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NMBM drought emergency measures

INTRODUCTION

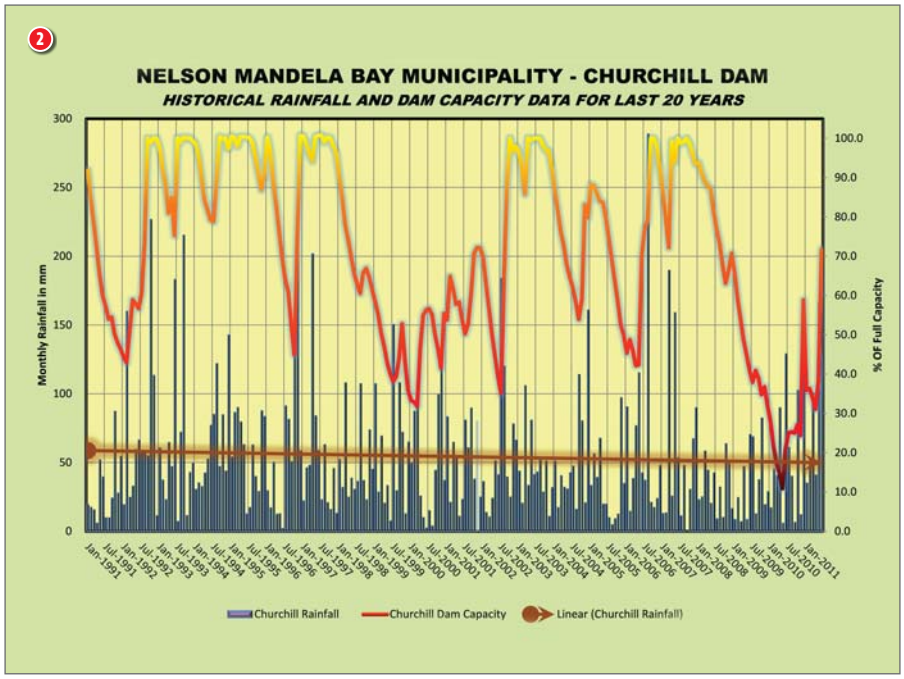
The drought conditions of the past three years, in the dam catchment areas supplying the Nelson Mandela Bay Metropolitan area (NMBM), were severe. A series of interventions, initiated by the NMBM and the Department of Water Affairs (DWA), were started with the express intention of alleviating the drastic water shortage. A team of multidisciplinary consulting engineers and specialist experts was appointed to investigate, report and act on each of these options, from technical, budgetary and time requirement perspectives. The team was made up of the NMBM, the DWA, Aurecon (lead consultant), Africoast, Groundwater Africa, Uhambiso, Ndodana and Carifro.

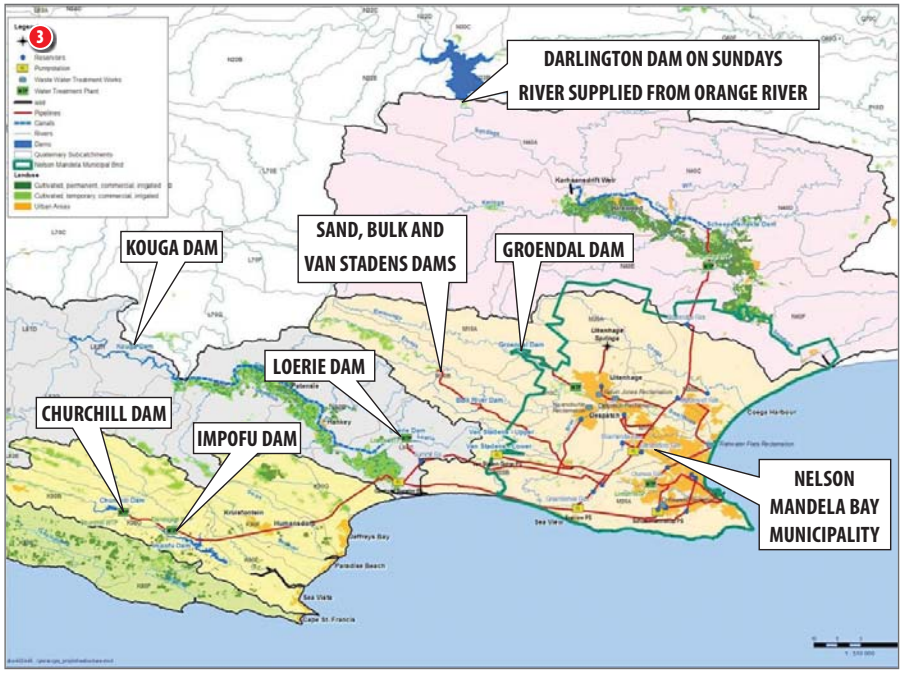
The analysis of the historical data has shown that the average monthly rainfall at the Churchill Dam has decreased over the past 20 years from 60 mm per month to 50 mm per month. The data has also revealed that the recurrence of drought is cyclic, occurring every four years on average.

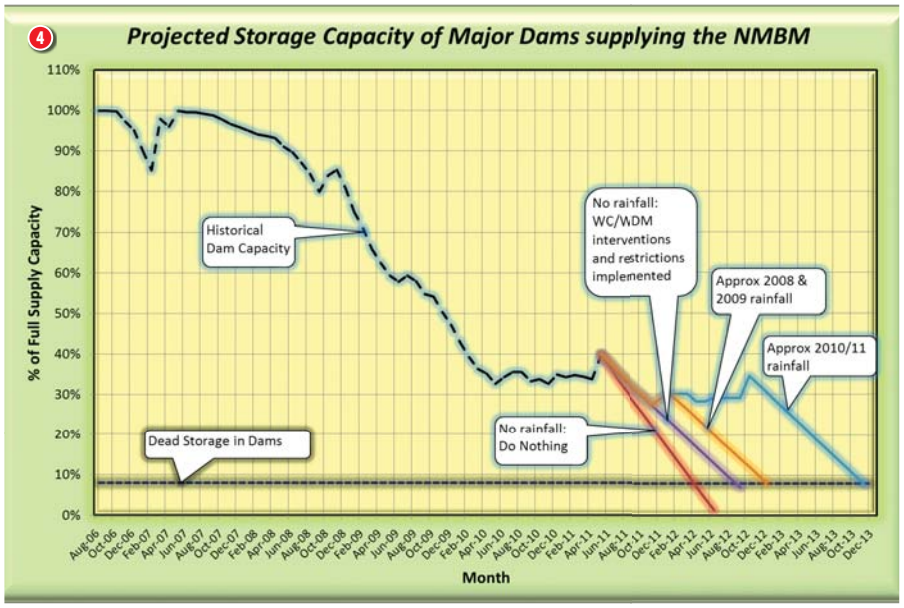
In view of the relatively long lead times necessary to implement emergency measures, the team prepared an Emergency Action Plan to ensure that there would be sufficient water stored in the dams for the needs of the NMBM and the various coastal towns that it supplies. The Emergency Action Plan entailed:

- Identification of options that could be implemented rapidly in order to further curtail water usage or to augment the supply.
- Screening of these potential options and the development of a short-list for implementation, together with the authorities responsible for approvals.
- Fast-tracking the implementation of the selected options.

1 Churchill Dam: January 2010 (26% of full capacity)







BACKGROUND TO THE ALGOA WATER SUPPLY SYSTEM

The NMBM is supplied by the Algoa Water Supply System (AWSS). The main dams in this system are the Churchill and Impofu Dams on the Krom River, and the Kouga Dam on the Kouga River.

The Kouga Dam also serves the Gamtoos Irrigation Board (GIB). The relatively small Loerie, Van Stadens, Bulk and Sand River Dams and the Uitenhage Springs only supply water to the NMBM, whereas the Groendal Dam also serves irrigators. Approximately 30% of the NMBM's requirements are supplied with water from the Orange River via the Darlington Dam on the Sundays River and the Scheepersvlakte balancing dam. These withdrawals were not subject to restrictions, other than the capacity limitations of the NMBM's existing Nooitgedagt scheme, which is to be upgraded by 2013.

NMBM EMERGENCY ACTION PLAN

The Emergency Action Plan has identified three main types of options which could be implemented by the NMBM and the coastal towns to reduce the water usage from the AWSS:

A. More severe water restrictions
B. Additional water conservation and demand management measures (WC/WDM)
C. Emergency supply schemes

A number of sub-options to each of these options have been identified as possibilities for reducing water usage from the existing AWSS, thus preventing the rapid drawing down of dam levels. Figure 4 indicates the historical combined water storage in the major dams, as well as the predicted effect of the drought and some of the interventions on the storage. These sub-options are also briefly described below.

A. MORE SEVERE WATER RESTRICTIONS

Improving effectiveness of February 2010 restrictions

Restrictions were originally imposed by the NMBM on 9 October 2009, but these were not fully effective in reducing demands. Because the drought

2 Churchill Dam: historical rainfall and dam capacity for the last 20 years
3 Layout of the Algoa Water Supply System
4 Projected storage capacity of major dams with interventions

persisted, additional restrictions were imposed on 1 February 2010. Key to the Emergency Action Plan was the ongoing monitoring of water usage from the dams by the NMBM and the coastal towns to determine whether these restrictions were sufficiently effective in curtailing the water demands. It proved not to be the case and additional measures had to be implemented to improve the effectiveness of the existing restrictions. These measures included:

- More intensive ongoing public awareness campaigns
- More intensive policing of restrictions and particularly the monitoring of high-use consumers
- Increased restrictions by implementing a new tariff structure with punitive increases.

B. WATER CONSERVATION AND WATER DEMAND MANAGEMENT MEASURES

The purpose of WC/WDM is to permanently reduce water demands. Numerous studies have shown that WC/WDM measures provide the most cost-effective means of reducing water demands by minimising losses and wastage, and by so doing delaying the need to construct additional infrastructure, usually at very high capital cost. Additional budget and resources were therefore allocated to the WC/WDM programme to address these interventions. The interventions include the following:

Dedicated WC/WDM team

Effective WC/WDM requires a dedicated manager and team of staff with a sufficient annual budget.

Thermal imaging to detect leaks in bulk pipelines

Thermal imaging involves periodic flights along the routes of the major pipelines using infrared imaging to rapidly identify leaks which can then be repaired as soon as possible by the maintenance teams.

WC/WDM measures upstream of household consumer meters

WC/WDM measures in the reticulation system upstream of consumer water meters include:

- Completion of the programme of installation of zone meters and the ongoing monthly monitoring to determine where losses or excessive usage are occurring. This also includes the monitoring of night flows.
- Ongoing monthly monitoring of the water balance between "water purchased" and "water sold", with the aim of reducing unaccounted for water from 30% to about 20% initially.
- The location and repair of leaks, including the setting up of an effective reporting system and a dedicated rapid-response leakage repair team.
- Pressure management, particularly to reduce night flows.

WC/WDM downstream of consumer meters

WC/WDM measures at, or downstream of, consumer meters include:

- Continuing the programme of replacement of old domestic and industrial meters
- Metering and billing of all domestic and industrial consumers
- Repair of communal stand pipes
- On-site leakage repairs at private households in low-income areas
- Drafting a policy in support of WC/WDM bylaws requiring the use of water efficient fittings
- Implementing and policing the three-stepped water tariff with a very high tariff for excessive usage.

Schools programme

A sample survey of schools has identified the very poor state of the internal infrastructure at schools, leading to considerable water losses. Although the Department of Education is responsible for this infrastructure, the potential savings are so significant that the NMBM deems it necessary for the Municipality to expedite this initiative.

Low-income housing water loss programme

ATTP (Assistance to the Poor) houses receive 8 kℓ of water per month. In reality, in excess of 8 000 units were identified that consumed more than 30 kℓ/month, mostly due to faulty plumbing. To date 12 136 houses have been repaired. Emergency repairs are conducted at all ATTP households, irrespective of their average water consumption. The water consumption records indicate that on average the repaired erven are now using approximately 67% less water. This is an on-going initiative.

Private homes programme

A call centre was established to actively target private high water consumers. The centre contacted more than 3 000 high consumers, resulting in an average reduction in water consumption of 23%.

Public Awareness

Ongoing public awareness is very important and includes measures such as the schools awareness programme, informative billing, pamphlets and brochures on household savings, and ongoing messages on local radio stations and in the press.

Substantial saving achieved

As a result of the implementation of the above measures, the daily water

consumption was reduced from 280 Mℓ/day to 230 Mℓ/day. The saving realised was thus 50 Mℓ/day or 18% of the total daily demand.

C. EMERGENCY WATER SUPPLY SCHEMES

On account of the long lead times to implement an emergency scheme, planning and design had to commence as soon as possible for the following reasons:

- The existing WC/WDM measures were not as successful as had been anticipated.
- The drought was more severe than the 1 in 100 year event for which the restriction measures had been planned.
- The water supply from some of the major dams would have been depleted by mid-2012, with no prediction of any abnormal rainfall.

A number of potential schemes were considered during a Drought Relief Workshop on 18 February 2010. A follow-up workshop was held to review the selection of emergency options, together with officials from the various government departments that would be responsible for the approvals. It was hoped that this early consultative process would minimise the potential delays that could arise from such approvals.

Maximising the supply from the existing Nooitgedagt scheme

The existing Nooitgedagt scheme is supplied with water from the Orange River via the Gariep water scheme. This supply is currently not restricted and therefore the DWA's analysis of the restriction measures for the NMBM assumed that the scheme would continuously supply water at its current maximum capacity of 90 Mℓ/day.

The emergency measures investigated included the following:

- Options for increasing the continuous delivery of the existing scheme to 100 Mℓ/day or more, if possible, without compromising water quality.
- Options for ensuring that the bulk supply network had sufficient capacity to transfer water from the Grassridge Reservoir to the areas served by the Chelsea Reservoir, while the supplies from Loerie in particular, and also from Elandsjagt, were restricted.
- Ensuring that the supply to the Scheepersvlakte balancing dam via the canal system would not be interrupted for maintenance or other reasons until the drought breaks, or until the new Nooitgedagt Low Level Scheme has been constructed.

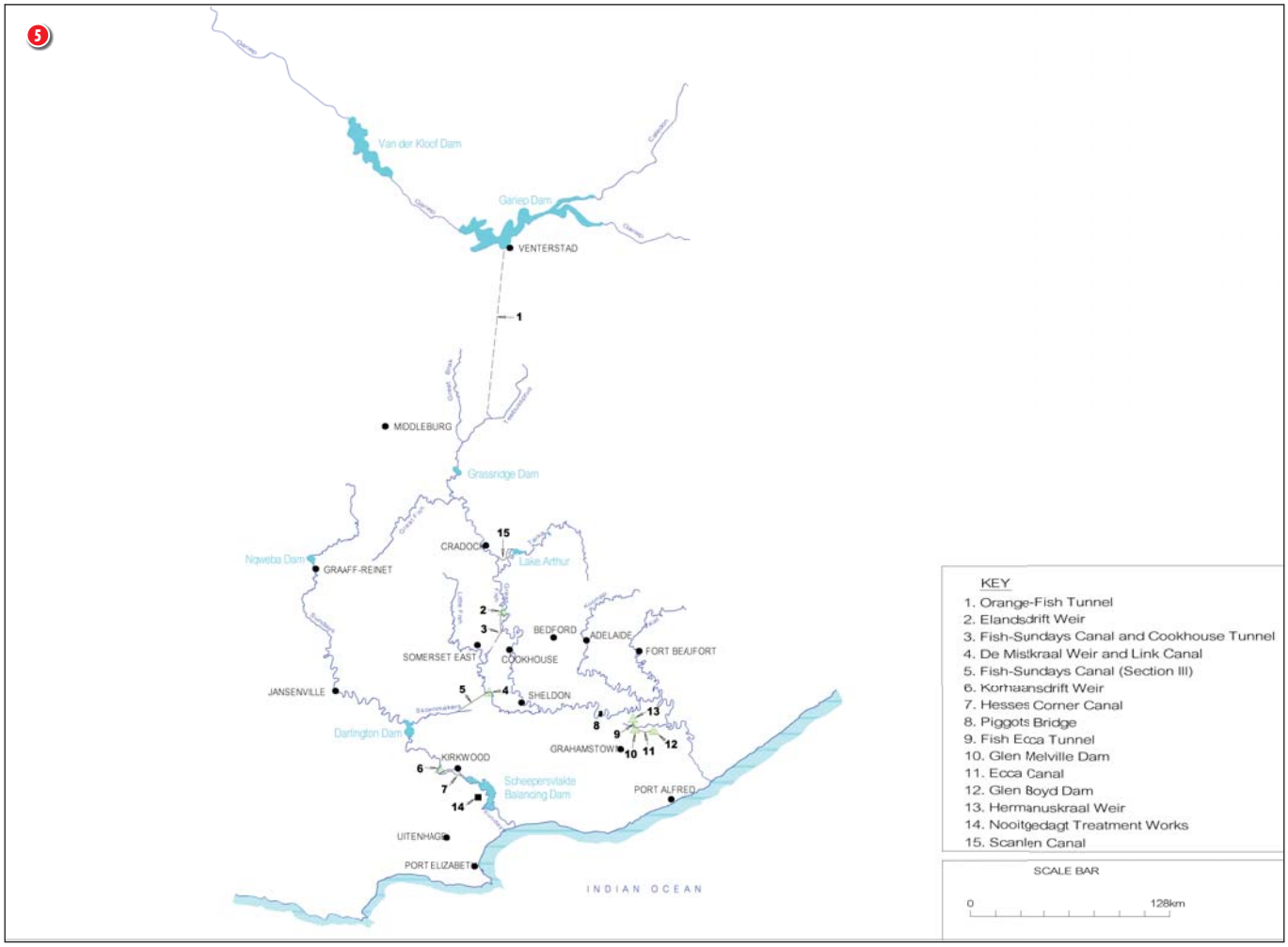
During the drought, the Nooitgedagt WTW was operating continuously at 95% of peak capacity.

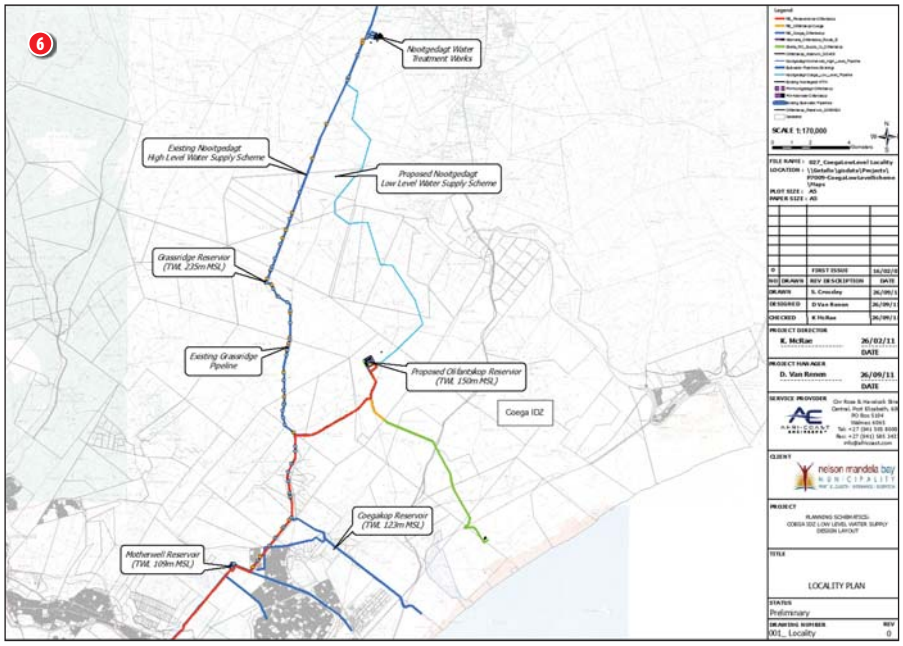
Fast-tracking the Nooitgedagt Low Level Scheme

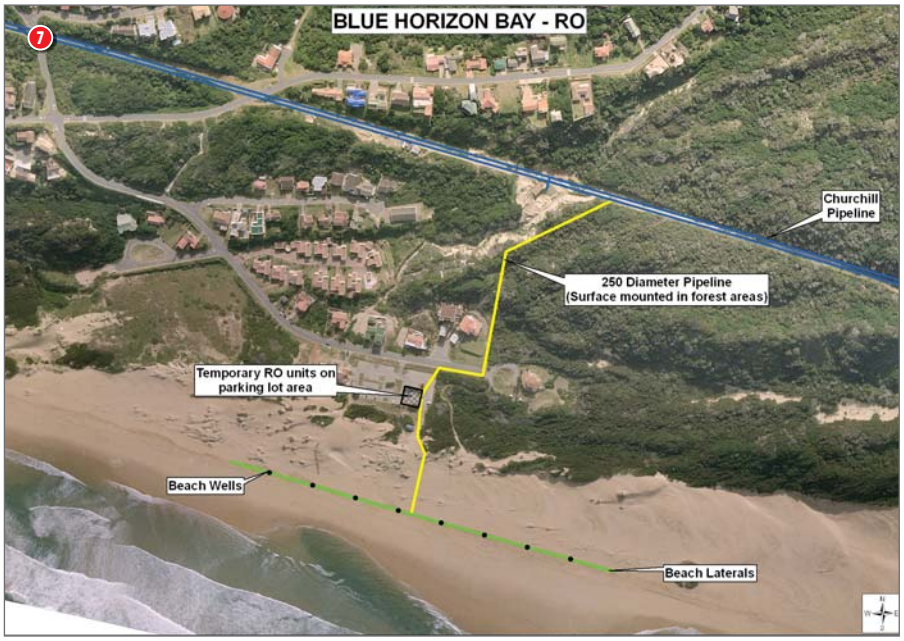
The Nooitgedagt Low Level Scheme (NLLS) was originally scheduled for completion in 2013. When completed, this scheme will augment the supply to the NMBM by 100-120 Mℓ/day. As this scheme would have a number of advantages, compared with other emergency schemes, consideration was given to the fast-tracking of its development. The NLLS consists of the following elements:

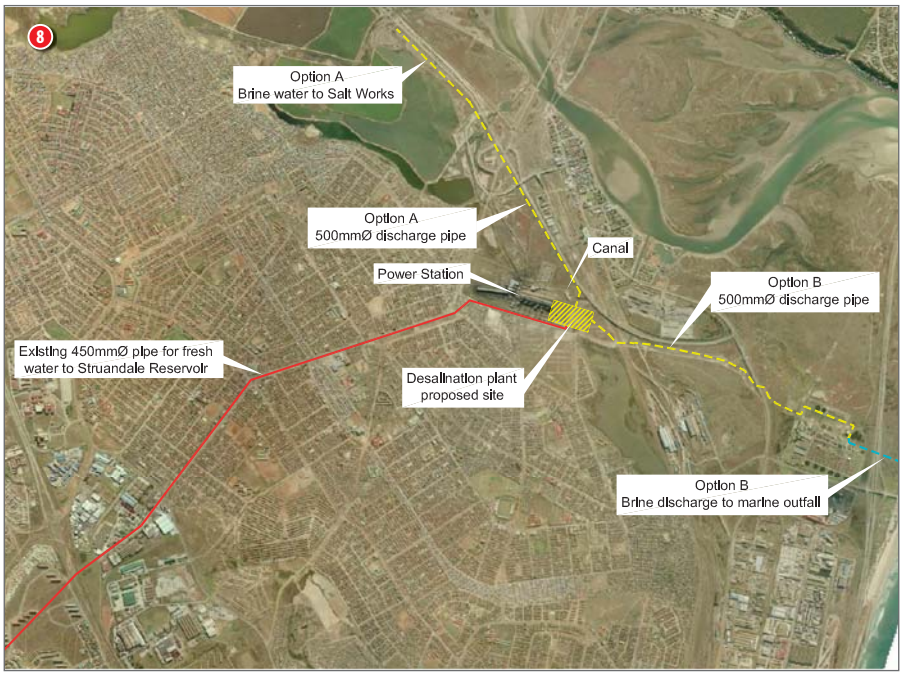
- Phase 1
  - Extensions to the Nooitgedagt WTW (civil)
  - Olifantskop 10 Mℓ reservoir and connecting pipework

5 Diagrammatic layout of the Gariep water scheme









- Electrical transformer for Nooitgedagt WTW
- Rising main pipeline to Olifantskop
- Gravity main pipeline to Motherwell and Coega IDZ
- Motherwell and Bethelsdorp Booster PS (civil, mechanical and electrical)

- Phase 2
  - Extensions to Nooitgedagt WTW (remainder civil, mechanical and electrical)
  - 45 Mℓ reservoir
  - Low lift pump station mechanical equipment

The fast-tracking of the NLLS commenced with Phase 1. It is estimated that the WTW 3rd module and the 45 Mℓ reservoir at Olifantskop (Phase 2) will be completed in February 2013.

Lower Gamtoos Pumping Scheme discharging into Canal

The Lower Gamtoos River Emergency Scheme would comprise a temporary pump station on the Gamtoos River and a short pipeline that would discharge into the Gamtoos Canal about 14 km upstream of the Loerie Dam. The relatively saline base flows originating from the Groot River and from irrigation return flows would be delivered into the canal and would be blended in the Loerie Dam with good quality water from the Kouga Dam. There is sufficient treatment and pumping capacity at Loerie to utilise the water.

Desalination of seawater abstracted from the beach

Three beaches to the southwest of the NMBM, and close to the Churchill pipelines, have been identified as possible sites for seawater desalination plants, each with an output of about 2 Mℓ/day of fresh water:

- Scheme D1: Van Stadens River Mouth
- Scheme D2: Maitland River Mouth
- Scheme D3: Blue Horizon Bay

Water would be abstracted from the beach using a well point system, or possibly a buried collector drain and pump station. The desalination plant would incorporate provision for any further

6 Layout of the Nooitgedagt Low Level Scheme

7 Proposed set-up for the Blue Horizon Bay desalination plant

8 Seawater desalination proposal at the Swartkops estuary

pre-treatment that may be necessary and the brine would be discharged back into the sea. The treated water might require stabilisation in addition to the disinfection that would be necessary, and would be pumped into the Churchill pipeline.

Desalination of seawater abstracted from the Swartkops estuary

The 30 Mℓ/d Swartkops desalination intervention was identified as one of the emergency interventions because this scheme could be implemented rapidly and its yield would not be affected by the drought. This option was one of two that could make large volumes of water available.

The desalination project entails the extraction of seawater from the lower reaches of the Swartkops estuary where tidal inflows from the sea dominate. The desalination plant would be situated at the old power station site and the old intake canal would be utilised. The brine would go to the Fishwater Flats Sea Outfall and to Swartkops Sea Salt. Clear water would be delivered to the Struandale Reservoir via an existing 450 mm pipeline that is currently not being used.

With the drought being over now, the Swartkops desalination plant designs and documentation have been shelved for the time being as a possible future emergency solution should another severe drought hit the area.

Groundwater

Groundwater Africa assisted the project team to explore groundwater options in the Metro. The scope of the work was twofold: firstly, to investigate existing boreholes on NMBM and privately owned land, and secondly, to investigate new drilling targets.

All existing municipal boreholes were investigated to establish whether any could be used for bulk supplies. The only boreholes with sufficiently high yields are those that the Metro had 'inherited' in the Motherwell area, but all these boreholes had been destroyed (blocked / collapsed / vandalised) and could not be used.

Of the private boreholes, those in the Bushy Park and Amanzi Estate areas were found to be best suited for bulk supplies. Three of the four boreholes in the Bushy Park area are suitable for use with a total yield of 1,5 Mℓ/d. Preliminary designs were developed to supply water to the Churchill pipeline. It was decided that the equipping and construction of conveyance infrastructure should be put on hold, but that the in-principle agreement with the owner would be kept in place.

Two of the three boreholes in the Amanzi area are suitable for use with a total yield of 3 Mℓ/day. However, communications with the land owners proved problematic, and as a result it was decided to rather identify new drill sites in the broader Uitenhage area.

The second part of the scope was to identify and site new boreholes with possible high yields that could augment bulk water supplies. To date, over 30 boreholes have been identified in the Coega Kop area, the Uitenhage area and the Churchill Dam area, and numerous other 'target areas' have been identified for further exploration. Extensive deep and shallow geophysical surveys have been done, as most of the targets lie deep below the surface (up to 400 m). A three-year annual drilling contract is currently out to tender and drilling should start early in the new year.

Impofu Dam: accessing of storage below pump station intake

As the wall of the Impofu Dam is located some 6 km downstream of the pump station, 17 000 Mℓ of the storage capacity cannot be accessed by the intake tower pumps. Of this, 9 000 Mℓ would be accessible with the use of a barge and submersible pumps at the base of the intake tower. Such pumps that were bought during a previous drought were taken out of storage and tested, and were ready to use when needed. Fortunately, this measure was not necessary. The extraction of the remaining 8 000 Mℓ via a scour valve was investigated. A 4,5 km length of pipeline would have to be constructed from the scour valve to add the water to the system.

Direct potable reuse of treated effluent from Driftsands WWTW

This scheme would comprise the further treatment of treated effluent from the Driftsands WWTW in order to deliver some 4 Mℓ/day of potable water into the Churchill pipelines.

Indirect potable reuse of treated effluent from Driftsands WWTW

This scheme would be the same as above except that instead of discharging the treated water directly into the Driftsands Reservoir or the Churchill pipelines, the water would be delivered to the sand aquifer through a spreading basin or injection wells and would be abstracted from the aquifer some distance away. The utilisation of the sand aquifer would have to be carefully planned to select a location where no pollution would occur and to provide sufficient storage and residence time in the aquifer to act as a safety barrier to meet the indirect reuse best international practice criterion.

CONCLUSIONS

- Interventions designed to reduce leaks and wasting of water have produced immediate results, but not significantly enough yet. The longer-term benefits will grow as the programmes develop. This will be an ongoing programme, irrespective of whether a drought is being experienced or not.
- The rate of depletion of the water supplies within the Metro should decrease measurably as the various interventions combine to reduce consumption or wastage.
- It is clear that if the identified interventions are not implemented, the Metro will find itself in the same situation in a few years' time as was experienced over the past four years.
- All of the interventions prioritised are in line with the Algoa Reconciliation Study (see article in *Civil Engineering*, June 2011, p 34). □

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Source:
http://www.saice.org.za/downloads/monthly_publications/2011/2011-Civil-Engineering-october/#/0