



# DEPARTMENT OF WATER AFFAIRS

DIRECTORATE OF DESIGN SERVICES

## GREAT BRAK RIVER

Estuary environmental study with reference to a management plan for the Wolwedans Dam and Great Brak River Mouth



Compiled by:  
EMATEK – CSIR

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THE GREAT BRAK RIVER ENVIRONMENTAL COMMITTEE (GEC)

## INTRODUCTION



When a dam is built in a river catchment, the estuary of the river is affected in four significant ways:

- The natural freshwater flow to the estuary is reduced, which changes the way in which the estuary functions naturally (in other words, the physical forces or the dynamics of the estuary are changed),
- the ecological environment of the estuary is changed,
- the quality of the water in the estuary is changed and
- the socio-economic character of the estuary and its surroundings are changed.

## BACKGROUND

The Great Brak Estuary lies about midway between the towns of George and Mossel Bay. The estuary, even before the Wolwedans Dam was built upstream in the Great Brak River, no longer reflected a natural environment. It was as long ago as the 19th century, in fact, that man had already started to open the mouth of the estuary artificially, mainly to try and control floods and high estuary water levels. When the building of the Wolwedans Dam was announced, the Department of Water Affairs (DWA) established the Great Brak River Environmental Committee (GEC) (or in Afrikaans, the Groot Brakrivier Omgewingskomitee (GOK)) to conduct an environmental study into the estuary. The GEC consisted of representatives of the DWA, the Great Brak River Municipality, the Island Plot Owners Association, the Chief Directorate Nature and Environmental Conservation and the CSIR.

*This committee had two functions:*

- It had to investigate the four ways in which the Wolwedans Dam would affect the Great Brak Estuary and
- it had to draw up a water release or estuarine management plan that would set out the best way in which the water reserved in the dam every year for the Great Brak Estuary should be used so that there would be as little change as possible to the estuarine environment.

The committee approached the Division of Earth, Marine and Atmospheric Science and Technology (EMATEK) of the CSIR to carry out the investigation and to draw up the management plan for approval by the GEC.

*This is a brief summary of the key findings and proposed management plan. A copy of the full report is available at the Great Brak River Municipal Library.*

## EMATEK

EMATEK went about its task in four steps:

*Under guidance of the GEC*

- it studied the existing status of the estuary,
- it predicted the possible changed status of the estuary,
- it drew up a water release management plan for the dam and
- it made recommendations on how the estuary should be monitored in the future to ensure a healthy environment and to measure the effectiveness of the management plan and, if necessary, adjust it.



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## ESTUARINE DYNAMICS

The water and sand movement in the estuary - the primary factors that maintain the physical environment - depend mainly on the tides from the sea (in other words, on open mouth conditions). The study showed that normal river flow is not as important as the tidal flow, although it does play a role, together with spring tides, in keeping the mouth open. It was found that the dam would reduce the natural freshwater river flow to the estuary, especially in dry years. This would result in the mouth being closed more often and for longer periods, which in turn would result in high water levels in the estuary. The creation of these large expanses of water would increase the loss of water through seepage and evaporation.

## RIVER FLOW

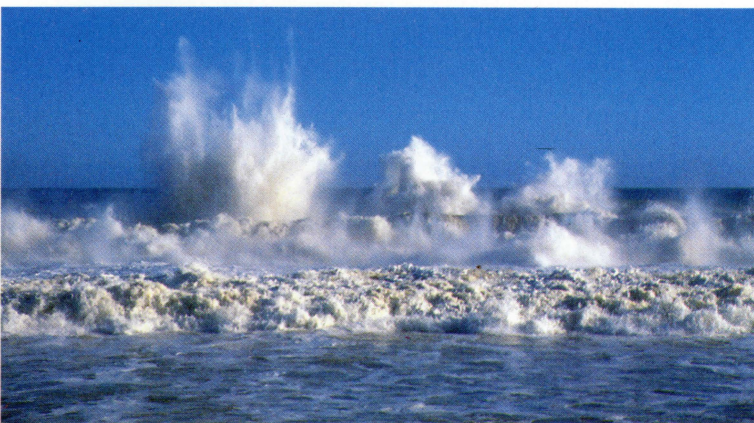
When the present situation was compared with that after completion of the dam, it was shown that the Wolwedans Dam will cause a reduction in the natural river inflow to the estuary.

## TIDAL VARIATION

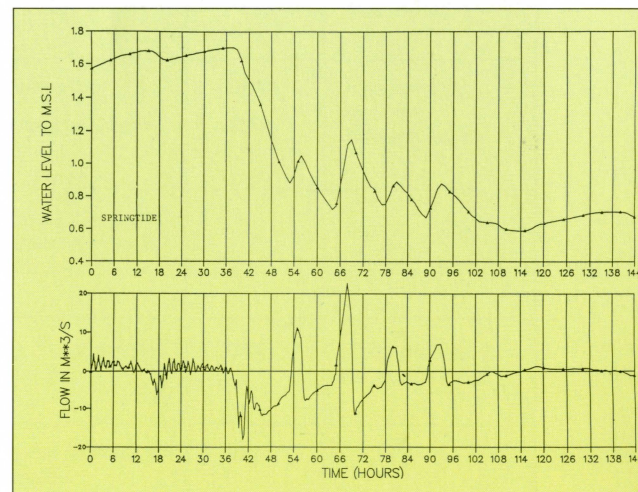
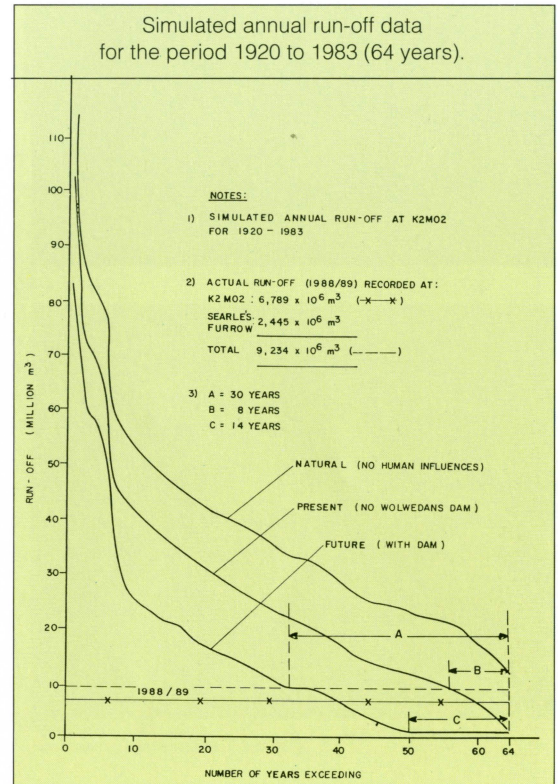
The tidal influence and threshold effect of the estuary mouth can be seen on the water level trace. Calculated water flows in the mouth show a marked difference ( $\pm 50\%$ ) between the maximum incoming tidal water flow compared to the maximum outgoing water flow. On average it takes 4 hours for the tide to come in and 8,5 hours for the tide to flow out of the estuary.

## COASTAL DYNAMICS

The influence of waves and currents was studied. Insufficient data led to an inconclusive answer and it was thus decided that, since the coastal processes have a direct influence on the estuary mouth stability, further monitoring of the mouth characteristics, the nearshore wave conditions and the beach profile changes is necessary. This is at present being undertaken as part of a Continuous Low-level Environmental Observations (CLEO) programme to determine long-term trends in key parameters, such as the wave height and approach direction distributions.



## FINDINGS



## ESTUARINE ECOLOGY

Estuarine plants and benthic (or bottom-dwelling) animals are good indicators of the long-term health of the estuary; they are essentially immobile and therefore cannot escape adverse conditions by migrating. This is why they were chosen to evaluate the estuarine ecology.

*The following was concluded:*

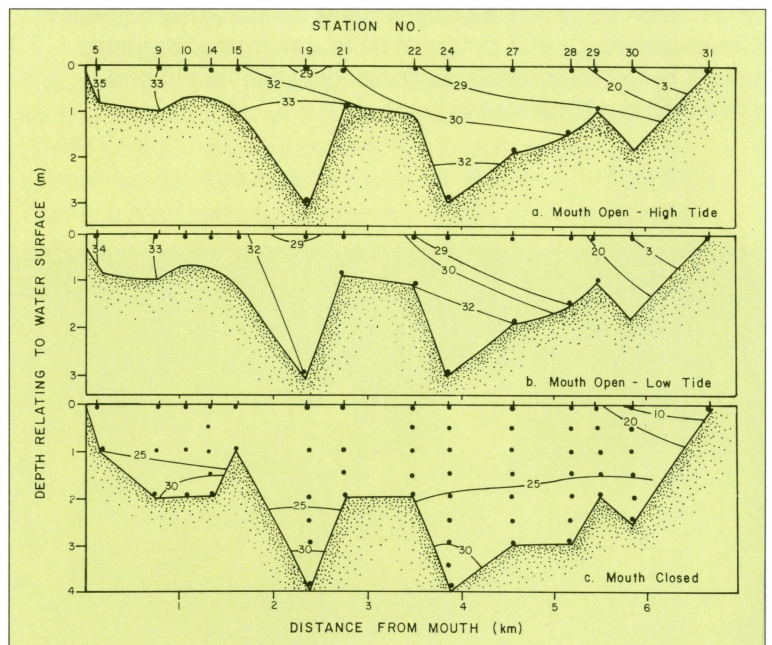
- The ecosystem is in a fairly stable condition.
- An open mouth is the most beneficial factor for maintaining the ecology of the estuary.
- The maintenance of the salinity between 7 and 40 parts per 1 000 is important.
- Water levels in excess of + 1,22 m (MSL) for extended periods should be avoided.

## WATER QUALITY

Reduced natural freshwater flow and more frequent and more protracted closure enhance the effects of pollution (like sewage), which in turn causes eutrophication, in other words an increase in nutrients and a decrease in the supply of oxygen and possible faecal bacterial contamination. This results in the death of certain plants and animals and the deterioration in the aesthetic qualities of an estuary and a potential health risk. The main problem at the moment is the lack of an effective sewage system. It was concluded that, although the Wolwedans Dam will influence the availability of fresh water to the estuary and thus have a negative effect on the water quality, the implementation of an effective sewage system for Great Brak River will more than compensate for this. The water quality will further be enhanced by ensuring that the mouth is open during and after the holiday season.



Photo: Chief Directorate  
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## SOCIO-ECONOMICS

EMATEK subcontracted the Environmental Evaluation Unit of the University of Cape Town to study the socio-economic aspects of the estuary, in other words the issues most important to the public. These aspects form an integral part of the management plan.

*Results of a questionnaire circulated at Great Brak River are summarised in Table 1. The key aspect was that the public felt that the ideal status of the estuary is an open mouth condition, which can be obtained through an effective management plan.*



Table 1: Comparative assessment of possible socio-economic effects with and without the Wolwedans Dam

AREA OF CONCERN				SOLUTION		
CONCERN	PRE-DAM CONSTR.	POST-DAM CONSTR.	EFFECT OF DAM	REMEDIAL MEASURES	ACTION BY	MONITORING REQUIREMENT
Reduced river flow to estuary	Gross MAR = 38,3 Mm <sup>3</sup> Net MAR = 18,3 Mm <sup>3</sup> ~ ~	Gross MAR = 38,3 Mm <sup>3</sup> Net MAR = 15,2 Mm <sup>3</sup>	Dam will reduce inflow to estuary	Water release plan Mouth management plan	DWA ~ GBM	Water level record River flow record.
Effect on estuary mouth	Artificially breached 2 to 3 times per year due to natural high estuary water level	Reduced in-flow, lower level, fewer breachings due to less river in-flow	Estuary mouth will close more often and be closed for longer periods	Water release plan Mouth management plan	DWA ~ GBM	Water level record River flow record Continuous observations (Checklist)
Effect on water quality of estuary	Some natural stress, especially during closed mouth conditions and at high season	Increased risk of oxygen depletion, excess nutrients and high bacterial counts	Possible water quality deterioration due to reduced river inflow	Water release plan Mouth management plan	DWA ~ GBM	Water quality monitoring.
Effect on aesthetic quality of estuary	Frequent open mouth and tidal action, especially during holiday seasons	Reduced aesthetic quality due to more frequent mouth closure	Frequent mouth closures and lower estuary water levels	Water release plan Mouth management plan	DWA ~ GBM	Water quality monitoring Water level record.
Effect on recreational value of estuary	Recreational activities concentrated around open mouth and tidal action	Activities will be influenced by mouth condition and estuary water level	Frequent mouth closures and lower estuary water levels	Water release plan Mouth management plan	DWA ~ GBM	Water quality monitoring Water level record.
Effect on biological aspects of estuary	Estuarine ecology appears healthy and productive	Water level change may cause salt marsh die-back and disrupt faunal production	Productivity may reduce and disrupt ecological processes	Water release plan Mouth management plan	DWA ~ GBM	Estuarine ecology monitoring. Water level record
Effect on property values	Valuable for holiday and retirement homes, especially on riverside and the Island	Sensitive to changes in aesthetic and recreational values	Expected trend not clear	Maintenance of aesthetic and recreational values as far as possible		
Effect on flooding	Major floods with loss of property have been recorded	Normal floods will be attenuated	Risk of damage by floods is reduced	Issuance of flood warning Evacuation plan	DWA	Estuary water level River flow Dam level
Effect on water rights	Industry uses 4 Mm <sup>3</sup> /a but owns rights to 10,6 Mm <sup>3</sup> /a. Riparian farmers use 6,3 Mm <sup>3</sup> /a ~ ~	At present utilised rights are acknowledged	Farmers are limited to a maximum for irrigation	Industry may be entitled to compensation	DWA	
Sociopsychological effect on down stream residents	No effect without dam	Concern at possible effect of dam failure and security, and effect on river	Some downstream residents feel insecure as result of dam	Involve community in flood warning evacuation plan and in devising management plan	DWA	

~ Mossref acts as an agent for the DWA and operates the dam.

~ ~ 1 Mm<sup>3</sup> = 1 million m<sup>3</sup>

## PROPOSED MANAGEMENT PLAN

The overall management goal, namely as far as possible to ensure the environmental quality of the estuary after completion of the Wolwedans Dam, can be achieved through the following objectives:

- To maintain the ecosystem as closely as possible to the current state.
- To maintain desirable aesthetic qualities of the estuary, in particular tidal influence around the Island as far as possible.
- To maintain the recreational value and potential of the estuary, especially during peak visitor periods.

From the study of all the relevant factors (Table 1), it was clear that the proposed management plan for the dam should be aimed at keeping the mouth open as long as and as often as possible, particularly during the holiday season.

It was found that an open estuary mouth could be created and maintained through

- controlled water releases from the dam,
- controlled artificial opening of the mouth or
- a combination of the above.

It is recommended that the present estuarine environment be maintained by substituting active management for the natural processes operative prior to the construction of the dam. This implies that the natural effect of unregulated river flow should be replaced by controlled water releases, together with the excavation of the beach berm, to open the estuary mouth when required.

### ARTIFICIAL MOUTH OPENINGS

*When an artificial mouth opening is required, the following is recommended:*

- The trench should be made close to the eastern bank to take full advantage of the natural ebb and flood channel patterns.
- The excavated trench should be as wide and as deep as possible.
- The excavated sand should be placed as far from the trench as possible on the eastern side of the mouth during normal wave conditions.
- The mouth should be opened four days after neap tide and about two hours before low tide.
- Water should be released during artificial breaching at a rate of between 5 m<sup>3</sup>/s and 10 m<sup>3</sup>/s to minimise seepage losses and to prevent mobilisation of pollutants from the river bottom.

### CHECK LIST

In order to establish when water releases would be necessary a continuous low-level monitoring programme, using a check list with relevant criteria, is to be carried out. During the non-critical off-season period these key parameters should be measured on a monthly basis at several points in the estuary. During the holiday season, however, the parameters should be



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measured weekly. Nutrient concentrations should also be monitored every week during the holiday season.

## MONITORING

In order to evaluate the adopted management policy, a functional monitoring programme incorporating regular surveys of key parameters pertaining to the estuarine dynamics, the ecology and the water quality should be followed to ensure the health of the estuary. Detailed follow-up investigations should be undertaken in 1995 and in 2000 to evaluate the actual effect of the Wolwedans Dam on the estuary. A survey among residents and visitors to the area should be undertaken after the management programme has been in operation for two years. The results of the survey would indicate whether modifications to the adopted management plan would be required to meet the needs of the users of the Great Brak Estuary more effectively.

GREAT BRAK RIVER: ESTUARY STATUS CHECKLIST				
CHECKED BY: _____			DATE: _____	
A	CRITERIA	SCORE YES/NO	SCORE?	COMMENTS
1	IS THE MOUTH OPEN ?	2 0		DEPTH:    m ; WIDTH:    m
2	IS THE ESTUARY WATER LEVEL LESS THAN +1,22 MSL ?	2 0		LEVEL =
3	IS THERE A BAD SMELL AND/OR EXCESSIVE ALGAL GROWTH IN THE WATER ?	0 1		IF YES, PLEASE DESCRIBE:
4	IS THE E. COLI LEVEL LESS THAN 1000 ?	2 0		E. COLI LEVEL =
5	IS THE SALINITY LEVEL MORE THAN 7 AND LESS THAN 40 ?	2 0		SALINITY LEVEL =
6	ARE FISH DYING OR UNDER STRESS e.g. GAPING AT THE SURFACE FOR AIR ?	0 2		IF YES, PLEASE DESCRIBE:
7	IS IT FEBRUARY ? IS IT JUNE ? IS IT NOVEMBER ?	-1 0 -1 0 -2 0		
NOTE: OPEN MOUTH IF TOTAL < 9			TOTAL:	ACTION?
D	MONITORING INFORMATION	TIME	DATE	OTHER
1	WATER RELEASE STARTED:			} VOLUME RELEASED:    m <sup>3</sup>
2	WATER RELEASE STOPPED:			
3	MOUTH OPENING STARTED:			} ACTUAL MACHINE TIME:    hrs
4	MOUTH OPENING COMPLETED:			
5	MOUTH CLOSED ON:			
6	TOTAL RAINFALL RECORDED PER MONTH:			mm
7	GENERAL COMMENTS:			

## CONCLUSION

The study has shown that, by careful usage of water available for the estuary and additional mechanical mouth openings, a situation can be established that is beneficial to the estuarine environment. In this way negative effects of the dam on the estuary can be counterbalanced successfully and the overall management objective, "to ensure the environmental conservation of the estuary", can be met.

DATA	
Year of completion	1990
Purpose	Industrial, domestic and ecological use
River	Great Brak River
Nearest town and province	Great Brak River, Cape Province
Type	Rollcrete arch-gravity
Gross storage capacity	24 million m <sup>3</sup>
Wall height above lowest foundation	70 m
Crest length	270 m
Type of spillway	Uncontrolled
Spillway capacity	960 m <sup>3</sup> /s
Reservoir surface area at full supply level	109 ha
Owner, design and construction	Department of Water Affairs
Length of pipeline	30,5 km
Pumping head	410 m



# GREAT BRAK ESTUARY FLOW DIAGRAM

