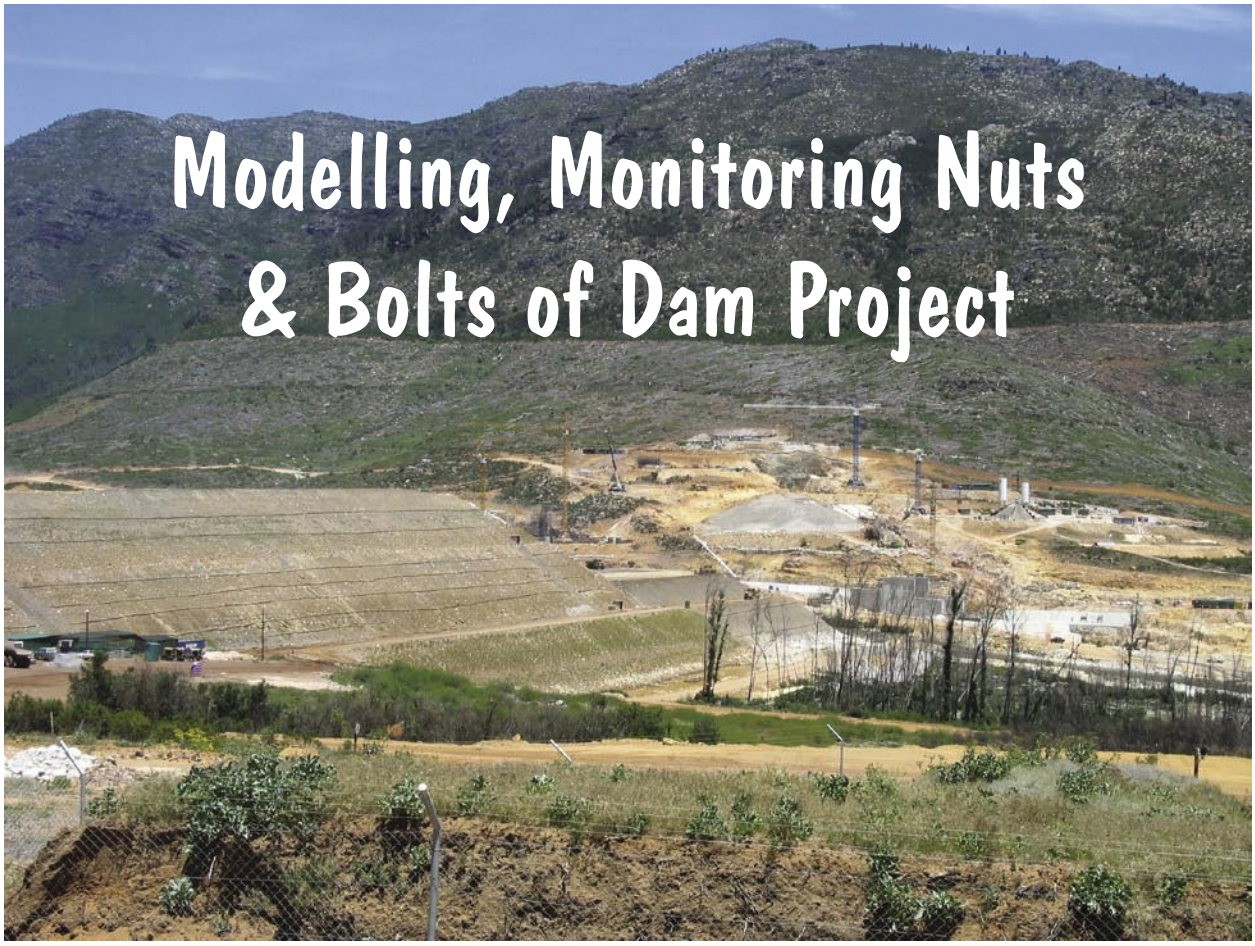
Modelling, Monitoring Nuts & Bolts of Dam Project



By the end of 2005 the dam wall – constructed of river boulders with the upstream face covered in concrete – was 45 m high. Ultimately the crest of the wall will be 60 m high and 900 m long.

Construction of the Berg River Dam, near Franschhoek in the Western Cape, is in full swing, and all indications are that it will be completed during 2007 as planned. Sue Matthews reports.

The dam will have a gross storage capacity of some 130 million cubic metres, and will operate in conjunction with Theewaterskloof Dam in the Breede River catchment. The two dams are linked by the Riviersonderend inter-basin transfer tunnel, bored through the imposing Franschhoek mountains.

The streams and runoff flowing into the Berg River Dam would only provide enough water to sustain a yield of approximately 56 million cubic metres per year. However, this will be supplemented by an abstraction works 9 km downstream of the dam – below the confluence of the Dwars River and a number of other tributaries – which in winter will divert water from the Berg River and pump it back to the dam or Theewaterskloof, from where it can be gravity-fed to Cape Town. The Supplement Scheme will increase the yield by 25 million cubic metres, bringing the total contribution of the Berg Water Project to 81 million cubic metres.

This should be enough extra water to meet Cape Town's needs until 2013, by which time other projects will have to be implemented to satisfy the growing demand.

In November, a three-year baseline monitoring programme designed to describe the present state of the river, including its estuary, floodplains and groundwater, came to an end. The comprehensive programme encompassed ecological, physical, chemical, hydrological and hydraulic characteristics, as well as social aspects such as recreational use and dam safety. Determining the system's present state and its natural variability will provide a baseline against which changes resulting from the Berg Water Project can be measured.

The Freshwater Consulting Group's Geordie Ratcliffe, who acts as

- The Berg Water Project is being undertaken by public entity TCTA on behalf of DWAF.
- A syndicated loan of R1.6 billion was secured by TCTA from the European Investment Bank (R800 million), the Development Bank of Southern Africa (R500 million) and ABSA Bank (R300 million) to fund the project. Water users in the City of Cape Town will repay this loan by 2027 through a Berg Water Charge added to the tariff imposed by DWAF on water supplied from the Western Cape Water System.
- In order to ensure that the local community benefits from the Berg Water Project, TCTA introduced the "Franschhoek First Policy". The FFP sets out targets and guidelines aimed at maximising employment, procurement and training opportunities for the area's inhabitants. A social monitoring programme has also been initiated to monitor the impacts of the project, both positive and negative.

technical coordinator of the specialists involved in the baseline monitoring programme, explains that data are currently being analysed and a series of reports written, with the final report due in July. "TCTA is obliged to continue monitoring in terms of its environmental management plan, but the form that this monitoring will take is uncertain," she says. "There is also no point in monitoring if it is not aimed at corrections, so there needs to be a very clear commitment to monitoring as a tool for adaptive management."

As part of the baseline monitoring programme, a conceptual model of ecosystem functioning is being developed. Given that the dam will significantly alter the flow regime of the Berg River, the model pays particular attention to the links between the flow regime and other ecosystem components. Some of its uses will be to improve prediction of future changes, and determine the effectiveness of the environmental flows released from the dam to meet the instream flow requirements (IFR).

In November the Berg River was closed off by the dam, and diverted temporarily though the outlet conduit shown here.

"Basically what we are required to do in IFR assessments is use the best available knowledge to make predications," says Ratcliffe. "But monitoring is vital in telling us how well we did it, and if the flow releases are shown to be insufficient to maintain the ecosystem in a particular class, they need to be adjusted. That's going to be the acid test – if we get the amounts wrong, will DWAF be prepared to put their money where their mouth is and make the necessary changes?"

One aspect that is already causing concern is the system of artificial flood releases that has been proposed. The dam will have a dampening effect on floods, which are important for scouring the system of sediment build-up and river obstructions, such as fallen trees. Dr Gerrit Basson of the University of Stellenbosch's Department of Civil Engineering, estimates that as a result of the dam the Berg River will narrow by on average 15% down to Hermon, 70 km downstream. Below that the dam's influence will not be as severe, because a number of tributaries join the river, increasing its flow.

Dr Basson was contracted to develop operational procedures for flood releases from the dam, and used a hydrodynamic modelling to simulate the effect of the artificial floods. In November, at a Berg Water Project open day hosted by the South African National Committee on Large Dams (SANCOLD), he explained that the IFR assessments undertaken during the 1990s had proposed a small flood release of 15 m^3/s in April, a medium-sized one of 70-100 m^3/s in June, and a larger release of 100-220 m^3/s between July and September. However, the operating rules used in his hydrodynamic model stipulate that:

- The 70-100 m^3/s artificial flood will be released only if a natural flood

Dr Gerrit Basson explains the functioning of the Supplement Scheme.

A scale model shows how the Berg River Dam will be prevented from overflowing. Excess water will spill over a 40 m spillway and flow down a deep concrete chute to a 'ski jump.' After being thrown 30 m up into the air, the water will land in a plunge pool 80 m away.

event of 70 m³/s or more occurs in June or July, its magnitude depending on the size of the incoming flood but with a maximum of 100 m³/s;

- The 100-220 m³/s artificial flood will be released with the first naturally occurring flood of more than 160 m³/s in July or August, its magnitude depending on the size of the incoming flood but with a maximum of 220 m³/s. Should none of these requirements be met, no flood will be released.

This kind of talk is alarming to river ecologists. "We do not have much direct evidence of what type of floods cause movement of bed particles, and to what extent this regulates algal biomass and its invertebrate consumers, which would have a cascading effect all the way up the food chain," says Ratcliffe. "So when Gerrit produced this modelled output, the immediate response of most specialists was that it seems to reduce the environmental flow allocation to levels inadequate to sustain the river."

"We will therefore recommend in our final report that we use the hydrodynamic model to evaluate various alternatives for flood releases, based on the new knowledge we've gained as a result of the baseline monitoring programme. We will also suggest extending the model into the estuarine floodplain to show when it will be inundated, which is very important for migratory birds. When the estuarine reserve was undertaken in the early 1990s, it was in the early days of IFR assessments, and there was a whole lot they did not know."

Another long-standing issue of concern is whether the Berg Water Project will increase salinity in the lower reaches of the river, with negative consequences for the ecosystem and water users alike. Soils derived from the underlying Malmesbury Shales have a naturally high salt content, so irrigation and poor land management practices result in an increase in inorganic salt concentrations in the river.

Wageed Kamish of Ninham Shand is conducting a modelling study on salinity in the Misverstand Dam for DWAF, and one of the key questions is the effect of the Berg Water Project. "The hypothesis is that if you take away water it won't dilute the salts," he explains. "Without the dilution effect of winter floods, one would assume there'd be some deterioration in water quality."

Wageed is also project-managing a hydrodynamic study for TCTA on the Berg River Dam. "The top section of river – down to the supplement scheme – is considered to be sensitive, so the model aims to ensure that dam releases have temperatures close to that of the natural inflow. If water is released from the bottom of the dam it will be cold throughout the year, while water from the surface will be too warm.

"This particular study focuses on temperature, but the model could be used in future for other aspects. For example, the dam might develop algal problems later on, and then we'd have to figure out how best to manage the system. The advantage of modelling is that various scenarios can be tested before implementation."

Clearly, monitoring and modelling not only form an integral part of the pre-operational investigations for the Berg Water Project, but also have the potential to play a key role in its future implementation. They are the nuts and bolts in the environmental management toolbox, complementing one another to build a stronger information base.