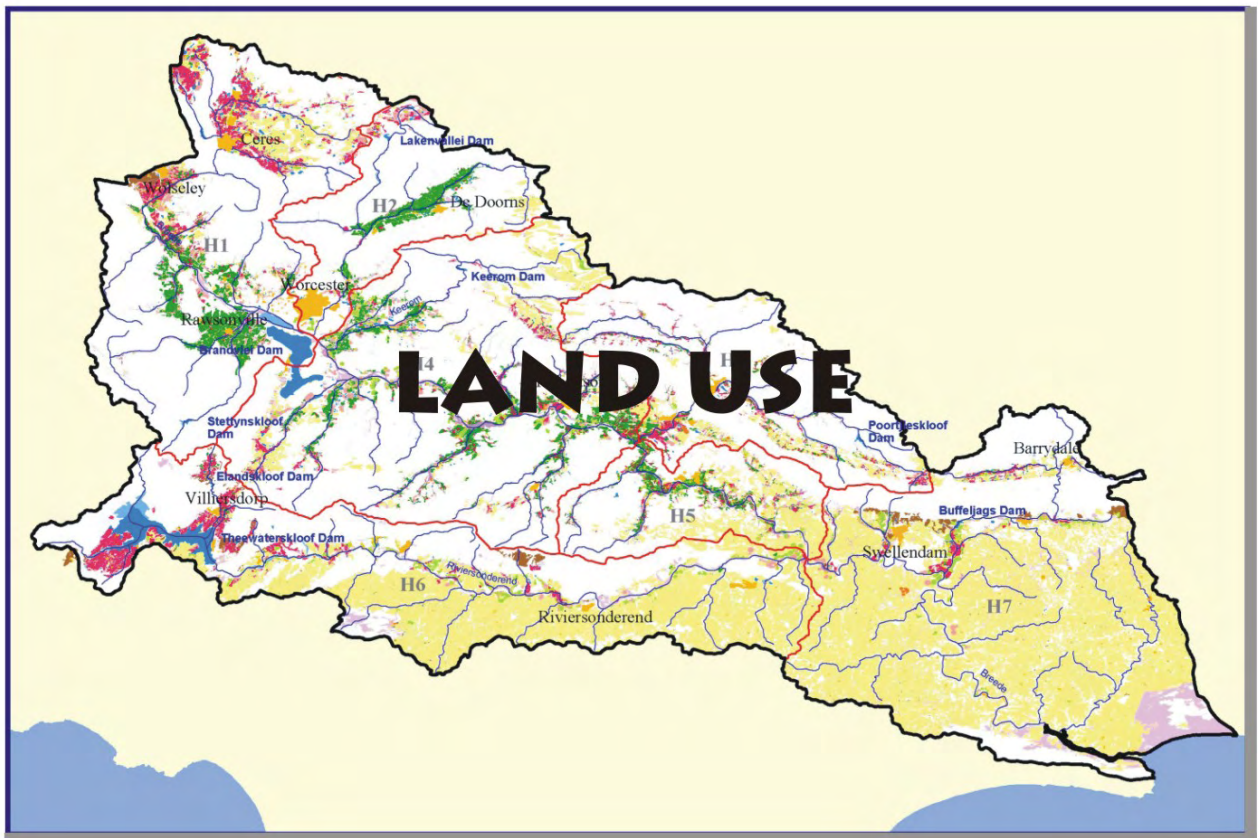




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DEPARTMENT OF WATER AFFAIRS  
AND FORESTRY  
DIRECTORATE OF WATER RESOURCES PLANNING

BREEDE RIVER BASIN STUDY



LAND USE

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**BREEDE RIVER BASIN STUDY**

**LAND USE**

**Final**

**May 2003**

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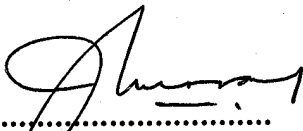
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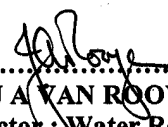
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# BREEDER RIVER BASIN STUDY

## LAND USE

### EXECUTIVE SUMMARY

#### INTRODUCTION

Any study into the availability of water and the use thereof in a catchment, especially one characterised by extensive dryland and irrigated agriculture, has to include an investigation into the historical and present day land use in the area.

The capturing of relevant land use information for use in various tasks included in the Breeder River Basin Study (BRBS), therefore formed an important part of the study. This included both the completion and updating of existing data on land use, and capturing of data on the present day land use for the entire area.

#### HISTORICAL LAND USE

The Breeder River Hydrological Study (BRHS) was completed in 1995 by DWAF. Central to this study was the determination of irrigation, afforestation and municipal water demands. Another important aspect of the study was the naturalisation of the historical hydrology of the Breeder River. For these purposes the following data on historical land use in the catchment were obtained :

- |    |               |      |                    |                |
|----|---------------|------|--------------------|----------------|
| a. | Time slice 1: | 1967 | Aerial photographs | 1:50 000 scale |
| b. | Time slice 2: | 1973 | Aerial photographs | 1:50 000 scale |
| c. | Time slice 3: | 1980 | Orthophotographs   | 1:10 000 scale |
| d. | Time slice 4: | 1987 | Aerial photographs | 1:50 000 scale |

For each of these time slices, the photography was used to determine the extent and spatial distribution of agricultural crops and dams. Based on water requirements, identified crops were classified as Crop type 1: vineyards and fruit trees or Crop type 2: wheat, lucerne and cash crops.

The different land use types were marked up on 1:15 000 enlargements of the photographs and were then digitised into Arc-Info GIS. Verification of digitised data was carried out by means of ground truthing.

The historical land use data sets generated in the BRHS did not include secondary catchments H600 and H700 as these two sub-catchments did not form part of the BRHS study area.

The existing historical land use data sets were extended to cover the entire Breeder River Basin by mapping of historical land use for secondary catchments H600 and H700 at a scale of 1:50 000.

The results of the historical land use mapping for secondary catchments H600 and H700 are as shown in Table E1.

**TABLE E1 : H600 AND H700 HISTORICAL LAND USE**

DATA SET	CROP TYPE 1 (ha)	CROP TYPE 2 (ha)	FORESTRY (ha)	FARM DAMS (ha)	TOTAL (ha)
H600 - 1973	705,5	2 734,7	911,4	113,5	4 465,1
H600 - 1980	1 002,9	2 819,1	2 212,5	111,2	6 145,7
H600 - 1987	1 489,5	3 422,8	2 005,7	182,3	7 100,3
H700 - 1973	2 330,4	2 655,1	889,8	267,5	6 142,8
H700 - 1980	2 056,8	1 959,5	1 889,8	298,3	6 204,5
H700 - 1987	2 461,2	2 854,5	1 807,0	302,4	7 425,1

### PRESENT DAY LAND USE

Previous experiments (notably during the BRHS) with affordable satellite-based remote sensing techniques indicated that the resolution of the available data was not suitable for fairly detailed mapping at a scale of 1:50 000. New colour aerial photography of the entire study area was therefore used as a basis for all present day mapping. This photography will in the future be used by the Regional Office of DWAF for verification of water use registrations and for detailed mapping of areas infested with invasive alien vegetation.

Aerial photography, in colour and at a scale of 1:30 000 was undertaken by a specialist contractor. The area covered included secondary catchments H100 to H700. Since catchment boundaries follow mountain ridges, it was agreed within the Department to extend the photography to include the "back slopes" of mountain ranges along the boundaries for the purpose of future mapping of conservation areas, State forests, mountain catchment areas and infestations of invasive alien vegetation.

Land use mapping was done in Arc View 3.1 by means of on-screen digitising.

The results of the present day (year 2000) land use mapping for the entire study area are shown in Table E2. The results give a clear picture of the extent of development in the study area.

**TABLE E2 : BREEDE RIVER BASIN YEAR 2000 LAND USE**

SUB-CATCHMENT	H100 (ha)	H200 (ha)	H300 (ha)	H400 (ha)	H500 (ha)	H600 (ha)	H700 (ha)	TOTAL (ha)
<b>Total area</b>	<b>204 647</b>	<b>83 200</b>	<b>120 725</b>	<b>260 820</b>	<b>69 510</b>	<b>224 165</b>	<b>292 270</b>	<b>1 255 337</b>
<b>Agriculture</b>								
Cash crop	100	1	183	274	109	148	205	1 021
Pasture	1 210	299	477	3 312	1 772	3 561	3 248	13 880
Orchard	9 146	827	3 194	4 757	1 540	7 708	1 877	29 049
Vineyard	10 986	4 987	2 269	12 734	3 508	365	151	35 000
Fallow land	5 916	1 222	1 477	6 461	1 612	1 998	1 481	20 166
<b>Sub-total</b>	<b>27 358</b>	<b>7 336</b>	<b>7 600</b>	<b>27 538</b>	<b>13 741</b>	<b>13 780</b>	<b>6 757</b>	<b>99 116</b>
Dryland crops	10 732	1 557	5 574	14 838	12 571	84 617	157 453	287 343
<b>Total</b>	<b>38 090</b>	<b>8 893</b>	<b>13 174</b>	<b>42 376</b>	<b>26 312</b>	<b>98 397</b>	<b>164 210</b>	<b>386 459</b>
<b>Forestry</b>								
Plantation	891	9	34	14	0	1 874	1 937	4 760
Woodlots	447	42	30	153	28	347	347	1 047
<b>Total</b>	<b>1 338</b>	<b>51</b>	<b>64</b>	<b>167</b>	<b>28</b>	<b>2 221</b>	<b>2 284</b>	<b>5 807</b>
<b>Alien Vegetation</b>								
Landscape	1 322	427	291	2 322	188	11 176	11 036	26 761
Riparian	2 265	547	827	3 411	1 077	3 123	4 177	15 427
<b>Total</b>	<b>3 587</b>	<b>974</b>	<b>1 118</b>	<b>5 733</b>	<b>1 265</b>	<b>14 299</b>	<b>15 213</b>	<b>42 188</b>
<b>Infrastructure</b>								
Built-up (towns)	874	2 094	419	760	0	0	730	4 877
Villages	419	197	379	113	284	667	534	2 593
Farmsteads	1 056	397	311	745	323	968	1 323	5 123
Labour housing	181	113	134	213	87	109	111	949
Informal housing	0	0	0	0	20	0	0	20
Institutional	95	5	6	105	0	77	19	307
Commercial	312	79	10	80	40	145	21	687
<b>Total</b>	<b>2 937</b>	<b>2 885</b>	<b>1 259</b>	<b>2 016</b>	<b>754</b>	<b>1 966</b>	<b>2 738</b>	<b>14 556</b>
<b>Wetlands</b>	<b>684</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1 648</b>	<b>17</b>	<b>2 350</b>
<b>Riparian zones</b>	<b>2 142</b>	<b>418</b>	<b>612</b>	<b>3 310</b>	<b>849</b>	<b>808</b>	<b>1 578</b>	<b>9 717</b>
<b>Dams</b>	<b>4 439</b>	<b>565</b>	<b>606</b>	<b>3 494</b>	<b>465</b>	<b>5 924</b>	<b>655</b>	<b>16 148</b>
<b>Total Developed</b>	<b>46 804</b>	<b>12 394</b>	<b>15 103</b>	<b>48 053</b>	<b>27 559</b>	<b>108 508</b>	<b>169 887</b>	<b>428 308</b>
<b>Developed %</b>	<b>22,9</b>	<b>14,9</b>	<b>12,5</b>	<b>18,4</b>	<b>39,6</b>	<b>48,4</b>	<b>58,1</b>	<b>34,1</b>

**ACCURACY ACHIEVED**

A hydrocensus of the Hex River Valley (in H200) was commissioned by DWAF in co-operation with the irrigation boards in the valley.

Cross-checks were performed to compare registered water use and estimates of water requirements in the valley. The estimates were based on the year 2000 land use mapping conducted for the BRBS.

In the estimation of the water requirement for irrigation, the mapped irrigated area was reduced by 2,5% to allow for farm roads and windbreaks which were not mapped separately. The irrigated areas within the area of each irrigation board as derived from the BRBS land use mapping and from the actual

hydrocensus were compared. For the entire Hex River Valley with a total irrigated area of about 4500 ha, the difference between the two figures was less than 3 %. Clearly a high degree of accuracy was achieved with the land use mapping methodologies used.

## **CONCLUSION**

It is envisaged that the datasets that were prepared for the BRBS will assist the various water management institutions in the basin with the implementation of the National Water Act. Typically this data will serve as the baseline information for aspects of catchment management planning and water resource management plans. Data on existing irrigated crops will also serve as baseline information for the registration of existing water use.

# BREEDE RIVER BASIN STUDY

## LAND USE

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## **APPENDICES**

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## ABBREVIATIONS

BRB	Breede River Basin
BRBS	Breede River Basin Study
BRHS	Breede River Hydrological Study
CCWR	Computing Centre for Water Research
CSIR	Council for Scientific and Industrial Research
d.p.i.	dots per inch
DWAF	Department of Water Affairs and Forestry
FSA	Full supply area
FSC	Full supply capacity
GIS	Geographic Information Systems
GPS	Geographic Positioning System
ha	hectare
IFR	instream flow requirements
Mb	Megabytes
MBB	Murray, Biesenbach & Badenhorst
m <sup>2</sup>	square metres
m <sup>3</sup>	cubic metres
TOR	Terms of Reference
WCA	water catchment areas
WfW	Working for Water
WH	Wall height
WRC	Water Research Commission

# BREEDE RIVER BASIN STUDY

## LAND USE

### 1. INTRODUCTION

#### 1.1 GENERAL BACKGROUND

The very nature of a study such as the Breede River Basin Study (BRBS) creates the necessity for the availability of information regarding the physical characteristics of the study area. The study of the availability of water and the use thereof in an area, especially in an area characterised by extensive dryland and irrigated agriculture, inevitably has to include an investigation into the land use in the area. Data on historical and present day land use, and in particular agricultural land use patterns, is a prerequisite for hydrological modelling of the study area.

The capturing of relevant land use information for use in various tasks included in the BRBS, therefore formed an important part of the Terms of Reference (TOR) for the study. The TOR allowed for both the completion and updating of existing data on land use, and for capturing of data on the present day land use for the entire area.

Apart from the data requirements of the study, it was soon realised that implementation of the National Water Act (Act 36 of 1998) by various water management institutions in the basin, created another need for reliable updated land use data. Typically this data will serve as the baseline information for some aspects of catchment management planning and water resource management plans. Data on existing irrigated crops will also serve as baseline information for the registration of existing water use. Thus it was necessary to try and accommodate as many as possible of these different uses of the data generated.

#### 1.2 PURPOSE OF THIS REPORT

The primary purpose of this report is to document the methods used to capture land use data for the BRBS. This information will serve to inform all the potential users of the land use data on the degree of confidence with which the data can be used for different purposes. It will also serve to identify the sources of the different sets of information integrated into the land use data.

In the second instance, this report summarises some of the land use information generated. However, as a result of the data being made available in electronic format, it was not deemed necessary to embark on an extensive analysis and detailed presentation of the data. Secondary users of the land use data could readily access and manipulate the data to meet their specific needs.

Thirdly, the report documents the formats in which the land use information were captured and made available.

## 2. TASK DESCRIPTION

### 2.1 TERMS OF REFERENCE (TOR)

In the TOR for the BRBS, the land use task was described as follows :

#### **"5.2 Land-use**

*To assist in planning and catchment management a present day land-use map covering all areas will be required. For this purpose an initial assessment must be made regarding the applicability of existing surveys (if there is any) and to cover any outstanding areas.*

*Currently CSIR is busy with countrywide land use survey. It is proposed that CSIR should be consulted about the survey.*

*Provision must be made for a field visit, the marking up of photographs and digitising the land-use in the whole area of the study area.*

*This task also includes potential land-use, demographics and general infrastructure such as roads, railways, powerlines."*

This rather cryptic description of the land use mapping task was used as a basis for a far more detailed outline of the task in the Technical Proposal for the BRBS. In this proposal the different data requirements for various other study tasks were considered in the description of the land use mapping task.

### 2.2 FINAL TASK DESCRIPTION

During the Inception Phase of the study, the task description for the land use mapping task was finalised to read as follows:

#### **"Update existing spatial data:**

*Objective: To provide historical land-use data for the entire catchment, including the H6 and H7 catchments which were not included in the BRHS, for the purpose of calibration of the hydrological model.*

*To update GIS coverages for existing (ex-BRHS) data, and in particular the rivers, irrigation board boundaries, WCAs and hydrological data for those time slices needed for calibration purposes.*

*Methodology: In the BRHS, the following land-use data-sets were generated:*

<i>Time slice 1</i>	<i>1967</i>
<i>Time slice 2</i>	<i>1973</i>
<i>Time slice 3</i>	<i>1980</i>
<i>Time slice 4</i>	<i>1987</i>

*Secondary catchments H6 and H7 were however not included in the BRHS, and no historical land-use data for these two catchments exists.*

- *For one previous time slice, existing 1:50 000 aerial photographs will be scanned and crop type and land-use will be digitised for catchments H600 and H700.*
- *1:50 000 Digital data will be obtained from the Chief Directorate: Surveys and Mapping, and will be used to improve the rivers coverage for the entire catchment.*
- *Revised hydrological data supplied by the hydrological task team will be imported for one previous time slice.*
- *Crop type and land-use data for one time slice generated by the BRHS, will be reviewed for accuracy and correctness using the original marked-up aerial photographs.*

*Product: An updated and improved data set for catchments H1 to H5, and new crop type and land use coverages for catchments H6 and H7 for one previous time slice, to be used in calibration of the hydrological model.*

***Present day land-use mapping:***

*Objective: To provide present day land-use data to be used in hydrological modelling. To provide updated base maps for use by the agricultural, ground water, riverine IFR, soils suitability, public participation, and socio-economic task teams. To compile data generated by the study on GIS for use in catchment management.*

*Methodology: New colour aerial photography of the entire study area will be undertaken in November/December 1999. 1:30 000 photographs will be scanned and transferred to GIS, to be used to capture present day land-use*

*Data will be included in the Breede River Catchment GIS as follows:*

- (i) *Infrastructure (roads, railways, towns/villages, farmsteads, major power lines ) from 1:50 000 digital topo maps, and where necessary corrected using aerial photography.*
- (ii) *Topography (20 m contours) from 1:50 000 digital topo maps.*
- (iii) *Water features (rivers, wetlands, dams, canals) from 1:50 000 digital topo maps, and in the case of dams and canals, updated using aerial photography.*
- (iv) *Soils will be captured as land type information for the entire catchment, and soil suitability class information where it is available from previous surveys. (Both these data sets will be supplied in digital format by the soils task team).*

- (v) *Climate (evaporation, temperature, rainfall) imported in digital format from the CCWR.*
- (vi) *Catchment boundaries (quaternary and tertiary) imported in digital format from WR90.*

*Land-use classification at a 1:50 000 scale will comprise of the following:*

- (i) *Agriculture, showing:*
  - *orchards*
  - *vineyards*
  - *pastures*
  - *cash crops (irrigated)*
  - *dryland crops*
  - *fallow land, with all of these mapped on a per land-use rather than per field basis.*
- (ii) *Alien vegetation to WfW standards*
- (iii) *Riparian zones*
- (iv) *Roads (to detail shown on 1:50 000 maps)*
- (v) *Railways (to detail shown on 1:50 000 maps)*
- (vi) *Towns/villages*
- (vii) *Farmsteads and clusters of farm labourers' housing (individual buildings will not be mapped)*
- (viii) *Rivers and wetlands (to detail shown on 1:50 000 maps)*
- (ix) *Dams (to detail used in BRHS)*

*Land-use classification will be ground-truthed by means of selective site inspections of areas where sufficient detail is not shown on the aerial photographs. Cadastral boundaries as supplied in digital format by the Surveyor General will be imported, but no large scale correction of data will be undertaken.*

*Irrigation board and Water Control Area boundaries as supplied in digital format by DWAF will be imported.*

*All major water infrastructure e.g. major dams, river diversions, canals, major pump stations and pipelines will be captured in GIS.*

*Data such as demographic data, potentially irrigable land, classification of water resources etc. which will be generated by the study and that can be provided in digital format, will be imported in GIS.*

*Product: Updated present day land-use maps and GIS with complete present day coverage for the entire Breede River Catchment".*

### **2.3 REFINEMENT OF TASK DESCRIPTION**

It was realised that with the large number of potential users, the data generated by the mapping exercise would have to conform to some accepted standard. At the same time it was realised that in the context of the Department of Water Affairs and Forestry (DWAF) in the Western Cape, the Working for Water (WfW) project at the start of the exercise, has made the most progress in terms of standardising GIS data and publishing mapping and data capture standards. This led to a number of meetings under the chairmanship of Mr Derek Malan of the WfW programme, at which standards for land use identification and the structure of databases were agreed upon.

This inevitably had an influence on the methods used to map land use and on the content of the database. However, even though this led to increased effort required in some instances, it is believed to have enhanced the usefulness of the end product.

### 3. METHODOLOGY

#### 3.1 HISTORICAL LAND USE

##### 3.1.1 Background

The Breede River Hydrological Study (BRHS) was completed in 1995 by DWAF: Directorate of Project Planning. Central to this study was the determination of irrigation, afforestation and municipal water demands. Another important aspect of the study was the naturalisation of the historical hydrology of the Breede River. For these two purposes data on the historical land use in the catchment was needed.

For the determination of historical land use, the availability of suitable aerial photography was considered, and four "time slices" or dates were chosen. These dates and the available photography were as follows:

- |    |               |      |                    |                |
|----|---------------|------|--------------------|----------------|
| a. | Time slice 1: | 1967 | Aerial photographs | 1:50 000 scale |
| b. | Time slice 2: | 1973 | Aerial photographs | 1:50 000 scale |
| c. | Time slice 3: | 1980 | Orthophotographs   | 1:10 000 scale |
| d. | Time slice 4: | 1987 | Aerial photographs | 1:50 000 scale |

For each of these time slices, the photography was used to determine the extent and spatial distribution of agricultural crops and dams. Identified crops were classified as one of two types based on water requirements, as follows :

- a. Crop type 1: Vineyards and fruit trees
- b. Crop type 2: Wheat, lucerne and cash crops

The different land use types were marked up on 1:15 000 enlargements of the photographs and were then digitised into Arc-Info GIS. Verification of digitised data was carried out by means of ground truthing.

The historical land use data sets generated in the BRHS however did not include secondary catchments H600 and H700 as these two sub-catchments did not form part of the BRHS study area. There also were some GIS coverages in the BRHS data sets which needed improvement. This gave rise to the need for the task described as "update existing spatial data".

##### 3.1.2 Methodology

Historical land use for secondary catchments H600 and H700 was mapped in ArcView 3.1b at a scale of 1:50 000. The basic "background" against which this mapping was executed consisted of the following:

- a. 1:50 000 Master tic coverage (supplied by DWAF)
- b. 1:50 000 Topographic vector data (acquired from Directorate Surveys & Mapping)
- c. 1:50 000 Scanned topographical maps (supplied by DWAF via Ninham Shand in ".jpeg" format)
- d. Primary, secondary and quaternary catchment boundaries (from WR90)

The original intention was to also import the cadastral boundaries as supplied by the Surveyor General, and to use this as a check on field and farm boundaries. The data set that was eventually supplied by the Surveyor General's office was however not geo-referenced, and could not be imported into GIS.

Although the final task description (see Section 2.2) called for the completion of historical land use mapping for only one time slice, the Hydrology task team very soon realised that multiple historical land use data sets would be needed for the calibration of the hydrological model and naturalisation of run off. After examination of the available historical aerial photography, it was decided to complete the land use mapping for H600 and H700 only for 1973, 1980, and 1987. The photography available for 1967 did not cover the study area adequately to be used for completion of the land use mapping.

As a first step in execution of the task, the original marked-up photographs and orthophoto maps used during the BRHS in the mapping of historical land use for secondary catchments H100, H200, H300, H400 and H500 were acquired from DWAF. These were used in the first place to examine the level of accuracy used in marking up of land use for the BRHS, and secondly to determine the boundaries for land use mapping to be used for H600 and H700.

The second step was to acquire enlargements of photographs and prints of orthophoto maps for the different time slices from the Directorate Surveys & Mapping. Photographs were not ordered in stereo pairs, but overlaps of  $\pm 20\%$  were aimed for. On each set of photographs the secondary catchment boundaries were transferred by inspection and compared with the 1:50 000 topographical images as well as the BRHS photographs. Thereafter the photographs were marked up in order to identify the following land use classes:

- a. Crop type 1: Vineyards and fruit trees
- b. Crop type 2: Wheat, lucerne, and cash crops
- c. Farm dams
- d. Forestry (including plantations, woodlots, and windbreaks)

These land use classes were digitised into ArcView as shapefiles. This procedure was followed for both secondary catchments H600 and H700 for all three time slices, with the exception of quaternary catchments H60A, H60B and H60C where only the 1973 time slice land use was mapped. This was because the other time slices for this area were already covered during the Western Cape System Analysis.

Printouts were made of the mapped land use classes overlain on the 1:50 000 vector data, and these "maps" were visually compared between time slices, and checked for obvious errors. Inadvertent errors for example in crop type identification were then corrected by editing the relevant data tables.

## **3.2 PRESENT DAY LAND USE**

### **3.2.1 Background**

Although the original TOR did not fully specify the level of detail required for the present day land use mapping, it was realised that the level of detail adopted for the BRHS was probably not adequate for the purposes of the BRBS. It was deemed to be an over-simplification to put irrigated crops in one of only two classes, i.e. perennial or annual crops. The various irrigated crops in the study area have widely varying irrigation demands, and even the water demand of the same crop can vary markedly from one point in the study area to another. Thus it was proposed in the Technical Proposal that much more detail should be captured in the mapping of present day land use than originally envisaged, and this proposal was adopted.

Previous experiments (notably during the BRHS) with affordable satellite-based remote sensing techniques indicated that the resolution of the available data was not suitable for fairly detailed mapping at a scale of 1:50 000. Thus it was proposed to do new colour aerial photography of the entire study area to serve as basis for all present day mapping. At the same time it was realised that this photography would be extremely useful in the verification of water use registrations required by the National Water Act (Act 36 of 1998). A third use for the photography was the mapping of areas infested with invasive alien vegetation in the study area.

The realisation that a number of secondary uses of the present day land use mapping existed, made it necessary to ensure that in all aspects of the task, from the photography to the structure of the database and the actual mapping, the right provisions were made for enhancing the value of the data generated and for future improvement of the data.

### **3.2.2 Methodology**

Aerial photography, in colour and at a scale of 1:30 000 has been undertaken by a specialist contractor. The area covered included secondary catchments H100 to H700. Since catchment boundaries follow mountain ridges, it had been decided to extend the photography to include the "back slopes" of mountain ranges along the boundaries for the purpose of future mapping of conservation areas, State forests, mountain catchment areas and invasive alien vegetation.

Photography was done in the conventional way with 60% overlap of frames along flight lines, and 20% side overlap between flight lines. Photographs have also been geo-referenced by means of GPS control points recorded simultaneously with the photography. (Although this provides

the means to complete the ground control and ortho-rectification of the photographs, these actions were not allowed for in the study budget.). Photography was planned to take place during November and December 1999, but adverse weather and numerous veld fires delayed the work so that it has only been done in the period from February to May 2000.

Colour negatives of the photographs were scanned by means of a Vexcell high accuracy and high resolution scanner at a resolution of 25 microns (approximately 1016 d.p.i.). This translates to an actual pixel size of 0.75 x 0.75 m on the ground. Every second frame has been scanned since stereo pairs were not needed, and  $\pm 30\%$  overlap in line was still achieved. Images were scanned in ".tiff" file format resulting in file sizes of  $\pm 250$  Mb per image. In order to limit file space and to speed up manipulation of the data, image files were compressed to ".ecw" file format using the ER Mapper ECW Compressor software. This resulted in file sizes of  $\pm 5$  Mb per image. Visually some image quality was sacrificed but not at all to the extent that the interpretation of land use was compromised, and where necessary image files could be "uncompressed" to the original format.

For reasons of economy, the actual photography had not been undertaken in blocks coinciding with sub-catchment boundaries, but in blocks with optimised flight strip directions and lengths. This required that images had to be sorted into sets for each secondary catchment by overlaying the catchment boundaries on the flight plan. Thereafter the approximate overlaps between images have been marked on individual images to prevent double mapping.

Mapping of the different classes of land use was done in ArcView 3.1 by means of on-screen digitising. This produced a non-referenced and non-rectified land use shape file for each photograph image. Shapewarp 2.2 script was used to warp or "rubber-stretch" shape files to 1:50 000 Geographic projection. Warping of individual shape files was done by identifying up to 10 ground control points on both the photographic image and the 1:50 000 topographical map background. Intersections of fences or roads were typically used as ground control points, and points were selected to uniformly cover the entire photo image. Although not truly geo-referenced and ortho-rectified, this procedure resulted in rectified shape files with a positional accuracy of better than 10 m as compared with the 1:50 000 topographical mapping. This was deemed to be accurate enough for the purpose of the hydrological modelling to be undertaken for the BRBS.

Rectified shape files were joined or merged to create one shape file per secondary sub-catchment. This was done by loading adjoining separate shape files onto the 1:50 000 background map, and merging polygons while also cleaning up overlaps in the mapping. Editing of merged shape files was also carried out. Hard copies of the merged shape files on the background of 1:50 000 topo maps were printed. These were visually inspected for obvious errors such as incorrect land use classification. In this regard it was especially useful to have access to technicians with many years of first hand exposure to farming in the study area. Field trips were conducted and mapped land use, especially crop types, were compared with actual land use. In this way a number of corrections were made where, for example, young vineyards or fruit trees were misinterpreted on the photo images.

As a result of the meetings referred to in Section 2.3, a GIS database structure that is compatible with the WfW structure, was agreed to. Merged shape files were split into separate land use files as follows:

- a. **Agric50:** Agricultural land use with sub-types
  - (i) **Cash crops**, i.e. vegetables and irrigated grain
  - (ii) **Dryland crops**, i.e. non-irrigated field crops
  - (iii) **Fallow land**, i.e. land which has recently been irrigated but currently bare
  - (iv) **Pastures**, i.e. irrigated fodder crops
  - (v) **Orchards**, i.e. citrus, deciduous stone and pome fruit, and olives
  - (vi) **Vineyards**, i.e. table grapes and wine grapes
  
- b. **Nbal:** Invasive alien vegetation in classes
  - (i) **Dense**
  - (ii) **Medium**
  - (iii) **Sparse**
 and also classified as "riparian" or "landscape".
  
- c. **Forest50:** Plantations of (usually) non-indigenous trees with sub-types
  - (i) **Plantations**, i.e. large commercial plantations for wood production
  - (ii) **Woodlots**, i.e. smaller plantations usually for firewood
  - (iii) **Windbreaks**
  
- d. **Infra50:** Infrastructure and non-agricultural land use with sub-types
  - (i) **Built-up**, i.e. towns
  - (ii) **Commercial** with sub-types
    - **Aquaculture**, i.e. dams for cultivation of "waterblommetjies"
    - **Fish hatcheries**
    - **Industrial**, i.e. industries outside municipal areas such as brickyards
    - **Organic waste**, i.e. composting and disposal sites for organic waste such as grape husks and manure
    - **Pack sheds**, i.e. facilities for packing fruit and vegetables
    - **Poultry**, i.e. commercial poultry farms
    - **Power sub-station**, i.e. ESKOM sub-stations
    - **Race tracks**
    - **Resorts**, i.e. holiday resorts and caravan parks
    - **Silo**, i.e. grain storage silos
    - **Wine cellar**, i.e. private and co-operative wineries outside municipal areas
  - (iii) **Farmstead**, i.e. houses, outbuildings and surrounding gardens
  - (iv) **Informal**, i.e. squatter camps without formal layout and services

- (v) **Institutional** with sub-types
    - **Churches**, i.e. church buildings outside municipal areas
    - **Government**, i.e. national, provincial and local government facilities outside municipal areas, such as construction camps
    - **Prison**, i.e. Dept Correctional Services facilities outside municipal areas
    - **School**, i.e. schools outside municipal areas
  - (vi) **Labour**, i.e. farm labourers' housing
  - (vii) **Village**, i.e. small residential areas usually with agricultural plots in between residential erven.
- e. **Dam50**: Private and state owned dams with sub-types
- (i) **Hillside** dams, i.e. dams typically with walls on three sides, constructed on a side slope
  - (ii) **Valley** dams, i.e. typical "in-stream" dams with a single wall constructed across a valley
  - (iii) **Hilltop** dams, i.e. dams with artificial walls on all sides
- f. **Riparian**: The strip of undeveloped land on either side of rivers and streams flowing through intensively cultivated areas.
- g. **Wet50**: Wetlands as shown on 1:50 000 topographical maps

It must be emphasised that especially in the case of agriculture, mapping was done per land use sub-type or crop, and not per individual field or plantation. This also meant that after an initial attempt to map all windbreaks in intensively cultivated landscapes, this was abandoned because of the large increase in polygons that would need to be mapped. In most areas it would also have virtually resulted in mapping per field. In the final instance this means that in calculating the areas of different crops, an allowance has to be made for windbreaks and farm roads.

### 3.3 OTHER COVERAGES

As with the historical land use mapping, a number of other coverages have been added to the present day land use GIS data set. This included the following:

- a. The 1:50 000 Master tic coverage (supplied by DWAF).
- b. 1:50 000 Topographic vector data, including contours, rivers, and infrastructure (acquired from Directorate Surveys & Mapping).
- c. 1:50 000 Scanned topographical maps to serve as "background" (supplied by DWAF).
- d. Primary, secondary and quaternary catchment boundaries (from (WR90).
- e. Soils suitability coverage supplied by the soils task team. The coverage as supplied by the soils team, put a soil suitability rating on a scale from 0 to 10 to each individual soil mapping unit. Due to the method used to arrive at the rating value, ratings were not integer values. In order to make the printed copy of the soils suitability map more legible, another coverage was generated where rating values were "lumped" to values of 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, and 7.0.

Soils with a rating of less than 4.0 were deemed to be unsuitable for irrigation, and virtually no soils with a rating of better than 7.0 were mapped in the study area.

- f. Irrigation board boundaries (supplied by DWAF, and corrected and completed where necessary). The areas of jurisdiction of Water User Associations have not yet been finalised, and thus these boundaries have not been available to be added to the data set.

### 3.4 FARM DAMS

In order to extend the hydrology undertaken in the BRHS to secondary catchments H600 and H700, information on farms dams were needed. According to Report PH 000/00/0392: *Breede River Hydrological Study – Procedure for the Evaluation of Farm Dams*, the following parameters for each dam are required:

- a. Full supply capacity (FSC)
- b. Full supply area (FSA)
- c. Wall height (WH)

In the BRHS these parameters were generated by digitising the FSA of each dam off aerial photography, and then calculating the other two parameters by means of empirical formulae as follows :

- a.  $FSC (1000 m^3) = A \times FSA (ha)$
- b.  $WH (m) = B \times FSA (ha)^C$

Different values of coefficients A, B and C for the three types of dams and for different sub-catchments were used.

This methodology and the coefficients were tested by applying the empirical formulae and coefficients to 16 dams of which all the relevant information were available from MBB's records. The results of this test are shown in Table 1. It is clear that as compared to real values, the empirically determined values of the relevant parameters are not at all reliable and that a large degree of variation can be expected to occur.

**TABLE 1 : TEST OF BRHS FARM DAM METHODOLOGY**

MBB NO.	DAM TYPE	AREA	FSA MBB (ha)	FSA BRBS (ha)	% diff.	FSC MBB (m <sup>3</sup> )	FSC BRBS (m <sup>3</sup> )	% diff.	WH MBB (m)	WH BRBS (m)	% diff.
22	H	H300	0,8	0,8	0	27 000	9 600	-64,4	8,4	1,6	-81,5
33	H	H300	2,1	1,4	-33,3	59 000	16 800	-71,5	6,5	2,0	-69,0
49	H	H300	1,5	0,6	-60,0	58 300	7 200	-87,7	14,5	1,3	-90,7
68	H	H300	1,2	0,5	-58,3	54 000	6 000	-88,9	13,0	1,2	-90,5
2	H	H400	5,2	5,0	-3,8	227 000	149 765	-34,0	14,0	10,3	-26,1
8	H	H400	1,0	1,2	+20,0	30 000	35 944	+19,8	10,0	5,4	-46,3
14	V	H400	4,7	4,7	0	280 000	216 148	-22,8	15,7	8,7	-44,8
27	H	H400	1,0	1,6	+60,0	35 000	47 925	+36,9	6,5	6,1	-6,1
36	H	H400	6,0	5,1	-15,0	370 000	152 760	-58,7	16,0	10,4	-35,0
38	V	H400	3,8	2,9	-23,7	118 000	133 368	+13,0	8,0	6,8	-15,5
39	V	H400	5,7	5,5	-3,5	196 200	252 940	+28,9	11,0	9,4	-14,6
40	V	H400	5,4	4,7	-13,0	250 000	216 148	-13,5	14,0	8,7	-38,1
51	V	H400	3,8	5,2	+36,8	160 000	239 143	+49,5	13,7	9,1	-33,3
56	P	H400	6,0	5,8	-3,3	184 000	245 995	+33,7	6,7	8,1	+20,4
4	V	H500	3,5	2,3	-34,3	130 000	28 750	-77,9	13,0	2,6	-79,9
46	H	H500	1,0	0,5	-50,0	20 600	6 000	-70,9	4,0	4,4	+8,9

A more accurate method for determining the required parameters for hydrological modelling of farm dams had to be found. Various methods were considered including the generation of Digital Terrain Models of individual dams from stereography, but in the end budgetary constraints dictated that a more cost effective procedure had to be used.

From the BRBS aerial photography the perimeter of all dams with a surface area bigger than 1 000 m<sup>2</sup> was digitised as part of the land use mapping. This data was extracted from the land use coverage and grouped into the 7 secondary catchments, and the resultant files included the following information for each dam:

- a. X and Y coordinates
- b. Type of dam (valley, hillside, or hilltop)
- c. Digitised perimeter of dam
- d. Digitised surface area of dam

Available data on the characteristics of individual dams in the study area were then obtained from different sources as follows:

- a. DWAF dam safety register (179 dams)
- b. WRC Report 298/4.1/94: Surface water resources of South Africa 1990 (246 dams)
- c. Ninham Shand register of dam projects (78 dams)
- d. MBB register of dam projects (74 dams)
- e. Van Breda & Associates register of dam projects (22 dams)

The characteristics of dams from different sources were compared, and in the case of differences, a decision was made on what appeared to be the most reliable set of information that was then accepted for the particular dam. The data was input into files containing the dam characteristics, and at this stage the following information for each dam in the sample existed:

- a. Coordinates
- b. Surface area of dam
- c. Capacity of dam
- d. Maximum water depth
- e. Volume at 25%, 50%, and 75% of maximum water depth (only for some dams)

At this point in the procedure 154 dams qualified for inclusion in the sample on the basis of reliability of information. This information was then compared with the digitised characteristics, and a number of dams were disqualified due to big discrepancies in full supply surface areas.

The procedure to calculate FSC/FSA and FSA/WH relationships for the dams was as follows:

- A linear FSC/FSA relationship was accepted, i.e.  $FSC = A \times FSA$
- To determine the A coefficient for the valley dams, all these dams were categorised into size categories namely for surface areas bigger than 50 ha, between 25 and 50 ha, between 2 and 25 ha, and smaller than 2 ha. Four different values for A have been calculated, and applied to valleys dams in the entire study area.
- The A coefficients for the hillside and hilltop dams were determined from the characteristics of all dams of these types and with known characteristics. As with valley dams, no difference was made from one sub-catchment to the other.
- Where reliable information was available for a dam, this was accepted and included in the data set, and capacities for such dams were not recalculated.
- A logarithmic FSA/WH relationship was accepted, i.e.  $WH = B \times FSA^C$
- For valley and hillside dam types, coefficients B and C were calculated from data on dams with known characteristics. Two sets of these coefficients were calculated for the region, namely one set for H100, H200, H400 and H600, and another set for H300, H500 and H700. This was based on the findings during the BRHS regarding typical coefficients in the sub-catchments.
- For the hilltop dam type there were no actual dams with suitable and reliable data, and theoretical values for the coefficients were calculated.
- The dam capacity to water depth relationship for each dam type was calculated as a percentage of the FSC at water depths of 25%, 50% and 75% of the maximum water depth.

The information for each dam was entered in the files containing data on dam characteristics, and these were then used in the hydrological modelling.

The accuracy of the formulae and coefficients were verified by comparing the calculated values with the actual values of the different characteristics of dams in the sample. The average of the calculated values for FSC as percentages of the actual values were as follows:

- FSA larger than 50 ha: 110 %
- FSA between 25 and 50 ha: 87 %
- FSA between 2 and 25 ha: 100%
- FSA smaller than 2 ha: 88%

For sub-catchments H600 and H700 it was further required to determine the existence of individual farm dams at previous time slice dates for the purpose of calibration of the hydrology. These time slices were for 1973, 1980, and 1987.

The procedure followed was to superimpose the farm dam coverage for each time slice on the present day coverage, and to identify those dams that were constructed during the alternative intervals. Great difficulty was experienced with this task due to the fact that different sets of unrectified photography were used for the historical land use mapping. The search function in ArcView was used with a search radius of 150 m to locate the same dam on different time slices. It was further accepted that any alterations of existing dams which might have taken place between the different time intervals would have had a minimal effect on the final results, and for this reason it was deemed not to be cost effective to attempt to trace such alterations. Files containing the farm dam characteristics for farm dams that existed in 1973, 1980 and 1987 in sub-catchments H600 and H700 were prepared for use in the calibration of the hydrology.

### **3.5 DEVIATIONS FROM TASK DESCRIPTION**

#### **3.5.1 Historical Land Use**

As already stated above, where the Task Description called for the land use of only one previous time slice to be mapped, crop types and farm dams for three previous time slices were mapped on request of the hydrology team.

While it was intended in the TOR to use both the methodology and coefficients for the determination of farm dam characteristics as used in the BRHS, new coefficients for the equations used for the calculation of FSC and WH had been calculated.

Difficulty was experienced in obtaining the BRHS GIS data sets for some coverages. However, in the end enough of the BRHS data was recovered from various sources to serve the purposes of this study. This did however prevent the extensive review of the BRHS crop type data as intended in the Task Description.

#### **3.5.2 Present Day Land Use**

The updating of the infrastructure coverage was done for farmsteads and the outlines of towns and villages. Roads, railway lines and major power lines were however not updated since the 1:50 000 vector data which include these types of infrastructure is in the process of being updated by the Chief Directorate Surveys and Mapping.

Regarding water features, all dams were mapped and characterised as described in Paragraph 3.4. Canals were however not mapped, as the use of unrectified photography would have resulted in inaccurate data on a feature where the exact location is of importance. Therefore it was thought to be better not to attempt to map canals at all.

The WfW standards to which aliens were to be mapped, created a problem since these standards were substantially rewritten from the time of tendering to the time of mapping. It also proved impossible to achieve accuracy in the mapping of aliens without extensive field verification, especially in areas densely infested with young plants and in areas where the aliens do not show up in contrast to the surrounding fynbos. These problems were communicated with the WfW programme, and it was agreed to make use of existing data sets available from Cape Nature Conservation instead.

Infrastructure such as roads and railways were handled as described for the historical land use mapping.

Dams were also handled as described for the historical land use mapping.

Cadastral data were acquired from the Surveyor General, but could not be imported into the GIS since the data as supplied were not geo-referenced!

While all irrigation board boundaries were supplied by DWAF and imported into the GIS, no digital information was available on the boundaries of Water Control Areas.

Accurate information on the exact location of existing water infrastructure was not readily available and the unrectified photography was not suitable for the mapping of this type of coverage. As with the historical land use mapping it was considered better not to map infrastructure than to generate inaccurate data.

No spatial demographic data was generated in the study and therefore none of this type of data was imported into the GIS.

#### 4. PRESENTATION OF DATA

Past experience has shown that land use mapping produced for basin studies are highly sought-after products for use in research projects, water resources assessments at sub-basin scale, feasibility studies, et cetera. To facilitate the distribution of the land use datasets (and databases developed for other study components) to the Client and stakeholders, this data has been prepared in a two CD set, as follows :

CD 1: a complete set of electronic reports, and

CD 2: a GIS data exploration tool and database.

The following GIS data sets are housed on CD 2 :

- Land use (Year 2000 for the entire Breede Basin; Years 1973, 1980 and 1987 for secondary catchments H6 and H7)
- Soil irrigation potential
- Contours of crop water requirements
- Groundwater recharge (based on geology and rainfall)
- Slope TIN and hill shaded image (from the 400m x 400m Surveys & Land Information DTM)
- Miscellaneous smaller datasets (rainfall stations, calibration sub-catchments, flow gauging stations, etc.)

The data sets are provided as ArcView shapefiles and Arc/Info TINs with metadata as specified in the DWAF Guidelines. A hard copy of the land use metadata is attached in Appendix A.

## 5. SUMMARISED RESULTS

### 5.1 BACKGROUND

As stated previously, the purpose of this document was not to report exhaustively on the results of the land use mapping undertaken for the BRBS. The idea behind doing the mapping and presenting the data in a GIS was that secondary users of the data can interrogate the database to provide the answers to their own unique questions. However, for the sake of completeness some basic results are reported.

### 5.2 HISTORICAL LAND USE

The results of the historical land use mapping for secondary catchments H600 and H700 are as shown in Table 2.

**TABLE 2 : H600 AND H700 HISTORICAL LAND USE**

DATA SET	CROP TYPE 1 (ha)	CROP TYPE 2 (ha)	FORESTRY (ha)	FARM DAMS (ha)	TOTAL (ha)
H600 - 1973	705,5	2 734,7	911,4	113,5	4 465,1
H600 - 1980	1 002,9	2 819,1	2 212,5	111,2	6 145,7
H600 - 1987	1 489,5	3 422,8	2 005,7	182,3	7 100,3
H700 - 1973	2 330,4	2 655,1	889,8	267,5	6 142,8
H700 - 1980	2 056,8	1 959,5	1 889,8	298,3	6 204,5
H700 - 1987	2 461,2	2 854,5	1 807,0	302,4	7 425,1

The decline in cultivated crops from 1973 to 1980 in H700 seemed suspicious at first. The marking up of photographs were checked, and the land use classification in the GIS had also been cross-checked for errors, and the final conclusion was that the data is actually correct.

### 5.3 PRESENT DAY LAND USE

The results of the present day (year 2000) land use mapping for the entire study area are as shown in Table 3. The results give a clear picture of the extent of development in the study area.

**TABLE 3 : BREEDE RIVER BASIN YEAR 2000 LAND USE**

SUB-CATCHMENT	H100 (ha)	H200 (ha)	H300 (ha)	H400 (ha)	H500 (ha)	H600 (ha)	H700 (ha)	TOTAL (ha)
<b>Total area</b>	<b>204 647</b>	<b>83 200</b>	<b>120 725</b>	<b>260 820</b>	<b>69 510</b>	<b>224 165</b>	<b>292 270</b>	<b>1 255 337</b>
<b>Agriculture</b>								
Cash crop	100	1	183	274	109	148	205	1 021
Pasture	1 210	299	477	3 312	1 772	3 561	3 248	13 880
Orchard	9 146	827	3 194	4 757	1 540	7 708	1 877	29 049
Vineyard	10 986	4 987	2 269	12 734	3 508	365	151	35 000
Fallow land	5 916	1 222	1 477	6 461	1 612	1 998	1 481	20 166
<b>Sub-total</b>	<b>27 358</b>	<b>7 336</b>	<b>7 600</b>	<b>27 538</b>	<b>13 741</b>	<b>13 780</b>	<b>6 757</b>	<b>99 116</b>
Dryland crops	10 732	1 557	5 574	14 838	12 571	84 617	157 453	287 343
<b>Total</b>	<b>38 090</b>	<b>8 893</b>	<b>13 174</b>	<b>42 376</b>	<b>26 312</b>	<b>98 397</b>	<b>164 210</b>	<b>386 459</b>
<b>Forestry</b>								
Plantation	891	9	34	14	0	1 874	1 937	4 760
Woodlots	447	42	30	153	28	347	347	1 047
<b>Total</b>	<b>1 338</b>	<b>51</b>	<b>64</b>	<b>167</b>	<b>28</b>	<b>2 221</b>	<b>2 284</b>	<b>5 807</b>
<b>Alien Vegetation</b>								
Landscape	1 322	427	291	2 322	188	11 176	11 036	26 761
Riparian	2 265	547	827	3 411	1 077	3 123	4 177	15 427
<b>Total</b>	<b>3 587</b>	<b>974</b>	<b>1 118</b>	<b>5 733</b>	<b>1 265</b>	<b>14 299</b>	<b>15 213</b>	<b>42 188</b>
<b>Infrastructure</b>								
Built-up (towns)	874	2 094	419	760	0	0	730	4 877
Villages	419	197	379	113	284	667	534	2 593
Farmsteads	1 056	397	311	745	323	968	1 323	5 123
Labour housing	181	113	134	213	87	109	111	949
Informal housing	0	0	0	0	20	0	0	20
Institutional	95	5	6	105	0	77	19	307
Commercial	312	79	10	80	40	145	21	687
<b>Total</b>	<b>2 937</b>	<b>2 885</b>	<b>1 259</b>	<b>2 016</b>	<b>754</b>	<b>1 966</b>	<b>2 738</b>	<b>14 556</b>
<b>Wetlands</b>	<b>684</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1 648</b>	<b>17</b>	<b>2 350</b>
<b>Riparian zones</b>	<b>2 142</b>	<b>418</b>	<b>612</b>	<b>3 310</b>	<b>849</b>	<b>808</b>	<b>1 578</b>	<b>9 717</b>
<b>Dams</b>	<b>4 439</b>	<b>565</b>	<b>606</b>	<b>3 494</b>	<b>465</b>	<b>5 924</b>	<b>655</b>	<b>16 148</b>
<b>Total Developed</b>	<b>46 804</b>	<b>12 394</b>	<b>15 103</b>	<b>48 053</b>	<b>27 559</b>	<b>108 508</b>	<b>169 887</b>	<b>428 308</b>
<b>Developed %</b>	<b>22,9</b>	<b>14,9</b>	<b>12,5</b>	<b>18,4</b>	<b>39,6</b>	<b>48,4</b>	<b>58,1</b>	<b>34,1</b>

One of the more important objectives of the land use mapping was not only to determine the extent of existing development in the study area, but also to determine the remaining potential for future agricultural development. This was done by considering the total area with soils suitable for sustained irrigated agriculture (as determined by the soils task team), the areas with terrain slopes suitable for agriculture (<15%), and the areas already developed. The results of this exercise (described in more detail in Report PH 00/00/1902) were as shown in Table 4 and Figure 1 (bound at the back of this report).

**TABLE 4 : POTENTIAL FOR NEW IRRIGATION**

<b>SUB-CATCHMENT</b>	<b>TOTAL AREA (ha)</b>	<b>SUITABLE SOIL (ha)</b>	<b>SLOPE &lt; 15% (ha)</b>	<b>IRRIGATED (ha)</b>	<b>POTENTIAL (ha)</b>
H100	204 647	63 220	101 870	21 340	33 310
H200	83 200	16 330	38 410	6 090	7 680
H300	120 725	8 500	75 290	6 110	3 590
H400	260 820	58 790	57 470	21 060	36 530
H500	69 510	13 990	57 660	6 920	6 950
H600	224 165	29 620	165 600	11 780	15 950
H700	292 270	77 810	263 340	5 450	68 870
Total	1 255 337	268 260	759 640	78 750	172 880

#### **5.4 ACCURACY ACHIEVED**

A hydrocensus of the Hex River Valley (in H200) was commissioned by DWAF in co-operation with the irrigation boards in the valley.

Crosschecks were performed to compare registered water use and estimates of water requirements in the valley. The estimates were based on the Year 2000 land use mapping conducted for the BRBS.

In the estimation of the water requirement for irrigation, the mapped irrigated area was reduced by 2,5% to allow for farm roads and windbreaks which were not mapped separately. The irrigated areas within the area of each irrigation board as derived from the BRBS land use mapping and from the actual hydrocensus were compared. For the entire Hex River Valley with a total irrigated area of about 4500 ha, the difference between the two figures was less than 3 %. Clearly a high degree of accuracy was achieved with the land use mapping methodologies used.

## REFERENCES

- CSIR Environmentek; January 2000; *Working for Water Programme: Metadata: National Invasive Alien Plant Database: April 1998*; CSIR Report No ENV-S-C 2000-12.
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- Department of Water Affairs and Forestry, South Africa. 1995. *Breede River Hydrological Study – Procedure for the Evaluation of Farm Dams*; DWAF Report No PH 000/00/0392.
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# **Appendix A**

## **Metadata**

Title of data set:Crop types (agric50)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified crop types in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:as needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Crops  
Theme Reference:Crops  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Destribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:agric50  
Region:Western Cape Province  
Feature:Crop types  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_agric50.xls

ID:

Related data files:

-----

ITEM:Type

Type:Character

Length:20

Description:Type of crops

Example:Cash crops

.....

ITEM:Area\_ha

Type:Number (3DEC)

Length:16

Description:The area in hectares

Example:

Title of data set:Dams (dams50)  
Captured by:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified dams in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Dams  
Theme Reference:Dams  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:dams50  
Region:Western Cape Province  
Feature:Dams  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_dams50.xls

ID:

Related data files:

-----

ITEM:Name  
Type:Character  
Length:40  
Description:Name of dam  
Example:Brandvlei

-----

ITEM:Register  
Type:Character  
Length:1  
Description:Is the dam officially registeres? (Y/N)  
Example:Y

-----

ITEM:Dam\_no  
Type:Character  
Length:7  
Description:Dam number  
Example:H10L5

-----

ITEM:Type  
Type:Character  
Length:2  
Description:Type of dam - V = Valley, H = Hillside, P = Hilltop  
Example:P

Title of data set:Afforestation (forest50)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified afforestation in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Forestry  
Theme Reference:Forestry  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:forest50  
Region:Western Cape Province  
Feature:Afforestation  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_forest50.xls

ID:

Related data files:

-----  
ITEM:Class

Type:Character

Length:40

Description:Type of afforestation

Example:Plantation

-----  
ITEM:Area\_ha

Type:Number (3DEC)

Length:20

Description:Area in hectares

Example:

Title of data set:Infrastructure (infra50)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified infrastructure in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Infrastructure  
Theme Reference:Infrastructure  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:infra50  
Region:Western Cape Province  
Feature:Infrastructure  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_infra50.xls

ID:

Related data files:

---

ITEM:Name

Type:Character

Length:40

Description:Name of town

Example:Ceres

---

ITEM:Type

Type:Character

Length:40

Description:Type of infrastructure

Example:Farmstead

---

ITEM:Sub\_type

Type:Character

Length:40

Description:Detail of type

Example:Wine Cellar

---

ITEM:Area\_ha

Type:Number (3DEC)

Length:16

Description:Area in hectares

Example:

Title of data set:Alien infestation (nbal)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified alien infestation in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Alien  
Theme Reference:Alien  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:nbal  
Region:Western Cape Province  
Feature:Aliens  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_nbal.xls

ID:

Related data files:

---

ITEM:Nbalid  
Type:Character  
Length:10  
Description:Unique Id used within the WFW project  
Example:

---

ITEM:Area\_ha  
Type:Number (3DEC)  
Length:12  
Description:Area in hectares  
Example:

---

ITEM:Sp\_code  
Type:Number  
Length:3  
Description:Species type  
Example:

---

ITEM:Densecode  
Type:Character  
Length:2  
Description:CSIR density code  
Example:m = medium

---

ITEM:Sizecode  
Type:Character  
Length:1  
Description:CSIR age/size/maturity code  
Example:

---

ITEM:Rip\_code  
Type:Character  
Length:1  
Description:CSIR Riparian code  
Example:r = riparian zone

---

ITEM:First\_inf  
Type:Character  
Length:10

Description:Date when infestation started

Example:

---

ITEM:Ini\_stat

Type:Character

Length:2

Description:Initial vegetation status before infestation

Example:

---

ITEM:Notes

Type:Character

Length:100

Description:Notes and observations

Example:

---

Title of data set:Riparian zones (ripar50)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified riparian zones in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Riparian zones  
Theme Reference:Riparian zones  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:ripar50  
Region:Western Cape Province  
Feature:Riparian zones  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_ripar50.xls

ID:

Related data files:

-----

ITEM:Type

Type:Character

Length:20

Description:The zone of undeveloped land left by farmers in highly developed landscapes

Example:

.....

ITEM:Area\_ha

Type:Number (3DEC)

Length:16

Description:Area in hectares

Example:

Title of data set:Wetlands (wetl50)  
Captured By:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Publish date:  
Edition:1  
Intranet address:<http://dwaf-www.pwv.gov.za/FrameSys.htm>  
Abstract:Identified wetlands in the Breede River Basin  
Purpose:Breede Basin Study  
Supplemental Information:Coverage completed 26-02-2001  
Source date:24-02-2000 to 04-05-2000  
Progress:Completed  
Update Frequency:As needed  
East (Min X) :21  
South (Min Y):-35  
West (Max X):19  
North (Max Y):-33  
Theme Keywords:Wetlands  
Theme Reference:Wetlands  
Place Keywords:Breede River Basin  
Place Reference:Breede River Basin  
Restricted:  
Type of Restriction:  
Spatial Type:Polygon  
Distribution Organisation:DWAF  
Contact Person:  
Phone Number:  
Source:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Custodian:MBB Consulting Engineers  
Contact Person: Johann Murray  
Phone Number: 021-8871026  
Date last updated:  
Coverage Scale:1:50 000  
Coverage name:wetl50  
Region:Western Cape Province  
Feature:Wetlands  
Capture Method:Digitized  
Format: ArcView  
Source Material Nature: 1 : 30 000 Scanned aerial photographs  
Projection:Geographical co-ordinates  
Spheroid:CLARKE 1880  
Standard Parallel 1:  
Standard Parallel 2:  
Central Meridian:  
Fuzzy Tolerance:  
Quality of data:  
Base or Process:Processed  
Coverage Type:Vector  
Related data files:meta\_wetl50.xls

ID:

Related data files:

-----

ITEM:Name

Type:Character

Length:40

Description:Name of wetland

Example:Papenkuils

-----

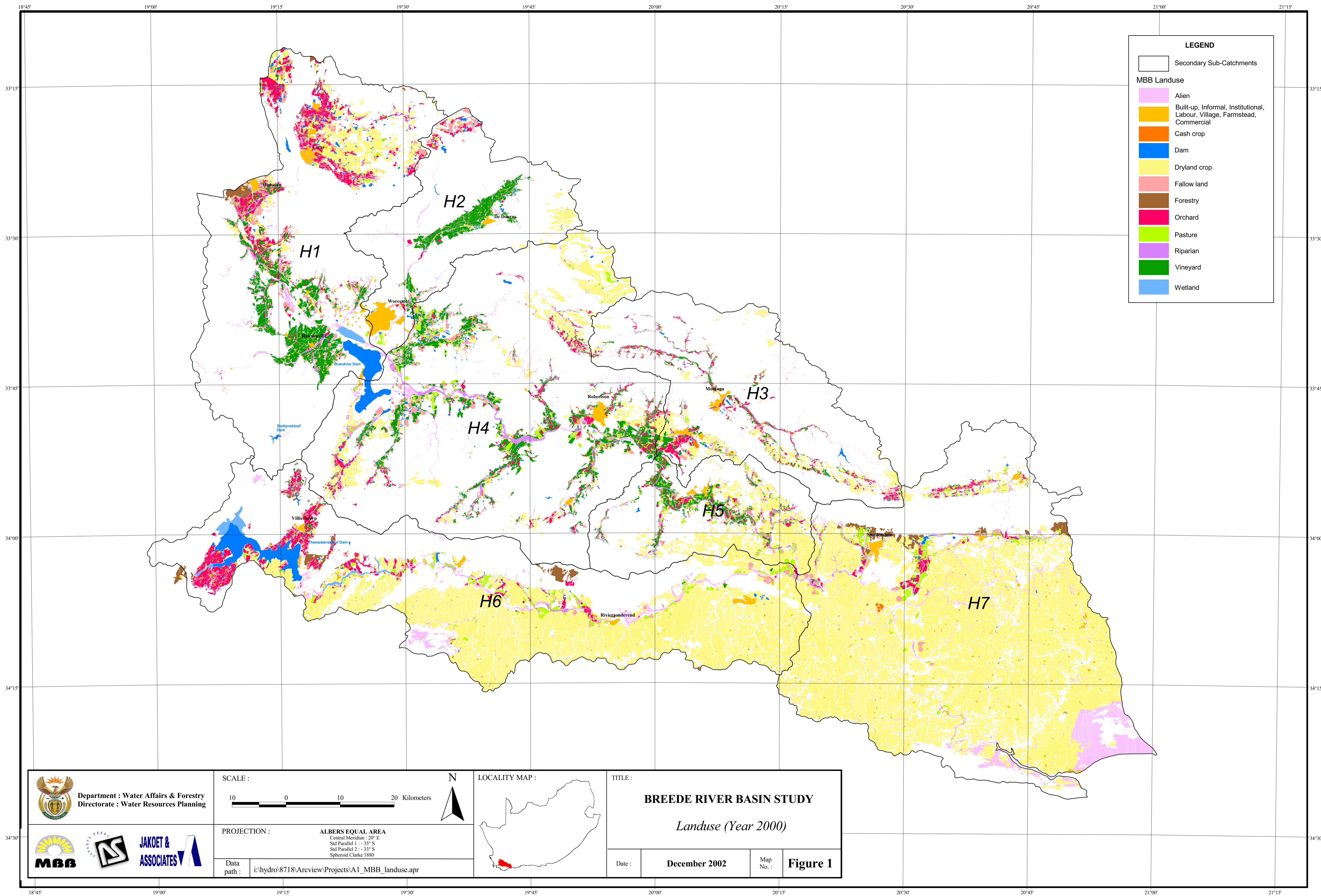
ITEM:Area\_ha

Type:Number (3DEC)

Length:16

Description:Area in hectares

Example:




**LEGEND**

Secondary Sub-Catchments

**MBB Landuse**

- Alien
- Built-up, Informal, Institutional, Labour, Village, Farmstead, Commercial
- Cash crop
- Dam
- Dryland crop
- Fallow land
- Forestry
- Orchard
- Pasture
- Riparian
- Vineyard
- Wetland


 Department : Water Affairs & Forestry  
 Directorate : Water Resources Planning

SCALE :

10 0 10 20 Kilometers

N



TITLE :

**BREEDE RIVER BASIN STUDY**

*Landuse (Year 2000)*

Date : **December 2002**      Map No. : **Figure 1**




PROJECTION :

**ALBERS EQUAL AREA**  
 Central Meridian : 20° E  
 Std Parallel 1 : - 35° S  
 Std Parallel 2 : - 33° S  
 Spheroid Clarke 1880

Data path : i:\hydro\8718\Arcview\Projects\A1\_MBB\_landuse.apr