

Berg River Dam: Designed With Rivers in Mind



TCTA *The Berg River Dam during construction.*

The R1,5-billion Berg River Dam, outside Franschhoek in the Western Cape, is an international showcase of integrated planning, design and implementation, writes Nigel Rossouw, TCTA Head: Environment and Dana Grobler of Cape Action for People and the Environment.

The Berg Water Project (BWP) is the culmination of a 14-year strategic integrated planning process by the Department of Water Affairs & Forestry (DWAFF) to identify appropriate measures to address the water shortage in the Western Cape. The planning process was initiated in 1989. Back then it was called the Western Cape Systems Analysis (WCSA).

The purpose of the WCSA was to reconcile the water demand and water supply for the Western Cape region. The WCSA was a democratic public strategy process and was supported by technical and scientific assessment to aid decision

making. The water situation assessment conducted as part of the WCSA determined that the City of Cape Town (CCT) would be the first metropolitan area in South Africa where water demand would exceed the available supply. The WCSA provided a list of project options that could be implemented to increase the water supply.

A KEY PROJECT

One of the key projects identified involved the construction of a dam on the upper reaches of the Berg River. DWAF initiated the environmental

impact assessment (EIA) process and the EIA report as produced for decision making in 1996. The Department of Environmental Affairs & Tourism (DEAT) issued the Record of Decision in 1999. The Record of Decision stipulated that the dam should be designed so as to ensure flows for the Ecological Reserve. In addition, it also stipulated that if monitoring demonstrated that the dam had an undesirable effect on the river, then the release pattern and Ecological Reserve quantity would have to be revised.

In April 2002 Cabinet approved the construction of the BWP on condition that



The Berg Water Project comprises the Berg River Dam (which is about 6 km west of Franschhoek) and the Supplement Scheme situated about 12 km downstream. The latter comprises a 1,6 m-high diversion weir that diverts a portion of the winter high flows into a 3 ha off-channel balancing dam from where the water is pumped via a 12 km pipeline back into the Berg River Dam.

the CCT reduces the demand for water by 20% by the year 2020. The BWP is the first bulk water resource development project in South Africa that is directly linked to water demand management. In May 2002 the Minister of Water Affairs & Forestry directed the TCTA in terms of Section 103(2) of the National Water Act of 1998 to fund and implement the BWP as the implementing agent for DWAF.

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The BWP would increase the yield of the Western Cape Water Supply System by 81 million m³ or 18% from 2008. It was the first large water resource infrastructure development project in South Africa to be designed, constructed and operated within the framework of the National Water Act (Act 36 of 1998) and in accordance with the guidelines of the World Commission on Dams. The dam was therefore required to be able to make releases to satisfy all aspects of the Ecological Reserve as prescribed by the National Water Act.

The Berg River Dam is a concrete-face-rockfill dam type. The dam is 65 m high, 990 m wide and 220 m in width. The gross storage capacity of the dam is 130 million m³.

The outlet works have been designed to release both low flows and high flows with provision for a peak release of up to 200 m³/s, making it the first dam in South Africa in which provision is made for flood releases for environmental purposes.

WHAT IS THE ECOLOGICAL RESERVE?

In the National Water Act the Ecological Reserve is defined as: “relating to the water required to protect the aquatic ecosystems of the water resource. The Reserve refers to both the quantity and quality of the water in the resource, and will vary depending on the class of the resource.”

In South Africa the terminology used for the provision of water of a suitable quality to protect the water resource is the Ecological Reserve. It is the only right in law. The term Instream Flow Requirement (IFR) is also commonly used in South Africa. This refers specifically to the flow requirement (both flow volumes and variability) to

maintain a desired level of ecosystem functioning.

Internationally other terms such as environmental flow and ecological flow are also used. Globally accepted definitions are based on two aspects:

- ◆ The quality, quantity and timing of water flows required to maintain the components, functions, processes and resilience of aquatic ecosystems which provide goods and services to people, and
- ◆ The foundation from which socially-valued resources are derived and supported, and without which no sustainable use of the resource are possible.

A sustainable water resource and catchment management plan must be built upon a foundation of detailed scientific knowledge about the river flows (in terms of quantity and variability) and water quality needed to sustain ecosystem health and functioning. When the water needs of aquatic ecosystems (e.g. rivers, wetlands, estuaries, and groundwater) are clearly defined by scientists, engineers and other professionals, water managers will be able to find ways of meeting human needs for water while maintaining adequate river flows for the ecosystem to ensure long-term sustainable use of the Berg River.

In South Africa, aquatic ecosystem's water needs are determined during an Ecological Reserve Determination Study. This is an environmental water requirement prescription, which describes the necessary seasonal and inter-annual variation needed in low flows, high flows and floods, as well as the water quality requirement to support critically important ecological functions and for the continued provision of valued services.

The Ecological Reserve provides for the maintenance of critically important aquatic attributes, goods and services (such as biodiversity, dilution capacity, habitat integrity, prevention of sedimentation etc) and associated social services (including fishing and water for river-dependent users).

THE ECOLOGICAL RESERVE AND THE BERG RIVER CATCHMENT

The preliminary determination of the Ecological Reserve for the upper Berg River catchment for water quantity was set at 31,1% (i.e. 44,061 million m³) of the mean annual runoff of 141,7 million m³.

For the Ecological Reserve determination, detailed background studies and a comprehensive analysis were undertaken of the historical flows for the upper catchment. In the determination of the Ecological Reserve, the duration curves for the low flow releases to be made from

the Berg River Dam were determined and the high flow releases required were established to be as follows:

- ◆ Daily average peak 65 m³/s over three days = 10,11 million m³ (160 m³/s instantaneous peak)
- ◆ Daily average peak 30 m³/s over three days = 4,67 million m³
- ◆ Daily average peak 5 m³/s over three days = 0,78 million m³

What this means is that the Ecological Reserve releases will be based on

providing a portion of the natural flow contributions (of inflows to the dam) of the upper Berg River catchment for ensuring the continued functioning of the aquatic ecosystem below the dam. According to the Determination, the ecological category of the Berg River was set at C (see Table 1).

DAM DESIGN AND THE ECOLOGICAL RESERVE

How has the Ecological Reserve influenced the design of the Berg River Dam? The requirement to implement the Ecological Reserve has dictated that the

The south section of the intake tower is an open vertical shaft (wet well) with multi-level gates for drawing water from the dam for high flows/floods (up to 200 m³/s) as required by the Ecological Reserve.



The Berg River Dam from the air.

Berg River Dam be designed to cater for two distinct flow release systems, i.e. small releases and large releases.

The system for small releases occurs in the range from 0,3 m³/s to 12 m³/s. These releases occur continually and are adjusted in magnitude as required by the Ecological Reserve and depending on the inflow into the Berg River Dam.

The system for small releases is a conventional pipe system that extracts water from the dam for either environmental flows or for pumping to Cape Town to meet urban water demand. The system consists of pipes and valves in the intake tower, pipes under the embankment and the sleeve valves at the outlet works.

The Berg River Dam intake tower is

divided into two sections. The north section is a dry shaft equipped with multi-level inlets, piped and valves, which provides the facility for drawing water into the Cape Town supply system and provides for low flow (under 12 m³/s) environmental releases.

The radial arm gate system for large flows is able to make releases up to 200 m³/s. These large flow releases will mimic naturally occurring flood events. The system for large flood releases is purely as a requirement of the Ecological Reserve and is unique. The system consists of a wet well in the intake tower, a concrete conduit through the dam wall and control gates.

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DAM RELEASES AND THE ECOLOGICAL RESERVE

No base flow and high flow releases will occur out of phase with natural inflows into the Berg River Dam. Environmental flow releases to meet the requirements of the Reserve will comprise the summer and winter base flows of 4 m³/s on average in June, July, August and September and the winter high flow releases of up to 160 m³/s.

During the summer months inflows into the dam will be released to supply

the Ecological Reserve. Flood events of different magnitudes will be made each year to simulate the natural 65 m³/s and a maximum instantaneous peak of 160 m³/s. The outlet structure of the dam is designed to allow the instantaneous peak to be increased to 200 m³/s. Dam releases will be operated in phase with the natural flood events.

High flow releases from the dam will be no greater than inflows into the dam, in other words, these would coincide with the magnitude of natural events. During periods of drought the magnitude of the Reserve releases would be reduced.

In drought years high flows will be released unless no natural flood inflow into the dam occurs at the appropriate time of the year. On average, about 16 million m³ will be allocated for high flow releases each year and 27 million m³ for low flow releases.

CONCLUSION

Compliance with the requirements of the Ecological Reserve is expected to achieve the following benefits:

- Maintain the Berg River in ecological category C;
- Maintain the river ecosystem to continue to provide users with acceptable water quality and an ecosystem that can support the living organisms in it;
- Prevent increased sedimentation in specific areas downstream of the dam (e.g. at Paarl); and
- Ensure that release patterns occur as close to the natural flow variability as possible (e.g. for inter- and intra-annual floods and wet and dry season low flows).

The Berg River Dam is internationally unique and is the first large in-stream dam in South Africa that is required to make both low and high flow (flood) Ecological Reserve releases. The dam will be operated to ensure that the releases of low flows and high flows coincide as closely as possible with natural inflows and natural flood events. 

TABLE 1: River Ecological Categories

Categories	Description
A	Negligible modification from natural conditions. Negligible risk to sensitive species.
B	Slight modification from natural conditions. Slight risk to intolerable biota.
C	Moderate modification from natural conditions. Especially intolerant biota may be reduced in number and extent.
D	High degree of modification from natural conditions. Intolerant biota unlikely to be present.



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