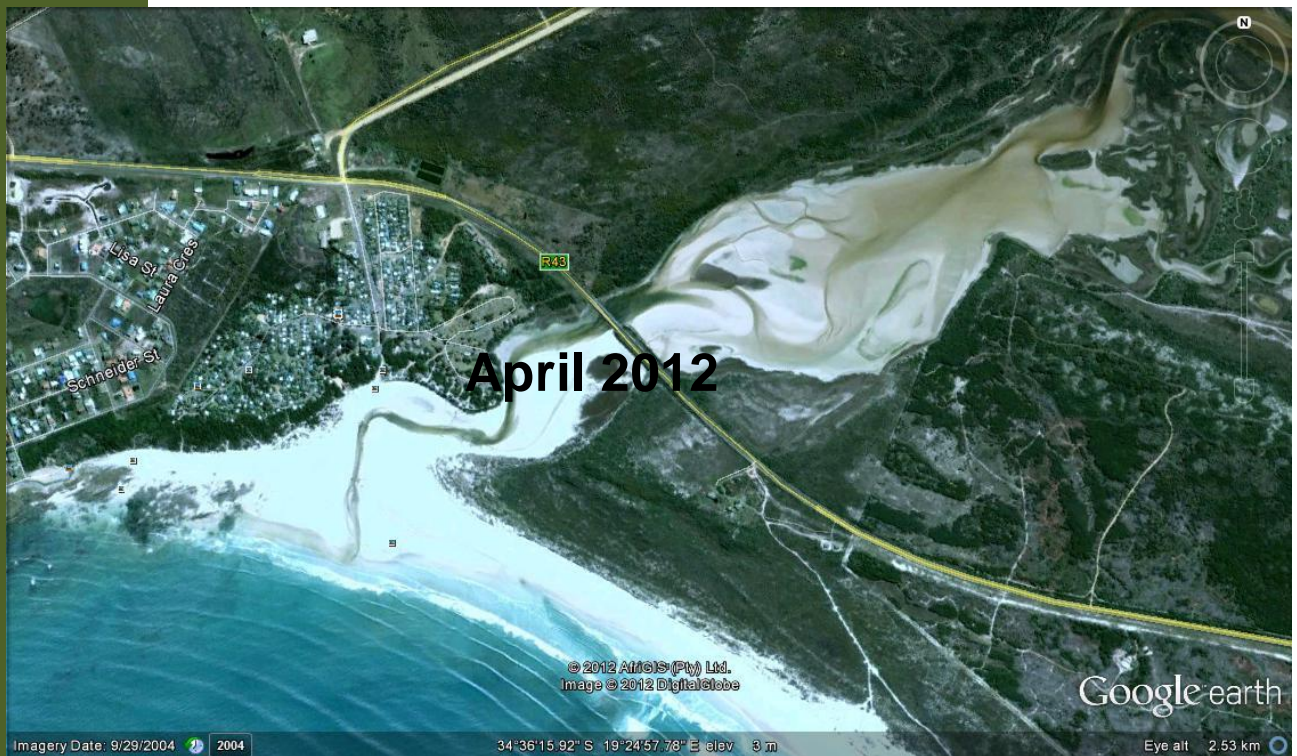


# HYDROLOGY AND SCENARIO ANALYSIS OF THE UILKRAALS CATCHMENT



Prepared by:  
IWR Water Resources (Pty) Ltd



## TABLE OF CONTENTS

---

<b>TABLE OF CONTENTS</b> .....	<b>i</b>
<b>LIST OF TABLES</b> .....	<b>i</b>
<b>LIST OF FIGURES</b> .....	<b>i</b>
<b>1 INTRODUCTION</b> .....	<b>1-1</b>
<b>2 DATA AND MODEL CALIBRATION</b> .....	<b>2-2</b>
2.1 HYDROLOGY AND CLIMATE .....	2-2
2.2 WATER USE .....	2-3
2.3 RAINFALL .....	2-5
2.4 MODEL CALIBRATION .....	2-6
2.4.1 Assumptions in model set up: .....	2-7
<b>3 SCENARIO MODELLING</b> .....	<b>3-1</b>
3.1 MODEL SETUP .....	3-1
3.2 SCENARIOS.....	3-2
3.3 SCENARIO RESULTS.....	3-2
<b>4 FLOOD HYDROLOGY</b> .....	<b>4-1</b>
<b>5 REFERENCES</b> .....	<b>5-1</b>
<b>APPENDICES</b> .....	<b>A-1</b>
APPENDIX A WARMS IRRIGATION DATA.....	A-1
APPENDIX B FLOOD PEAK CALCULATIONS.....	B-1

## LIST OF TABLES

---

Table 2.1	Monthly observed flow data for the Uilkraals River based on flow records from 2002 to 2010.....	2-2
Table 2.2	Simplified crops types and area (from WARMS).....	2-3
Table 2.3	List of rainfall stations in and around Uilkraals River Catchment.....	2-6
Table 2.4	Calibration statistics .....	2-8
Table 2.5	Incremental natural simulated runoff from sub-catchments.....	2-9
Table 3.1	Summary of flows into the estuary under various scenarios (units million m <sup>3</sup> /annum) .....	3-2
Table 4.1	Flood peaks for the G40M catchment.....	4-1

## LIST OF FIGURES

---

Figure 1.1	Map of Uilkraals River catchment.....	1-1
Figure 2.1	Kraaibosch Dam and Avoca weir.....	2-3
Figure 2.2	Recorded abstraction from Kraaibosch Dam for irrigation.....	2-4
Figure 2.3	Recorded abstraction from the Kraaibosch Dam for Gansbaai .....	2-5
Figure 2.4	Map showing location of rainfall stations .....	2-6
Figure 2.5	Sub-catchments of G40M quaternary catchment.....	2-7
Figure 2.6	Comparison of observed and simulated flow before recalibration .....	2-8
Figure 2.7	Comparison of observed and simulated flow after recalibration observed record at Avoca weir .....	2-9

Figure 3.1	Water Resources modelling system diagram.....	3-1
Figure 3.2	Natural (red), present day (green) and full allocated flow scenarios .....	3-3
Figure 3.3	Duration curves of flow at the estuary for three scenarios .....	3-3
Figure 3.4	Duration curves of flow at the estuary for three scenario (zoomed in to lower flows) .....	3-4

## TERMINOLOGY AND ACRONYMS

ha	hectare
IAPs	Invasive Alien Plants
MAR	Mean Annual Runoff

## 1 INTRODUCTION

The analysis of the hydrological regimes of estuaries is important to better understand the ecological functioning of the estuary. In the absence of observed stream flow records, the inflow time series is simulated using a rainfall-runoff model (i.e. Pitman Monthly model) while development scenarios are generally simulated using a water resources model. The purpose of this study is to simulate the monthly river inflow to the Uilkraals Estuary located in the G40M quaternary catchment, in the Breede Water Management Area in Western Cape. See **Figure 1.1**. The gross catchment area of Uilkraals River is 393 km<sup>2</sup>.

The Kraaibosch Dam was constructed on the Uilkraals River in 1999 to supply the town of Gansbaai with water for domestic and industrial use and the surrounding areas with water for irrigation. The dam wall is located approximately 10 km upstream from the estuary, has a surface area of 102 ha when full and has a full supply capacity of 5.5 million m<sup>3</sup>. Detailed flow records of river inflow, spillage, rainfall and outflow are kept on a daily basis, but were never made available to Department of Water Affairs. The recent study by the Water Research Commission (Middleton and Bailey, 2009) therefore did not take this valuable information into account when modelling this catchment. The catchment area of the dam is 220 km<sup>2</sup> which is approximately 56% of the total catchment and therefore the majority of the catchment Mean Annual Runoff (MAR) flows into the Kraaibosch dam.

The Boesmans River joins the Uilkraals River approximately 6 km from the estuary. The Nieuwedam is a significant farm dam located on this river upstream of the estuary. There are also a number of small dams with associated water abstraction for irrigation upstream of the Kraaibosch Dam. The total volumes abstracted from these dams are not known but can be estimated from the registered areas under irrigation.



**Figure 1.1** Map of Uilkraals River catchment

## 2 DATA AND MODEL CALIBRATION

### 2.1 HYDROLOGY AND CLIMATE

The catchment of the Uilkraals River is characterised by hilly slopes in the upper reaches of the catchment and a very flat coastal plain in the lower reaches. It is surmised that the rainfall-runoff relationship of these two areas will be very different with relatively high runoff from the upper reaches and much less runoff from the coastal plain. The hydrology of the upper reaches can be modelled realistically using the inflow records into the Kraaibosch Dam while there is no observed flow with which to calibrate the rainfall-runoff response of the coastal plain.

The focus of this study is to simulate the inflows into the estuary under the reference state, the present state and two alternative scenarios over as long a period as possible in order to cover the full spectrum of possible hydrological events from extreme droughts to extreme floods. Previous studies (WR90 and WR2005) did not use observed flows to calibrate Uilkraals river catchment. For this study, observed flow data (July 1992 to June 2011) at Avoca weir upstream of Kraaibosch Dam (**Figure 2.1**) obtained from **Wayne Gabb of Lomond Farm** were used to calibrate the Pitman hydrological model to realistically estimate the inflows into the dam and consequently model flows for the whole catchment.

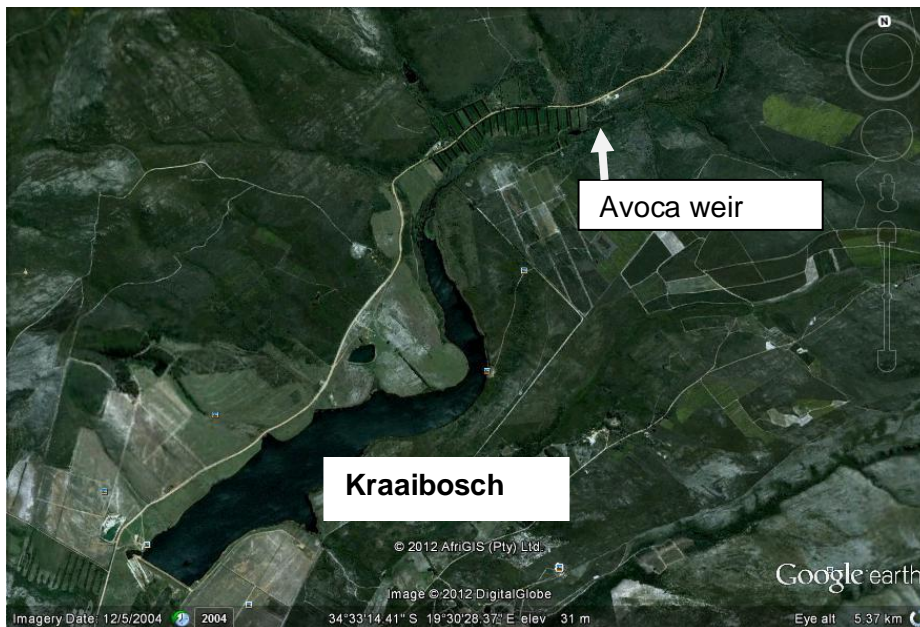
The data and flow statistics over the observed period (**Table 2.1**) shows variable flows throughout the year with zero flows during the summer period (January to March) with floods occurring from April through to November.

**Table 2.1 Monthly observed flow data for the Uilkraals River based on flow records from 2002 to 2010**

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
2002	1.03	0.11	0.00	0.00	0.00	1.32	0.82	1.47	1.51	0.74	10.38	3.25
2003	1.17	0.07	0.03	0.00	0.00	0.00	0.01	0.05	0.18	0.49	1.17	0.35
2004	2.01	0.26	0.01	0.00	0.00	0.00	17.45	1.91	5.13	2.17	1.38	2.45
2005	0.82	0.51	0.03	0.00	0.00	0.00	0.01	0.26	0.73	5.50	15.87	2.74
2006	0.92	0.68	0.11	0.00	0.00	0.00	0.00	0.10	0.39	1.57	3.02	1.06
2007	1.25	4.22	1.92	0.27	0.00	0.00	0.01	0.05	0.31	1.25	0.74	2.47
2008	2.06	5.71	0.64	0.07	0.02	0.00	0.00	0.01	0.22	1.29	1.14	0.66
2009	5.26	0.75	0.03	0.00	0.00	0.00	0.00	0.01	0.13	0.78	0.27	0.14
<b>Average Volume (10<sup>6</sup> m<sup>3</sup>)</b>	<b>1.81</b>	<b>1.54</b>	<b>0.34</b>	<b>0.04</b>	<b>0.00</b>	<b>0.16</b>	<b>2.29</b>	<b>0.48</b>	<b>1.07</b>	<b>1.72</b>	<b>4.24</b>	<b>1.64</b>
<b>Average flow(m<sup>3</sup>/s)</b>	<b>0.68</b>	<b>0.59</b>	<b>0.13</b>	<b>0.02</b>	<b>0.00</b>	<b>0.06</b>	<b>0.88</b>	<b>0.18</b>	<b>0.41</b>	<b>0.64</b>	<b>1.59</b>	<b>0.63</b>

Daily rainfall time series from a representative rain gauge (Station Name: Boskloof; Code: 0007263W) were obtained from South African Weather Service. This is the only gauge with recent

rainfall records within the proximity of the catchment. The rainfall time series data were used to patch and extend the WR2005 spatial rainfall record from 1920 to 2010. Information on regional mean monthly evaporations values were obtained from Midgley et al. (1994). The hydrological simulations were therefore extended to 90 years (1920-2010).



**Figure 2.1** Kraaibosch Dam and Avoca weir

## 2.2 WATER USE

Water use within the catchment consists of irrigation and domestic use. Information on irrigation was obtained from the WARMS data base and is summarised in **Table 2.2** while the full list of crops is attached as Appendix A.

**Table 2.2** Simplified crops types and area (from WARMS)

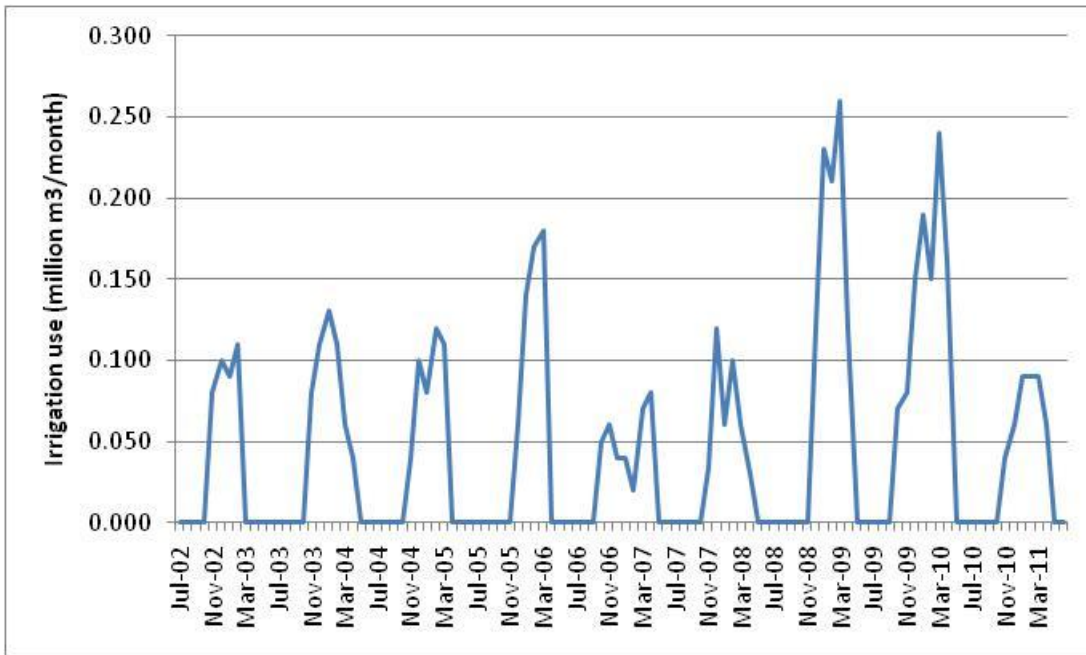
Crop Type	Crop area (ha)
Pastures	325
Deciduous fruit	192
Vegetable (summer)	74
Grapes	30
Maize	30
<b>Total</b>	<b>651</b>

The water use by crops is not uniform throughout the year but depends on the potential rate of evapotranspiration and rainfall. The assumption is made that rainfall contributes to crop water requirements. Hence if there is sufficient rainfall on any one day then the farmer will not need to irrigate. The assumption is also made that irrigators are sufficiently skilled to practice irrigation in this manner.

With the aid of an irrigation model the water requirements for the above crops was estimated to be 4.1 million m<sup>3</sup>/annum. It is not known exactly how this irrigation is distributed throughout the catchment but with the aid of Google maps the following distribution was made:

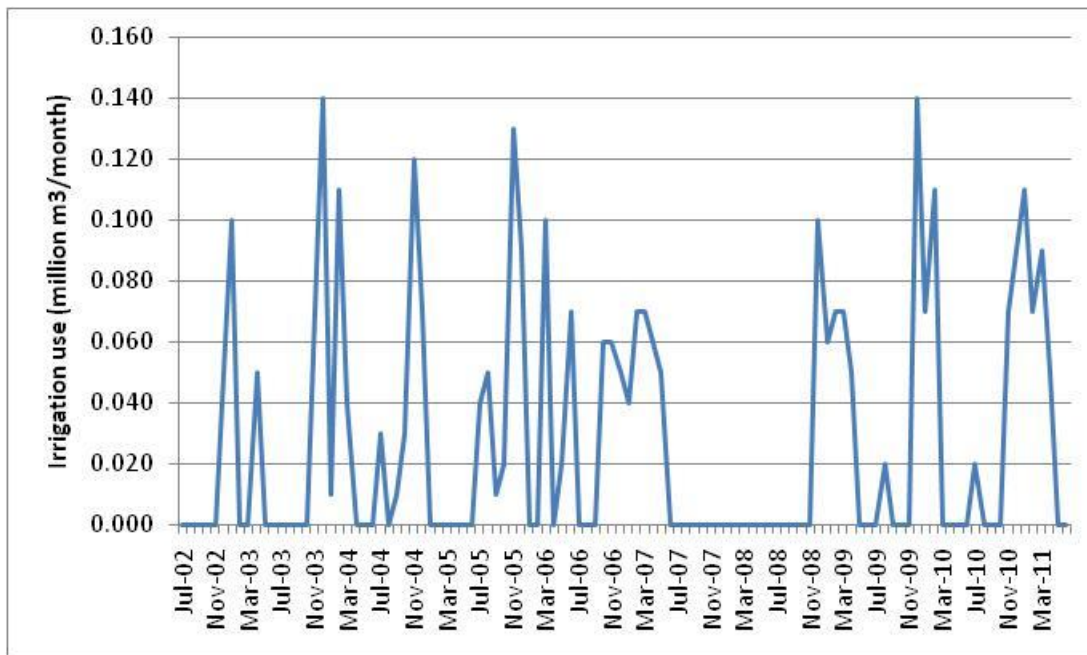
- Upstream of Kraaibosch Dam: 48%, supplied from farm dams
- Boesmans River: 24%, supplied from farm dams
- Kraaibosch Dam: 28%

The actual allocation to irrigators from the Kraaibosch Dam is 3.21 million m<sup>3</sup>/annum. However, records of abstractions from the dam indicate that at most they have used 1.04 million m<sup>3</sup>/annum. A plot of actual recorded abstraction from the dam for irrigation is shown in **Figure 2.2**.



**Figure 2.2** Recorded abstraction from Kraaibosch Dam for irrigation

The other significant water use from the catchment is domestic supply to the town of Gansbaai from the Kraaibosch Dam. Gansbaai have an allocation of 2 million m<sup>3</sup>/annum but are not fully utilising this allocation. The maximum abstraction to date has been only 0.53 million m<sup>3</sup>/annum. **Figure 2.3** shows the historical abstraction from the dam for Gansbaai.



**Figure 2.3** Recorded abstraction from the Kraaibosch Dam for Gansbaai

### 2.3 RAINFALL

There are four rainfall stations in and around the G40M catchment (**Figure 2.4** and **Table 2.3**). However, all of these except 0007263W are now closed. Rainfall data from station 0007263W was obtained from SAWS and used to extend the WR2005 zonal rainfall from 2004 to the end of the 2010 hydrological year (September 2011). It is important to note that this rainfall station is located outside the catchment and therefore poses a source of uncertainty in rainfall estimation. It was therefore only used to extend the rainfall record to 2011 while the original zonal rainfall data from 1920 to 2004 was maintained. Thus, Mean Annual Precipitation (MAP) that was used to generate the rainfall input to the Pitman model was 509mm to be consistent with spatial rainfall record in WR2005 study. The uncertainty in rainfall was therefore compensated by calibrating the model using the observed flow record. It would have been appropriate to use rainfall measurements at the dam site but the rainfall record is only 10 years long and the correlation of this data with other stations is not known. It is therefore recommended that the recording of rainfall at the Kraaibosch Dam continue in order to improve on the hydrological modelling in future.



**Figure 2.4** Map showing location of rainfall stations

**Table 2.3** List of rainfall stations in and around Uilkraals River Catchment

Name	Lat	Long	Start	End	MAP(mm)	Condition
Uilenkraal (0001726W)	-34 <sup>0</sup> .36	19 <sup>0</sup> .25	1961	1992	500.6	Closed
Loeufontein (0001813W)	-34 <sup>0</sup> .33	19 <sup>0</sup> .28	1949	1956	897.7	Closed
Peters Gate (0002069W)	-34 <sup>0</sup> .39	19 <sup>0</sup> .32	1943	1978	559.4	Closed
Boskloof (0007263W)	-34 <sup>0</sup> .23	19 <sup>0</sup> .39	1933	2011	456	Reliable

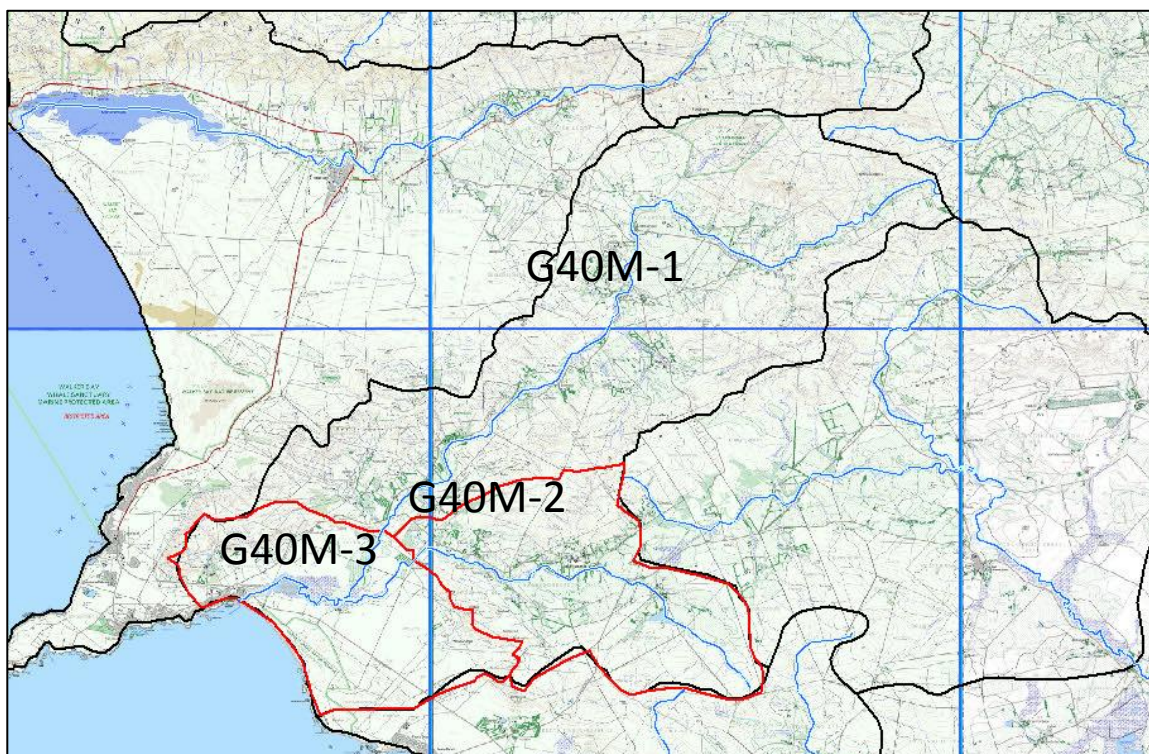
## 2.4 MODEL CALIBRATION

Following the collection and preparation of all required data to model the Uilkraals River Catchment, the enhanced WRSM2000 model was used to simulate flows for the period 2002 to 2010 in order to calibrate the model. The WR2005 calibration (Pitman) parameters were initially chosen from regional parameter datasets provided in the WR2005 reports (Middelton and Bailey 2009) and then adjusted until the statistics of the simulated flow were similar to the observed flow.

### 2.4.1 Assumptions in model set up:

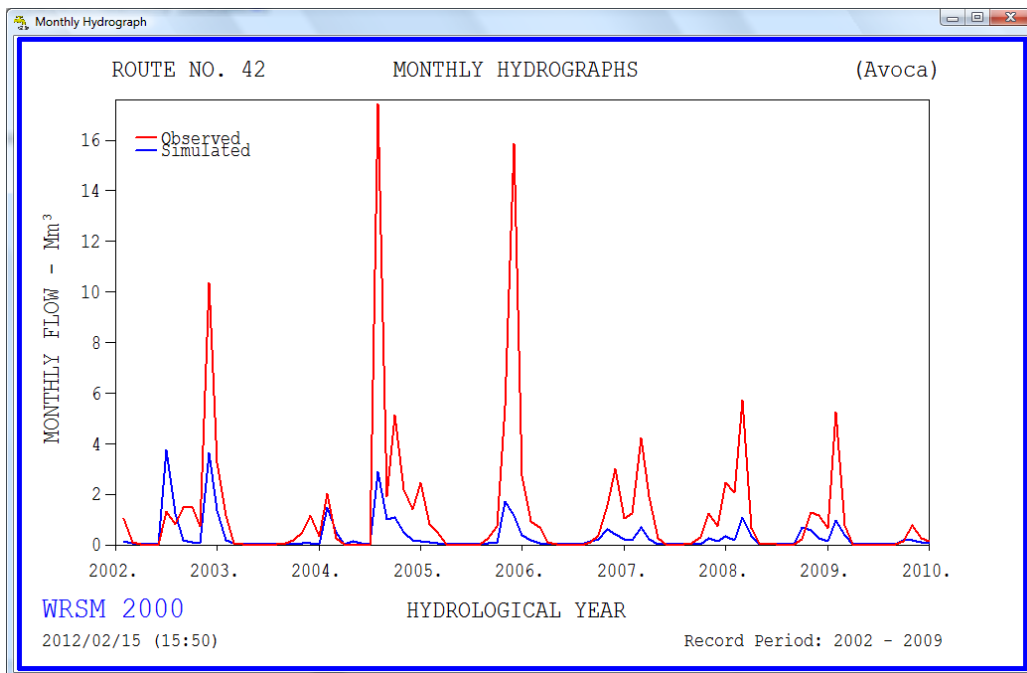
In order to realistically simulate the flows into the estuary the catchment was divided into three sub catchments and assumes:

- i. 70% of the G40M catchment flows into the Kraaisboch dam (G40M-1 with area of 220km<sup>2</sup>)
- ii. The Boesmans River occupied 30% of the G40M catchment (G40M-2 with area of 92.3 km<sup>2</sup>). The same parameters determined for the Kraaibosch Dam catchment were used to simulate runoff from this catchment.
- iii. The coastal plain has a catchment area of 80.7 km<sup>2</sup>. This area is overlain by deep coastal sand dunes and while the actual runoff from this type of terrain is unknown, it can be expected to be lower than the upper reaches of the catchment. In the absence of any data, the assumption was made that the unit runoff from the coastal plain is half that of the upper catchments. This catchment is referred to in **Figure 2.4** and G40M-3.



**Figure 2.5** Sub-catchments of G40M quaternary catchment.

After the initial model set up with WR2005 parameters the result of the simulation is as presented in **Figure 2.5**. Clearly the model under simulates the observed flow when using the regional parameters.



**Figure 2.6 Comparison of observed and simulated flow before recalibration**

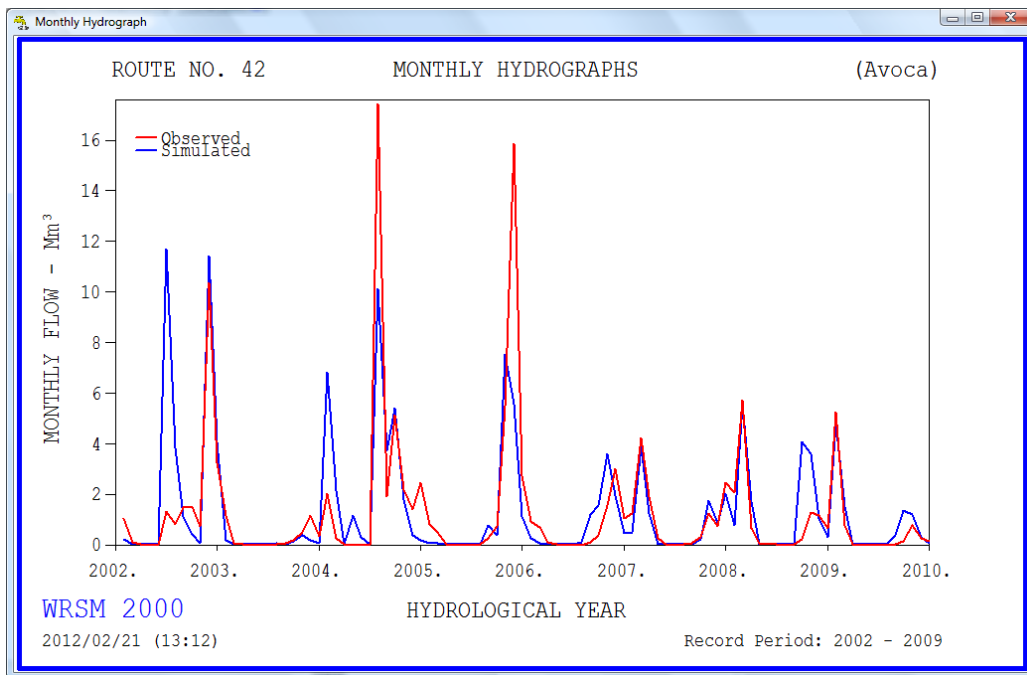
In order reproduce the observed flows at Avoca weir the following parameters were adjusted:

- ST - Soil moisture capacity in mm
- FT - Subsurface flow at soil moisture capacity in mm/month
- ZMIN - Minimum catchment absorption in mm/month
- ZMAX - Maximum catchment absorption in mm/month

The calibration was for a period October 2001 to September 2010 and the simulation results are as presented in **Table 2.3** and the hydrographs shown in **Figure 2.6**.

**Table 2.4 Calibration statistics**

Statistics	Observed	Simulated
MAR (million m <sup>3</sup> /annum)	15.35	15.42
Mean (Log) (million m <sup>3</sup> /annum)	1.09	1.05
Std Deviation (million m <sup>3</sup> /annum)	10.25	10.75
Log Std Dev	0.32	0.44
Seasonal Index (%)	29.72	21.67



**Figure 2.7 Comparison of observed and simulated flow after recalibration observed record at Avoca weir**

**Table 2.5** presents the incremental natural runoff from the three sub-catchments of Uilkraals River Catchment. The net natural runoff for G40M published in the WR2005 and WR90 studies is 15.4 million m<sup>3</sup>/annum and 20.8 million m<sup>3</sup>/annum respectively. This is considerably less than the 36.3 million m<sup>3</sup>/annum obtained from this study, but it must be borne in mind that this is the first hydrological analysis to make use of the observed data at the Avaco weir to calibrate the Pitman model. Sasman and du Preez (1999) reported that the calculated natural MAR of the Uilkraals River at the dam site is 19.7 million m<sup>3</sup>/annum which is very similar to the findings of this study.

**Table 2.5 Incremental natural simulated runoff from sub-catchments**

Sub-catchment	Area (km <sup>2</sup> )	Net Incremental MAR (Million m <sup>3</sup> /annum)	Net Unit Runoff (mm)
G40M-1	220.0	21.63	109
G40M-2	92.3	9.27	110
G40M-3	80.7	5.44	67
<b>Total</b>	<b>393</b>	<b>36.34</b>	-

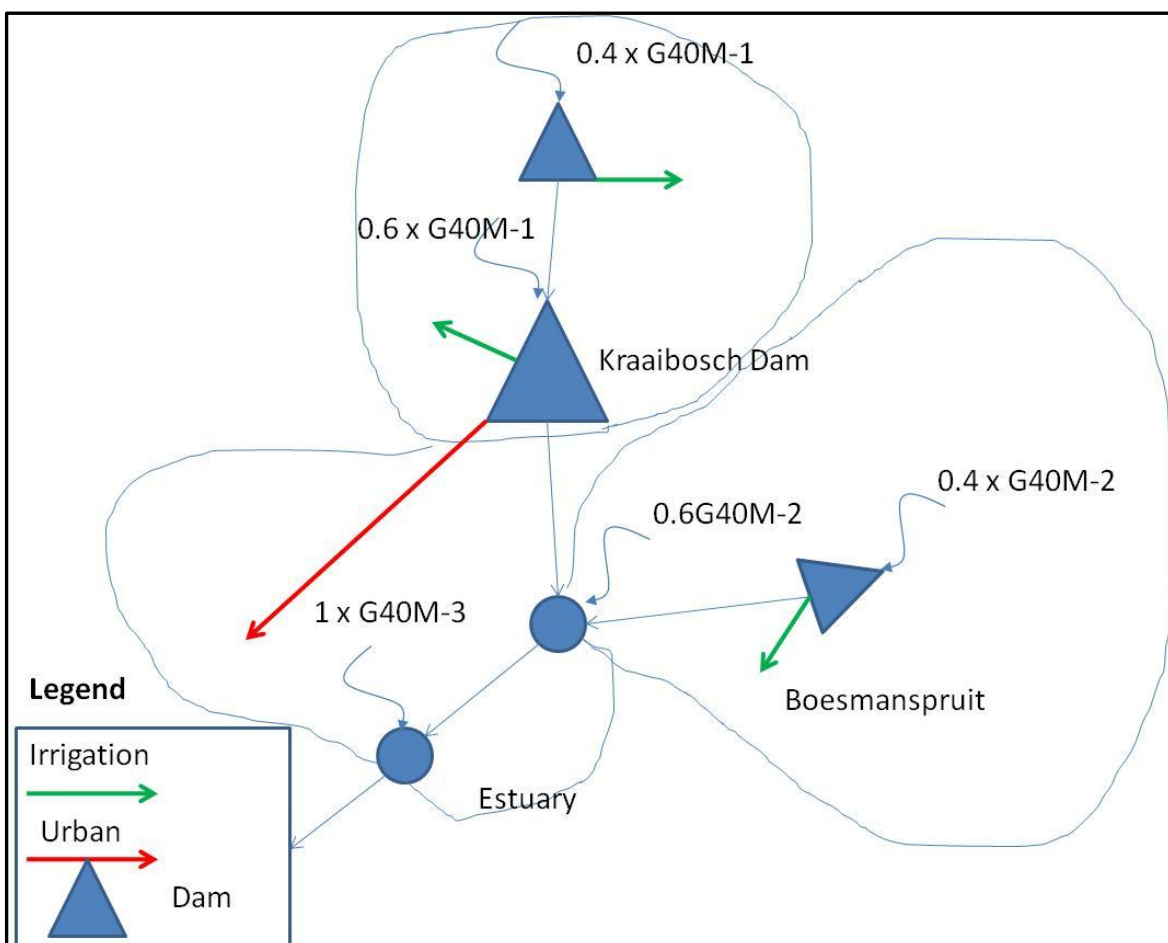
### 3 SCENARIO MODELLING

#### 3.1 MODEL SETUP

The Water Resources Modelling Platform (Mallory et al, 2010) was set up to simulate various scenarios for the G40M catchment. This model is a monthly time step model using natural incremental hydrology as its basic input. Water use is either incorporated as time series files (specified by the modeller) or (in the case of irrigation) modelled based on crop type, crop area, evapotranspiration and rainfall. Dams are modelled by assuming a mass balance at each time step taking into account rainfall onto and evaporation from the surface to the dam.

This model also has a module to model streamflow reduction due to invasive alien plants (IAP) (Mallory et al, 2011). The survey of IAPs carried out in 2010 by the Agricultural Research Council indicates an area of 89 km<sup>2</sup> in the G40M catchment. The coastal plain (G40M-3) is highly infested with Bloukrantz Wattle while not much IAPs were observed higher in the catchment. It was assumed therefore that the 89 km<sup>2</sup> of IAPs are found primarily in the coastal sub-catchment (G40M3) with the remainder located in the lower reaches of the Boesmans River. The results of this large area of IAPs is that there is probably very little runoff from the coastal area.

A systems diagram of the model setup is shown in **Figure 3.1**.



**Figure 3.1** Water Resources modelling system diagram

An important consideration when setting up a water resources model is to consider how the dams in the catchment are operated and/or to model the dams in the way they should be operated in order to assess the impact of alternative operating rules. In the case of the Kraaibosch Dam, the records provided by the operators of dam indicates that 40% of the inflow into the dam is released out of the dam, probably as an ecological flow. The dam outlet valves are adjusted at least once a week to adapt the release to the inflow.

### 3.2 SCENARIOS

The following scenarios have been modelled to produce monthly time series of flow into the estuary:

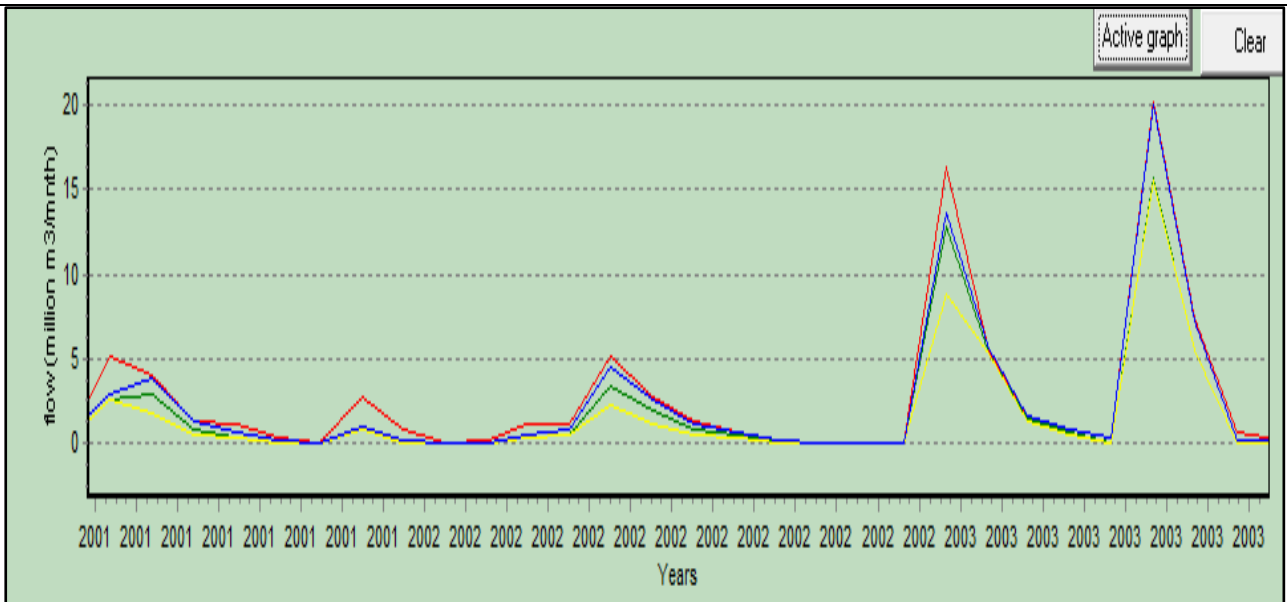
- Natural conditions: Before any development or encroachment of IAPs. This is essentially the sum of the natural incremental flows.
- Present day conditions: Includes the effect of farm dams, the Kraaibosch Dam, abstractions and IAPs.
- Full use of allocations: Allocations from the Kraaibosch Dam have not been fully taken up. This scenario increases the abstractions to full allocation.
- Present day conditions with IAPs removed.

### 3.3 SCENARIO RESULTS

The results of these scenarios are summarised in **Table 3.1** while time series of flows are shown in **Figure 3.2**.

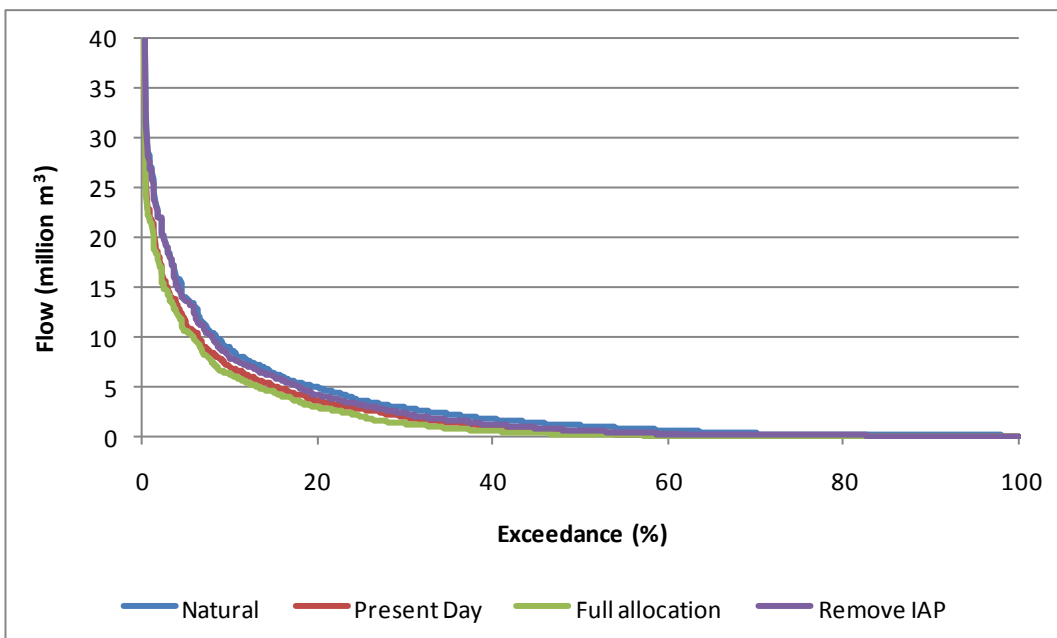
**Table 3.1 Summary of flows into the estuary under various scenarios (units million m<sup>3</sup>/annum)**

Scenario	MAR	Irrigation		Domestic		IAPs
		Requirement	Supply	Requirement	Supply	
Natural	39.3	0.0	0.0	0.0	0.0	0
Present Day	29.2	4.1	2.6	1.0	1.0	6.1
Full allocation	26.3	6.1	4.7	2.0	1.9	6.1
PD with no IAPs	35.2	4.1	2.6	1.0	1.0	0.0

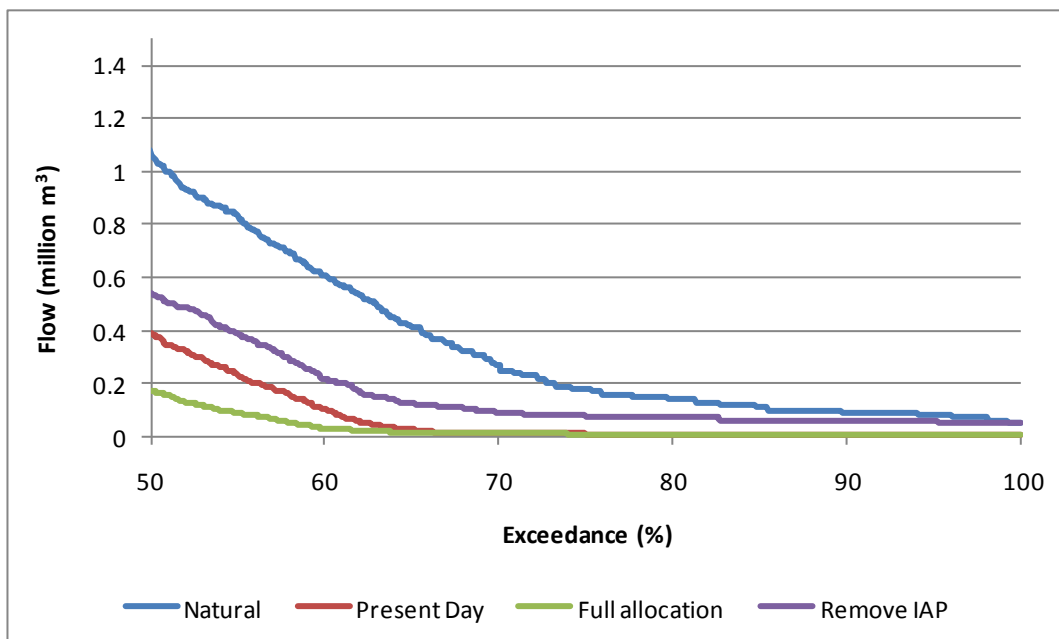


**Figure 3.2** Natural (red), present day (green) and full allocation (yellow) and IAPs removed (blue) flow scenarios

Figure 3.2 shows that high flows are only moderately influenced by water use in the catchment while low flow is close to zero under natural conditions. Removal of IAPs will have a significant influence on medium to high flows, improving the MAR to the estuary significantly. The duration of low flow period is perhaps of significance and this is shown by means of a duration curve in Figures 3.3 and 3.4.



**Figure 3.3** Duration curves of flow at the estuary for three scenarios



**Figure 3.4 Duration curves of flow at the estuary for three scenario (zoomed in to lower flows)**

The current developments in the catchment have already led to very low to zero flows at the estuary. This is due largely due to the IAPs in the lower reaches of the catchment and not due to lawful abstractions or the Kraaibosch Dam. Removal of IAPs could improve the low flows from present condition, possibly changing the system from non-perennial to a perennial system.

## 4 FLOOD HYDROLOGY

A flood analysis was carried out using the SDF method (Alexander, 2002). The results are summarised in **Table 4.1** while the details of the calculations are give in Appendix B.

**Table 4.1 Flood peaks for the G40M catchment**

	RECURRENCE (YEARS)					
	2	10	20	50	100	200
<b>Peak Discharge (<math>Q_T</math>, m<sup>3</sup>/s)</b>	58	197	268	370	453	541
<b>Runoff Volume (<math>V_T</math>, '000m<sup>3</sup>)</b>	2 816	9 628	13 082	18 070	22 152	26 424

## 5 REFERENCES

---

Alexander, WA (2002). The Standard Design Flood: Theory and Practice.

Bailey A and Pitman W.V (2008) Integrated Surface Water Resources of South Africa 2005, Water Research Commission, Pretoria, South Africa.

Mallory, SJL, Desai, A, Odendaal, P. (2011). The Water Resources Modelling Platform: Users Guide. Version 3.2. available on [www.waterresources.co.za](http://www.waterresources.co.za)

Mallory, SJL, Versfeld, D, Nditwani, T (2011). Estimating streamflow reduction due to invasive alien vegetation. Are we getting it right?. Paper presented at the 14<sup>th</sup> SANCIAHS symposium, Grahamstown, South Africa.

Midgley, D C, Pitman, W V and Middleton, B J, 1994. Surface Water Resources of South Africa 1990. WRC Report Number 298/6.1/94.

Sasman M and du Preez D (1999) Environmental Management Plan-Operational Phase – Kraaibosch Dam, Farm Uylenkrall 695/20, June 1999.

---

## APPENDICES

### APPENDIX A WARMS IRRIGATION DATA

Crop Area (ha)	Crop type
2.0000	ALMONDS
34.0000	APPLES
5.0000	CUT FLOWERS
5.0000	CUT FLOWERS
6.0000	FESCUE-GRAZING
6.0000	FESCUE-GRAZING
15.0000	FESCUE-GRAZING
50.0000	FESCUE-GRAZING
3.0000	FESCUE-GRAZING
5.0000	FESCUE-GRAZING
5.5000	FESCUE-GRAZING
2.0000	FESCUE-GRAZING
12.0000	FESCUE-GRAZING
7.5000	FESCUE-GRAZING
3.0000	FESCUE-GRAZING
9.0000	FESCUE-GRAZING
7.5000	FESCUE-GRAZING
10.5000	FESCUE-GRAZING
10.0000	GARDEN
1.0000	GARLIC
5.0000	GRAPES-TABLE
16.0000	GRAPES-WINE
5.0000	GRAPES-WINE
2.0000	GRAPES-WINE
2.0000	GRAPES-WINE
3.0000	HONEYBUSH TEA
5.0000	LUCERNE
1.0000	LUCERNE
1.0000	LUCERNE
1.0000	LUCERNE
1.0000	LUCERNE
27.4000	LUCERNE
2.0000	LUCERNE
1.0000	MACADAMIA NUTS
1.0000	MACADAMIA NUTS
1.0000	MACADAMIA NUTS
2.0000	MACADAMIA NUTS
21.0000	MACADAMIA NUTS
1.0000	MACADAMIA NUTS
1.0000	MACADAMIA NUTS
30.0000	MAIZE

6.0000	OLIVES
2.2000	OLIVES
1.5000	OLIVES
2.0000	OLIVES
1.0000	ONIONS
2.0000	ONIONS
1.0000	PASTURES-PERENNIAL
15.0000	PASTURES-PERENNIAL
0.5000	PASTURES-PERENNIAL
120.0000	PASTURES-PERENNIAL
10.0000	PEARS
2.0000	POTATOES
5.0000	POTATOES
2.0000	POTATOES
10.0000	POTATOES
3.0000	POTATOES
3.0000	RYE GRASS
4.0000	RYE GRASS
0.6000	RYE GRASS
0.8000	RYE GRASS
0.5000	STARFRUIT
5.0000	STARFRUIT
35.0000	STARFRUIT
9.0000	TEA
1.8000	TEA
2.2000	TEA
3.0000	TEA
2.0000	VEGETABLES-SUMMER
1.0000	VEGETABLES-SUMMER
2.0000	VEGETABLES-SUMMER
4.0000	VEGETABLES-SUMMER
5.0000	VEGETABLES-SUMMER
10.0000	VEGETABLES-SUMMER
1.0000	VEGETABLES-SUMMER
5.0000	VEGETABLES-SUMMER
1.0000	VEGETABLES-SUMMER
3.0000	VEGETABLES-SUMMER
20.5000	VEGETABLES-SUMMER
1.8000	VEGETABLES-SUMMER
0.2000	VEGETABLES-SUMMER
10.0000	VEGETABLES-SUMMER
1.0000	VEGETABLES-SUMMER
0.4000	VEGETABLES-SUMMER
6.0000	VEGETABLES-WINTER
0.8000	WHEAT

**APPENDIX B FLOOD PEAK CALCULATIONS**

<b>Project Number</b>	-					
<b>Project Name</b>	Uilkraals River					
<b>Designer</b>	Ahmed Desai					
<b>Date</b>	28-Feb-12					
<b>Checked</b>						
<b>Date</b>						
<b>River Name</b>	Uilkraals					
<b>Site Location</b>	Estuary					
<b>Input Data:</b>						
<b>Drainage Basin</b>	18					
<b>Catchment Area (A)</b>	394 km <sup>2</sup>					
<b>Length Longest Watercourse (L)</b>	49.3 km					
<b>Elevation at 10% of L</b>	4 m					
<b>Elevation at 85% of L</b>	260 m					
<b>1085 Slope (S)</b>	6.92 m/km					
<b>Time of Concentration (t)</b>	9.1 hours					
	543 minutes					
<b>Area Reduction Factor (ARF)</b>	89.3 %					
<b>Page 1</b>						
	<b>2</b>	<b>10</b>	<b>20</b>	<b>50</b>	<b>100</b>	<b>200</b>
Point Precipitation Depth (P <sub>T,T</sub> )	26.7	58.8	72.7	91.0	104.8	118.7
Average Rainfall Over Catchment	23.8	52.5	64.9	81.3	93.6	106.0
Intensity (I <sub>T</sub> )	2.6	5.8	7.2	9.0	10.3	11.7
Runoff Coefficient (C <sub>T</sub> )	0.20	0.31	0.34	0.38	0.40	0.42
<b>Peak Discharge (Q<sub>T</sub>, m<sup>3</sup>/s)</b>	<b>58</b>	<b>197</b>	<b>268</b>	<b>370</b>	<b>453</b>	<b>541</b>
<b>Runoff Volume (V<sub>T</sub>, '000m<sup>3</sup>)</b>	<b>2 816</b>	<b>9 628</b>	<b>13 082</b>	<b>18 070</b>	<b>22 152</b>	<b>26 424</b>
see SDF Users Manual, WJR Alexander, March 2002						