 6-8	Summary	of Exceeded and Missing Data at G2H030
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			E	xcee	danc	e (No.	days	per n	nonth)			¥			N	lissin	g Dat	a (No	. days	s per r	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	0	8	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	4	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1983	0	0	0	0	0	4	30	2	0	0	0	0
1984	0	0	0	0	0	1	0	0	0	1	0	0	1984	0	0	0	0	0	0	8	0	8	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	8	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	1	0	0	1992	0	8	0	0	0	22	0	0	4	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	1	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0

Recommendations

The WCSA had made recommendations for a trash rack to be installed on the upstream side of the weir to prevent debris from entering the canal and that this should be cleaned every week. This has not been implemented as it was considered that the observed debris accumulation was typical only during periods of very high flow. The station is maintained and under normal flow conditions is not a problem (Ref: WCRO, 2007).

6.9 G2H037 : JONKERSHOEK RIVER AT KLEINPLAAS



Background

The station was established in 1989. The gauge lies between G2H008 and G2H005 (just downstream of Kleinplaas Dam on the Jonkershoek River). The crump section is considered to be accurate up to 1,29m. The station is rarely exceeded or submerged. It was not used for catchment calibration during the WCSA as the record period would have been too short at that time.

Data Availability

Stage-time data is available from 1989 to date and one DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1989 to date	1,29	35,3

Table 6-9 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

Table 6-9	Summary of	Exceeded and	Missing Data	a at G2H037

¥			E	Excee	danc	e (No.	days	s per n	nonth)			V			N	lissin	g Dat	a (No	. days	s per r	nonth	1)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1988									0	0	0	0	1988									0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	1989	0	0	0	0	0	0	0	0	26	17	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	22	1	0	0	0	25	18	16	0	22
1991	0	0	0	0	0	0	0	0	1	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	1	1	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	1	0	0	0	0	0	0	0	0	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	1	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	12	7	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0					2005	0	0	0	0	0	0	0	0				

In comparison to the situation at the time of the WCSA, there are now 16 years of additional flow record available at this station. A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 6-6. This also shows the few occasions on which the gauge has been exceeded.



Figure 6-6 Primary data plot for G2H037

Recommendations

This station should be used for catchment calibration purposes. Consideration should be given to possibly excluding the 1989 and 1990 hydrological years from the calibration, as these contain the majority of the months in which data is missing. The missing or exceeded data occurring in the remainder of the record can be patched using simulated flows.





Background

G2H040 consists of a crump weir and was opened in 1999, with 7 years of recorded information to date. It is considered to be reliable and particularly accurate for small and medium flows. There is a downstream gauge plate which records water levels for purposes of submergence. The DT of the crump is also correlated with current gauging using a cable located about 10 m downstream of the structure. However, there have been very few current gaugings undertaken during periods of high flow, so the accuracy of predicting high flows is not known. The station was not in existence at the time of the WCSA.

Data Availability

Stage-time data is available from 1999 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1999 to date	1,39	50,3

Table 6-10 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. The gauge is often exceeded during winter months and there is some missing data which could be patched.

 Table 6-10
 Summary of Exceeded and Missing Data at G2H040

Voor			1	Excee	danc	e (No.	days	s per n	nonth)			Voor			M	lissin	g Dat	a (No	. days	s per r	nonth	1)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1998		0	0	0	0	0	0	0	0	1	1	1	1998		0	0	0	0	4	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	1	1999	0	0	0	0	0	0	0	15	28	0	0	0
2000	0	0	0	0	0	0	0	0	0	9	3	2	2000	0	0	0	0	0	0	0	0	0	9	14	0
2001	0	0	0	1	0	0	0	0	1	1	0	0	2001	11	1	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	2	0	0	0	0	3	1	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	1	0	1	0	3	0	2003	0	0	0	0	13	2	9	5	0	0	0	0
2004	0	0	0	0	0	0	0	0	2	2	3	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	1	1	0	1	0	2005	0	0	0	0	0	3	0	0	0	0	0	0

Recommendations

This gauging station could be used for catchment model calibration in the current study, although the record length may not be long enough to achieve a suitable calibration. If the October 1998 value were to be patched, along with the other missing and exceeded data in the record, then there are seven complete hydrological years of data against which to calibrate.

DWAF to investigate if the available current gauging has been taken into consideration in the DTs, and if not, to do so. Furthermore, the old station at Faure (G2H015) which was reopened in 2002 should be used to correlate with G2H040, and extend the flow record at either site.

6.11 G2H043 : LOURENS RIVER AT ESTUARY

Background

This is a rated cross section, located at the road bridge along the foreshore in the Strand, at the entrance to the Lourens River Estuary. It is the most downstream gauging station on the Lourens River, and was established to measure the effects of tidal submergence at the next upstream gauge (G2H029). The gauge has only been in operation since 2000. There is neither a flow record nor a DT available for it on the DWAF database. It cannot be used for catchment calibration purposes due to the problems associated with tidal influence and raised water levels occurring when the estuary mouth is closed.

6.12 G2H044 : LOURENS RIVER AT STRAND



Background

The gauging stations downstream of G2H044 are all subjected to tidal influence and to closure of the estuary mouth. This station is relatively new and was only opened in 2004. It is a crump weir that should give accurate recordings up to the structure limit, which is about 0,85 m. There are however only two years of recorded data. The station was not in existence at the time of the WCSA.

Data Availability

Stage-time data is available from 2004 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	2004 to date	1,69	49,8

Table 6-11 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

Table 6-11 Summary of Exceeded and Missing Data at G2H044

Voor			E	Excee	dance	e (No.	days	per n	nonth)			Veer			N	lissin	g Dat	a (No	. days	s per i	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2003									0	0	1	0	2003									0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0		2005	0	0	0	0	0	0	0	0	0	0	0	

Recommendations

This gauging station cannot be used for catchment calibration purposes yet, because it has only data for one complete hydrological year. However it could be used for low flow correlation purposes with the record at G2H029, or *visa versa*. G2H029 should be maintained to facilitate a possible correlation with G2H044 over a longer period and for a range of flow conditions.

The present DT limit (1,69m) is likely to be exceeded during flood periods. Current gauging should be undertaken to extend the DT, either by making use of the existing current gauging site (exposure to vandalism), or the bridge at Lourensford Road.

ASSESSMENT OF STREAMFLOW GAUGING STATIONS DIEP RIVER CATCHMENT

7. DIEP RIVER CATCHMENT

- G2H012 : DIEP RIVER AT MALMESBURY
- G2H013 : MOSSELBANK RIVER AT KLIPHEUWEL
- G2H014 : DIEP RIVER AT VISSERSHOK
- G2H042 : DIEP AT ADDERLEY



Figure 7-1 shows the Diep River catchment and the location of the streamflow gauging stations.

Figure 7-1 Streamflow Gauging Stations in the Diep River Catchment

7.1 G2H012 : DIEP RIVER AT MALMESBURY



Background

G2H012 was used for catchment calibration in the WCSA for the period 1965 to 1988. It consists of two hydro flumes and three sharp crested weirs and it has an observed record dating back to 1965. It is regularly submerged as such has a DT limit of 1,19m, which is lower than the structure limit itself. The river gradient is extremely flat but there may be opportunity to undertake a flood calibration so as to extend the DT limit to about 1,8m. This would not be a simple exercise and would not be available in time to provide improved flow gauging for hydrological calibrations as part of this study.

Data Availability

Stage-time data is available from 1965 to date. One DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
4	1965 to date	1,19	49,1

Table 7-1 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data. The gauge is frequently exceeded during winter months and there are two months where the record is missing and patching would be required.

V			E	xcee	danc	e (No.	days	per n	nonth))			V			М	issin	g Dat	a (No	. days	s per r	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Νον	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1964						0	0	0	0	0	0	0	1964						0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	1	0	1965	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	1	1	0	0	1967	0	0	0	0	0	0	5	3	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	1	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	27	2	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	2	0	7	0	1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	1	0	0	0	1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	4	5	2	0	1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	1	0	1	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	1	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	2	2	0	0	1982	0	8	0	0	0	0	0	0	0	0	0	18
1983	0	0	0	0	0	0	0	1	0	0	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	1	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	1	2	0	1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	2	2	0	0	1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	4	0	0	1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	1	0	0	0	1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	1994	0	0	0	0	0	0	0	0	0	8	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1995	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	1	0	0	0	1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	1997	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	2	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	U	0	0	0	U	U	2001	0	0	0	0	0	0	0	0	0	0	0	U
2002	0	0	0	0	U	0	0	0	0	0	0	U	2002	0	0	0	0	0	0	0	0	0	0	0	U
2003	0	0	0	0	0	0	U	0	0	0	U	U	2003	0	0	0	0	0	0	0	0	0	0	0	U
2004	0	0	0	0	0	0	U	0	0	0	U	U	2004	0	0	0	0	0	0	0	0	0	0	U	U
2005	U	U	U	U	U	U	U	U	U	U			2005	U	U	U	U	U	U	U	U	U	U		

Table 7-1 Summary of Exceeded and Missing Data at G2H012

A plot of recorded primary data (flow depths) across the weir for the full duration of the available record is shown in Figure 7-2.



Figure 7-2 Primary data plot for G2H012

Recommendations

The record post-1988 contains no missing data and very little exceeded data. Therefore, a further 16 complete hydrological years of observed record are available from that which was used in the previous calibration.

7.2 G2H013 : MOSSELBANK RIVER AT KLIPHEUWEL

Background

This gauging station was used for catchment calibration in the WCSA for the period 1966 to 1978. It now has recorded flows up to 1986 but the gauge is no longer in operation because it was submerged by the construction of a small dam by the landowner. The river has a quick response time and as a result, the DT for the gauge has often been exceeded.

Data Availability

Stage-time data is available from 1966 to 1986. There are two DWAF DTs applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1966 to 1975	1,24	26,6
4	1975 to date	1,22	23,1

Table 7-2 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

Veer			E	xcee	danc	e (No.	days	per n	nonth)			Veer			Ν	lissin	g Dat	a (No	. days	s per r	nonth)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1965							0	0	0	0	2	0	1965							0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	1966	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	3	4	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	1	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	2	0	10	1	1973	0	0	0	0	0	0	18	7	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	3	2	0	1974	6	5	4	0	0	0	0	3	17	0	6	9
1975	0	0	0	0	0	0	0	0	4	0	1	0	1975	31	4	0	0	0	13	0	0	2	26	17	15
1976	0	0	0	0	0	0	0	0	6	2	0	0	1976	26	0	0	0	0	3	0	3	8	23	25	8
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	8	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	8	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	4	3	0	0	1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	3	0	1	0	0	1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	2	0	0	0	0	0	0	0	0	5	6	0	1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	5	5	5	5	1986	0	0	0	0	0	0	0	0	5	5	5	5

 Table 7-2
 Summary of Exceeded and Missing Data at G2H013

There are twenty complete hydrological years of recorded data at this gauging station with the majority of missing data occurring between 1973 and 1976. These values were patched during the WCSA calibration. The gauge is also fairly regularly exceeded during the winter months.

Recommendations

Missing and exceeded data can be patched using simulated flows and a calibration attempted over the full record period up to the end of the 1985/86 hydrological year. The resulting parameters should be compared with those from the calibration at G2H012.

7.3 G2H014 : DIEP RIVER AT VISSERSHOK

Background

G2H014 is located on the Diep River, upstream of the Rietvlei wetland and is the most downstream gauging station on the Diep River. During the WCSA, this gauging station was used for catchment calibration for the period between 1967 and 1978. A total (cumulative) calibration was undertaken and not an incremental one, due to the extent of missing data from the record. It now has recorded flows up to 1982 but the record is still considered unreliable. During periods of high flow, the weir is often bypassed.

Data Availability

Stage-time data is available from 1966 to 1982 and there is one DT applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
2	1966 to 1982	2,99	90,5

Table 7-3 provides information on the number of days per month during which the DT limit was exceeded and the extent of missing data.

						-								-											
Voor			E	Excee	danc	e (No.	. days	per n	nonth)			Voor			Ν	lissin	g Dat	a (No	. days	s per r	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Νον	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1966							0	0	0	0	0	0	1966							0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	1967	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	1968	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	1969	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	1970	0	0	0	26	28	31	30	7	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	1972	0	0	0	0	0	0	14	31	30	9	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	1973	0	0	22	31	28	31	30	7	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	1974	0	0	29	31	28	31	30	8	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	1975	13	0	13	0	19	31	24	14	0	8	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	1976	0	0	0	0	7	10	0	9	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	1977	0	0	0	1	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	1981	0	0	0	0	0	0	0	6	30	31	31	30
1982	0	0											1982	31	10										

Table 7-3 Summary of Exceeded and Missing Data at G2H014

This gauging station has a record length of 15 years and although it contains no exceeded data, the period between 1972 and 1975 contains significant missing data. The station was closed in 1982 due to its poor performance and a new one constructed upstream at Adderley (G2H042) in 1998.

Recommendations

Most of the missing information occurs during the low flow season. This station could be used for catchment calibration but would require significant patching during the low flow period. A correlation with G2H042 should be attempted.

7.4 G2H042 : DIEP RIVER AT ADDERLEY



Background

This station is located on the Diep River near Adderley and has been operational since 1998. It was constructed as a replacement to G2H014 at Vissershok which had produced a flow record considered to be unreliable for stream flow calibration purposes.

Data Availability

One DWAF DT is applicable.

DWAF DT NO.	PERIOD APPLICABLE	DT LIMIT (m)	FLOW LIMIT (m³/s)
1	1998 to date	2,38	124,2

There are 7 years of available record against which to calibrate.

Table 7-4 Summary of Exceeded and Missing Data at G2H042

Vaar			E	Excee	danc	e (No.	days	per n	nonth)			Vaar			Ν	lissin	g Dat	a (No	. days	s per i	nonth	ı)		
rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	rear	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1998	0	0	0	0	0	0	0	0	0	0	0	0	1998	0	0	0	0	0	0	0	0	0	21	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	1	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	2005	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0		2006	0	0	0	0	0	0	0	0	0	0	0	

The gauge has only once been exceeded and there is one month in which missing data would require patching.

Recommendations

This record should be used to calibrate its catchment area and compare the resulting parameter set with that obtained at G1H012 (Diep River at Malmesbury).

CONCLUSIONS AND RECOMMENDATIONS

8. THE EXISTING NETWORK FROM A SURFACE WATER PERSPECTIVE

As seen on Figure 1-1, the spread of available streamflow gauging stations within the study area is to a large extent adequate from a surface-water modelling perspective. This is also supported by the fact that, with a few exceptions, there are sufficient stations with data quality that is adequate for surface-water modelling. Certain stations are fairly new and their records are still too short, whilst some stations have been discontinued and no further data is available from them. It is important that the new stations as well as those ultimately selected for catchment calibration purposes be maintained to allow continuous recordings to be taken.

There are few key areas which require particular attention in terms of data to support future updates of water availability. From a surface water modelling perspective, the recommendations are largely focused on improving the integrity of the data that is available. At gauges where catchment calibrations are possible, but where the DTs (DTs) are regularly exceeded, every attempt should be made by DWAF to increase the limits of the DTs. In particular, the stations on the Upper Breede River are very important due to the potential for the development of water resource infrastructure in the future. These options are currently being identified in the Western Cape Reconciliation Strategy Study.

From the information presented in this assessment, the following new streamflow gauging stations are recommended to provide information in support of surface water modelling:

- A new gauging station on the Lower Berg River, particularly for the benefit of monitoring the provision of estuarine flow requirements for the Estuary. The challenge associated with this is to identify a suitable site that is beyond the tidal influence.
- A new gauging station on the Breede River between Witbrug and Greater Brandvlei Dam. This river reach is limited in terms of the available information to support catchment calibration. A site should be selected such that it also corresponds with the groundwater monitoring needs along the Breede River, as described hereafter.

The weirs on the Banhoek (G1H019) and Wolwekloof Rivers (G1H038) require structural attention and modification in order to limit the impact of boulder accumulation on the diversion into the tunnel. The transfer of water into the Theewaterskloof tunnel at both of these inlets is not monitored. The opportunity exists to undertake remedial work at both weirs, whilst there is a contractor already established on site at the Berg River Dam. It is recommended that a specialist inspection first be undertaken, followed by an appropriate redesign and then modification of both structures. The flow gauging on the Lourens River remains problematic despite the construction of the G2H029 weir in 1986 and the new weir (G2H044) in 2004. Whilst the latter is considered accurate, the data available is only for the past 2 years. It is vitally important that this station be well maintained and a continuous record be established in order that it provides a record against which to calibrate the Lourens River catchment in the future.

In general, where new gauges are installed to provide improved streamflow data, existing gauges must be maintained, particularly where there is an opportunity to correlate the existing with the new. This enables the existing records to be improved and used for catchment calibration purposes.

RECOMMENDED ADDITIONAL STREAMFLOW STATIONS TO SUPPORT SURFACE WATER / GROUNDWATER INTERACTION MODELLING

9. OVERVIEW

Historically, the interaction between surface water and groundwater has been poorly understood primarily due to the absence of any appropriate monitoring to support such an understanding. The most significant recommendations in terms of the suitability of the current network and its required enhancements are driven by the need to better understand this interaction. Surface water flow stations can be used to monitor surface water / groundwater interaction. There are however two important components to be considered, namely:

- i) The flow gauging stations must be constructed and operated in such a way that the low flow measurements are accurate.
- ii) The location of the stations must allow for determining aquifer specific contributions from or losses into the groundwater along localised river reaches.

Considering the existing streamflow gauging station network in the Western Cape, several additional sites and sites that can be reinstated have been identified where streamflow data is required in order to be able to accurately model the surface water / groundwater interaction in this study area in the future.

Motivation is provided hereafter for:

- existing sites that can be used for groundwater modelling during this study;
- existing sites that should be upgraded or reinstated for the purpose of groundwater modelling in the future;
- new sites at river reaches that are required for future studies, and
- new or existing flow measurement stations at selected springs.

10. UPGRADING AND/OR REINSTATING OF EXISTING STREAMFLOW STATIONS

The assessment of the streamflow gauging stations has revealed several stations that are suitable for providing data for the groundwater component of the study. In some cases, these stations are no longer active and need to be reinstated in order to collect data suitable for future studies. In addition, some of the existing streamflow stations need to be upgraded and calibrated for accurate "low flow" measurements.

Where possible, the recommendations are focused on reinstatement of existing (yet inactive) stations as opposed to the siting of a new one, so as to reduce the likely capital cost. Table 10-1 shows a list of existing flow gauge stations that are suited for surface water / groundwater interaction modelling. The same information is shown schematically on Figure 10-1. Existing data sets from these stations will be used for base flow calculations and as input into the groundwater models. It must be ensured that these stations are suitable for "low flow" measurements.

ID	LAT	LONG	RIVER	PLACE	COMMENTS AND REASONING
G1H002	-33.134	19.061	Vier en Twintig	Driebosch	Measures the water exiting the TMG-based part of the study area. Gives an indication of groundwater volumes in the Groot Winterhoek Mountains.
G1H008	-33.314	19.075	Klein Berg	Nieuwkloof	In the centre of the Nieuwkloof Pass. Measures water volumes exiting the Tulbagh-Ceres valley to the west.
G1H011	-33.380	19.150	Watervals	Watervalsberge	Measures the groundwater from the Skurweberg aquifer to the south.
G1H012	-33.352	19.101	Waterval River	Voëlvlei Mountains	Positioned on a fault. Can compare flow differences in the Skurweberg aquifer (G1H011) vs along a conduit at this site (also requires data from G1H057 in the diversion weir).
**G1H014	-33.828	19.036	Wemmershoek	Tributary	Zachariashoek – former CSIR monitoring site. Measures groundwater from Peninsula aquifer when compared with G1H017 and with boreholes available in the vicinity.
**G1H015	-33.815	19.062	Wemmershoek	Tributary	Zachariashoek – former CSIR monitoring site. Measures groundwater influence from the Skurweberg aquifer to the north and with boreholes available in vicinity.
**G1H016	-33.822	19.060	Wemmershoek	Tributary	Zachariashoek – former CSIR monitoring site. Measures groundwater from Peninsula aquifer when compared with G1H016 and with boreholes available in vicinity.
**G1H017	-33.826	19.029	Wemmershoek	Tributary	Zachariashoek – former CSIR monitoring site. Comparative point for G1H014 and with boreholes available in vicinity.
**G1H018	-33.823	19.047	Wemmershoek	Tributary	Zachariashoek – former CSIR monitoring site. Measures influence of Peninsula aquifer and water draining from Skurweberg aquifer in north.
G1H019	-33.913	18.944	Banhoek	Jonkershoek	Measures groundwater draining from the Peninsula aquifer in the Drakenstein Mountains to the east.
G1H021	-33.184	19.156	Klein Berg	Mountain View	In the headwaters of the Klein Berg River. For comparative use for Site 5 (Table 11-1).
G1H035	-33.048	18.832	Matjies	Matjiesfontein	Measures water entering the Berg from the Krom, Assegaaibos and Bothmans Rivers.
G1H066	-33.294	19.058	Klein Berg	Nieuwkloof Pass	On the exiting side of the Tulbagh valley. Measures groundwater from the Peninsula aquifer in the Voëlvlei Mountains. Listed on DWAF webpage as "Little Berg River @ Inlet Canal @ Nieuwkloof".
G2H005	-33.974	18.938	Jonkershoek	Kleinplaas Dam	Measures groundwater draining from the Peninsula aquifer in the Hottentots Holland Mountains.
G2H008	-33.986	18.956	Jonkershoek	Jonkershoek	Measures groundwater draining from the Peninsula aquifer in the Hottentots Holland Mountains.
G4H030	-34.269	19.022	Palmiet	Krabbefontein	On a fault set. Measures flow before groundwater influence from the Skurweberg aquifer in lower river reaches.
H1H003	-33.381	19.302	Upper Breede	Ceres Golf Club	At the entrance to the Michell's Pass. Measures influence of water on the Bokkeveld. Use as comparative site before influence of Skurweberg aquifer at Site 6 (Table 11-1).

Table 10-1 Exisitng Streamflow Gauging Stations for Reinstatement and Low Flow Measurement Enhancement

ID	LAT	LONG	RIVER	PLACE	COMMENTS AND REASONING
H1H006	-33.422	19.267	Klein Berg	Michell's Pass	Requires upgrading for low flow measurements. At the exit of the Michell's Pass. Measures influence of groundwater from the Peninsula aquifer when compared with Site 6 (see Table 11-1).
H1H007	-33.569	19.145	Wit River	Drosterskloof	On a river/fault intersection. Measures the groundwater contribution of the Peninsula aquifer in the Slanghoek Mountains to the south.
H1H013	-33.360	19.298	Koekedouw	Ceres	On a tributary to the Dwars River. Measures the groundwater contribution of the Skurweberg aquifer to the west. Use for comparison of Skurweberg aquifer contribution at Site 6 (see Table 11-1) further south at the entrance to the Michell's Pass.
H1H018	-33.725	19.170	Molenaars	Hawequas Forest	In the headwaters of the Smalblaar River. Measures the groundwater contribution of the Peninsula aquifer in the Du Toits Kloof.
**H2H004	-33.486	19.529	Sanddrif River	Zanddriftskloof	Situation north of Site 10 (see Table 11-1). Measures groundwater from the Peninsula aquifer in the Hex River mountains to the north and west.
H6H007	-33.939	19.171	Du Toits	Purgatory Outspan	On a fault termination. Measurement separates the Peninsula and Skurweberg aquifer contributions before draining into the Theewaterskloof Dam.
H6H008	-34.062	19.073	Riviersonderend	Nuweberg Forest	Measures groundwater from the Skurweberg aquifer before entering the Theewaterskloof Dam.

Notes:

** These stations are additional to those already described in the assessment of surface water gauging in the previous sections of this report.



Figure 10-1 Existing Streamflow Gauging Stations Required for Groundwater Monitoring

EXPANSION OF EXISTING STREAMFLOW MONITORING NETWORK

11. ADDITIONAL STREAMFLOW GAUGING STATIONS REQUIRED

In addition to the existing streamflow gauging stations that can be used for groundwater modelling, several additional stations are recommended to expand the station network for future studies.

These additional flow stations have been sited taking into account the following parameters:

- i) Lithology
- ii) Geological structures
- iii) Surface water channels and water divides
- iv) Existing flow stations in the surrounding area

Stations were added in those locations where the existing network of streamflow gauging stations is insufficient for surface water / groundwater interaction modelling. In certain cases it might be possible to reinstate an existing structure as opposed to the construction of a completely new one. These stations are listed in Table 11-1, shown schematically on Figure 11-1, and each site described thereafter.

SITE	LATITUDE	LONGITUDE	RIVER	COMMENT
1	-33.84751	19.01585	Berg	At proposed abstraction weir
2	-33.477300	19.175670	Breede	
3	-33.552490	19.220890	Breede	Or reinstating of H1H001
4	-33.589240	19.263540	Breede	
5	-33.318630	19.098090	Klein-Berg	
6	-33.397410	19.290110	Breede	
7	-33.314790	19.298780	Skaap	
8	-33.409070	19.443540	Titus	
9	-33.506490	19.493220	Amandel	
10	-33.495940	19.530250	Sanddrif	Or utilising H2H004
11	-33.512220	19.534970	Amandel	

 Table 11-1
 Additional Streamflow Gauges Required



Figure 11-1 Location of additional flow gauges required

11.1 SITE 1 : BERG RIVER (G10C)

Location

LATITUDE	LONGITUDE
-33.84751	19.01585

Site 1 is sited at the proposed abstraction weir that forms part of the

Berg Water Project. The site is located on the Berg River just downstream of the confluence with the Dwars River.

Motivation

The purpose of this site is to obtain an indication of the volume of water that is entering the Berg River from the Dwars River, as well as groundwater input from the Peninsula and alluvium aquifers in the southern portion of the Klein Drakenstein Mountains. Together with information about the volume of releases at the Berg River Dam, and the volume of water diverted at the abstraction works, the site will give an indication of the net loss or gain of water between the Dam and the abstraction point.

11.2 SITE 2 : BREEDE RIVER (H10F)

Location

LATITUDE	LONGITUDE
-33.47730	19.17567

Site 2 is located on the Breede River where it enters the Klaarfontein Valley. The site is positioned on the geological contact between the Peninsula Aquifer and the Malmesbury Shales, directly above the west-end of the Worcester fault.

Motivation

The site is positioned such that it will indicate the quantity of water in the Breede River before the river is supplemented by groundwater from the Peninsula Aquifer in the west. In addition, by making a comparison of the volume of water that is measured on the opposite side of the Tulbagh-Ceres valley at station H1H006, it will be possible to determine whether the Malmesbury shales have any effect on the Breede River and what the scale of groundwater flow is within these shales.

11.3 SITE 3 : BREEDE RIVER (H10G)

Location

LATITUDE	LONGITUDE		
-33.55249	19.22089		

Site 3 is located on the Breede River downstream of the streamflow gauging station at H1H001, where the river exits the Klaarfontein Valley, after the confluence of the Wit River from the west and the Wabooms River from the east. The site is positioned to correspond with the Breede River coming alongside the Worcester fault.

Motivation

This site (when compared with the flow volume at Site 2) will reveal the input of the surface waters of the Wit River (perennial) and Steenbok River (non-perennial) into the Breede River, as well as the groundwater contribution from mainly the Peninsula Aquifer with some influence from the Skurweberg aquifer via local fault networks.

11.4 SITE 4 : BREEDE RIVER (H10G)

Location

LATITUDE	LONGITUDE			
-33.58924	19.26354			

Site 4 is located on the Breede River where the river re-crosses the Worcester fault, at a point downstream from Site 3.

Motivation

The site is positioned such that it may indicate whether groundwater is being added to the Breede River by means of the Worcester fault. The site also takes into account additional water entering the Breede River from the unconfined Peninsula aquifer in the mountains located to the southwest of the site.

11.5 SITE 5 : KLEINBERG RIVER (G10E)

Location

LATITUDE	LONGITUDE		
-33.31863	19.09809		

Site 5 is located in the headwaters of the Klein Berg River at the entrance to the Nieuwkloof Pass, separating the Tulbagh valley from the Swartland. The site is positioned on the Malmesbury shales just east of the contact between the Malmesbury shales with the Peninsula Aquifer.

Motivation

The site is positioned to show the volume of water entering the Berg River from its head waters before it drains into the Swartland via the Nieuwkloof Pass. In combination with site G1H008 in the middle of the Nieuwkloof Pass, Site 5 will act as a control measure, indicating the quantity of groundwater entering the Klein Berg River from the Peninsula aquifer in the Voëlvlei Mountains. In the event that the groundwater contribution in that section of the Klein Berg River needs to be quantified in more detail, a second additional flow gauging station at the western exit of the Nieuwkloof Pass will be required.

11.6 SITE 6 : BREEDE RIVER (H10D)

Location

LATITUDE	LONGITUDE		
-33.39741	19.29011		

Site 6 is located on the Breede River in the middle of the Michell's Pass, downstream of site H1H003 and upstream of site H1H006 (see Table 10-1). The site is positioned on the contact between the Goudini and Cedarberg Formations, which separate the Skurweberg Aquifer in the east from the Peninsula Aquifer in the west.

Motivation

Streamflow gauging station H1H003 gives an indication of the water in the Breede River entering the Michell's Pass. Site 6 is positioned so as to determine the quantity of water entering the Breede River solely from the Skurweberg Aquifer that forms the eastern portion of the encompassing Skurweberg Mountain range. Site H1H006 will use Site 6 as a comparison for determining the quantity of groundwater entering the Breede River from the Peninsula aquifer.

11.7 SITE 7 : SKAAP RIVER (H10C)

Location

LATITUDE	LONGITUDE		
-33.31479	19.29878		

Site 7 is located on the Skaap River, just before the confluence of the Skaap River with the Modder River. The site is positioned adjacent to a large east-west aligned fault that spans the extent of the Bokkeveld outcrop.

Motivation

The site is positioned so as to determine the quantity of water entering the Modder River from the northern part of the Warm Bokkeveld to the east.

11.8 SITE 8 : TITUS RIVER (H10B)

Location

LATITUDE	LONGITUDE		
-33.40907	19.44354		

Site 8 is located on the Titus River in the south-eastern portion of the Warm Bokkeveld. It is positioned over the formations of the Bokkeveld Group at a fault termination.

Motivation

The site is located so as to determine the quantity of water entering the Titus River from the Skurweberg Aquifer in the south at the fault termination, which contributes to the surface water flow.

11.9 SITE 9 : AMANDEL RIVER (H20E)

Location

LATITUDE	LONGITUDE		
-33.50649	19.49322		

Site 9 is located on the Amandel River on the southern side of the Hexriver Mountains. The site is positioned on the contact between the Peninsula Aquifer and the Cedarberg shale.

Motivation

The site is located so as to determine the quantity of groundwater from the Peninsula Aquifer to the north and west that enters the Hex River by means of the Amandel River.

11.10 SITE 10 : SANDDRIF RIVER (H20D)

Location

LATITUDE	LONGITUDE		
-33.49594	19.53025		

This site is located on the Sanddrif River downstream from the H2H004 streamflow gauging station (See Table 10-1), on the southern side of the Hexriver Mountains. Its position is on the contact between the Peninsula Aquifer and the Cedarberg shale.

Motivation

The location will allow for the quantity of groundwater from the Peninsula Aquifer from the north and east, that enters the Hexriver by means of the Sanddrif River to be determined. Although it would be possible to utilize data from the existing H2H004 streamflow gauging station, Site 10 is a preferred location. This is due to the fact that it is situated on the contact between the Peninsula aquifer and the aquitard, which will provide a clearer view of the groundwater entering the Hexriver in the south from the Peninsula aquifer in the north.

11.11 SITE 11 : HEX RIVER (CONFLUENCE)

Location

LATITUDE	LONGITUDE		
-33.51222	19.53497		

Site 11 is located on the Sanddrif River just upstream of the confluence of the Sanddrif River with the Amandel River. The site is positioned on the Skurweberg Aquifer.

Motivation

Having knowledge of the volume of water at Site 10 (measuring groundwater contribution from the Peninsula aquifer), Site 11 indicates the quantity of groundwater entering the Sanddrif River from the Skurweberg Aquifer.

RECOMMENDED SPRING FLOW MONITORING STATIONS

12. ADDITIONAL SPRING FLOW STATIONS REQUIRED

Several springs have been located during previous studies and initial measurements of temperature and flow have been taken (see Table 12-1). Natural springs provide a direct indication of the flow of water in the aquifer and it is important that flow stations capable of measuring "low" flow are set up at all springs known to be linked to the aquifer.

Table 12-1	Spring Locations and Characteristics			

ID	LATITUDE	LONGITUDE	RIVER	TEMP (℃)	FLOW (∟/s)	REASONING
3319CA00063	33.74694	19.06834	Hugos	11-18		Comparison for confined
3319CAU0002	33.73220	19.41360	Brandvlei	47.3-49	13-15	High flowing, very hot
3319CB00085	33.66500	19.26639	Klip	30.9-32		Tepid
3319CB00086	33.73000	19.41556	Brandvlei	59.1-60		Very hot
3418BBU0008	34.21200	18.83580	Boskloof		25	High flowing
3418BBU0009	34.22700	18.84290	Dappas se gat		12	High flowing
3418BDU0001	34.25650	18.85450	Rooiels		15	High flowing
3418DDU0001	34.05000	18.88480	Lourens	18	3-5	Comparison for confined
3419AA00110	34.23888	19.16861	Bot	18		Comparison for confined
3419AA00114	34.22722	19.18055	Bot	16		Comparison for confined
3419AAU0007	34.09190	19.04900	Palmiet	20.1-21.7	2-3	Comparison for confined
3419AB00022	34.22167	19.43805	Swart	46-50		Very hot
3419ACU0001	34.25230	19.09780	Palmiet	24.7	5	Cool

Table 12-1 shows the springs that have been identified in previous studies. Generally it can be assumed that hot springs and high-flowing springs are connected to the confined portions of the aquifers. Data from these springs reveal the hydrologic properties of the aquifer. Data from cold springs and springs with low flow are useful as a comparative tool between the natural unconfined aquifer conditions and confined conditions. The locations of the springs are shown schematically on Figure 12-1.



Figure 12-1 Location of Springs

Recommendations

There are currently only a handful of springs in the greater study area that are being monitored. The information about the location of springs, their flow pattern and monitoring data are invaluable in groundwater studies as they provide a direct window into the aquifers themselves. For this reason we recommend that a full spring hydrocensus is conducted with the aim of locating and identifying all perennial springs in the western portion of the Western Cape, as relevant to this study area.

Ideally, the spring hydrocensus should be approached with an initial desktop study to identify key areas of interest, followed by field verification. The desktop study will entail a GIS based methodology combined with remote sensing techniques using high resolution satellite imagery to identify:

- local geology,
- geological structures,
- aquifer characteristics,
- surface water patterns, and
- vegetation.

In addition, overlaying the above information with the locations of all towns or farms with a name pertaining to "*-spring" or "*-fontein" should further constrain areas where springs are likely to occur.

Subsequently field verification will be required as a next phase to determine the validity of the identified potential spring locations and the suitability for installation of automated flow measurements (e.g. weirs, v-notches or flumes) as well as to determine parameters such as their water temperature and flow.