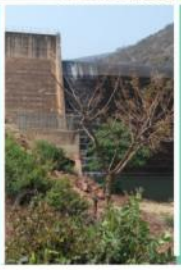
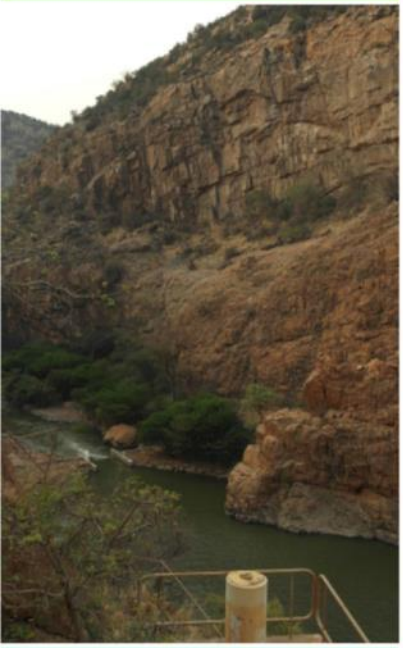
water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

REPORT NO: PWMA 01/000/00/02914/3





# THE DEVELOPMENT OF THE LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATEGY

## HYDROLOGICAL ANALYSIS

Volume 2: Appendices

**FINAL**

**DECEMBER 2015**

W71_2014/J02173

| | |
|---|---|
| *Project Name:* | ***Limpopo Water Management Area North Reconciliation Strategy*** |
| *Report Title:* | ***Hydrological Analysis: Volume 2 – Appendices*** |
| *Authors:* | ***J Lombaard, S Sikosana, E van Niekerk*** |
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***CONSULTANTS: AECOM in association with Hydrosol, Jones & Wagener and VSA Rebotile Metsi Consulting.***

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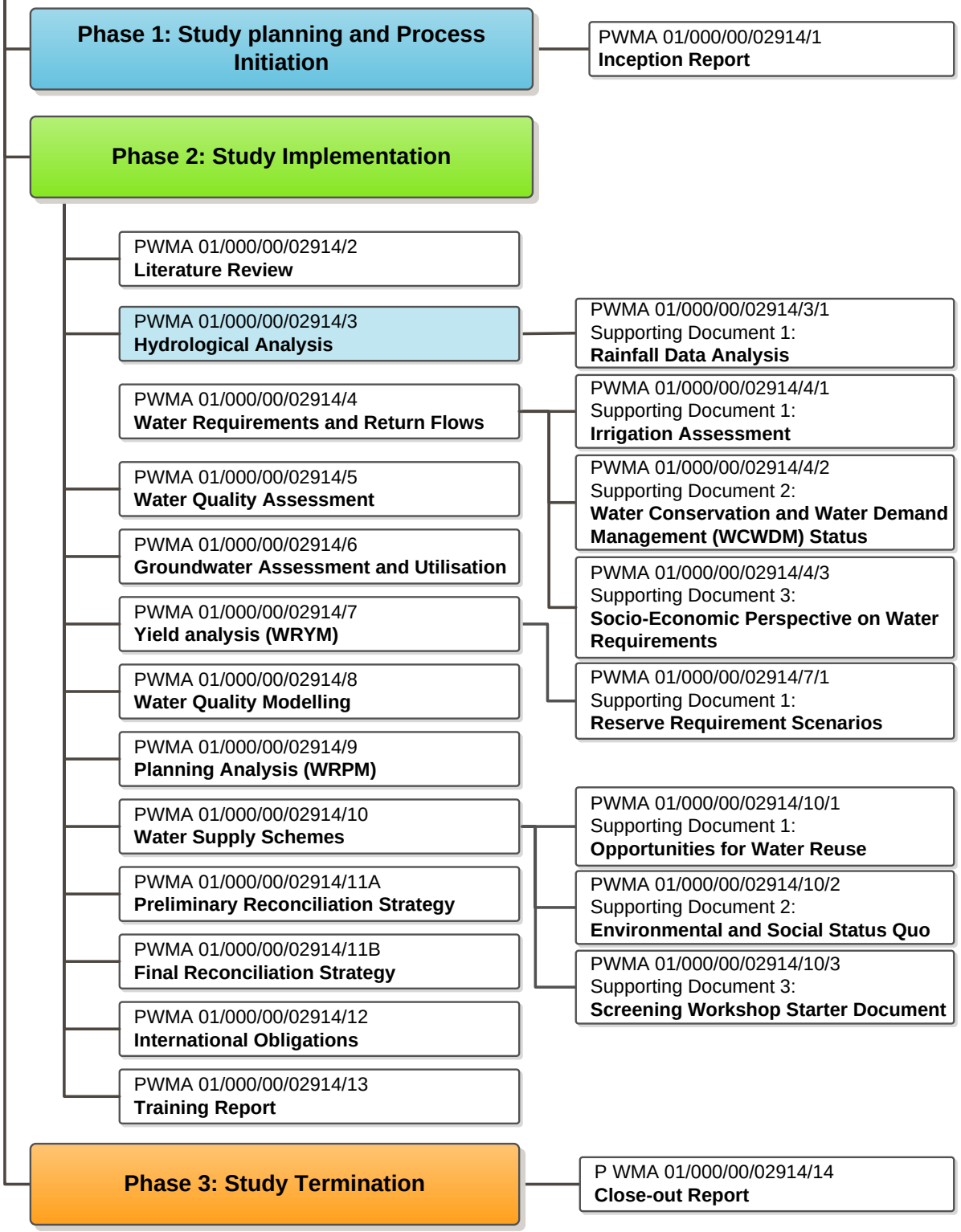
# Limpopo Water Management Area North Reconciliation Strategy

*Date: December 2015*



# CONTENTS OF REPORT

The *Limpopo Water Management Area North Reconciliation Strategy Hydrological Analysis Report* is divided into two Volumes.

The first volume (**Volume 1: Main Report**) contains the main text, dealing with the description of the modelling process, results, conclusions and recommendations of the hydrological analysis.

The second volume (**Volume 2: Appendices**) contains the appendices referenced in *Volume 1* of the Hydrological Analysis Report. The appendices contain tables, figures and information related to the input and results of the hydrological analysis using the *Water Resources Simulation Model 2000* (WRSM2000).

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# Appendix A

## Maps


| | |
|---|---|
| Project Title: | **LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATGEGY** |
| Map Title: | **Limpopo WMA North Study Area** |

Whilst every care has been taken in compiling the information on this map, AECOM cannot accept responsibility for any inaccuracies. 

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Scale 1:1 300 000 (When page size is: A3 landscape)

**Figure A.1**

| | |
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| Projection: | Geographic |
| Datum: | Hartebeesthoek 1994 |
| Compiled By: | LC Gallagher |
| GIS QC By: | |
| Approved By: | J Lombaard |
| Date Saved: | 2015/06/08 |
| Project Number: | J02172 03 *** |
| Map Ref: | FigA.1_WMA_StudyArea_A3L.mxd |
| Revision: | 01 |

**Sources:**

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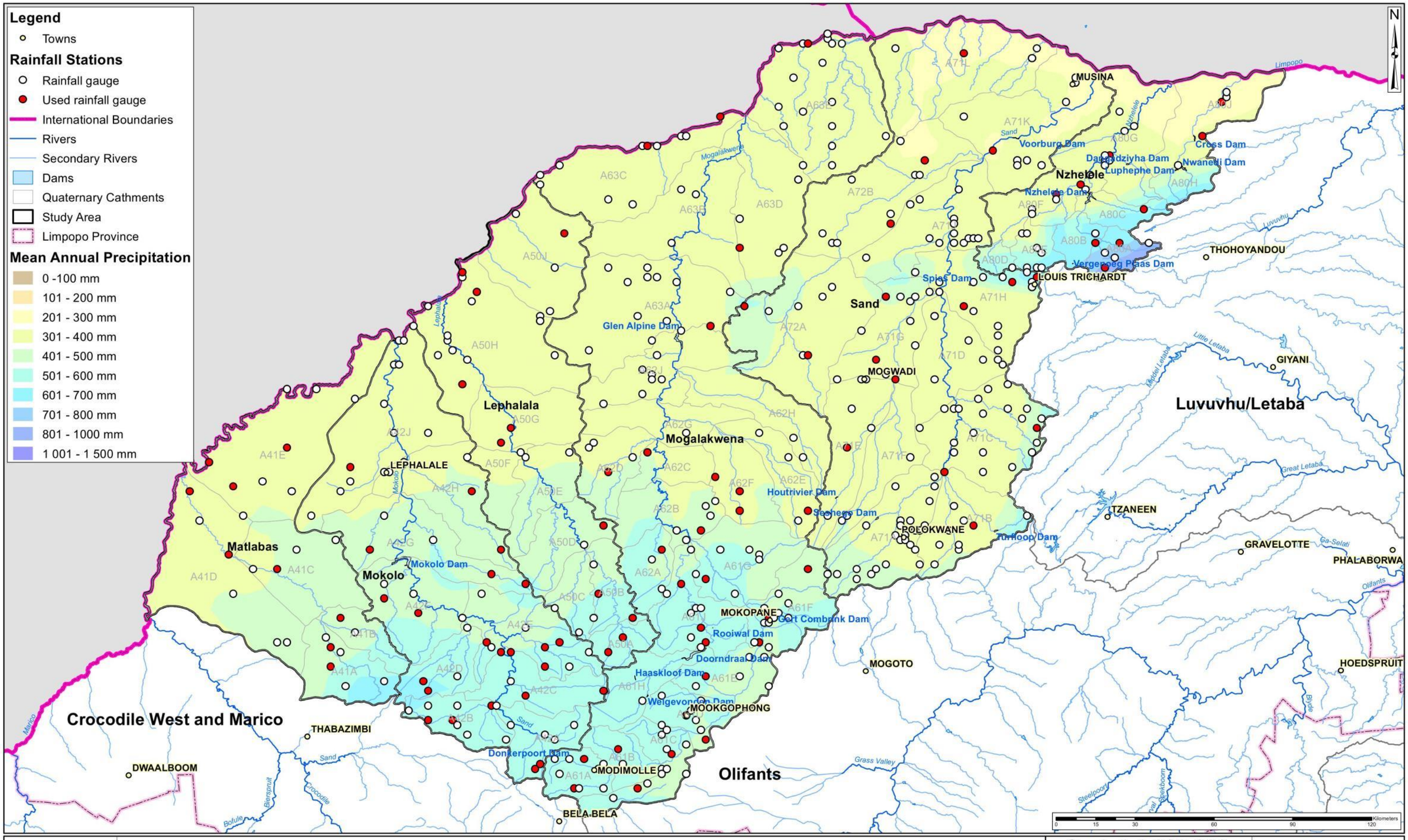


| | |
|---|---|
| Project Title: | **LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATGEGY** |
| Map Title: | **Mean Annual Precipitation (mm/a) for the Limpopo WMA North** |

Scale 1:1 300 000 (When page size is: A3 landscape)

**Figure A.2**

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| GIS QC By: | |
| Approved By: | J Lombaard |
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| Revision: | 01 |

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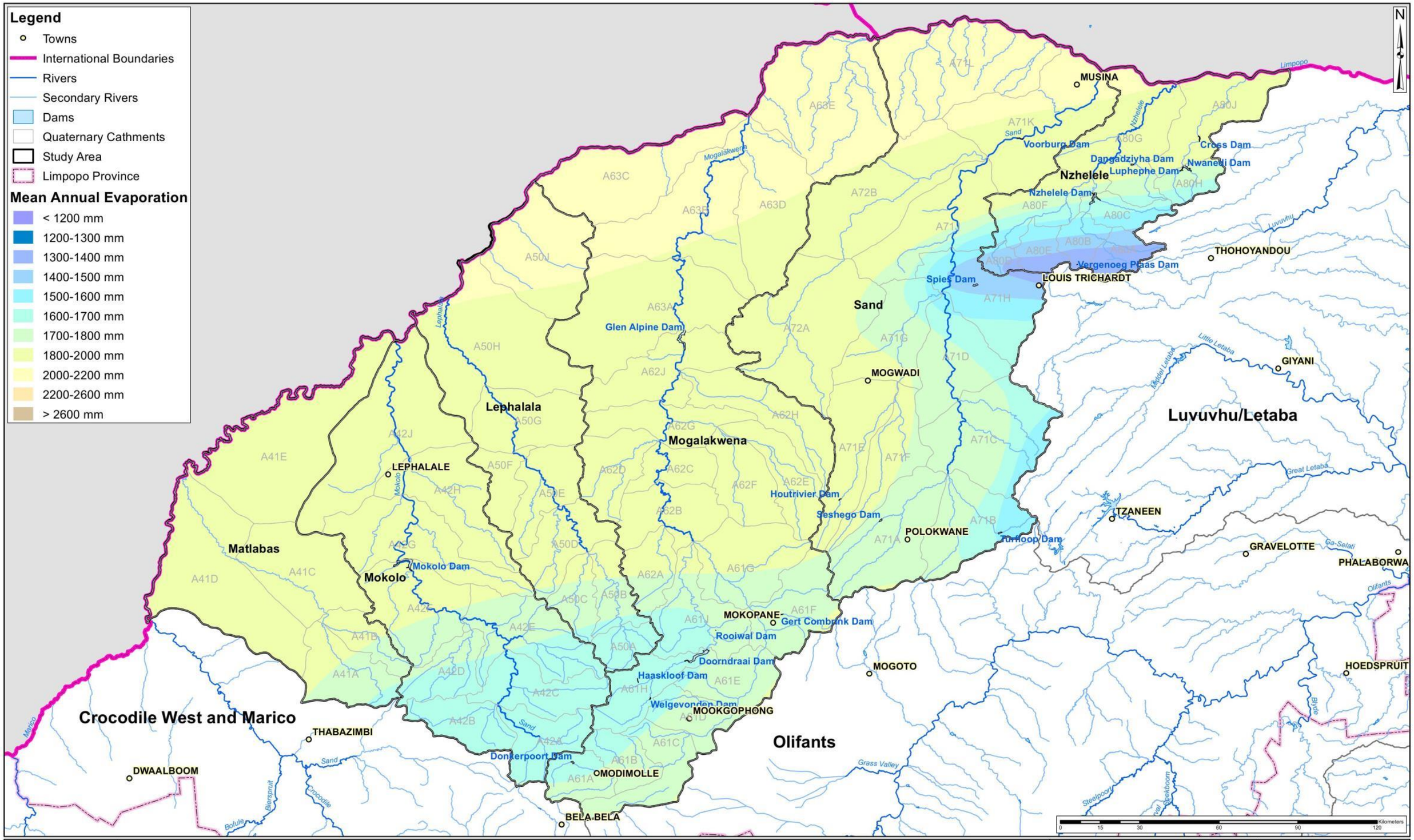


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| Map Title: | **Mean Annual Evaporation (mm/a) for the Limpopo WMA North** |

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**Figure A.3**

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| Approved By: | J Lombaard |
| Date Saved: | 2015/06/08 |
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| Map Ref: | FigA.3_MAE_A3L.mxd |
| Revision: | 01 |

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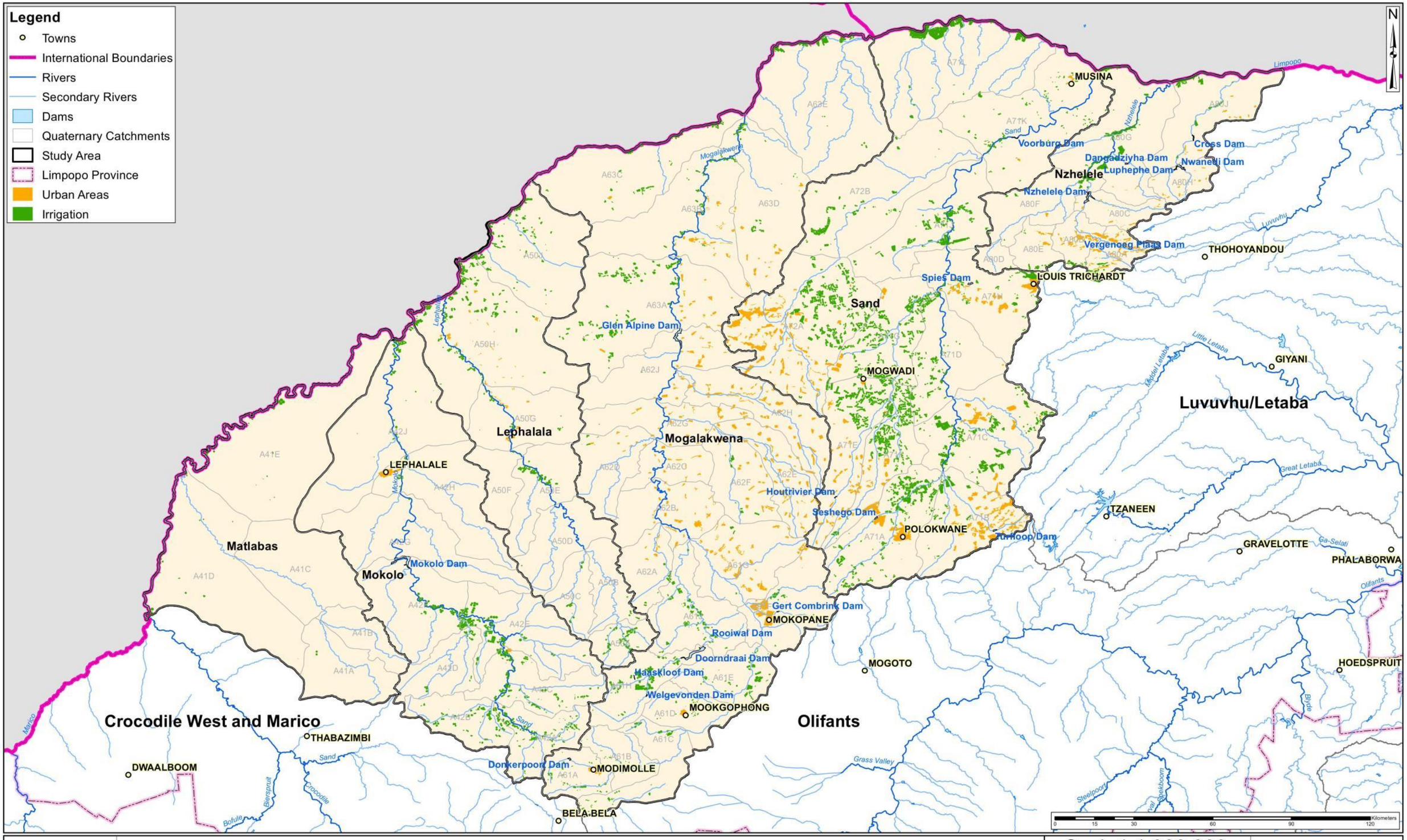


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|---|---|
| Project Title: | **LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATGEGY** |
| Map Title: | **Location of irrigated areas in the Limpopo WMA North at 2010-development level** |

Scale 1:1 300 000 (When page size is: A3 landscape)

**Figure A.4**

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| Approved By: | J Lombaard |
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| Project Number: | J02172 03 *** |
| Map Ref: | FigA.4_WMA_Irrigation_A3L.mxd |
| Revision: | 01 |

**Sources:**

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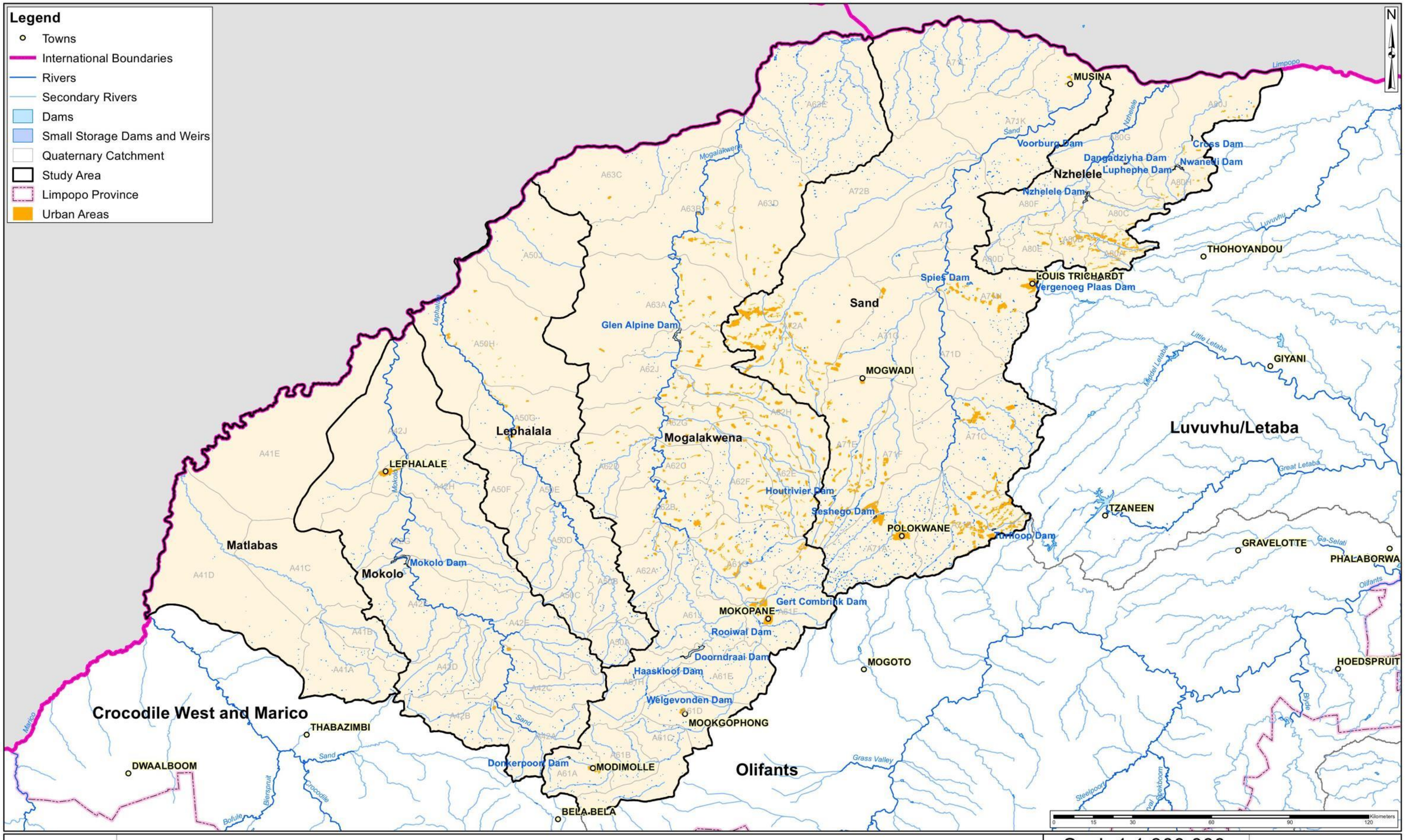


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| Project Title: | **LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATGEGY** |
| Map Title: | **Location of small dams and weirs in the Limpopo WMA North at 2010-development level** |

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**Figure A.5**

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**Legend**

**Streamflow Gauges**

- Stream flow gauge
- Stream flow gauge used for calibration
- Stream flow gauge used for verification
- Towns
- International Boundaries
- Rivers
- Secondary Rivers
- Dams
- Quaternary Cathments
- Study Area
- Limpopo Province

**Mean Annual Runoff**

- 0 - 2.5 mm
- 2.5 - 5 mm
- 5 - 10 mm
- 10 - 20 mm
- 20 - 50 mm
- 50 - 100 mm
- 100 - 200 mm
- 200 - 500 mm
- > 500 mm

N

Crocodile West and Marico

Olifants

Luvuvhu/Letaba

Matlabas

Mokolo

Lephalala

Mogalakwena

Sand

MUSINA

THOHOYANDOU

LOUIS TRICHARDT

GIYANI

MOGWADI

LEPHALALE

Nzhelele

POLOKWANE

TZANEEN

GRAVELOTTE

PHALABORWA

MOKOPANE

MOGOTO

HOEDSPRUIT

THABAZIMBI

DWAALBOOM

MODIMOLLE

BELA-BELA

MOOKGOPHONG

Glen Alpine Dam

Spies Dam

Vergenoeg Peaas Dam

Voorburg Dam

Dapgadziyha Dam

Luphephe Dam

Nwanedi Dam

Cross Dam

Nzhelele Dam

Houtrivier Dam

Seshego Dam

Tom Hoop Dam

Mokolo Dam

Gert Combrink Dam

Rooiwal Dam

Doorndraai Dam

Haaskloof Dam

Welgevonden Dam

Donkerpoort Dam

A41A A41B A41C A41D A41E A42A A42B A42C A42D A42E A42F A42G A42H A42J A50A A50B A50C A50D A50E A50F A50G A50H A50J A61A A61B A61C A61D A61E A61F A61G A61H A61J A62A A62B A62C A62D A62E A62F A62G A62H A63A A63B A63C A63D A63E A71A A71B A71C A71D A71E A71F A71G A71H A71J A71K A71L A72A A72B A80A A80B A80C A80D A80E A80F A80G A80H A80J

| | |
|---|---|
| Project Title: | **LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATGEGY** |
| Map Title: | **Natural Runnoff (mm/a) for the Limpopo WMA North** |

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**Figure A.6**

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| GIS QC By: | |
| Approved By: | J Lombaard |
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| Map Ref: | FigA.6_MAR_A3L.mxd |
| Revision: | 01 |

**Sources:**

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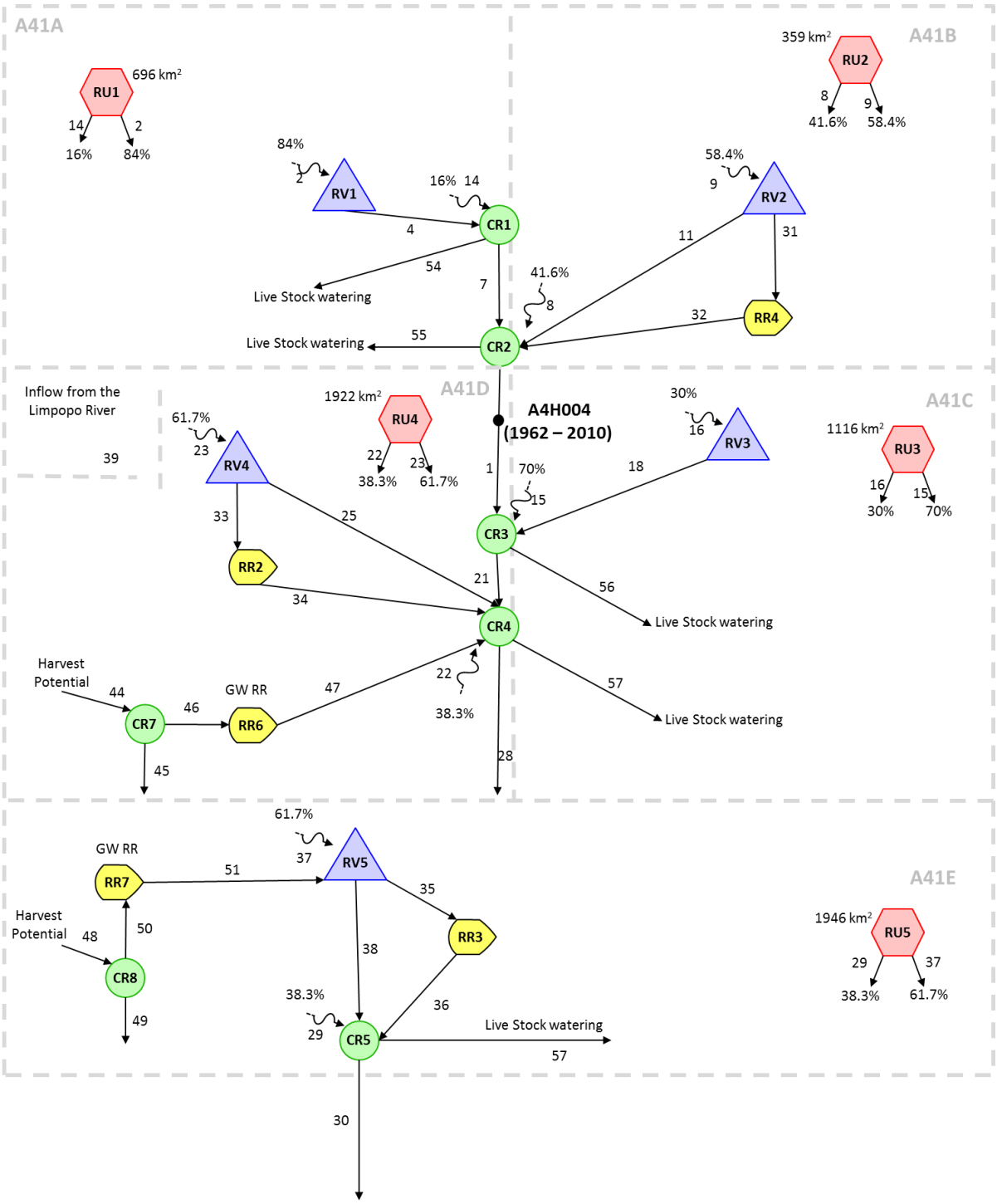
# Appendix B

# Enhanced WRSM2000 system schematic diagrams




## Figure B.1: Matlabas System (A41)

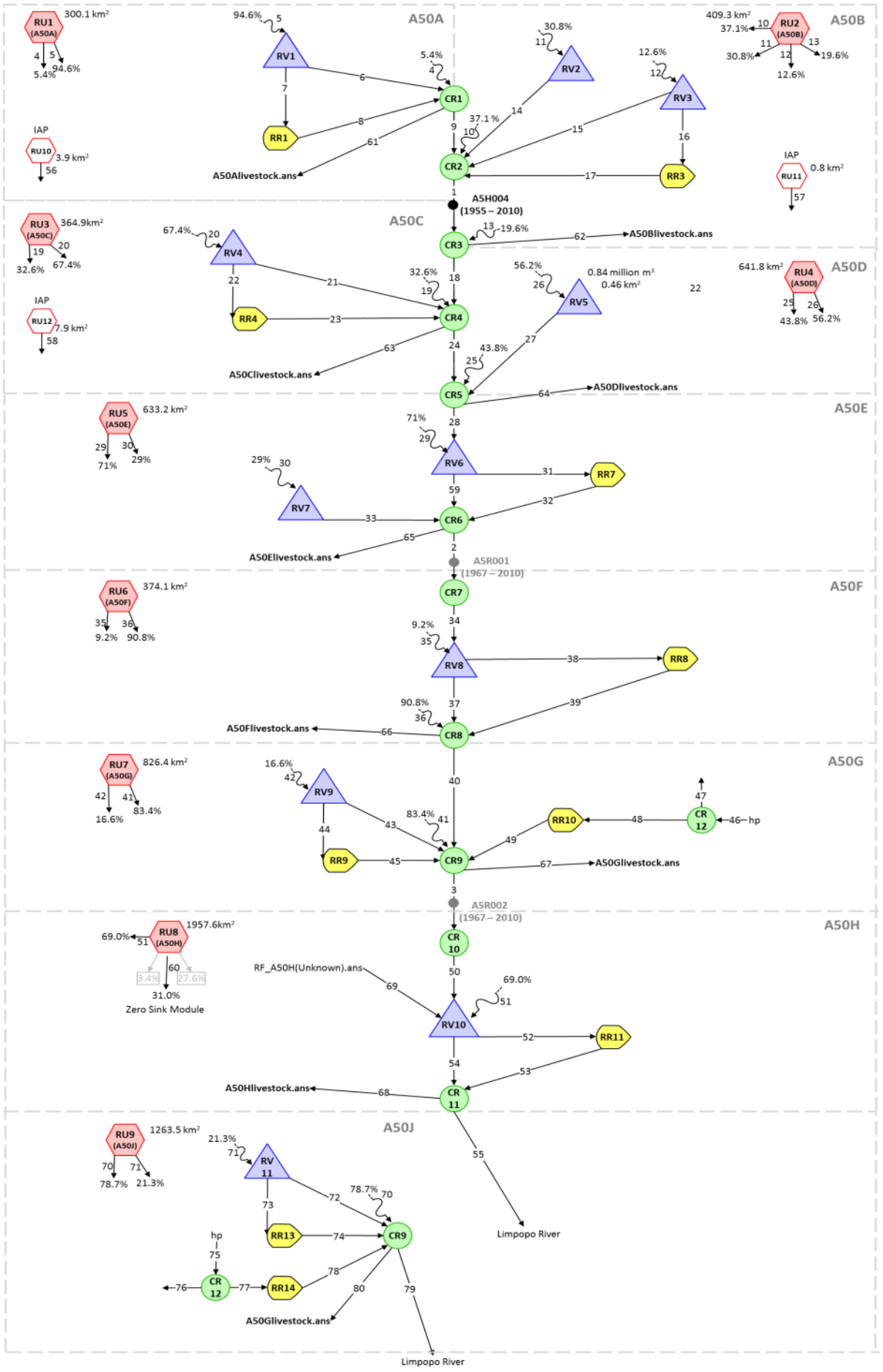



Figure B.2: Lephalala System (A50)

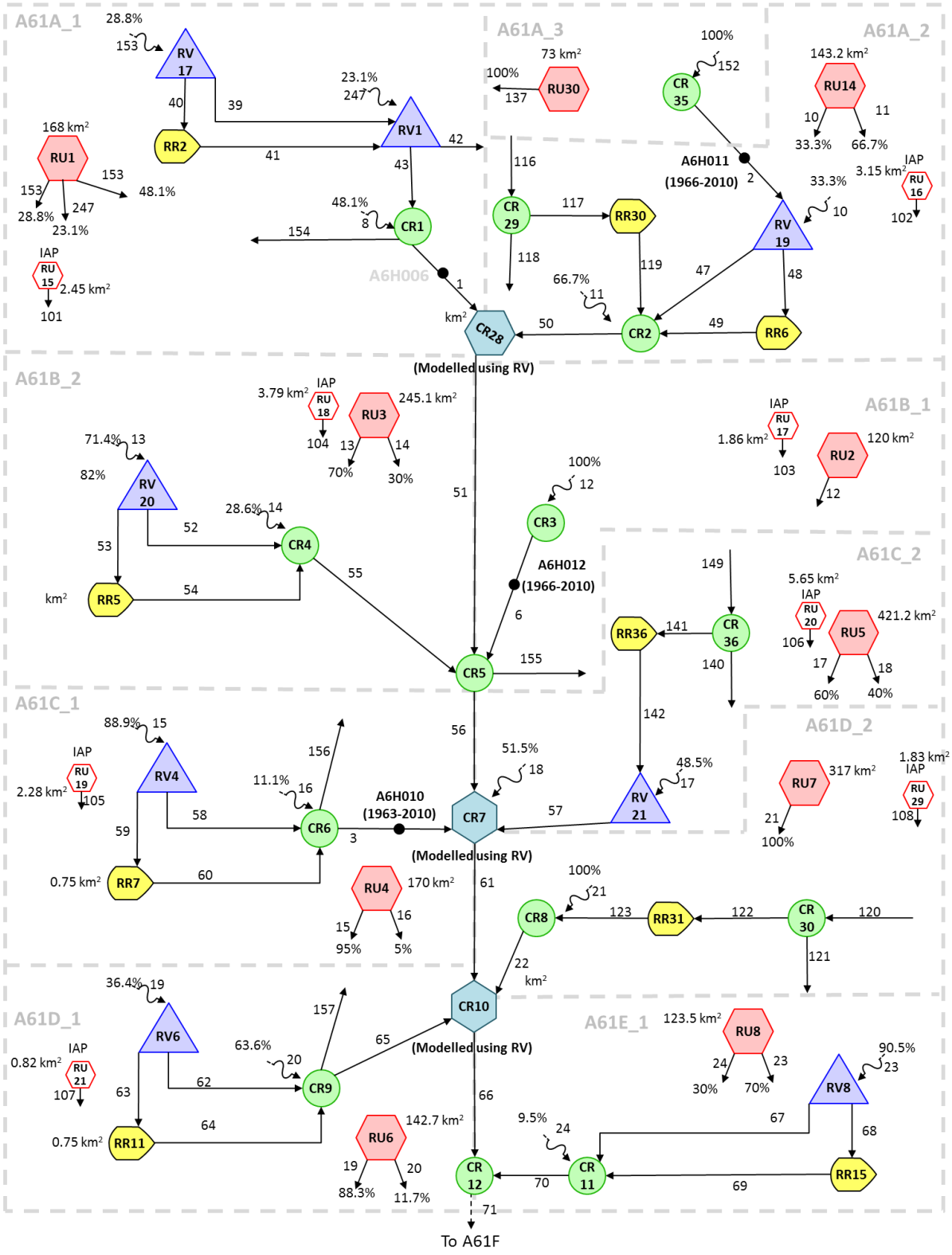



Figure B.3: Mogalakwena System (A61)

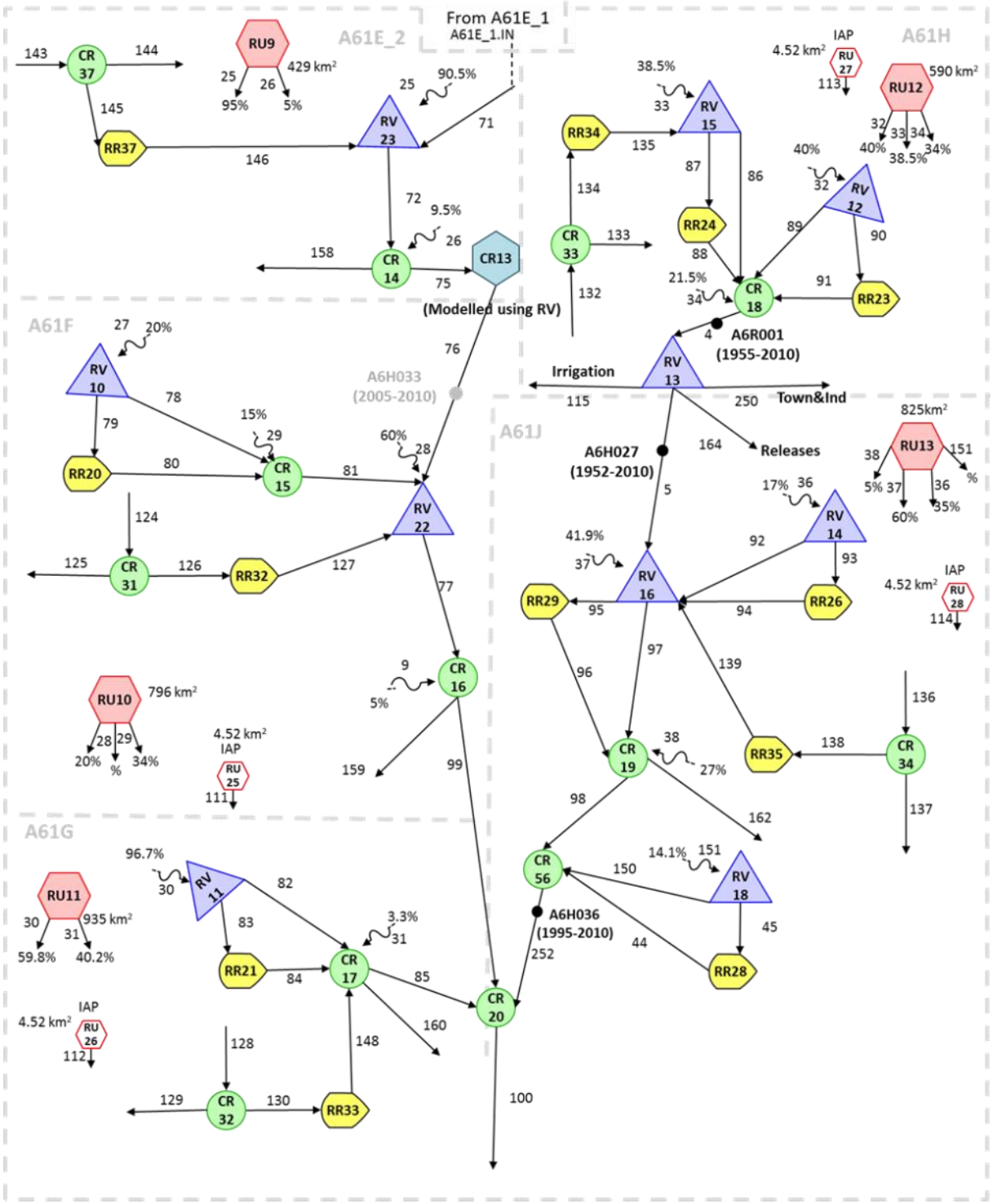
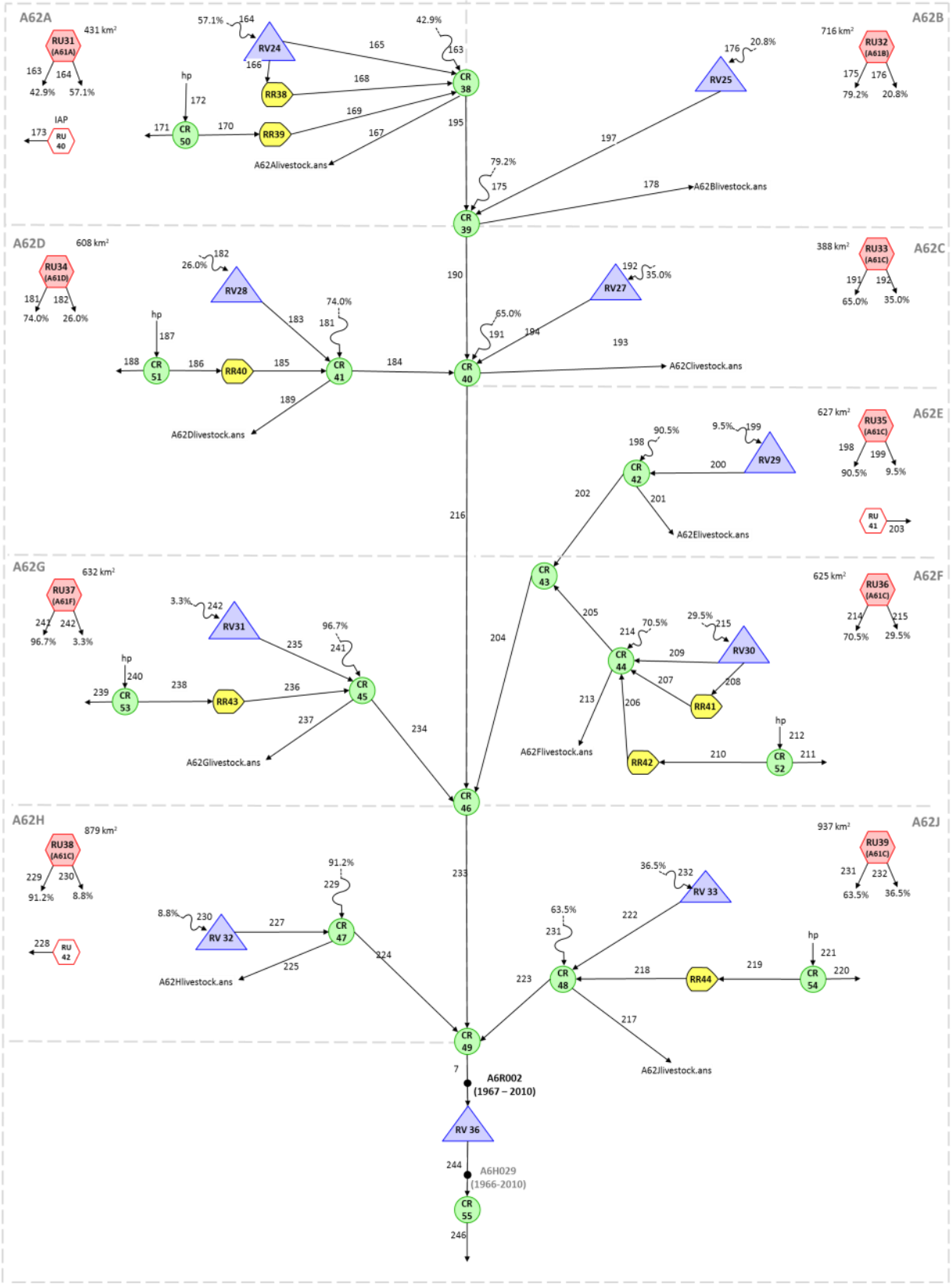



**Figure B.3: Mogalakwena System (A61) continue**




## Figure B.4: Mogalakwena System (A62)

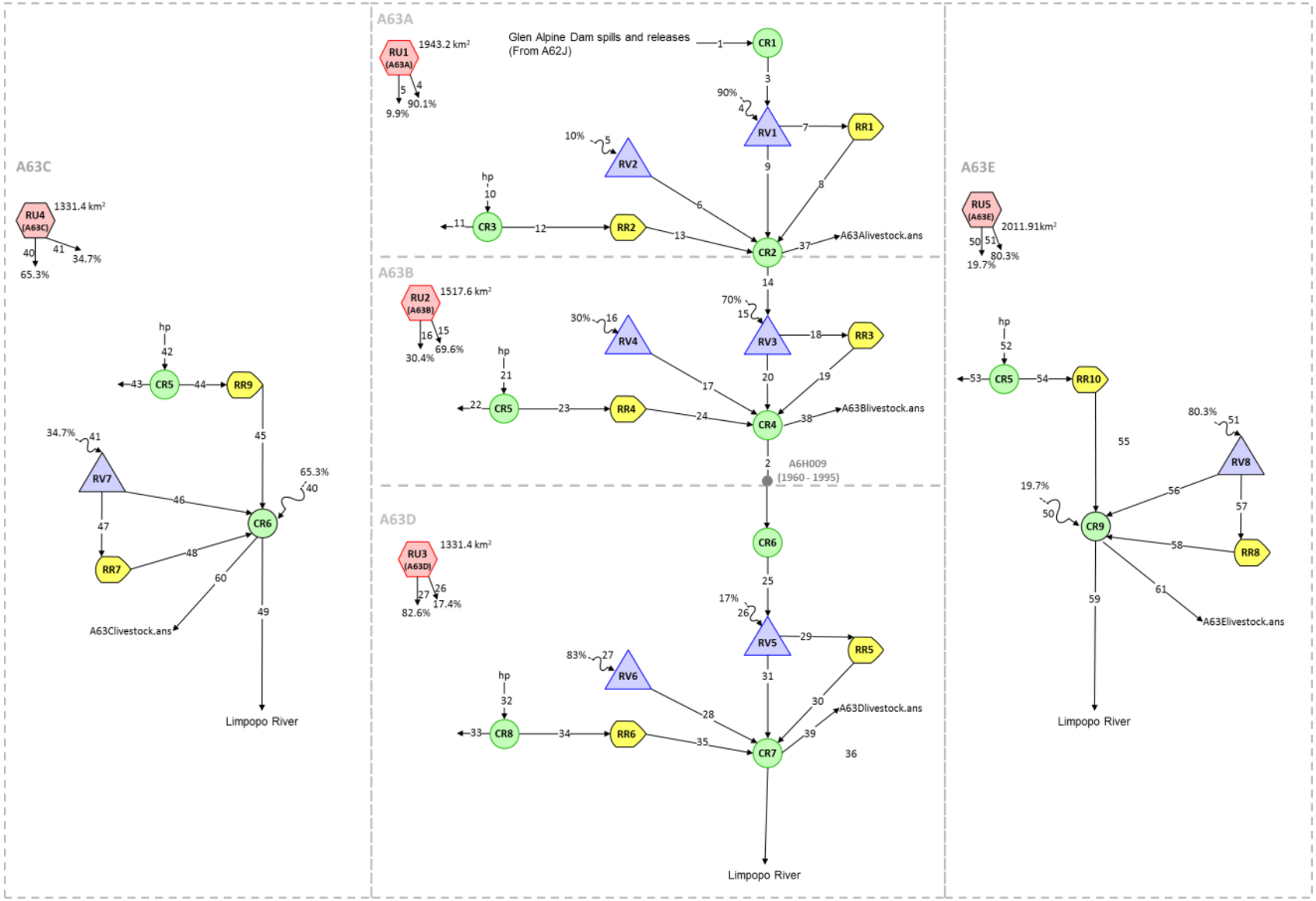
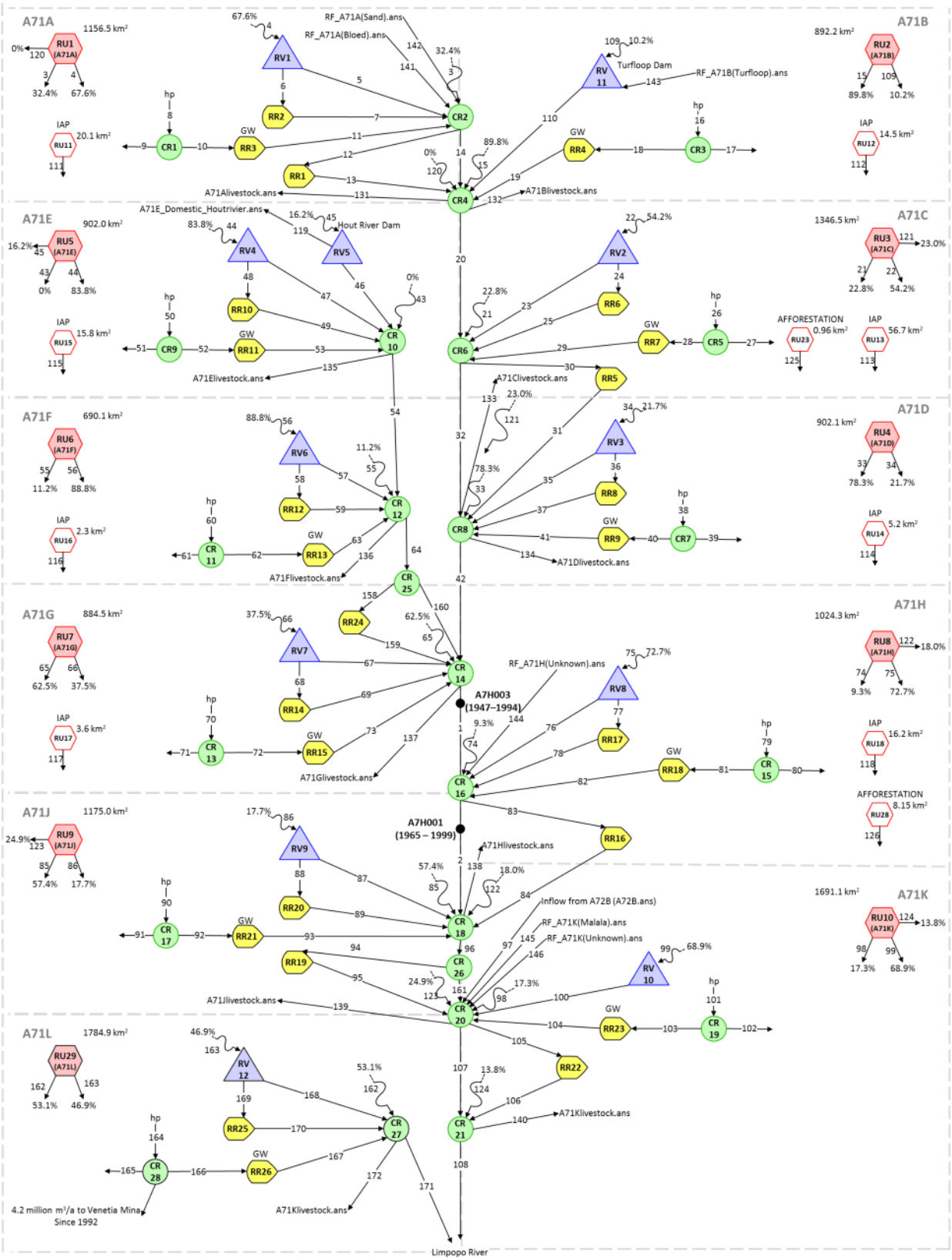



**Figure B.5: Mogalakwena System (A63)**




## Figure B.6: Sand System (A71)

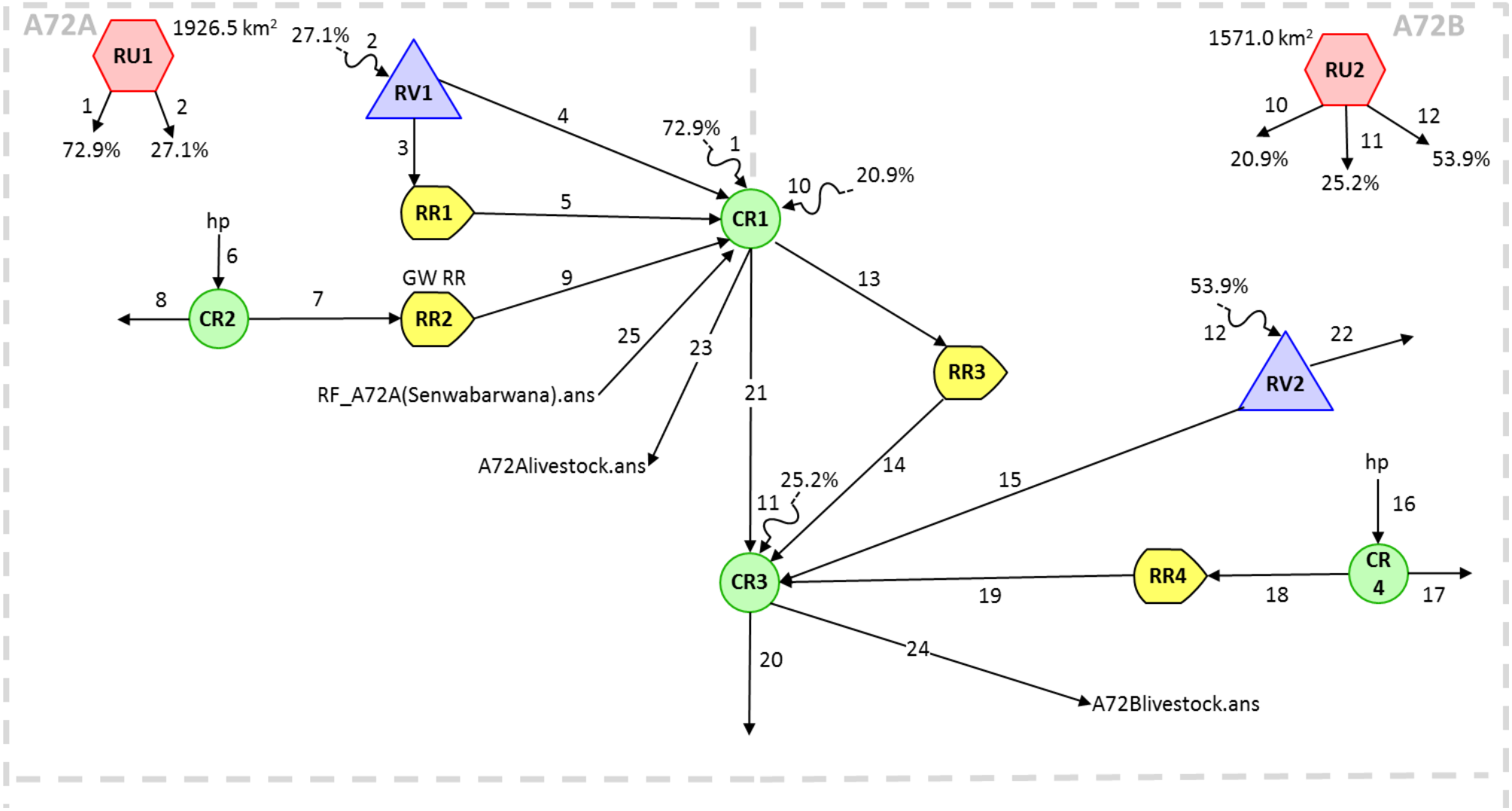
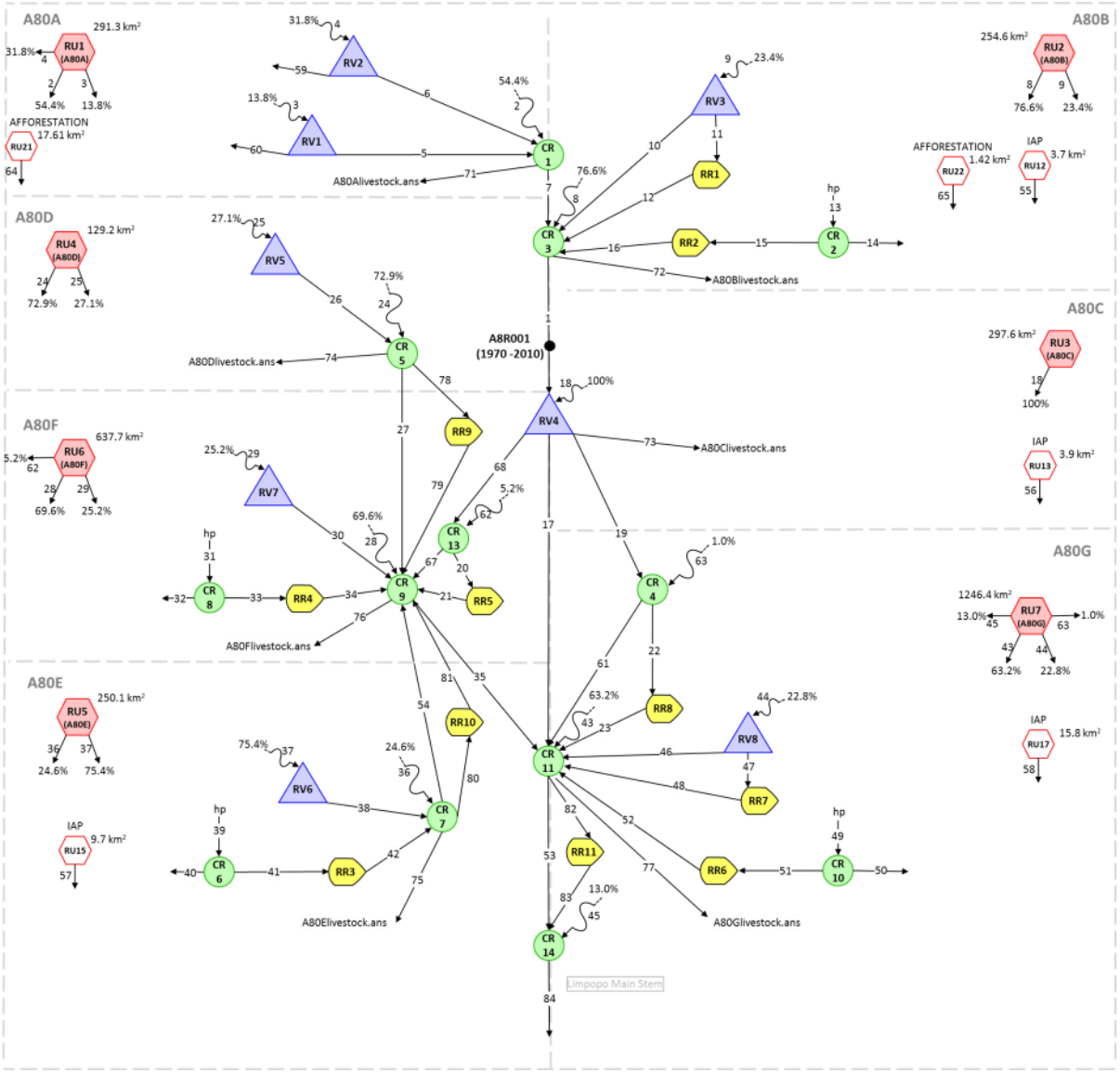



**Figure B.7: Sand System (A72)**




## Figure B.8: Nzhelele System (A80A to A80G)

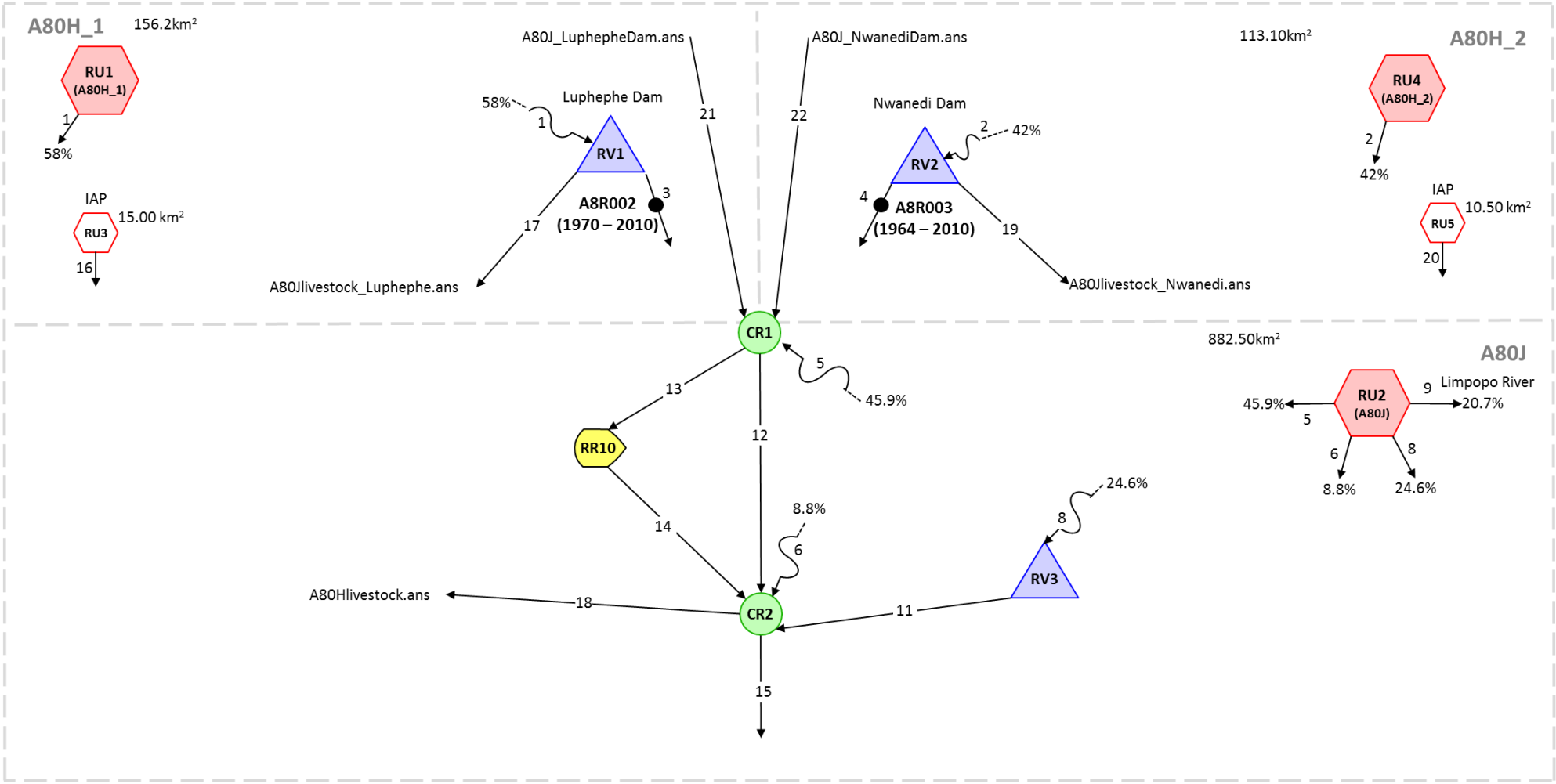



**Figure B.9: Nzhelele System (A80H and A80J)**

# Appendix C

## Water use and return flows

## Table C.1: Summary of total domestic water requirements in the Limpopo WMA North at the 2010-development level

| Quaternary | Demand centre | Source | Surface Water Source | | Groundwater Source | Total (million $m^3$/a) |
|---|---|---|---|---|---|---|
| | | | Quantity (million $m^3$/a) | Location | Quantity (million $m^3$/a) | |
| A42C | Vaalwater | GW | | | 0.47 | 0.47 |
| A42E | Vaalwater | GW | | | 0.35 | 0.35 |
| A42H | Lephalale town | Mokolo Dam and GW | 5.00 | A42F | 0.03 | 5.03 |
| **Mokolo Total** | | | **5.00** | | **1.01** | **6.01** |
| A50G | Villages | GW | | | 1.27 | 1.27 |
| A50H | Villages | GW | | | 1.70 | 1.70 |
| **Lephalala Total** | | | **0.00** | | **2.98** | **2.98** |
| A61A | Modimolle | Donkerpoort Dam and GW | 2.05 | A61A | 0.07 | 2.12 |
| A61B | Modimolle | Donkerpoort Dam and GW | 0.87 | A61A | 0.03 | 0.90 |
| A61D | Mookgopong | Welgevonden Dam and GW | 0.49 | A61H | 1.01 | 1.50 |
| A61E | Mookgopong | Doorndraai Dam and GW | 0.41 | A61H | 0.24 | 0.66 |
| A61F | Mokopane | Doorndraai Dam and GW | 3.25 | A61H | 2.81 | 6.06 |
| A61G | Villages | Doorndraai Dam and GW | 0.14 | A61H | 2.23 | 2.36 |
| A61J | Villages | Doorndraai Dam and GW | 0.58 | A61H | 0.37 | 0.95 |
| A62A | Villages | GW | | | 0.34 | 0.34 |
| A62B | Villages | GW | | | 1.45 | 1.45 |
| A62C | Villages | GW | | | 1.24 | 1.24 |
| A62D | Villages | GW | | | 0.46 | 0.46 |
| A62E | Villages | Hout River Dam (Mathala Dam) and GW | 0.13 | A71E | 0.66 | 0.79 |
| A62F | Villages | GW | | | 1.88 | 1.88 |
| A62G | Villages | GW | | | 0.86 | 0.86 |

| Quaternary | Demand centre | Source | Surface Water Source | | Groundwater Source | Total (million $m^3$/a) |
|---|---|---|---|---|---|---|
| | | | Quantity (million $m^3$/a) | Location | Quantity (million $m^3$/a) | |
| A63A | Villages | GW | | | 0.24 | 0.24 |
| A63B | Villages | GW | | | 0.28 | 0.28 |
| A63D | Villages | GW | | | 0.50 | 0.50 |
| **Mogalakwena Total** | | | **7.94** | | **14.83** | **22.77** |
| A71A | Polokwane | Transfers (Ebenezer Dam, Dap Naude Dam and Olifantspoort weir) and GW | | B81A, B81B and B52D | 1.89 | 1.89 |
| A71B | Mankweng | Transfers | | B81A | 13.08 | 13.08 |
| A71C | Villages | | | | 9.18 | 9.18 |
| A71E | Villages | Hout River Dam (Mathala Dam) and GW | 0.29 | | 2.34 | 2.63 |
| A71F | Villages | Transfers (Ebenezer Dam, Dap Naude Dam and Olifantspoort weir) and GW | | B81A, B81B and B52D | 1.33 | 1.33 |
| A71G | Villages | GW | | | 0.42 | 0.42 |
| A71H | Louis Trichardt | Transfers (Nandoni Dam) and GW | | A91F | 2.20 | 2.20 |
| A71K | Musina | Limpopo River/Sand Aquifer and GW | 10.37 | A71K | | 10.37 |
| A72A | Villages | GW | | | 1.49 | 1.49 |
| **Sand Total** | | | **10.66** | | **31.96** | **42.62** |
| A80A | Siloam & Dzanani | Mutshedzi Dam, Tshifiri/Murunwa Weir and GW | 1.34 | A80A | 0.70 | 2.04 |
| A80B | Makhado town | Mutshedzi Dam and GW | 0.96 | A80A | 0.40 | 1.36 |
| A80C | Villages | Mutshedzi Dam and GW | 0.19 | A80A | 0.93 | 1.11 |
| A80E | Villages | Mutshedzi Dam and GW | 0.34 | A80A | 0.13 | 0.47 |
| A80F | Villages | Mutshedzi Dam and GW | 0.11 | A71K, A80A | 0.06 | 0.17 |
| A80G | Villages | Limpopo River/Sand Aquifer, Mutshedzi Dam and GW | 0.18 | A80A | 0.19 | 0.38 |
| A80H | Villages | Mutshedzi Dam and GW | 0.04 | A80A | 1.51 | 1.55 |

| Quaternary | Demand centre | Source | Surface Water Source | | Groundwater Source | Total (million $m^3$/a) |
|---|---|---|---|---|---|---|
| | | | Quantity (million $m^3$/a) | Location | Quantity (million $m^3$/a) | |
| A80J | Villages | GW | | | 0.64 | 0.64 |
| **Nzhelele Total** | | | **3.16** | | **4.56** | **7.72** |
| **Limpopo WMA North** | | | **26.76** | | **55.34** | **82.10** |

*Note: (1) Only GW supply quantities > 0.1 million $m^3$/a shown*

*(2) Transfer supplies not modelled in the WRSM2000*

## Table C.2: Historical growth of irrigated areas supplied from surface water and groundwater sources in the Limpopo WMA North

| Catchment/ Quaternary | | Network Element | Supplied from | Growth in Irrigation Areas ($km^2$) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1920 | 1950 | 1989 | 1998 | 2010 |
| Matlabas | A41A | | Groundwater | 0.00 | 0.00 | 0.00 | 0.30 | 0.30 |
| | A41B | RR4 | Dams | 0.00 | 0.00 | 0.00 | 0.08 | 0.08 |
| | A41C | | Groundwater | 0.00 | 0.00 | 0.00 | 2.63 | 2.63 |
| | A41D | RR2 | Surface Water | 0.00 | 0.00 | 0.00 | 0.48 | 0.48 |
| | | RR6 | Groundwater | 0.00 | 0.00 | 0.00 | 1.55 | 1.55 |
| | A41E | RR3 | Surface Water | 0.00 | 0.00 | 0.00 | 1.99 | 1.99 |
| | | RR7 | Groundwater | 0.00 | 0.00 | 0.00 | 0.36 | 0.36 |
| **Matlabas Total** | | | | **0.00** | **0.00** | **0.00** | **7.37** | **7.39** |
| **Matlabas (excl. Limpopo River)** | | | | **0.00** | **0.00** | **0.00** | **4.44** | **4.46** |
| Mokolo[1] | A42A | | Surface Water | 0.40 | 4.36 | 17.63 | 19.14 | 18.10 |
| | | | Groundwater | 0.00 | 0.01 | 0.50 | 1.50 | 1.41 |
| | A42B | | Surface Water | 0.41 | 4.44 | 16.56 | 14.90 | 14.56 |
| | | | Groundwater | 0.01 | 0.11 | 0.70 | 1.22 | 1.29 |
| | A42C | | Surface Water | 0.47 | 5.10 | 18.88 | 16.71 | 17.07 |
| | | | Groundwater | 0.02 | 0.17 | 1.10 | 2.13 | 3.13 |
| | A42D | | Surface Water | 0.22 | 2.37 | 7.82 | 4.66 | 4.35 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| | A42E | | Surface Water | 1.09 | 11.84 | 40.13 | 26.73 | 18.45 |
| | | | Groundwater | 0.00 | 0.01 | 0.60 | 1.94 | 1.85 |
| | A42F | | Surface Water | 0.28 | 3.03 | 10.91 | 8.94 | 8.59 |
| | | | Groundwater | 0.02 | 0.22 | 1.00 | 1.49 | 1.54 |
| | A42G | | Surface Water | 0.00 | 0.01 | 0.02 | 0.02 | 0.77 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A42H | | Surface Water | 0.01 | 0.06 | 0.16 | 0.00 | 1.86 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A42J | | Surface Water | 0.03 | 0.31 | 0.83 | 0.00 | 8.11 |
| | | | Groundwater | 0.01 | 0.13 | 0.40 | 0.11 | 0.18 |
| **Mokolo Total** | | | | **2.97** | **32.16** | **117.24** | **99.49** | **101.36** |
| **Mokolo (excl. Limpopo River)** | | | | **2.97** | **32.16** | **117.24** | **99.49** | **101.36** |
| Lephalala | A50A | RR1 | Dams | 0.00 | 0.16 | 12.31 | 12.31 | 12.31 |
| | | | Groundwater | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 |
| | A50B | RR3 | Dams | 0.00 | 0.02 | 1.82 | 1.82 | 1.82 |
| | A50C | RR4 | Rivers & Dams | 0.00 | 0.00 | 2.12 | 2.12 | 2.12 |
| | A50D | | Groundwater | 0.00 | 0.00 | 0.11 | 0.11 | 0.11 |
| | A50E | RR7 | Rivers & Dams | 0.00 | 0.00 | 12.90 | 12.90 | 12.90 |
| | | | Groundwater | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 |
| | A50F | RR8 | Rivers & Dams | 0.00 | 0.00 | 0.33 | 0.32 | 0.32 |
| | A50G | RR9 | Dams | 0.00 | 0.00 | 1.15 | 1.90 | 1.90 |

| Catchment/ Quaternary | | Network Element | Supplied from | Growth in Irrigation Areas (km$^2$) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1920 | 1950 | 1989 | 1998 | 2010 |
| | | RR10 | Groundwater | 0.00 | 0.00 | 0.42 | 0.70 | 0.70 |
| | A50H | RR11 | Surface Water | 0.00 | 0.00 | 40.39 | 15.41 | 15.41 |
| | | | Groundwater | 0.00 | 0.00 | 50.08 | 19.10 | 19.10 |
| | A50J | RR13 | Surface Water | 0.00 | 0.00 | 5.78 | 5.79 | 5.79 |
| | | RR14 | Groundwater | 0.00 | 0.00 | 10.45 | 10.47 | 10.47 |
| **Lephalala Total** | | | | **0.00** | **0.18** | **137.90** | **83.00** | **82.99** |
| **Lephalala (excl. Limpopo River)** | | | | **0.00** | **0.18** | **87.67** | **63.75** | **63.74** |
| **Mogalakwena** | A61A | RR2 | Surface Water | 0.10 | 1.39 | 1.39 | 1.54 | 1.54 |
| | | RR6 | Surface Water | 0.09 | 1.29 | 1.29 | 1.43 | 1.43 |
| | | RR30 | Groundwater | 0.10 | 1.44 | 1.44 | 1.60 | 1.60 |
| | A61B | RR5 | Surface Water | 0.00 | 0.00 | 0.42 | 0.37 | 0.38 |
| | | | Groundwater | 0.00 | 0.00 | 0.33 | 0.30 | 0.30 |
| | A61C | RR7 | Surface Water | 0.00 | 0.00 | 1.59 | 2.07 | 2.07 |
| | | RR36 | Groundwater | 0.00 | 0.00 | 2.76 | 3.60 | 3.60 |
| | A61D | RR11 | Surface Water | 0.00 | 0.00 | 0.26 | 0.26 | 0.26 |
| | | RR31 | Groundwater | 0.00 | 0.00 | 3.41 | 3.43 | 3.43 |
| | A61E | RR15 | Surface Water | 0.00 | 0.00 | 0.01 | 0.06 | 0.06 |
| | | RR37 | Groundwater | 0.00 | 0.00 | 1.77 | 10.10 | 10.10 |
| | A61F | RR20 | Surface Water | 0.00 | 0.00 | 0.18 | 0.57 | 0.57 |
| | | RR32 | Groundwater | 0.00 | 0.00 | 0.99 | 3.04 | 3.04 |
| | A61G | RR21 | Surface Water | 0.00 | 0.00 | 0.61 | 0.78 | 0.78 |
| | | RR33 | Groundwater | 0.00 | 0.00 | 0.39 | 0.50 | 0.50 |
| | A61H | RR23 | Surface Water | 0.00 | 0.00 | 30.16 | 11.19 | 11.18 |
| | | RR24 | Surface Water | 0.00 | 0.00 | 30.16 | 11.19 | 11.18 |
| | | RR34 | Groundwater | 0.00 | 0.00 | 2.97 | 1.10 | 1.10 |
| | A61J | RR26 | Surface Water | 0.00 | 0.00 | 10.15 | 7.49 | 7.50 |
| | | RR28 | Surface Water | 0.00 | 0.00 | 0.95 | 0.70 | 0.70 |
| | | RR29 | Scheme | 0.00 | 0.00 | 4.53 | 3.35 | 3.35 |
| | | RR35 | Groundwater | 0.00 | 0.00 | 2.88 | 2.13 | 2.13 |
| | A62A | RR38 | Surface Water | 0.00 | 0.00 | 3.55 | 2.42 | 2.42 |
| | | RR39 | Groundwater | 0.00 | 0.00 | 0.72 | 0.49 | 0.49 |
| | A62B | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62C | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62D | RR40 | Groundwater | 0.03 | 0.47 | 0.56 | 0.81 | 0.81 |
| | A62E | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62F | RR41 | Surface Water | 0.00 | 0.00 | 0.00 | 0.24 | 0.24 |
| | | RR42 | Groundwater | 0.00 | 0.00 | 0.00 | 3.55 | 3.55 |
| | A62G | RR43 | Groundwater | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| | A62H | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62J | RR44 | Groundwater | 0.00 | 0.00 | 0.00 | 0.53 | 0.53 |
| | A63A | RR1 | Scheme | 0.00 | 0.00 | 0.04 | 1.49 | 1.49 |

| Catchment/ Quaternary | | Network Element | Supplied from | Growth in Irrigation Areas (km$^2$) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1920 | 1950 | 1989 | 1998 | 2010 |
| | | RR2 | Groundwater | 0.00 | 0.00 | 0.49 | 20.29 | 20.29 |
| | A63B | RR3 | Scheme | 0.03 | 0.42 | 1.56 | 3.85 | 3.85 |
| | | RR4 | Groundwater | 0.01 | 0.23 | 0.87 | 2.15 | 2.15 |
| | A63C | RR7 | Surface Water | 0.00 | 0.00 | 0.00 | 1.90 | 1.90 |
| | | RR9 | Groundwater | 0.00 | 0.00 | 0.00 | 1.54 | 1.54 |
| | | | Surface Water | 0.00 | 0.00 | 0.00 | 2.84 | 2.84 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 2.31 | 2.31 |
| | A63D | RR5 | Scheme | 0.06 | 0.99 | 2.21 | 2.22 | 2.22 |
| | | RR6 | Groundwater | 0.08 | 1.19 | 2.65 | 2.66 | 2.66 |
| | A63E | RR8 | Surface Water | 0.00 | 0.00 | 0.00 | 1.24 | 1.24 |
| | | RR10 | Groundwater | 0.00 | 0.00 | 0.00 | 0.59 | 0.59 |
| | | | Surface Water | 0.00 | 0.00 | 0.00 | 1.86 | 1.86 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 14.14 | 14.14 |
| **Mogalakwena Total** | | | | **0.51** | **7.42** | **111.28** | **133.91** | **133.93** |
| **Mogalakwena (excl. Limpopo River)** | | | | **0.51** | **7.42** | **110.95** | **112.46** | **112.48** |
| **Sand** | A71A | RR1 | Rivers | 0.00 | 0.00 | 0.20 | 0.97 | 0.98 |
| | | RR2 | Dams | 0.00 | 0.00 | 0.34 | 2.86 | 1.68 |
| | | RR3 | Groundwater | 0.00 | 0.00 | 8.52 | 44.49 | 41.90 |
| | A71B | RR4 | Groundwater | 0.00 | 0.00 | 3.16 | 10.30 | 10.05 |
| | A71C | RR5 | Rivers | 0.00 | 0.00 | 0.11 | 1.34 | 0.52 |
| | | RR6 | Dams | 0.00 | 0.00 | 0.48 | 2.51 | 2.36 |
| | | RR7 | Groundwater | 0.00 | 0.00 | 6.88 | 32.13 | 33.87 |
| | A71D | RR8 | Dams | 0.00 | 0.01 | 0.04 | 0.10 | 0.33 |
| | | RR9 | Groundwater | 0.00 | 0.14 | 1.01 | 9.55 | 8.24 |
| | A71E | RR10 | Dams | 0.00 | 0.01 | 0.09 | 0.41 | 0.41 |
| | | RR11 | Groundwater | 0.00 | 0.40 | 3.17 | 15.10 | 15.18 |
| | A71F | RR12 | Dams | 0.00 | 0.17 | 0.74 | 0.80 | 0.98 |
| | | RR13 | Groundwater | 0.00 | 2.85 | 12.08 | 15.23 | 16.04 |
| | A71G | RR24 | Rivers | 0.00 | 0.01 | 0.07 | 0.21 | 0.22 |
| | | RR14 | Dams | 0.00 | 0.02 | 0.15 | 0.52 | 0.46 |
| | | RR15 | Groundwater | 0.00 | 0.88 | 6.50 | 23.69 | 19.55 |
| | A71H | RR16 | Rivers | 0.00 | 0.01 | 0.03 | 0.32 | 0.11 |
| | | RR17 | Dams | 0.00 | 0.04 | 0.09 | 0.45 | 0.36 |
| | | RR18 | Groundwater | 0.00 | 0.23 | 0.50 | 3.69 | 1.95 |
| | A71J | RR19 | Rivers | 0.00 | 0.00 | 1.58 | 4.28 | 4.15 |
| | | RR20 | Dams | 0.00 | 0.00 | 0.14 | 0.08 | 0.36 |
| | | RR21 | Groundwater | 0.00 | 0.00 | 8.02 | 21.41 | 21.03 |
| | A71K | RR22 | Rivers | 0.00 | 0.00 | 1.57 | 0.73 | 0.55 |
| | | RR23 | Groundwater | 0.00 | 0.00 | 9.66 | 2.80 | 3.38 |
| | A71L | RR25 | Dams | 0.00 | 0.00 | 0.00 | 15.37 | 12.63 |
| | | RR26 | Groundwater | 0.00 | 0.00 | 0.00 | 39.86 | 38.36 |

| Catchment/ Quaternary | | Network Element | Supplied from | Growth in Irrigation Areas ($km^2$) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1920 | 1950 | 1989 | 1998 | 2010 |
| | | | Surface Water | 0.00 | 0.00 | 0.00 | 34.01 | 27.94 |
| | A72A | RR1 | Dams | 0.00 | 0.00 | 0.47 | 1.34 | 1.00 |
| | | RR2 | Groundwater | 0.00 | 0.00 | 13.38 | 31.79 | 28.17 |
| | A72B | RR3 | Rivers | 0.00 | 0.00 | 0.00 | 0.40 | 0.40 |
| | | RR4 | Groundwater | 0.00 | 0.00 | 0.00 | 7.57 | 5.75 |
| **Sand Total** | | | | **0.00** | **4.77** | **78.98** | **324.31** | **298.91** |
| **Sand (excl. Limpopo River)** | | | | **0.00** | **4.77** | **78.98** | **290.30** | **270.97** |
| **Nzhelele** | A80A | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80B | RR1 | Dams | 0.00 | 0.00 | 0.13 | 0.83 | 0.78 |
| | | RR2 | Groundwater | 0.00 | 0.00 | 0.06 | 0.17 | 0.36 |
| | A80C | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80D | RR9 | River | 0.00 | 0.00 | 0.03 | 0.14 | 0.14 |
| | A80E | RR10 | River | 0.00 | 0.00 | 0.13 | 0.28 | 0.13 |
| | | RR3 | Groundwater | 0.00 | 0.00 | 1.38 | 2.55 | 1.41 |
| | A80F | RR4 | Groundwater | 0.00 | 0.00 | 1.76 | 0.34 | 0.44 |
| | | RR5 | Scheme (Canal) | 0.00 | 0.00 | 22.32 | 5.72 | 5.58 |
| | A80G | RR11 | River | 0.00 | 0.00 | 0.00 | 0.30 | 0.13 |
| | | RR6 | Groundwater | 0.00 | 0.00 | 0.05 | 2.69 | 3.39 |
| | | RR7 | Dams | 0.00 | 0.00 | 0.00 | 0.33 | 0.16 |
| | | RR8 | Scheme (Canal) | 0.00 | 0.00 | 0.28 | 22.84 | 19.65 |
| | | | Surface Water | 0.00 | 0.00 | 0.02 | 2.03 | 1.70 |
| | A80H | - | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80J | RR10 | River | 0.00 | 0.00 | 0.00 | 1.39 | 1.11 |
| | | | Surface Water | 0.00 | 0.00 | 0.00 | 8.48 | 6.36 |
| | | | Groundwater | 0.00 | 0.00 | 0.00 | 0.20 | 0.14 |
| **Nzhelele Total** | | | | **0.00** | **0.00** | **26.16** | **48.30** | **41.48** |
| **Nzhelele Total (excl. Limpopo)** | | | | **0.00** | **0.00** | **26.14** | **37.59** | **33.28** |
| **LIMPOPO WMA NORTH** | | | | **3.48** | **44.53** | **471.56** | **696.38** | **666.06** |
| **LIMPOPO WMA NORTH (EXCL. LIMPOPO)** | | | | **3.48** | **44.53** | **420.98** | **608.03** | **586.29** |

*Note: (1) As per the "Updating the Hydrology and Yield Analysis of the Mokolo River Catchment" Study (DWA, 2007).*

*(2) Irrigation areas indicated in grey text is supplied form the Limpopo River main stem and associated sand aquifers – hence not from the water resources fed by runoff generated in the Study Area*

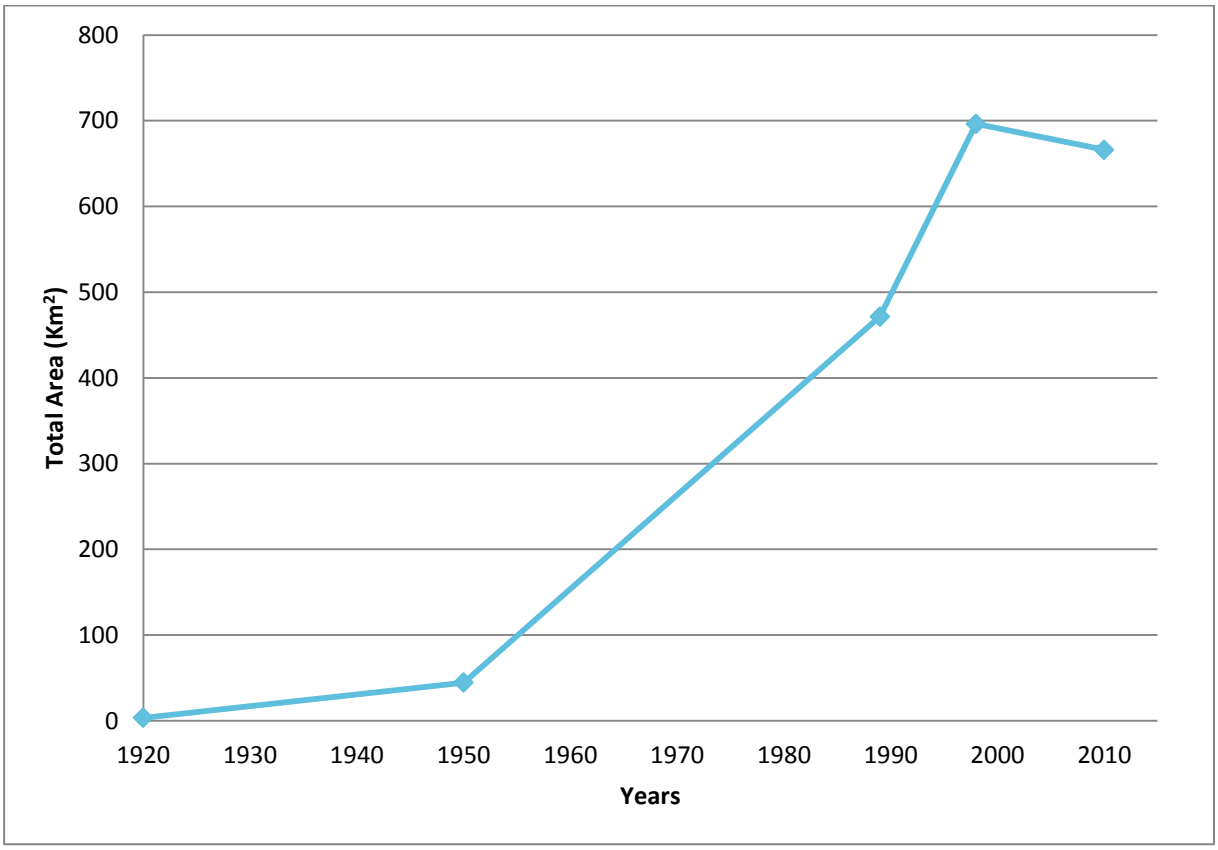



**Figure C.1: Historical growth in the total irrigated areas supplied from surface water sources in the Limpopo WMA North**

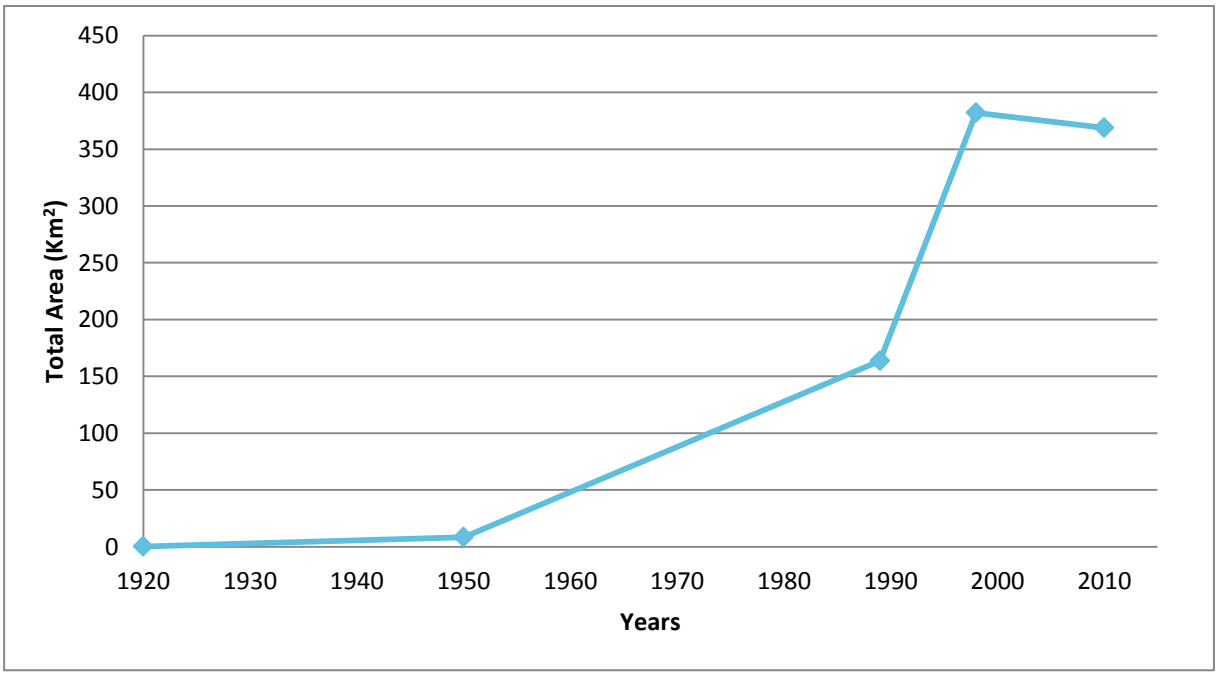



**Figure C.2: Historical growth in the total irrigated areas supplied from groundwater sources in the Limpopo WMA North**

## Table C.3: Representative crop irrigation requirements for the Limpopo WMA North

| Catchment/ Quaternary | | Representative crop irrigation requirement for indicated month (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Matlabas | A41A | 209.6 | 179.3 | 152.3 | 45.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 75.2 | 104.5 | 185.2 |
| | A41B | 85.2 | 144.6 | 157.6 | 162.0 | 138.2 | 136.7 | 78.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | A41C | - | - | - | - | - | - | - | - | - | - | - | - |
| | A41D | 133.5 | 150.4 | 188.0 | 197.8 | 130.0 | 93.3 | 83.8 | 76.5 | 75.8 | 83.0 | 87.0 | 109.6 |
| | A41E | 92.6 | 144.4 | 187.1 | 188.2 | 115.8 | 84.5 | 68.9 | 60.0 | 51.5 | 49.7 | 36.9 | 47.1 |
| | | | | | | | | | | | | | |
| Mokolo* | A42A | 110.0 | 96.8 | 135.7 | 118.3 | 42.1 | 14.0 | 9.4 | 8.2 | 19.4 | 24.3 | 39.6 | 64.9 |
| | A42B | 87.0 | 101.0 | 140.3 | 121.0 | 38.4 | 9.1 | 6.1 | 5.4 | 18.9 | 25.2 | 43.4 | 64.6 |
| | A42C | 74.9 | 84.7 | 121.2 | 106.1 | 33.9 | 23.8 | 18.1 | 17.7 | 26.5 | 32.6 | 44.9 | 53.4 |
| | A42D | 74.1 | 71.9 | 100.2 | 86.9 | 0.0 | 0.0 | 0.0 | 0.0 | 19.2 | 32.5 | 50.5 | 63.5 |
| | A42E | 138.2 | 120.5 | 127.7 | 36.7 | 9.4 | 8.2 | 3.2 | 3.0 | 7.3 | 18.5 | 28.7 | 80.9 |
| | A42F | 112.7 | 99.4 | 143.5 | 130.5 | 17.5 | 4.8 | 0.9 | 1.0 | 17.9 | 24.5 | 41.7 | 61.0 |
| | A42G | 102.8 | 136.7 | 174.4 | 124.6 | 56.4 | 37.8 | 25.7 | 20.3 | 19.2 | 23.0 | 32.2 | 41.2 |
| | A42H | 94.6 | 97.4 | 132.2 | 93.0 | 40.6 | 10.7 | 9.7 | 9.2 | 17.7 | 21.5 | 36.8 | 48.9 |
| | A42J | 107.4 | 125.3 | 152.4 | 135.6 | 71.4 | 44.2 | 29.2 | 21.0 | 23.1 | 25.7 | 38.6 | 50.1 |
| | | | | | | | | | | | | | |
| Lephalala | A50A | 151.9 | 113.5 | 159.4 | 170.0 | 97.0 | 59.1 | 25.6 | 11.6 | 31.0 | 37.9 | 64.0 | 99.1 |
| | A50B | 110.5 | 40.4 | 129.2 | 201.5 | 127.2 | 120.3 | 14.0 | 15.8 | 41.2 | 46.7 | 70.5 | 101.8 |
| | A50C | 114.7 | 134.5 | 203.8 | 206.6 | 84.0 | 14.1 | 10.5 | 8.4 | 17.2 | 20.9 | 33.2 | 47.7 |
| | A50D | 107.9 | 109.7 | 114.9 | 115.8 | 97.8 | 97.9 | 49.8 | 63.8 | 53.9 | 57.9 | 74.9 | 94.0 |
| | A50E | 119.3 | 147.2 | 198.4 | 204.1 | 111.2 | 55.4 | 54.9 | 52.9 | 51.5 | 45.3 | 28.5 | 43.3 |
| | A50F | 116.6 | 149.5 | 166.8 | 173.0 | 148.6 | 122.6 | 82.6 | 42.2 | 33.2 | 35.3 | 45.3 | 60.1 |
| | A50G | 98.2 | 141.1 | 193.9 | 191.0 | 112.1 | 88.4 | 56.8 | 40.5 | 33.1 | 30.4 | 33.2 | 41.1 |

| Catchment/ Quaternary | | Representative crop irrigation requirement for indicated month (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| | A50H | 103.1 | 132.7 | 177.2 | 171.5 | 82.9 | 90.6 | 77.8 | 87.2 | 83.9 | 74.9 | 48.4 | 49.0 |
| | A50J | 79.4 | 147.9 | 194.0 | 164.3 | 37.5 | 60.1 | 62.5 | 72.0 | 70.3 | 58.9 | 15.8 | 16.3 |
| | | | | | | | | | | | | | |
| Mogalakwena | A61A | 106.7 | 131.3 | 170.5 | 168.4 | 104.7 | 67.0 | 47.6 | 34.1 | 34.1 | 34.7 | 43.8 | 53.6 |
| | A61B | 120.2 | 130.3 | 142.4 | 137.3 | 103.7 | 79.2 | 49.2 | 38.1 | 31.6 | 33.5 | 46.0 | 81.8 |
| | A61C | 108.6 | 133.2 | 172.0 | 173.5 | 101.8 | 59.3 | 35.9 | 27.7 | 24.8 | 26.7 | 37.3 | 63.0 |
| | A61D | 119.2 | 127.2 | 176.7 | 180.0 | 105.1 | 48.3 | 25.6 | 17.2 | 26.5 | 31.7 | 48.7 | 60.9 |
| | A61E | 173.1 | 124.2 | 177.8 | 182.0 | 92.7 | 45.5 | 30.4 | 26.5 | 51.3 | 60.8 | 94.3 | 122.1 |
| | A61F | 67.2 | 117.4 | 170.9 | 165.1 | 83.5 | 50.1 | 25.0 | 7.0 | 6.1 | 6.2 | 8.3 | 11.3 |
| | A61G | 102.4 | 104.9 | 112.0 | 113.3 | 96.9 | 94.3 | 49.9 | 60.5 | 51.1 | 52.9 | 67.4 | 84.4 |
| | A61H | 133.1 | 131.4 | 189.6 | 185.1 | 69.8 | 23.7 | 18.9 | 17.2 | 29.1 | 33.3 | 45.0 | 69.7 |
| | A61J | 33.5 | 46.0 | 81.8 | 120.2 | 130.3 | 142.4 | 137.3 | 103.7 | 79.2 | 49.2 | 38.1 | 31.6 |
| | A62A | 199.7 | 143.2 | 179.6 | 162.0 | 53.6 | 53.2 | 41.3 | 17.4 | 52.5 | 62.7 | 82.1 | 121.5 |
| | A62B | - | - | - | - | - | - | - | - | - | - | - | - |
| | A62C | - | - | - | - | - | - | - | - | - | - | - | - |
| | A62D | 95.3 | 91.5 | 89.9 | 85.9 | 74.4 | 88.7 | 83.4 | 90.0 | 80.5 | 77.3 | 87.3 | 85.9 |
| | A62E | - | - | - | - | - | - | - | - | - | - | - | - |
| | A62F | 117.3 | 83.7 | 90.6 | 90.4 | 78.3 | 77.9 | 40.7 | 51.4 | 55.1 | 58.6 | 82.9 | 106.7 |
| | A62G | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 69.5 | 94.1 | 130.3 | 5.3 |
| | A62H | - | - | - | - | - | - | - | - | - | - | - | - |
| | A62J | 87.2 | 123.7 | 167.0 | 185.0 | 162.8 | 40.5 | 19.0 | 17.7 | 14.4 | 14.5 | 18.8 | 23.0 |
| | A63A | 103.2 | 140.6 | 182.7 | 142.7 | 64.8 | 40.8 | 65.3 | 93.3 | 96.2 | 91.0 | 34.3 | 49.4 |
| | A63B | 89.7 | 137.4 | 191.2 | 191.2 | 124.0 | 43.6 | 31.5 | 24.6 | 20.2 | 19.9 | 24.9 | 33.0 |
| | A63C | 78.2 | 139.2 | 200.5 | 198.5 | 101.5 | 37.0 | 28.9 | 22.0 | 19.0 | 15.6 | 12.5 | 16.0 |
| | A63D | 107.5 | 146.3 | 170.3 | 169.4 | 133.6 | 137.6 | 110.2 | 79.7 | 71.5 | 67.2 | 42.7 | 50.7 |

| Catchment/ Quaternary | | Representative crop irrigation requirement for indicated month (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| | A63E | 116.5 | 133.2 | 177.1 | 186.7 | 126.0 | 77.7 | 55.3 | 65.1 | 64.3 | 60.9 | 52.2 | 67.7 |
| | | | | | | | | | | | | | |
| Sand | A71A | 81.9 | 117.3 | 159.4 | 159.8 | 91.2 | 58.6 | 63.2 | 70.5 | 67.7 | 63.5 | 33.8 | 37.2 |
| | A71B | 76.8 | 107.0 | 153.2 | 162.6 | 117.0 | 54.4 | 42.7 | 55.5 | 58.6 | 59.3 | 28.5 | 26.0 |
| | A71C | 61.2 | 96.0 | 134.6 | 137.5 | 97.6 | 63.6 | 67.2 | 86.4 | 86.8 | 80.0 | 16.8 | 10.9 |
| | A71D | 50.7 | 81.0 | 113.4 | 118.7 | 86.1 | 53.6 | 79.9 | 98.0 | 95.2 | 84.5 | 8.9 | 6.1 |
| | A71E | 3.5 | 6.2 | 9.0 | 8.3 | 5.0 | 29.3 | 69.7 | 97.6 | 93.9 | 83.6 | 2.2 | 0.1 |
| | A71F | 17.1 | 24.5 | 30.3 | 31.2 | 22.6 | 32.7 | 72.6 | 96.6 | 93.3 | 84.1 | 5.1 | 5.8 |
| | A71G | 32.5 | 57.1 | 80.1 | 80.8 | 43.7 | 36.2 | 71.0 | 99.7 | 96.9 | 91.3 | 10.2 | 6.7 |
| | A71H | 69.7 | 116.8 | 166.9 | 161.0 | 94.8 | 46.4 | 31.3 | 12.0 | 12.7 | 13.9 | 17.5 | 18.5 |
| | A71J | 66.5 | 103.3 | 140.2 | 151.0 | 118.4 | 77.4 | 86.2 | 100.0 | 82.5 | 64.8 | 13.3 | 13.6 |
| | A71K | 82.1 | 126.2 | 172.2 | 182.2 | 136.6 | 94.4 | 121.9 | 111.3 | 43.8 | 18.6 | 16.1 | 21.7 |
| | A71L | 156.4 | 111.2 | 182.4 | 194.2 | 148.5 | 114.0 | 44.6 | 18.6 | 42.4 | 49.6 | 69.0 | 97.1 |
| | A72A | 38.2 | 67.0 | 94.1 | 97.9 | 57.5 | 31.9 | 73.7 | 106.3 | 103.2 | 92.6 | 7.5 | 8.8 |
| | A72B | 44.9 | 61.7 | 60.6 | 63.2 | 48.9 | 69.5 | 100.9 | 115.4 | 92.3 | 68.8 | 2.6 | 13.4 |
| | | | | | | | | | | | | | |
| Nzhelele | A80A | 51.2 | 100.7 | 163.7 | 161.2 | 74.0 | 15.2 | 10.3 | 9.5 | 9.8 | 9.4 | 10.0 | 13.3 |
| | A80B | 57.0 | 109.6 | 176.0 | 171.5 | 86.5 | 18.6 | 13.9 | 15.7 | 16.9 | 17.4 | 17.8 | 13.5 |
| | A80C | 53.3 | 105.3 | 166.7 | 161.6 | 90.6 | 5.1 | 2.0 | 3.2 | 3.9 | 3.9 | 2.8 | 2.0 |
| | A80D | 82.1 | 121.0 | 155.6 | 147.7 | 101.3 | 75.8 | 55.9 | 35.9 | 32.3 | 32.3 | 38.2 | 38.2 |
| | A80E | 82.4 | 125.7 | 171.8 | 161.2 | 100.6 | 52.2 | 38.1 | 30.9 | 27.0 | 26.6 | 31.7 | 41.3 |
| | A80F | 96.5 | 102.9 | 112.4 | 108.2 | 94.8 | 87.9 | 47.4 | 62.3 | 54.8 | 54.9 | 68.9 | 82.6 |
| | A80G | 92.0 | 118.5 | 150.7 | 151.2 | 115.7 | 67.3 | 39.1 | 45.4 | 38.5 | 37.2 | 45.7 | 57.9 |
| | A80H | 69.9 | 121.1 | 179.3 | 171.4 | 88.9 | 32.4 | 22.5 | 19.9 | 18.8 | 18.9 | 24.0 | 30.9 |
| | A80J | 66.5 | 120.6 | 181.3 | 192.5 | 133.2 | 15.4 | 6.6 | 5.2 | 6.1 | 7.2 | 8.1 | 10.8 |

## Table C.4: Irrigation application efficiencies and return flows for the Limpopo WMA North

| Catchment/ Quaternary | | Application efficiency (as a %) | Return flows (as % of supply) |
|---|---|---|---|
| Matlabas | A41A | - | - |
| | A41B* | 75.00% | - |
| | A41C | - | 11% |
| | A41D | 82.08% | 7% |
| | A41E | 86.78% | 14.43% |
| | | | |
| Mokolo | A42A | 83.01% | 8% |
| | A42B | 83.09% | 8% |
| | A42C | 82.88% | 9% |
| | A42D | 84.29% | 8% |
| | A42E | 83.85% | 8% |
| | A42F | 84.91% | 7% |
| | A42G | 88.10% | 6% |
| | A42H | 71.21% | 14% |
| | A42J | 84.29% | 8% |
| | | | |
| Lephalala | A50A | 84.22% | 9% |
| | A50B | 84.09% | 9% |
| | A50C | 84.82% | 9% |
| | A50D | 90.00% | - |
| | A50E | 85.96% | 6% |
| | A50F | 86.03% | 6% |
| | A50G | 83.07% | 9% |
| | A50H | 86.92% | 7% |
| | A50J | 88.26% | 7% |
| | | | |
| Mogalakwena | A61A | 81.08% | 6% |
| | A61B | 86.09% | 6% |
| | A61C | 87.33% | 9% |
| | A61D | 83.42% | 7% |
| | A61E | 86.06% | 7% |
| | A61F | 87.29% | 7% |
| | A61G | 90.00% | 5% |
| | A61H | 83.95% | 8% |
| | A61J | 84.86% | 8% |
| | A62A | 85.16% | 8% |
| | A62B | - | - |
| | A62C | - | - |

| Catchment/ Quaternary | | Application efficiency (as a %) | Return flows (as % of supply) |
|---|---|---|---|
| | A62D | 82.52% | 6% |
| | A62E | - | - |
| | A62F** | 89.08% | 10% |
| | A62G | 75.00% | 12% |
| | A62H | - | - |
| | A62J | 92.51% | 4% |
| | A63A | 87.61% | 6% |
| | A63B | 88.01% | 8% |
| | A63C | 87.09% | 7% |
| | A63D | 84.15% | 7% |
| | A63E | 88.17% | 7% |
| | | | |
| Sand | A71A | 82.54% | 8% |
| | A71B | 87.83% | 8% |
| | A71C | 86.73% | 9% |
| | A71D | 86.45% | 8% |
| | A71E | 85.16% | 12% |
| | A71F | 82.70% | 8% |
| | A71G | 85.40% | 9% |
| | A71H | 79.86% | 10% |
| | A71J | 92.32% | 5% |
| | A71K | 89.46% | 6% |
| | A71L*** | 85.60% | 7% |
| | A72A | 86.51% | 10% |
| | A72B | 86.97% | 7% |
| | | | |
| Nzhelele | A80A | 67.78% | - |
| | A80B | 69.31% | 14% |
| | A80C | 65.66% | - |
| | A80D | 66.53% | 17% |
| | A80E | - | 11% |
| | A80F | 90.90% | 4% |
| | A80G | 88.77% | 11% |
| | A80H | - | - |
| | A80J | 86.75% | - |
| | | | |
| **Limpopo WMA North** | | **83%** | **9%** |

## Table C.5: Annual average irrigation water requirements per quaternary catchment at the 2010-development level

| Catchment/ Quaternary | | Average annual irrigation requirement (million $m^3$/a) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Supplied by sources fed from Study Area runoff | | | | Supplied from Limpopo River | TOTAL |
| | | Surface water | Ground-water | Scheme | Total | | |
| Matlabas | A41A | 0.00 | 0.19 | 0.00 | 0.19 | 0.00 | 0.19 |
| | A41B | 0.05 | 0.00 | 0.00 | 0.05 | 0.00 | 0.05 |
| | A41C | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A41D | 0.56 | 1.81 | 0.00 | 2.37 | 0.00 | 2.37 |
| | A41E | 0.00 | 0.00 | 0.00 | 0.00 | 2.12 | 2.12 |
| **Matlabas Total** | | **0.61** | **2.00** | **0.00** | **2.61** | **2.12** | **4.73** |
| Mokolo* | A42A | 7.33 | 0.52 | 0.00 | 7.85 | 0.00 | 7.85 |
| | A42B | 5.56 | 0.35 | 0.00 | 5.91 | 0.00 | 5.91 |
| | A42C | 5.80 | 0.96 | 0.00 | 6.76 | 0.00 | 6.76 |
| | A42D | 1.19 | 0.00 | 0.00 | 1.19 | 0.00 | 1.19 |
| | A42E | 7.27 | 0.73 | 0.00 | 8.00 | 0.00 | 8.00 |
| | A42F | 3.76 | 0.62 | 0.00 | 4.38 | 0.00 | 4.38 |
| | A42G | 0.01 | 0.00 | 0.37 | 0.38 | 0.00 | 0.38 |
| | A42H | 0.00 | 0.00 | 0.83 | 0.83 | 0.00 | 0.83 |
| | A42J | 0.00 | 0.00 | 4.86 | 4.86 | 0.00 | 4.86 |
| **Mokolo Total** | | **30.92** | **3.18** | **6.06** | **40.16** | **0.00** | **40.16** |
| Lephalala | A50A | 8.43 | 0.01 | 0.00 | 8.44 | 0.00 | 8.44 |
| | A50B | 1.33 | 0.00 | 0.00 | 1.33 | 0.00 | 1.33 |
| | A50C | 1.31 | 0.00 | 0.00 | 1.31 | 0.00 | 1.31 |
| | A50D | 0.00 | 0.08 | 0.00 | 0.08 | 0.00 | 0.08 |
| | A50E | 10.83 | 0.02 | 0.00 | 10.85 | 0.00 | 10.85 |
| | A50F | 0.29 | 0.00 | 0.00 | 0.29 | 0.00 | 0.29 |
| | A50G | 1.62 | 0.60 | 0.00 | 2.22 | 0.00 | 2.22 |
| | A50H | 14.68 | 0.00 | 0.00 | 14.68 | 18.20 | 32.88 |
| | A50J | 0.00 | 0.00 | 0.00 | 0.00 | 12.41 | 12.41 |
| **Lephalala Total** | | **38.49** | **0.71** | **0.00** | **39.20** | **30.61** | **69.81** |
| Mogalakwena | A61A | 2.06 | 1.11 | 0.00 | 3.17 | 0.00 | 3.17 |
| | A61B | 0.25 | 0.20 | 0.00 | 0.45 | 0.00 | 0.45 |
| | A61C | 1.30 | 2.26 | 0.00 | 3.56 | 0.00 | 3.56 |
| | A61D | 0.17 | 2.24 | 0.00 | 2.41 | 0.00 | 2.41 |
| | A61E | 0.05 | 8.78 | 0.00 | 8.83 | 0.00 | 8.83 |
| | A61F | 0.22 | 1.18 | 0.00 | 1.40 | 0.00 | 1.40 |
| | A61G | 0.49 | 0.32 | 0.00 | 0.81 | 0.00 | 0.81 |
| | A61H | 14.92 | 0.73 | 0.00 | 15.65 | 0.00 | 15.65 |
| | A61J | 3.71 | 0.96 | 1.51 | 6.18 | 0.00 | 6.18 |
| | A62A | 2.12 | 0.45 | 0.00 | 2.57 | 0.00 | 2.57 |
| | A62B | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Catchment/ Quaternary | | Average annual irrigation requirement (million $m^3$/a) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Supplied by sources fed from Study Area runoff | | | | Supplied from Limpopo River | TOTAL |
| | | Surface water | Ground-water | Scheme | Total | | |
| | A62C | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62D | 0.00 | 0.64 | 0.00 | 0.64 | 0.00 | 0.64 |
| | A62E | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62F | 0.15 | 2.28 | 0.00 | 2.43 | 0.00 | 2.43 |
| | A62G | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62J | 0.00 | 0.31 | 0.00 | 0.31 | 0.00 | 0.31 |
| | A63A | 0.00 | 17.39 | 1.28 | 18.67 | 0.00 | 18.67 |
| | A63B | 0.00 | 1.50 | 2.68 | 4.18 | 0.00 | 4.18 |
| | A63C | 0.00 | 0.00 | 0.00 | 0.00 | 5.62 | 5.62 |
| | A63D | 0.00 | 2.89 | 2.41 | 5.30 | 0.00 | 5.30 |
| | A63E | 0.00 | 0.00 | 0.00 | 0.00 | 17.23 | 17.23 |
| **Mogalakwena Total** | | **25.44** | **43.24** | **7.88** | **76.56** | **22.85** | **99.41** |
| Sand | A71A | 2.04 | 32.27 | 0.00 | 34.31 | 0.00 | 34.31 |
| | A71B | 0.00 | 6.78 | 0.00 | 6.78 | 0.00 | 6.78 |
| | A71C | 2.01 | 23.62 | 0.00 | 25.63 | 0.00 | 25.63 |
| | A71D | 0.22 | 5.44 | 0.00 | 5.66 | 0.00 | 5.66 |
| | A71E | 0.14 | 5.26 | 0.00 | 5.40 | 0.00 | 5.40 |
| | A71F | 0.37 | 6.12 | 0.00 | 6.49 | 0.00 | 6.49 |
| | A71G | 0.34 | 9.59 | 0.00 | 9.93 | 0.00 | 9.93 |
| | A71H | 0.25 | 1.02 | 0.00 | 1.27 | 0.00 | 1.27 |
| | A71J | 3.30 | 15.42 | 0.00 | 18.72 | 0.00 | 18.72 |
| | A71K | 0.51 | 3.12 | 0.00 | 3.63 | 0.00 | 3.63 |
| | A71L | 0.00 | 0.00 | 0.00 | 0.00 | 84.94 | 84.94 |
| | A72A | 0.53 | 14.97 | 0.00 | 15.50 | 0.00 | 15.50 |
| | A72B | 0.22 | 3.16 | 0.00 | 3.38 | 0.00 | 3.38 |
| **Sand Total** | | **9.93** | **126.77** | **0.00** | **136.70** | **84.94** | **221.64** |
| Nzhelele | A80A | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80B | 0.38 | 0.17 | 0.00 | 0.55 | 0.00 | 0.55 |
| | A80C | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80D | 0.09 | 0.00 | 0.00 | 0.09 | 0.00 | 0.09 |
| | A80E | 0.08 | 0.82 | 0.00 | 0.90 | 0.00 | 0.90 |
| | A80F | 0.00 | 0.32 | 4.00 | 4.32 | 0.00 | 4.32 |
| | A80G | 0.21 | 2.53 | 14.69 | 17.43 | 1.26 | 18.69 |
| | A80H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80J | 0.00 | 0.00 | 0.00 | 0.00 | 4.53 | 4.53 |
| **Nzhelele Total** | | **0.76** | **3.84** | **18.69** | **23.29** | **5.79** | **29.08** |
| **Limpopo WMA North** | | **106.15** | **179.73** | **32.63** | **318.52** | **146.30** | **464.82** |

* *As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" study (DWA, 2007).*

## Table C.6: Annual average irrigation return flows per quaternary catchment at the 2010-development level

| Catchment/ Quaternary | | Average annual irrigation return flows (million $m^3$/a) | | | |
|---|---|---|---|---|---|
| | | Surface water | Groundwater | Scheme | Total |
| Matlabas | A41A | - | - | - | 0.00 |
| | A41B | 0.01 | 0.00 | 0.00 | 0.01 |
| | A41C | - | - | - | 0.00 |
| | A41D | 0.06 | 0.17 | 0.00 | 0.23 |
| | A41E | 0.13 | 0.02 | 0.00 | 0.15 |
| **Matlabas Total** | | **0.19** | **0.19** | **0.00** | **0.38** |
| Mokolo* | A42A | 0.59 | 0.04 | 0.00 | 0.63 |
| | A42B | 0.44 | 0.03 | 0.00 | 0.47 |
| | A42C | 0.52 | 0.09 | 0.00 | 0.61 |
| | A42D | 0.10 | 0.00 | 0.00 | 0.10 |
| | A42E | 0.58 | 0.06 | 0.00 | 0.64 |
| | A42F | 0.30 | 0.05 | 0.00 | 0.35 |
| | A42G | 0.00 | 0.00 | 0.02 | 0.02 |
| | A42H | 0.00 | 0.00 | 0.12 | 0.12 |
| | A42J | 0.00 | 0.00 | 0.39 | 0.39 |
| **Mokolo Total** | | **2.53** | **0.27** | **0.53** | **3.33** |
| Lephalala | A50A | 0.80 | 0.00 | 0.00 | 0.80 |
| | A50B | 0.12 | 0.00 | 0.00 | 0.12 |
| | A50C | 0.11 | 0.00 | 0.00 | 0.11 |
| | A50D | - | - | - | 0.00 |
| | A50E | 0.70 | 0.00 | 0.00 | 0.70 |
| | A50F | 0.02 | 0.00 | 0.00 | 0.02 |
| | A50G | 0.14 | 0.05 | 0.00 | 0.19 |
| | A50H | 1.07 | 1.33 | 0.00 | 2.40 |
| | A50J | 0.29 | 0.52 | 0.00 | 0.81 |
| **Lephalala Total** | | **3.25** | **1.90** | **0.00** | **5.15** |
| Mogalakwena | A61A | 0.13 | 0.07 | 0.00 | 0.20 |
| | A61B | 0.02 | 0.01 | 0.00 | 0.03 |
| | A61C | 0.11 | 0.19 | 0.00 | 0.30 |
| | A61D | 0.01 | 0.15 | 0.00 | 0.16 |
| | A61E | 0.00 | 0.60 | 0.00 | 0.60 |
| | A61F | 0.01 | 0.08 | 0.00 | 0.09 |
| | A61G | 0.02 | 0.02 | 0.00 | 0.04 |
| | A61H | 1.19 | 0.06 | 0.00 | 1.24 |
| | A61J | 0.30 | 0.08 | 0.12 | 0.50 |
| | A62A | 0.17 | 0.04 | 0.00 | 0.20 |
| | A62B | - | - | - | 0.00 |
| | A62C | - | - | - | 0.00 |

| Catchment/ Quaternary | | Average annual irrigation return flows (million $m^3$/a) | | | |
|---|---|---|---|---|---|
| | | Surface water | Groundwater | Scheme | Total |
| | A62D | 0.00 | 0.04 | 0.00 | 0.04 |
| | A62E | - | - | - | 0.00 |
| | A62F | 0.02 | 0.23 | 0.00 | 0.25 |
| | A62G | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62H | - | - | - | 0.00 |
| | A62J | 0.00 | 0.01 | 0.00 | 0.01 |
| | A63A | 0.00 | 1.10 | 0.08 | 1.18 |
| | A63B | 0.00 | 0.11 | 0.20 | 0.31 |
| | A63C | 0.23 | 0.19 | 0.00 | 0.41 |
| | A63D | 0.00 | 0.21 | 0.17 | 0.38 |
| | A63E | 0.21 | 0.99 | 0.00 | 1.20 |
| **Mogalakwena Total** | | **2.42** | **4.17** | **0.58** | **7.17** |
| **Sand** | A71A | 0.17 | 2.72 | 0.00 | 2.90 |
| | A71B | 0.00 | 0.57 | 0.00 | 0.57 |
| | A71C | 0.18 | 2.08 | 0.00 | 2.26 |
| | A71D | 0.02 | 0.44 | 0.00 | 0.45 |
| | A71E | 0.02 | 0.62 | 0.00 | 0.64 |
| | A71F | 0.03 | 0.50 | 0.00 | 0.53 |
| | A71G | 0.03 | 0.89 | 0.00 | 0.92 |
| | A71H | 0.03 | 0.10 | 0.00 | 0.13 |
| | A71J | 0.16 | 0.74 | 0.00 | 0.89 |
| | A71K | 0.03 | 0.20 | 0.00 | 0.23 |
| | A71L | 2.94 | 2.78 | 0.00 | 5.72 |
| | A72A | 0.05 | 1.54 | 0.00 | 1.59 |
| | A72B | 0.01 | 0.21 | 0.00 | 0.22 |
| **Sand Total** | | **3.67** | **13.38** | **0.00** | **17.05** |
| **Nzhelele** | A80A | - | - | - | 0.00 |
| | A80B | 0.05 | 0.02 | 0.00 | 0.08 |
| | A80C | - | - | - | 0.00 |
| | A80D | 0.02 | 0.00 | 0.00 | 0.02 |
| | A80E | 0.01 | 0.09 | 0.00 | 0.10 |
| | A80F | 0.00 | 0.01 | 0.16 | 0.17 |
| | A80G | 0.16 | 0.28 | 1.62 | 2.06 |
| | A80H | - | - | - | 0.00 |
| | A80J | 0.45 | 0.01 | 0.00 | 0.46 |
| **Nzhelele Total** | | **0.69** | **0.42** | **1.78** | **2.89** |
| **Limpopo WMA North** | | **12.75** | **20.34** | **2.89** | **35.98** |

* *As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" study (DWA, 2007).*

## Table C.7: Summary of analyses undertaken to determine *Return Flow Factor* values for quaternary catchments in Limpopo WMA North

| Catchment/ Quaternary | | Specified return flow (% of supply)** | Modelled return flow | | Calibrated Return Flow Factor |
|---|---|---|---|---|---|
| | | | (% of supply) | Percentage difference | |
| Matlabas | A41A | - | - | - | - |
| | A41B* | 13% | 15% | 2% | 0.021 |
| | A41C | - | - | - | 0.092 |
| | A41D | 9% | 11% | 1% | 0.015 |
| | A41E | 7% | 7% | 0% | 0.003 |
| **Matlabas average** | | **9%** | **11%** | | |
| Mokolo* | A42A | 8% | 8% | -1% | 0.005 |
| | A42B | 8% | 8% | -1% | 0.003 |
| | A42C | 9% | 9% | 0% | 0.002 |
| | A42D | 8% | 8% | 6% | 0.006 |
| | A42E | 8% | 8% | 1% | 0.024 |
| | A42F | 8% | 7% | -3% | 0.011 |
| | A42G | - | - | - | - |
| | A42H | - | - | - | - |
| | A42J | - | - | - | - |
| **Mokolo average** | | **8%** | **8%** | | |
| Lephalala | A50A | 9% | 9% | 1% | 0.006 |
| | A50B | 9% | 9% | 0% | 0.003 |
| | A50C | 9% | 9% | 0% | 0.002 |
| | A50D | - | - | - | - |
| | A50E | 6% | 6% | 0% | 0.000 |
| | A50F | 6% | 6% | 0% | 0.001 |
| | A50G | 8% | 9% | 1% | 0.010 |
| | A50H | 7% | 7% | 0% | 0.001 |
| | A50J | 6% | 7% | 1% | 0.007 |
| **Lephalala average** | | **7%** | **8%** | | |
| Mogalakwena | A61A | 8% | 6% | 1% | 0.014 |
| | A61B | 6% | 6% | 0% | 0.000 |
| | A61C | 8% | 9% | 0% | 0.004 |
| | A61D | 7% | 7% | 0% | 0.000 |
| | A61E | 7% | 7% | 0% | 0.002 |
| | A61F | 7% | 7% | 0% | 0.001 |
| | A61G | 5% | 5% | 0% | 0.001 |
| | A61H | 8% | 8% | 0% | 0.001 |
| | A61J | 8% | 8% | 0% | 0.001 |
| | A62A | 7% | 8% | 1% | 0.009 |
| | A62B | - | - | - | - |
| | A62C | - | - | - | - |

| Catchment/ Quaternary | | Specified return flow (% of supply)** | Modelled return flow | | Calibrated Return Flow Factor |
|---|---|---|---|---|---|
| | | | (% of supply) | Percentage difference | |
| | A62D | 7% | 6% | 1% | 0.006 |
| | A62E | - | - | - | - |
| | A62F | 9% | 10% | 1% | 0.008 |
| | A62G | 13% | 12% | 0% | 0.004 |
| | A62H | - | - | - | - |
| | A62J | 4% | 4% | 0% | 0.000 |
| | A63A | 6% | 6% | 0% | 0.001 |
| | A63B | 8% | 8% | 0% | 0.004 |
| | A63C | 7% | 7% | 1% | 0.006 |
| | A63D | 8% | 7% | 1% | 0.006 |
| | A63E | 7% | 7% | 0% | 0.004 |
| **Mogalakwena average** | | **7%** | **7%** | | |
| **Sand** | A71A | 8% | 8% | 0% | 0.001 |
| | A71B | 9% | 8% | 0% | 0.001 |
| | A71C | 8% | 9% | 0% | 0.005 |
| | A71D | 8% | 8% | 0% | 0.001 |
| | A71E | 12% | 12% | 0% | 0.000 |
| | A71F | 8% | 8% | 0% | 0.001 |
| | A71G | 9% | 9% | 0% | 0.000 |
| | A71H | 10% | 10% | 0% | 0.001 |
| | A71J | 5% | 5% | 0% | 0.001 |
| | A71K | 6% | 6% | 0% | 0.001 |
| | A71L | 7% | 7% | 0% | 0.001 |
| | A72A | 10% | 10% | 0% | 0.001 |
| | A72B | 7% | 7% | 0% | 0.001 |
| **Sand average** | | **8%** | **8%** | | |
| **Nzhelele** | A80A | - | - | - | - |
| | A80B | 13% | 14% | 1% | 0.014 |
| | A80C | - | - | - | - |
| | A80D | 16% | 17% | 1% | 0.011 |
| | A80E | 11% | 11% | 0% | 0.005 |
| | A80F | 4% | 4% | 0% | 0.003 |
| | A80G | 10% | 11% | 1% | 0.007 |
| | A80H | - | - | - | - |
| | A80J | 9% | 10% | 1% | 0.007 |
| **Nzhelele average** | | **10%** | **11%** | | |
| **Limpopo WMA North** | | **9%** | **9%** | | |

* *As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" study (DWA, 2007).*

** *As per the V&V Study*

## Table C.8: IAP distribution and estimated runoff reduction for 2010-development levels in the Limpopo WMA North

| Catchment/ Quaternary | | Condensed area ($km^2$) | Area in riparian ($km^2$) | % in riparian zone | Tall shrubs (%) | Medium trees (%) | Tall trees (%) | 2010-development runoff reduction) (million $m^3$/a) |
|---|---|---|---|---|---|---|---|---|
| Mokolo | A42A | 5.72 | 0.00 | 0.00 | 0 | 49 | 51 | |
| | A42B | 2.83 | 0.00 | 0.00 | 0 | 0 | 100 | |
| | A42C | 4.94 | 0.03 | 0.68 | 0 | 0 | 100 | |
| | A42D | 5.16 | 0.00 | 0.00 | 0 | 0 | 100 | |
| | A42E | 6.51 | 0.07 | 1.03 | 0 | 30 | 70 | |
| | A42J | 0.98 | 0.00 | 0.06 | 0 | 100 | 0 | |
| **Mokolo Total** | | **26.16** | **0.10** | **1.77** | | | | **-** |
| Lephalala | A50A | 3.90 | 0.03 | 0.72 | 0 | 0 | 100 | |
| | A50B | 0.77 | 0.02 | 2.68 | 50 | 0 | 50 | |
| | A50C | 7.90 | 0.02 | 0.31 | 0 | 0 | 100 | |
| **Lephalala Total** | | **12.58** | **0.07** | **3.70** | | | | **1.2** |
| Mogalakwena | A61A | 3.02 | 0.01 | 019 | 35 | 7 | 58 | |
| | | 2.58 | | | 35 | 7 | 58 | |
| | A61B | 1.86 | 0.01 | 0.13 | 13 | 16 | 70 | |
| | | 3.79 | | | 13 | 16 | 70 | |
| | A61C | 2.28 | 0.00 | 0.06 | 100 | 0 | 0 | |
| | | 5.65 | | | 100 | 0 | 0 | |
| | A61D | 0.82 | 0.00 | 0.00 | 12 | 62 | 25 | |
| | | 1.83 | | | 12 | 62 | 25 | |
| | A61F | 39.34 | 0.03 | 0.07 | 21 | 0 | 79 | |
| | A61G | 8.82 | 0.02 | 0.19 | 12 | 0 | 88 | |
| | A61H | 3.37 | 0.00 | 0.00 | 0 | 24 | 76 | |
| | A61J | 5.98 | 0.01 | 0.25 | 0 | 26 | 74 | |
| | A62A | 2.53 | 0.00 | 0.00 | 0 | 0 | 100 | |
| | A62C | - | - | - | - | - | - | |
| | A62D | - | - | - | - | - | - | |
| | A62E | 1.03 | 0.00 | 0.00 | 73 | 0 | 27 | |
| | A62F | - | - | - | - | - | - | |
| | A62G | - | - | - | - | - | - | |
| | A62H | 0.56 | 0,00 | 0,38 | 0 | 0 | 100 | |
| **Mogalakwena Total** | | **83.46** | **0.08** | **1.25** | | | | **2.6** |
| Sand | A71A | 20.13 | 0.07 | 0.32 | 81 | 3 | 15 | |
| | A71B | 14.46 | 0.03 | 0.20 | 54 | 0 | 46 | |
| | A71C | 56.71 | 0.01 | 0.02 | 76 | 1 | 23 | |
| | A71D | 5.21 | 0.00 | 0.00 | 76 | 24 | 0 | |
| | A71E | 15.77 | 0.00 | 0.01 | 56 | 7 | 37 | |

| Catchment/ Quaternary | | Condensed area ($km^2$) | Area in riparian ($km^2$) | % in riparian zone | Tall shrubs (%) | Medium trees (%) | Tall trees (%) | 2010-development runoff reduction) (million $m^3$/a) |
|---|---|---|---|---|---|---|---|---|
| | A71F | 2.30 | 0.00 | 0.02 | 50 | 50 | 0 | |
| | A71G | 3.57 | 0.00 | 0.01 | 39 | 0 | 61 | |
| | A71H | 16.16 | 0.00 | 0.00 | 24 | 0 | 76 | |
| **Sand Total** | | **134.31** | **0.11** | **0.58** | | | | **1.0** |
| **Nzhelele** | A80B | 3.73 | 0.00 | 0.00 | 0 | 0 | 100 | |
| | A80C | 3.89 | 0.00 | 0.00 | 100 | 0 | 0 | |
| | A80E | 9.74 | 0.00 | 0.00 | 0 | 0 | 100 | |
| | A80G | 15.85 | 0.00 | 0.00 | 100 | 0 | 0 | |
| | A80H | 14.96 | 0.00 | 0.00 | 100 | 0 | 0 | |
| | | 10.83 | | | 100 | 0 | 0 | |
| **Nzhelele Total** | | **59.01** | **0.00** | **0.00** | | | | **2.1** |
| **Limpopo WMA Total** | | **315.51** | **0.4** | **7.3** | | | | **6.9** |

* *Considered negligible in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" Study (DWA, 2007).*

# Appendix D

## Water bodies

## Table D.1: Summary of small storage dams and weirs in the Limpopo WMA North at the 2010-development level

| Catchment/ Quaternary | | FSA ($km^2$) | FSC (million $m^3$) | A-value | B-value |
|---|---|---|---|---|---|
| Matlabas | A41A | 1.22 | 1.28 | 0.021 | 0.72 |
| | A41B | 0.33 | 0.32 | 0.021 | 0.72 |
| | A41C | 0.02 | 0.01 | 0.021 | 0.72 |
| | A41D | 1.64 | 1.29 | 0.021 | 0.72 |
| | A41E | 1.08 | 1.12 | 0.021 | 0.72 |
| **Matlabas Total** | | **4.29** | **4.03** | | |
| Mokolo* | A42A | 1.39 | 2.17 | - | - |
| | A42B | 3.26 | 5.66 | - | - |
| | A42C | 2.12 | 3.32 | - | - |
| | A42D | 1.18 | 3.68 | - | - |
| | A42E | 3.14 | 4.9 | - | - |
| | A42F | 1.19 | 1.31 | - | - |
| | A42G | 0.56 | 0.56 | - | - |
| | A42H | 1.05 | 1.46 | - | - |
| | A42J | 0.54 | 0.29 | - | - |
| **Mokolo Total** | | **14.43** | **23.35** | | |
| Lephalala | A50A | 2.29 | 4.66 | 0.0176 | 0.69 |
| | A50B | 0.78 | 1.50 | 0.0176 | 0.69 |
| | A50C | 0.92 | 1.56 | 0.0176 | 0.69 |
| | A50D | 0.46 | 0.84 | 0.0176 | 0.69 |
| | A50E | 1.92 | 2.60 | 0.0176 | 0.69 |
| | A50F | 0.18 | 0.32 | 0.0154 | 0.75 |
| | A50G | 0.15 | 0.18 | 0.0154 | 0.75 |
| | A50H | 2.73 | 3.39 | 0.0154 | 0.75 |
| | A50J | 2.70 | 3.29 | 0.0154 | 0.75 |
| **Lephalala Total** | | **12.13** | **18.34** | | |
| Mogalakwena | A61A | 0.51 | 1.07 | 0.0092 | 0.75 |
| | A61B | 0.46 | 0.42 | 0.0211 | 0.69 |
| | A61C | 1.07 | 1.03 | 0.0211 | 0.69 |
| | A61D | 0.46 | 0.4 | 0.0211 | 0.69 |
| | A61E | 1.43 | 0.94 | 0.0211 | 0.69 |
| | A61F | 2.56 | 2.36 | 0.0211 | 0.69 |
| | A61G | 2.43 | 4.00 | 0.0211 | 0.69 |
| | A61H | 2.94 | 12.17 | 0.0211 | 0.69 |
| | A61J | 2.75 | 6.22 | 0.0211 | 0.69 |
| | A62A | 0.63 | 1.75 | 0.0211 | 0.69 |
| | A62B | 0.02 | 0.02 | 0.0211 | 0.69 |
| | A62C | 0.00 | 0.00 | 0.0211 | 0.69 |

| Catchment/ Quaternary | | FSA ($km^2$) | FSC (million $m^3$) | A-value | B-value |
|---|---|---|---|---|---|
| | A62D | 0.24 | 0.66 | 0.0211 | 0.69 |
| | A62E | 0.00 | 0.00 | 0.0211 | 0.69 |
| | A62F | 0.27 | 0.39 | 0.0211 | 0.69 |
| | A62G | 0.00 | 0.00 | 0.0211 | 0.69 |
| | A62H | 0.00 | 0.00 | 0.0211 | 0.69 |
| | A62J | 4.48 | 15.95 | 0.0211 | 0.69 |
| | A63A | 0.36 | 0.16 | 0.0211 | 0.69 |
| | A63B | 1.48 | 1.23 | 0.0211 | 0.69 |
| | A63C | 2.76 | 2.67 | 0.0211 | 0.69 |
| | A63D | 1.08 | 0.59 | 0.0211 | 0.69 |
| | A63E | 8.27 | 7.07 | 0.0211 | 0.69 |
| **Mogalakwena Total** | | **34.2** | **59.1** | | |
| **Sand**** | A71A | 1.26 | 4.71 | 0.0038 | 0.82 |
| | A71B | 0.98 | 0.00 | | |
| | A71C | 2.40 | 9.82 | | |
| | A71D | 0.08 | 0.21 | | |
| | A71E | 2.41 | 1.98 | | |
| | A71F | 2.09 | 4.55 | | |
| | A71G | 0.31 | 1.69 | | |
| | A71H | 1.06 | 3.80 | | |
| | A71J | 0.02 | 0.32 | | |
| | A71K | 0.79 | 9.50 | | |
| | A71L | 0.84 | 5.96 | | |
| | A72A | 1.08 | 1.68 | | |
| | A72B | 0.11 | 0.00 | | |
| **Sand Total** | | **13.43** | **44.22** | | |
| **Nzhelele**** | A80A | 0.00 | 0.09 | | |
| | A80B | 0.00 | 0.11 | | |
| | A80C | 0.0 | 0.0 | | |
| | A80D | 0.02 | 0.05 | | |
| | A80E | 0.00 | 0.02 | | |
| | A80F | 0.00 | 0.00 | | |
| | A80G | 0.43 | 2.17 | | |
| | A80H | 0.0 | 0.0 | | |
| | A80J | 0.82 | 0.03 | | |
| **Nzhelele Total** | | **1.27** | **2.47** | | |
| **Limpopo WMA North** | | **79.75** | **151.51** | | |

* *Refer to the "Updating the Hydrology and yield analysis in the Mokolo River Catchment" Study (DWA, 2007) for more detail.*

** *Standard B-value of 0.6*

## Table D.2: Historical growth of dummy dams representing small storage dams and weirs in the Limpopo WMA North (million $m^3$)

| Quaternary/ Quinary | | Network Element | 1920 | | 1950 | | 1989 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | FSA | FSC | FSA | FSC | FSA | FSC | FSA | FSC |
| Matlabas | A41A | RV1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.22 | 1.28 |
| | A41B | RV2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.32 |
| | A41C | RV3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 |
| | A41D | RV4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.64 | 1.29 |
| | A41E | RV5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 1.12 |
| **Matlabas Total** | | | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **4.29** | **4.03** |
| Mokolo | A42A | - | 0.04 | 0.04 | 0.41 | 0.57 | 0.98 | 1.64 | 1.39 | 2.17 |
| | A42B | - | 0.1 | 0.12 | 1.12 | 1.74 | 3.06 | 4.95 | 3.26 | 5.66 |
| | A42C | - | 0.04 | 0.06 | 0.57 | 0.85 | 1.74 | 2.41 | 2.12 | 3.32 |
| | A42D | - | 0.05 | 0.03 | 0.35 | 0.51 | 0.81 | 1.46 | 1.16 | 3.68 |
| | A42E | - | 0.11 | 0.09 | 1.01 | 1.36 | 2.55 | 3.88 | 3.14 | 4.90 |
| | A42F | - | 0.03 | 0.02 | 0.32 | 0.31 | 0.85 | 0.88 | 1.19 | 1.31 |
| | A42G | - | 0.01 | 0.01 | 0.17 | 0.17 | 0.42 | 0.55 | 0.56 | 0.56 |
| | A42H | - | 0.01 | 0.03 | 0.27 | 0.45 | 0.89 | 1.28 | 1.05 | 1.46 |
| | A42J | | 0.01 | 0.01 | 0.15 | 0.07 | 0.38 | 0.21 | 0.54 | 0.29 |
| **Mokolo Total** | | | **0.40** | **0.41** | **4.37** | **6.03** | **11.68** | **17.26** | **14.41** | **23.35** |
| Lephalala | A50A | RV1 | 0.00 | 0.00 | 0.03 | 0.06 | 2.29 | 4.66 | 2.29 | 4.66 |
| | A50B | RV2 | 0.00 | 0.00 | 0.01 | 0.01 | 0.50 | 0.93 | 0.50 | 0.93 |
| | | RV3 | 0.00 | 0.00 | 0.00 | 0.01 | 0.28 | 0.57 | 0.28 | 0.57 |
| | A50C | RV4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.92 | 1.56 | 0.92 | 1.56 |
| | A50D | RV5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.84 | 0.46 | 0.84 |
| | A50E | RV6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 | 2.34 | 0.64 | 2.34 |
| | | RV7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.26 | 0.27 | 0.26 |
| | A50F | RV8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.32 | 0.18 | 0.32 |
| | A50G | RV9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.17 | 0.13 | 0.17 |
| | A50H | RV10 | 0.00 | 0.00 | 0.00 | 0.00 | 2.73 | 3.39 | 2.73 | 3.39 |
| | A50J | RV11 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 | 3.28 | 2.70 | 3.29 |
| **Lephalala Total** | | | **0.00** | **0.00** | **0.04** | **0.08** | **11.11** | **18.32** | **11.11** | **18.32** |
| Mogalakwena | A61A1 | RV17 | 0.02 | 0.06 | 0.30 | 0.86 | 0.30 | 0.86 | 0.33 | 0.95 |
| | A61A2 | RV19 | 0.01 | 0.01 | 0.16 | 0.11 | 0.16 | 0.11 | 0.17 | 0.12 |
| | A61B | RV20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.42 | 0.46 | 0.42 |
| | A61C1 | RV4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.93 | 0.40 | 1.21 |
| | A61C2 | RV21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.93 | 0.40 | 1.21 |
| | A61D1 | RV6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 | 1.40 | 0.47 | 1.41 |
| | A61E1 | RV8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.23 | 0.33 | 1.30 |
| | A61E2 | RV23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.23 | 0.33 | 1.30 |
| | A61F | RV10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.84 | 1.67 | 2.57 | 5.14 |
| | | RV22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.84 | 1.67 | 2.57 | 5.14 |

| Quaternary/ Quinary | | Network Element | 1920 | | 1950 | | 1989 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | FSA | FSC | FSA | FSC | FSA | FSC | FSA | FSC |
| | A61G | RV11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 2.53 | 0.75 | 3.22 |
| | A61H | RV12 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 | 6.81 | 2.27 | 6.81 |
| | | RV15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 | 2.02 | 0.44 | 2.02 |
| | A61J | RV14 | 0.00 | 0.00 | 0.00 | 0.00 | 2.42 | 4.84 | 2.42 | 4.84 |
| | | RV16 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 | 6.81 | 2.27 | 6.81 |
| | | RV18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 | 2.40 | 0.56 | 2.40 |
| | A62A | RV24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 1.75 | 0.63 | 1.75 |
| | A62B | RV25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 |
| | A62C | RV27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62D | RV28 | 0.01 | 0.02 | 0.14 | 0.39 | 0.17 | 0.45 | 0.24 | 0.66 |
| | A62E | RV29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62F | RV30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.39 |
| | A62G | RV31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62H | RV32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A62J | RV33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.05 |
| | A63A | RV1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.12 |
| | | RV2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.05 |
| | A63B | RV3 | 0.01 | 0.01 | 0.14 | 0.12 | 0.54 | 0.47 | 1.33 | 1.15 |
| | | RV4 | 0.00 | 0.00 | 0.02 | 0.01 | 0.06 | 0.03 | 0.15 | 0.08 |
| | A63C | RV1 | 0.02 | 0.02 | 0.30 | 0.29 | 1.12 | 1.08 | 2.76 | 2.67 |
| | A63D | RV5 | 0.02 | 0.01 | 0.27 | 0.14 | 0.60 | 0.32 | 0.60 | 0.32 |
| | | RV6 | 0.01 | 0.01 | 0.21 | 0.12 | 0.47 | 0.27 | 0.48 | 0.27 |
| | A63E | RV8 | 0.24 | 0.20 | 3.69 | 3.15 | 8.23 | 7.04 | 8.27 | 7.07 |
| **Mogalakwena Total** | | | **0.34** | **0.34** | **5.22** | **5.19** | **24.16** | **45.27** | **31.93** | **58.89** |
| **Sand** | A71A | RV1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.96 | 1.26 | 4.71 |
| | A71C | RV2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 2.00 | 2.40 | 9.82 |
| | A71D | RV3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.08 | 0.21 |
| | A71E | RV4 | 0.00 | 0.00 | 0.06 | 0.05 | 0.50 | 0.41 | 2.41 | 1.98 |
| | A71F | RV6 | 0.00 | 0.00 | 0.37 | 0.81 | 1.58 | 3.42 | 2.09 | 4.55 |
| | A71G | RV7 | 0.00 | 0.00 | 0.01 | 0.08 | 0.10 | 0.56 | 0.31 | 1.69 |
| | A71H | RV8 | 0.00 | 0.00 | 0.12 | 0.44 | 0.27 | 0.96 | 1.06 | 3.80 |
| | A71J | RV9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.12 | 0.02 | 0.32 |
| | A71K | RV10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 9.50 | 0.79 | 9.50 |
| | A71L | RV12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.84 | 5.96 |
| | A72A | RV1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.80 | 1.08 | 1.68 |
| | A72B | RV2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.11 | 0.00 |
| **Sand Total** | | | **0.00** | **0.00** | **0.57** | **1.38** | **4.57** | **18.77** | **12.46** | **44.22** |
| **Nzhelele** | A80A | RV1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.09 |
| | A80B | RV3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.11 |
| | A80D | RV5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.05 |
| | A80E | RV6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 |

| Quaternary/ Quinary | | Network Element | 1920 | | 1950 | | 1989 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | FSA | FSC | FSA | FSC | FSA | FSC | FSA | FSC |
| | A80F | RV7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | A80G | RV8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.43 | 2.17 |
| | A80J | RV3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.48 | 2.64 |
| **Nzhelele Total** | | | **0.00** | **0.00** | **0.00** | **0.00** | **0.01** | **0.24** | **1.93** | **5.07** |
| **Limpopo WMA North** | | | **0.74** | **0.75** | **10.21** | **12.68** | **51.53** | **99.86** | **76.13** | **153.89** |

* *Refer to the "Updating the Hydrology and yield analysis in the Mokolo River Catchment" Study (DWA, 2007) for more detail.*

** *Not modelled*

*** *Dams modelled individually – does not contribute to the total storage area and capacity of each catchment and the Limpopo WMA North as shown in **Table D.2**.*

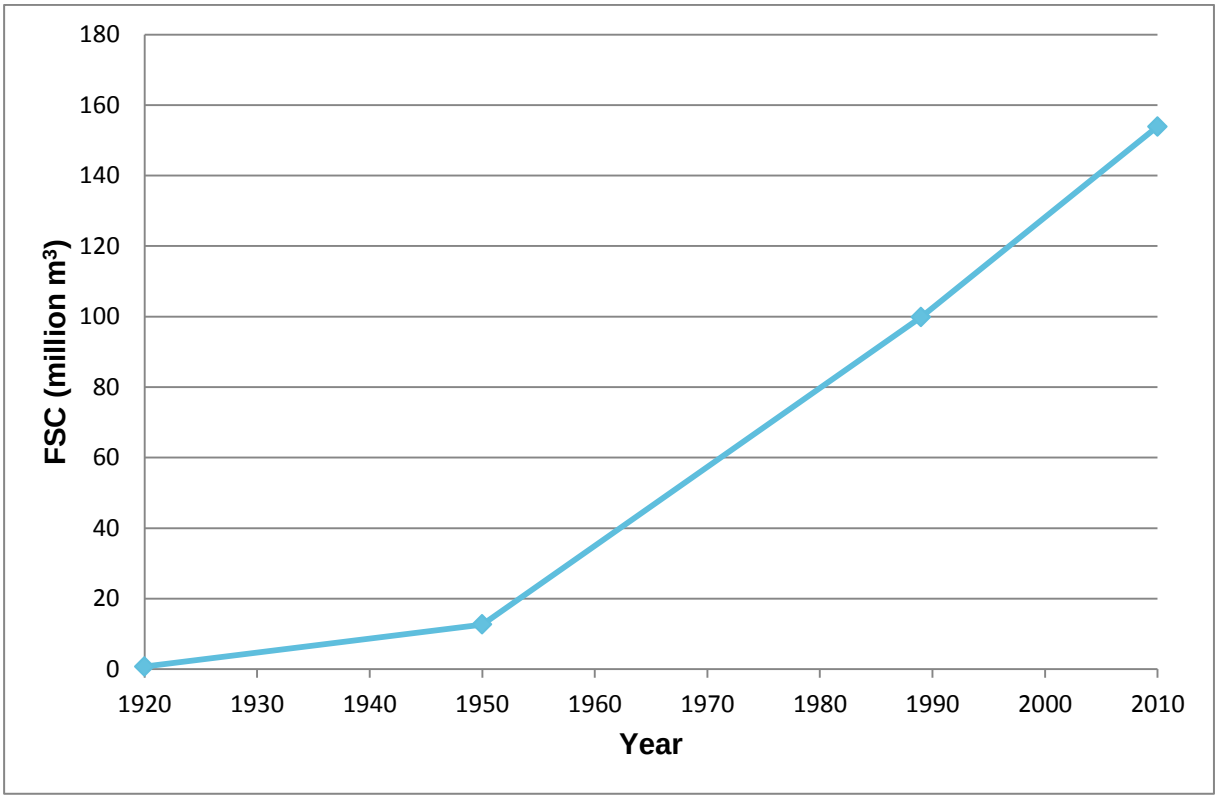



**Figure D.1: Historical growth in the total capacity of small storage dams and weirs in the Limpopo WMA North**

# Appendix E

# Hydro-meteorological Data

## Table E.1: A-pan evaporation data for the Limpopo WMA North

| Catchment/ Quaternary | | Average A-pan evaporation for indicated month (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
| Matlabas | A41A | 252 | 236 | 236 | 235 | 200 | 190 | 155 | 136 | 117 | 128 | 163 | 212 | 2260 |
| | A41B* | 264 | 247 | 247 | 246 | 210 | 200 | 162 | 142 | 122 | 134 | 170 | 222 | 2366 |
| | A41C | 264 | 247 | 247 | 246 | 210 | 200 | 162 | 142 | 122 | 134 | 170 | 222 | 2366 |
| | A41D | 270 | 253 | 253 | 252 | 214 | 204 | 166 | 145 | 124 | 136 | 174 | 227 | 2418 |
| | A41E | 270 | 253 | 253 | 252 | 214 | 204 | 166 | 145 | 124 | 136 | 174 | 227 | 2418 |
| | | | | | | | | | | | | | | |
| Mokolo | A42A | 235 | 238 | 231 | 224 | 185 | 187 | 147 | 139 | 115 | 126 | 171 | 211 | 2209 |
| | A42B | 246 | 243 | 241 | 229 | 189 | 191 | 149 | 141 | 116 | 129 | 174 | 217 | 2265 |
| | A42C | 238 | 240 | 234 | 225 | 187 | 188 | 149 | 140 | 115 | 127 | 172 | 213 | 2229 |
| | A42D | 245 | 245 | 239 | 228 | 188 | 191 | 151 | 142 | 117 | 130 | 175 | 217 | 2268 |
| | A42E | 242 | 245 | 238 | 230 | 191 | 192 | 150 | 141 | 116 | 129 | 173 | 216 | 2263 |
| | A42F | 259 | 256 | 254 | 242 | 199 | 200 | 153 | 144 | 118 | 133 | 177 | 225 | 2359 |
| | A42G | 262 | 257 | 256 | 245 | 202 | 202 | 155 | 145 | 118 | 135 | 178 | 229 | 2383 |
| | A42H | 262 | 259 | 256 | 247 | 205 | 204 | 155 | 146 | 118 | 135 | 178 | 229 | 2394 |
| | A42J | 275 | 272 | 269 | 259 | 214 | 212 | 158 | 148 | 119 | 139 | 181 | 237 | 2484 |
| | | | | | | | | | | | | | | |
| Lephalala | A50A | 239 | 224 | 224 | 223 | 190 | 181 | 148 | 130 | 112 | 122 | 155 | 202 | 2150 |
| | A50B | 245 | 230 | 230 | 229 | 195 | 186 | 152 | 133 | 114 | 125 | 159 | 207 | 2205 |
| | A50C | 245 | 230 | 230 | 229 | 195 | 186 | 152 | 133 | 114 | 125 | 159 | 207 | 2205 |
| | A50D | 258 | 242 | 242 | 240 | 205 | 195 | 159 | 139 | 119 | 131 | 167 | 217 | 2314 |
| | A50E | 264 | 247 | 247 | 246 | 210 | 200 | 162 | 142 | 122 | 134 | 170 | 222 | 2366 |
| | A50F | 264 | 247 | 247 | 246 | 210 | 200 | 162 | 142 | 122 | 134 | 170 | 222 | 2366 |
| | A50G | 270 | 253 | 253 | 252 | 214 | 204 | 166 | 145 | 124 | 136 | 174 | 227 | 2418 |
| | A50H | 270 | 253 | 253 | 252 | 214 | 204 | 166 | 145 | 124 | 136 | 174 | 227 | 2418 |
| | A50J | 270 | 253 | 253 | 252 | 214 | 204 | 166 | 145 | 124 | 136 | 174 | 227 | 2418 |
| | | | | | | | | | | | | | | |
| Mogalakwena | A61A | 230 | 215 | 227 | 228 | 194 | 189 | 153 | 131 | 112 | 119 | 155 | 197 | 2150 |
| | A61B | 230 | 215 | 227 | 228 | 194 | 189 | 153 | 131 | 112 | 119 | 155 | 197 | 2150 |
| | A61C | 234 | 219 | 231 | 232 | 198 | 193 | 155 | 133 | 113 | 121 | 158 | 201 | 2188 |
| | A61D | 234 | 219 | 231 | 232 | 198 | 193 | 155 | 133 | 113 | 121 | 158 | 201 | 2188 |
| | A61E | 234 | 219 | 232 | 233 | 198 | 193 | 156 | 134 | 114 | 121 | 158 | 201 | 2193 |
| | A61F | 242 | 226 | 239 | 240 | 204 | 199 | 160 | 137 | 117 | 124 | 163 | 207 | 2258 |
| | A61G | 242 | 226 | 239 | 240 | 204 | 199 | 160 | 137 | 117 | 124 | 163 | 207 | 2258 |
| | A61H | 230 | 215 | 227 | 228 | 194 | 189 | 153 | 131 | 112 | 119 | 155 | 197 | 2150 |
| | A61J | 236 | 221 | 233 | 234 | 199 | 194 | 156 | 134 | 114 | 122 | 159 | 202 | 2204 |
| | A62A | 242 | 226 | 239 | 240 | 204 | 199 | 160 | 137 | 117 | 124 | 163 | 207 | 2258 |
| | A62B | 242 | 226 | 239 | 240 | 204 | 199 | 160 | 137 | 117 | 124 | 163 | 207 | 2258 |
| | A62C | 253 | 237 | 251 | 252 | 214 | 209 | 168 | 144 | 122 | 130 | 170 | 217 | 2367 |
| | A62D | 253 | 237 | 251 | 252 | 214 | 209 | 168 | 144 | 122 | 130 | 170 | 217 | 2367 |

| Catchment/ Quaternary | | Average A-pan evaporation for indicated month (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
| | A62E | 248 | 232 | 245 | 246 | 209 | 204 | 164 | 141 | 119 | 127 | 166 | 212 | 2313 |
| | A62F** | 248 | 232 | 245 | 246 | 209 | 204 | 164 | 141 | 119 | 127 | 166 | 212 | 2313 |
| | A62G | 253 | 237 | 251 | 252 | 214 | 209 | 168 | 144 | 122 | 130 | 170 | 217 | 2367 |
| | A62H | 253 | 237 | 251 | 252 | 214 | 209 | 168 | 144 | 122 | 130 | 170 | 217 | 2367 |
| | A62J | 259 | 243 | 257 | 258 | 219 | 213 | 171 | 147 | 124 | 132 | 174 | 222 | 2419 |
| | A63A | 259 | 243 | 257 | 258 | 219 | 213 | 171 | 147 | 124 | 132 | 174 | 222 | 2419 |
| | A63B | 265 | 248 | 263 | 264 | 224 | 218 | 175 | 150 | 127 | 135 | 178 | 227 | 2474 |
| | A63C | 271 | 254 | 269 | 270 | 229 | 223 | 179 | 153 | 129 | 138 | 182 | 232 | 2529 |
| | A63D | 265 | 248 | 263 | 264 | 224 | 218 | 175 | 150 | 127 | 135 | 178 | 227 | 2474 |
| | A63E | 258 | 248 | 263 | 257 | 214 | 214 | 180 | 171 | 146 | 161 | 190 | 226 | 2528 |
| | | | | | | | | | | | | | | |
| Sand | A71A | 229 | 221 | 234 | 229 | 191 | 191 | 161 | 154 | 131 | 144 | 170 | 202 | 2257 |
| | A71B | 218 | 210 | 222 | 218 | 182 | 182 | 154 | 147 | 125 | 138 | 162 | 192 | 2150 |
| | A71C | 218 | 210 | 222 | 218 | 182 | 182 | 154 | 147 | 125 | 138 | 162 | 192 | 2150 |
| | A71D | 218 | 210 | 222 | 218 | 182 | 182 | 154 | 147 | 125 | 138 | 162 | 192 | 2150 |
| | A71E | 235 | 227 | 240 | 235 | 196 | 196 | 165 | 157 | 134 | 148 | 174 | 207 | 2314 |
| | A71F | 229 | 221 | 234 | 229 | 191 | 191 | 161 | 154 | 131 | 144 | 170 | 202 | 2257 |
| | A71G | 224 | 216 | 228 | 223 | 187 | 187 | 157 | 150 | 128 | 141 | 166 | 197 | 2204 |
| | A71H | 201 | 194 | 205 | 201 | 168 | 168 | 142 | 136 | 117 | 128 | 150 | 177 | 1987 |
| | A71J | 229 | 221 | 234 | 229 | 191 | 191 | 161 | 154 | 131 | 144 | 170 | 202 | 2257 |
| | A71K | 252 | 243 | 257 | 251 | 210 | 210 | 176 | 168 | 143 | 158 | 186 | 221 | 2475 |
| | A71L*** | 252 | 243 | 257 | 251 | 210 | 210 | 176 | 168 | 143 | 158 | 186 | 221 | 2475 |
| | A72A | 241 | 232 | 245 | 240 | 200 | 200 | 169 | 161 | 137 | 151 | 178 | 211 | 2365 |
| | A72B | 246 | 237 | 251 | 246 | 205 | 205 | 172 | 164 | 140 | 154 | 182 | 216 | 2418 |
| | | | | | | | | | | | | | | |
| Nzhelele | A80A | 184 | 178 | 188 | 184 | 155 | 155 | 131 | 125 | 108 | 118 | 138 | 163 | 1827 |
| | A80B | 190 | 183 | 193 | 190 | 159 | 159 | 135 | 129 | 111 | 122 | 142 | 168 | 1881 |
| | A80C | 207 | 200 | 211 | 206 | 173 | 173 | 146 | 139 | 120 | 131 | 154 | 182 | 2042 |
| | A80D | 190 | 183 | 193 | 190 | 159 | 159 | 135 | 129 | 111 | 122 | 142 | 168 | 1881 |
| | A80E | 190 | 183 | 193 | 190 | 159 | 159 | 135 | 129 | 111 | 122 | 142 | 168 | 1881 |
| | A80F | 224 | 216 | 228 | 223 | 187 | 187 | 157 | 150 | 128 | 141 | 166 | 197 | 2204 |
| | A80G | 241 | 232 | 245 | 240 | 200 | 200 | 169 | 161 | 137 | 151 | 178 | 211 | 2365 |
| | A80H | 224 | 216 | 228 | 223 | 187 | 187 | 157 | 150 | 128 | 141 | 166 | 197 | 2204 |
| | A80J | 241 | 232 | 245 | 240 | 200 | 200 | 169 | 161 | 137 | 151 | 178 | 211 | 2365 |

* *A41C values used*

** *A62E values used*

*** *A71K values used*

## Table E.2: S-pan evaporation data for the Limpopo WMA North

| Quaternary | | Average S-pan evaporation for indicated month (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
| Matlabas | A41A | 208 | 194 | 194 | 193 | 160 | 152 | 119 | 101 | 83 | 94 | 126 | 172 | 1796 |
| | A41B | 208 | 194 | 194 | 193 | 160 | 152 | 119 | 101 | 83 | 94 | 126 | 172 | 1796 |
| | A41C | 220 | 204 | 204 | 203 | 169 | 160 | 126 | 107 | 88 | 99 | 133 | 181 | 1894 |
| | A41D | 226 | 210 | 210 | 209 | 174 | 164 | 129 | 109 | 90 | 102 | 137 | 186 | 1946 |
| | A41E | 226 | 210 | 210 | 209 | 174 | 164 | 129 | 109 | 90 | 102 | 137 | 186 | 1946 |
| | | | | | | | | | | | | | | |
| Mokolo | A42A | 191 | 193 | 187 | 181 | 146 | 148 | 113 | 106 | 85 | 95 | 134 | 170 | 1748 |
| | A42B | 200 | 197 | 196 | 185 | 150 | 152 | 115 | 108 | 86 | 97 | 137 | 174 | 1797 |
| | A42C | 193 | 194 | 189 | 182 | 148 | 149 | 115 | 107 | 85 | 96 | 135 | 171 | 1765 |
| | A42D | 200 | 199 | 194 | 185 | 149 | 152 | 116 | 108 | 87 | 98 | 137 | 175 | 1799 |
| | A42E | 197 | 199 | 193 | 186 | 152 | 152 | 116 | 107 | 86 | 97 | 136 | 174 | 1795 |
| | A42F | 211 | 209 | 207 | 196 | 159 | 160 | 118 | 110 | 87 | 101 | 139 | 182 | 1879 |
| | A42G | 214 | 210 | 209 | 199 | 161 | 162 | 120 | 112 | 88 | 102 | 140 | 185 | 1901 |
| | A42H | 214 | 212 | 209 | 201 | 164 | 163 | 120 | 112 | 87 | 102 | 140 | 185 | 1910 |
| | A42J | 225 | 223 | 220 | 212 | 172 | 170 | 123 | 114 | 89 | 106 | 143 | 192 | 1989 |
| | | | | | | | | | | | | | | |
| Lephalala | A50A | 197 | 183 | 183 | 182 | 152 | 143 | 112 | 95 | 79 | 88 | 119 | 162 | 1695 |
| | A50B | 203 | 188 | 188 | 187 | 156 | 147 | 116 | 98 | 81 | 91 | 123 | 167 | 1745 |
| | A50C | 203 | 188 | 188 | 187 | 156 | 147 | 116 | 98 | 81 | 91 | 123 | 167 | 1745 |
| | A50D | 214 | 199 | 199 | 198 | 165 | 156 | 122 | 104 | 86 | 96 | 130 | 176 | 1845 |
| | A50E | 220 | 204 | 204 | 203 | 169 | 160 | 126 | 107 | 88 | 99 | 133 | 181 | 1894 |
| | A50F | 220 | 204 | 204 | 203 | 169 | 160 | 126 | 107 | 88 | 99 | 133 | 181 | 1894 |
| | A50G | 226 | 210 | 210 | 209 | 174 | 164 | 129 | 109 | 90 | 102 | 137 | 186 | 1946 |
| | A50H | 226 | 210 | 210 | 209 | 174 | 164 | 129 | 109 | 90 | 102 | 137 | 186 | 1946 |
| | A50J | 221 | 205 | 219 | 220 | 183 | 177 | 137 | 114 | 93 | 100 | 140 | 186 | 1995 |
| | | | | | | | | | | | | | | |
| Mogalakwena | A61A | 188 | 174 | 186 | 187 | 155 | 151 | 117 | 97 | 79 | 85 | 119 | 158 | 1696 |
| | A61B | 188 | 174 | 186 | 187 | 155 | 151 | 117 | 97 | 79 | 85 | 119 | 158 | 1696 |
| | A61C | 192 | 179 | 190 | 191 | 159 | 154 | 119 | 99 | 80 | 87 | 121 | 162 | 1733 |
| | A61D | 192 | 178 | 190 | 190 | 158 | 154 | 119 | 99 | 80 | 87 | 121 | 161 | 1729 |
| | A61E | 192 | 178 | 190 | 191 | 159 | 154 | 119 | 99 | 80 | 87 | 122 | 161 | 1732 |
| | A61F | 199 | 185 | 197 | 198 | 164 | 160 | 124 | 103 | 83 | 90 | 126 | 167 | 1796 |
| | A61G | 199 | 185 | 197 | 198 | 164 | 160 | 124 | 103 | 83 | 90 | 126 | 167 | 1796 |
| | A61H | 188 | 174 | 186 | 187 | 155 | 151 | 117 | 97 | 79 | 85 | 119 | 158 | 1696 |
| | A61J | 193 | 180 | 191 | 192 | 160 | 155 | 120 | 100 | 81 | 88 | 122 | 162 | 1744 |
| | A62A | 199 | 185 | 197 | 198 | 164 | 160 | 124 | 103 | 83 | 90 | 126 | 167 | 1796 |
| | A62B | 205 | 190 | 202 | 203 | 169 | 164 | 127 | 105 | 86 | 93 | 129 | 172 | 1845 |
| | A62C | 210 | 195 | 208 | 209 | 173 | 168 | 130 | 108 | 88 | 95 | 133 | 176 | 1893 |
| | A62D | 210 | 195 | 208 | 209 | 173 | 168 | 130 | 108 | 88 | 95 | 133 | 176 | 1893 |

| Quaternary | | Average S-pan evaporation for indicated month (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
| | A62E | 210 | 195 | 208 | 209 | 173 | 168 | 130 | 108 | 88 | 95 | 133 | 176 | 1893 |
| | A62F | 205 | 190 | 202 | 203 | 169 | 164 | 127 | 105 | 86 | 93 | 129 | 172 | 1845 |
| | A62G | 205 | 190 | 202 | 203 | 169 | 164 | 127 | 105 | 86 | 93 | 129 | 172 | 1845 |
| | A62H | 210 | 195 | 208 | 209 | 173 | 168 | 130 | 108 | 88 | 95 | 133 | 176 | 1893 |
| | A62J | 216 | 200 | 213 | 214 | 178 | 173 | 134 | 111 | 90 | 98 | 136 | 181 | 1944 |
| | A63A | 216 | 200 | 213 | 214 | 178 | 173 | 134 | 111 | 90 | 98 | 136 | 181 | 1944 |
| | A63B | 221 | 205 | 219 | 220 | 183 | 177 | 137 | 114 | 93 | 100 | 140 | 186 | 1995 |
| | A63C | 221 | 205 | 219 | 220 | 183 | 177 | 137 | 114 | 93 | 100 | 140 | 186 | 1995 |
| | A63D | 227 | 210 | 224 | 225 | 187 | 182 | 141 | 117 | 95 | 103 | 143 | 190 | 2044 |
| | A63E | 214 | 205 | 218 | 213 | 174 | 174 | 142 | 134 | 110 | 124 | 152 | 185 | 2045 |
| | | | | | | | | | | | | | | |
| Sand | A71A | 188 | 180 | 192 | 187 | 152 | 152 | 124 | 117 | 97 | 109 | 133 | 162 | 1793 |
| | A71B | 177 | 170 | 181 | 177 | 144 | 144 | 118 | 111 | 91 | 103 | 126 | 153 | 1695 |
| | A71C | 177 | 170 | 181 | 177 | 144 | 144 | 118 | 111 | 91 | 103 | 126 | 153 | 1695 |
| | A71D | 177 | 170 | 181 | 177 | 144 | 144 | 118 | 111 | 91 | 103 | 126 | 153 | 1695 |
| | A71E | 193 | 185 | 197 | 193 | 157 | 157 | 128 | 121 | 100 | 112 | 137 | 167 | 1847 |
| | A71F | 188 | 180 | 192 | 187 | 152 | 152 | 124 | 117 | 97 | 109 | 133 | 162 | 1793 |
| | A71G | 162 | 155 | 165 | 161 | 131 | 131 | 107 | 101 | 83 | 94 | 115 | 140 | 1545 |
| | A71H | 162 | 155 | 165 | 161 | 131 | 131 | 107 | 101 | 83 | 94 | 115 | 140 | 1545 |
| | A71J | 188 | 180 | 192 | 187 | 152 | 152 | 124 | 117 | 97 | 109 | 133 | 162 | 1793 |
| | A71K | 209 | 200 | 213 | 208 | 169 | 169 | 138 | 131 | 108 | 121 | 148 | 180 | 1994 |
| | A71L | 214 | 205 | 218 | 213 | 174 | 174 | 142 | 134 | 110 | 124 | 152 | 185 | 2045 |
| | A72A | 198 | 190 | 202 | 198 | 161 | 161 | 131 | 124 | 102 | 115 | 141 | 171 | 1894 |
| | A72B | 204 | 195 | 208 | 203 | 165 | 165 | 135 | 127 | 105 | 118 | 144 | 176 | 1945 |
| | | | | | | | | | | | | | | |
| Nzhelele | A80A | 146 | 140 | 149 | 146 | 118 | 118 | 97 | 91 | 75 | 85 | 103 | 126 | 1394 |
| | A80B | 151 | 145 | 154 | 151 | 123 | 123 | 100 | 95 | 78 | 88 | 107 | 130 | 1445 |
| | A80C | 167 | 160 | 170 | 166 | 135 | 135 | 111 | 104 | 86 | 97 | 118 | 144 | 1593 |
| | A80D | 151 | 145 | 154 | 151 | 123 | 123 | 100 | 95 | 78 | 88 | 107 | 130 | 1445 |
| | A80E | 151 | 145 | 154 | 151 | 123 | 123 | 100 | 95 | 78 | 88 | 107 | 130 | 1445 |
| | A80F | 183 | 175 | 186 | 182 | 148 | 148 | 121 | 114 | 94 | 106 | 129 | 158 | 1744 |
| | A80G | 198 | 190 | 202 | 198 | 161 | 161 | 131 | 124 | 102 | 115 | 141 | 171 | 1894 |
| | A80H | 183 | 175 | 186 | 182 | 148 | 148 | 121 | 114 | 94 | 106 | 129 | 158 | 1744 |
| | A80J | 198 | 190 | 202 | 198 | 161 | 161 | 131 | 124 | 102 | 115 | 141 | 171 | 1894 |

## Table E.3: S-pan-to-A-pan evaporation conversion factors for the Limpopo WMA North

| Catchment/ Quaternary | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Matlabas | A41A | 1.21 | 1.22 | 1.22 | 1.22 | 1.25 | 1.25 | 1.30 | 1.35 | 1.41 | 1.36 | 1.29 | 1.23 |
| | A41B | 1.27 | 1.27 | 1.27 | 1.27 | 1.31 | 1.32 | 1.36 | 1.41 | 1.47 | 1.43 | 1.35 | 1.29 |
| | A41C | 1.20 | 1.21 | 1.21 | 1.21 | 1.24 | 1.25 | 1.29 | 1.33 | 1.39 | 1.35 | 1.28 | 1.23 |
| | A41D | 1.19 | 1.20 | 1.20 | 1.21 | 1.23 | 1.24 | 1.29 | 1.33 | 1.38 | 1.33 | 1.27 | 1.22 |
| | A41E | 1.19 | 1.20 | 1.20 | 1.21 | 1.23 | 1.24 | 1.29 | 1.33 | 1.38 | 1.33 | 1.27 | 1.22 |
| | | | | | | | | | | | | | |
| Mokolo | A42A | 1.23 | 1.23 | 1.24 | 1.24 | 1.27 | 1.26 | 1.30 | 1.31 | 1.35 | 1.33 | 1.28 | 1.24 |
| | A42B | 1.23 | 1.23 | 1.23 | 1.24 | 1.26 | 1.26 | 1.30 | 1.31 | 1.35 | 1.33 | 1.27 | 1.25 |
| | A42C | 1.23 | 1.24 | 1.24 | 1.24 | 1.26 | 1.26 | 1.30 | 1.31 | 1.35 | 1.32 | 1.27 | 1.25 |
| | A42D | 1.23 | 1.23 | 1.23 | 1.23 | 1.26 | 1.26 | 1.30 | 1.31 | 1.34 | 1.33 | 1.28 | 1.24 |
| | A42E | 1.23 | 1.23 | 1.23 | 1.24 | 1.26 | 1.26 | 1.29 | 1.32 | 1.35 | 1.33 | 1.27 | 1.24 |
| | A42F | 1.23 | 1.22 | 1.23 | 1.23 | 1.25 | 1.25 | 1.30 | 1.31 | 1.36 | 1.32 | 1.27 | 1.24 |
| | A42G | 1.22 | 1.22 | 1.22 | 1.23 | 1.25 | 1.25 | 1.29 | 1.29 | 1.34 | 1.32 | 1.27 | 1.24 |
| | A42H | 1.22 | 1.22 | 1.22 | 1.23 | 1.25 | 1.25 | 1.29 | 1.30 | 1.36 | 1.32 | 1.27 | 1.24 |
| | A42J | 1.22 | 1.22 | 1.22 | 1.22 | 1.24 | 1.25 | 1.28 | 1.30 | 1.34 | 1.31 | 1.27 | 1.23 |
| | | | | | | | | | | | | | |
| Lephalala | A50A | 1.21 | 1.22 | 1.22 | 1.23 | 1.25 | 1.27 | 1.32 | 1.37 | 1.42 | 1.39 | 1.30 | 1.25 |
| | A50B | 1.21 | 1.22 | 1.22 | 1.22 | 1.25 | 1.27 | 1.31 | 1.36 | 1.41 | 1.37 | 1.29 | 1.24 |
| | A50C | 1.21 | 1.22 | 1.22 | 1.22 | 1.25 | 1.27 | 1.31 | 1.36 | 1.41 | 1.37 | 1.29 | 1.24 |
| | A50D | 1.21 | 1.22 | 1.22 | 1.21 | 1.24 | 1.25 | 1.30 | 1.34 | 1.38 | 1.36 | 1.28 | 1.23 |
| | A50E | 1.20 | 1.21 | 1.21 | 1.21 | 1.24 | 1.25 | 1.29 | 1.33 | 1.39 | 1.35 | 1.28 | 1.23 |
| | A50F | 1.20 | 1.21 | 1.21 | 1.21 | 1.24 | 1.25 | 1.29 | 1.33 | 1.39 | 1.35 | 1.28 | 1.23 |
| | A50G | 1.19 | 1.20 | 1.20 | 1.21 | 1.23 | 1.24 | 1.29 | 1.33 | 1.38 | 1.33 | 1.27 | 1.22 |
| | A50H | 1.19 | 1.20 | 1.20 | 1.21 | 1.23 | 1.24 | 1.29 | 1.33 | 1.38 | 1.33 | 1.27 | 1.22 |
| | A50J | 1.22 | 1.23 | 1.16 | 1.15 | 1.17 | 1.15 | 1.21 | 1.27 | 1.33 | 1.36 | 1.24 | 1.22 |
| | | | | | | | | | | | | | |
| Mogalakwena | A61A | 1.22 | 1.24 | 1.22 | 1.22 | 1.25 | 1.25 | 1.31 | 1.35 | 1.42 | 1.40 | 1.30 | 1.25 |
| | A61B | 1.22 | 1.24 | 1.22 | 1.22 | 1.25 | 1.25 | 1.31 | 1.35 | 1.42 | 1.40 | 1.30 | 1.25 |
| | A61C | 1.22 | 1.22 | 1.22 | 1.21 | 1.25 | 1.25 | 1.30 | 1.34 | 1.41 | 1.39 | 1.31 | 1.24 |
| | A61D | 1.22 | 1.23 | 1.22 | 1.22 | 1.25 | 1.25 | 1.30 | 1.34 | 1.41 | 1.39 | 1.31 | 1.25 |
| | A61E | 1.22 | 1.23 | 1.22 | 1.22 | 1.25 | 1.25 | 1.31 | 1.35 | 1.43 | 1.39 | 1.30 | 1.25 |
| | A61F | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.41 | 1.38 | 1.29 | 1.24 |
| | A61G | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.41 | 1.38 | 1.29 | 1.24 |
| | A61H | 1.22 | 1.24 | 1.22 | 1.22 | 1.25 | 1.25 | 1.31 | 1.35 | 1.42 | 1.40 | 1.30 | 1.25 |
| | A61J | 1.22 | 1.23 | 1.22 | 1.22 | 1.24 | 1.25 | 1.30 | 1.34 | 1.41 | 1.39 | 1.30 | 1.25 |
| | A62A | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.41 | 1.38 | 1.29 | 1.24 |
| | A62B | 1.18 | 1.19 | 1.18 | 1.18 | 1.21 | 1.21 | 1.26 | 1.30 | 1.36 | 1.33 | 1.26 | 1.20 |
| | A62C | 1.20 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.39 | 1.37 | 1.28 | 1.23 |
| | A62D | 1.20 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.39 | 1.37 | 1.28 | 1.23 |
| | A62E | 1.18 | 1.19 | 1.18 | 1.18 | 1.21 | 1.21 | 1.26 | 1.31 | 1.35 | 1.34 | 1.25 | 1.20 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A62F | 1.21 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.34 | 1.38 | 1.37 | 1.29 | 1.23 |
| | A62G | 1.23 | 1.25 | 1.24 | 1.24 | 1.27 | 1.27 | 1.32 | 1.37 | 1.42 | 1.40 | 1.32 | 1.26 |
| | A62H | 1.20 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.33 | 1.39 | 1.37 | 1.28 | 1.23 |
| | A62J | 1.20 | 1.22 | 1.21 | 1.21 | 1.23 | 1.23 | 1.28 | 1.32 | 1.38 | 1.35 | 1.28 | 1.23 |
| | A63A | 1.20 | 1.22 | 1.21 | 1.21 | 1.23 | 1.23 | 1.28 | 1.32 | 1.38 | 1.35 | 1.28 | 1.23 |
| | A63B | 1.20 | 1.21 | 1.20 | 1.20 | 1.22 | 1.23 | 1.28 | 1.32 | 1.37 | 1.35 | 1.27 | 1.22 |
| | A63C | 1.23 | 1.24 | 1.23 | 1.23 | 1.25 | 1.26 | 1.31 | 1.34 | 1.39 | 1.38 | 1.30 | 1.25 |
| | A63D | 1.17 | 1.18 | 1.17 | 1.17 | 1.20 | 1.20 | 1.24 | 1.28 | 1.34 | 1.31 | 1.24 | 1.19 |
| | A63E | 1.21 | 1.21 | 1.21 | 1.21 | 1.23 | 1.23 | 1.27 | 1.28 | 1.33 | 1.30 | 1.25 | 1.22 |
| | | | | | | | | | | | | | |
| **Sand** | A71A | 1.22 | 1.23 | 1.22 | 1.22 | 1.26 | 1.26 | 1.30 | 1.32 | 1.35 | 1.32 | 1.28 | 1.25 |
| | A71B | 1.23 | 1.24 | 1.23 | 1.23 | 1.26 | 1.26 | 1.31 | 1.32 | 1.37 | 1.34 | 1.29 | 1.25 |
| | A71C | 1.23 | 1.24 | 1.23 | 1.23 | 1.26 | 1.26 | 1.31 | 1.32 | 1.37 | 1.34 | 1.29 | 1.25 |
| | A71D | 1.23 | 1.24 | 1.23 | 1.23 | 1.26 | 1.26 | 1.31 | 1.32 | 1.37 | 1.34 | 1.29 | 1.25 |
| | A71E | 1.22 | 1.23 | 1.22 | 1.22 | 1.25 | 1.25 | 1.29 | 1.30 | 1.34 | 1.32 | 1.27 | 1.24 |
| | A71F | 1.22 | 1.23 | 1.22 | 1.22 | 1.26 | 1.26 | 1.30 | 1.32 | 1.35 | 1.32 | 1.28 | 1.25 |
| | A71G | 1.38 | 1.39 | 1.38 | 1.39 | 1.43 | 1.43 | 1.47 | 1.49 | 1.54 | 1.50 | 1.44 | 1.41 |
| | A71H | 1.24 | 1.25 | 1.24 | 1.25 | 1.28 | 1.28 | 1.33 | 1.35 | 1.41 | 1.36 | 1.30 | 1.26 |
| | A71J | 1.22 | 1.23 | 1.22 | 1.22 | 1.26 | 1.26 | 1.30 | 1.32 | 1.35 | 1.32 | 1.28 | 1.25 |
| | A71K | 1.21 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.28 | 1.28 | 1.32 | 1.31 | 1.26 | 1.23 |
| | A71L | 1.18 | 1.19 | 1.18 | 1.18 | 1.21 | 1.21 | 1.24 | 1.25 | 1.30 | 1.27 | 1.22 | 1.19 |
| | A72A | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.30 | 1.34 | 1.31 | 1.26 | 1.23 |
| | A72B | 1.21 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.27 | 1.29 | 1.33 | 1.31 | 1.26 | 1.23 |
| | | | | | | | | | | | | | |
| **Nzhelele** | A80A | 1.26 | 1.27 | 1.26 | 1.26 | 1.31 | 1.31 | 1.35 | 1.37 | 1.44 | 1.39 | 1.34 | 1.29 |
| | A80B | 1.26 | 1.26 | 1.25 | 1.26 | 1.29 | 1.29 | 1.35 | 1.36 | 1.42 | 1.39 | 1.33 | 1.29 |
| | A80C | 1.24 | 1.25 | 1.24 | 1.24 | 1.28 | 1.28 | 1.32 | 1.34 | 1.40 | 1.35 | 1.31 | 1.26 |
| | A80D | 1.26 | 1.26 | 1.25 | 1.26 | 1.29 | 1.29 | 1.35 | 1.36 | 1.42 | 1.39 | 1.33 | 1.29 |
| | A80E | 1.26 | 1.26 | 1.25 | 1.26 | 1.29 | 1.29 | 1.35 | 1.36 | 1.42 | 1.39 | 1.33 | 1.29 |
| | A80F | 1.22 | 1.23 | 1.23 | 1.23 | 1.26 | 1.26 | 1.30 | 1.32 | 1.36 | 1.33 | 1.29 | 1.25 |
| | A80G | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.30 | 1.34 | 1.31 | 1.26 | 1.23 |
| | A80H | 1.22 | 1.23 | 1.23 | 1.23 | 1.26 | 1.26 | 1.30 | 1.32 | 1.36 | 1.33 | 1.29 | 1.25 |
| | A80J | 1.22 | 1.22 | 1.21 | 1.21 | 1.24 | 1.24 | 1.29 | 1.30 | 1.34 | 1.31 | 1.26 | 1.23 |

## Table E.4: Stream flow monitoring points in the Limpopo WMA North

| Station no. | Name | Catchment area (km²) | Latitude | Longitude | Start | End | Years of data | Calibration, verification or unusable* |
|---|---|---|---|---|---|---|---|---|
| **River** | | | | | | | | |
| A4H001 | Mokolo River @ Weltevrede | 1606 | 24.4065 | 28.10915 | 1938 | 1948 | 11 | |
| A4H002 | Mokolo River @ Zandrivier | 1777 | 24.29944 | 28.0956 | 1948 | 2013 | 66 | Calibration |
| A4H003 | Sterkstroom @ Doornspruit | 519 | 24.19123 | 27.9472 | 1954 | 1964 | 11 | |
| A4H004 | Matlabas River @ Haarlem East | 1046 | 24.1605 | 27.47959 | 1962 | 2013 | 52 | Calibration |
| A4H005 | Mokolo River @ Dwaalhoek | 3786 | 24.08062 | 27.77301 | 1962 | 2012 | 51 | Calibration |
| A4H006 | Poerseloop @ Weltevreden | 477 | 23.85959 | 27.79108 | 1962 | 1967 | 6 | |
| A4H007 | Tambotie River @ Blakeney | 398 | 23.76389 | 27.909 | 1962 | 2013 | 52 | Calibration |
| A4H008 | Sterkstroom @ Doornspruit | 504 | 24.21686 | 27.9733 | 1964 | 2013 | 50 | Calibration |
| A4H009 | Witbank Spruit @ Hans Strijdom Natres | 10 | 23.96902 | 27.71636 | 1980 | 2001 | 22 | |
| A4H010 | Mokolo River @ Mokolo Nat Res | 4319 | 23.9711 | 27.72578 | 1980 | 2013 | 34 | |
| A4H014 | Mogol River | | 23.23571 | 27.71709 | 2004 | 2013 | 10 | |
| A5H001 | Palala River @ Melk River | 601 | 23.99402 | 28.41221 | 1937 | 1967 | 31 | |
| A5H002 | Palala River @ Over Yssel | 2303 | 23.63405 | 28.15637 | 1957 | 1966 | 10 | |
| A5H003 | Limpopo River @ Botswana | 98160 | 22.95076 | 27.97359 | 1959 | 2002 | 44 | |
| A5H004 | Palala River @ Muisvogelkraal | 629 | 23.98173 | 28.40006 | 1955 | 2013 | 59 | Calibration |
| A5H005 | Palala River @ Hopetown | 2331 | 23.62099 | 28.14693 | 1967 | 1984 | 18 | |
| A5H006 | Limpopo River @ Botswana | 98240 | 22.93476 | 28.00392 | 1971 | 2013 | 43 | |
| A6H001 | Nyl River @ Moorddrift | 2366 | 24.27608 | 28.97481 | 1919 | 2013 | 95 | |
| A6H002 | Nyl River @ Deelkraal | 738 | 24.68292 | 28.62923 | 1922 | 2013 | 92 | |
| A6H003 | Sterk River @ Bellevue | 1373 | 23.94181 | 28.73 | 1937 | 1946 | 10 | |
| A6H004 | Sterk River @ Paardedrift | 513 | 24.32261 | 28.69861 | 1938 | 1951 | 14 | |
| A6H005 | Sterk River @ Eckstein | 1352 | 23.97014 | 28.69666 | 1946 | 1952 | 7 | |
| A6H006 | Little Nyl River @ Nylstroom | 168 | 24.6985 | 28.407 | 1949 | 2013 | 65 | |
| A6H007 | Mogalakwena River @ Steilloop | 9487 | 23.43712 | 28.62444 | 1977 | 1980 | 4 | |

| Station no. | Name | Catchment area (km²) | Latitude | Longitude | Start | End | Years of data | Calibration, verification or unusable* |
|---|---|---|---|---|---|---|---|---|
| A6H008 | Sterk River @ Doorndraai | 579 | 24.27984 | 28.77889 | 1951 | 1953 | 3 | |
| A6H009 | Mogalakwena River @ Leniesrus | 14733 | 22.59801 | 28.88612 | 1960 | 1997 | 38 | Calibration |
| A6H010 | Badseloop River @ Vischgat | 70 | 24.57402 | 28.63971 | 1964 | 2013 | 50 | Calibration |
| A6H011 | Great-Nyl River @ Modderpoort | 73 | 24.76191 | 28.34458 | 1966 | 2013 | 48 | Calibration |
| A6H012 | Olifant Spruit @ Olifantspoort | 120 | 24.66552 | 28.47632 | 1966 | 2013 | 48 | Calibration |
| A6H013 | Groundwater Supplement From Nyl Riv. @ Du Toitskra | | 24.56732 | 28.76361 | 1971 | 1977 | 7 | |
| A6H015 | Groundwater Supplement From Nyl Riv. @ De Hoop | | 24.44038 | 28.90306 | 1971 | 1974 | 4 | |
| A6H018 | Rasloop River @ Sussensvale | 12 | 24.771 | 28.34901 | 1973 | 2013 | 41 | |
| A6H019 | Hessie Se Water @ Rietspruit | 16 | 24.65976 | 28.45104 | 1973 | 2013 | 41 | |
| A6H020 | Middelfontein Spruit @ Middelfontein | 43 | 24.67128 | 28.56068 | 1973 | 2013 | 41 | |
| A6H021 | De Wet Spruit @ Groenvaley | 16 | 24.63195 | 28.59549 | 1973 | 2013 | 41 | |
| A6H022 | Hartebeestlaagte@Spruit @ Hartebeestlaagte | 1.7 | 24.60204 | 28.60749 | 1973 | 1997 | 25 | |
| A6H023 | Tobias Spruit @ Saratoga | 130 | 24.45791 | 28.7494 | 1973 | 2013 | 41 | |
| A6H024 | Kootjie Se Loop@Spruit @ Waterval | 23 | 24.31653 | 28.91644 | 1973 | 2013 | 41 | |
| A6H026 | Haaskloof Spruit @ Haaskloof | 41.2 | 24.37705 | 28.53027 | 1988 | 1994 | 7 | |
| A6H027 | Sterk River @ Doorndraai | 579 | 24.27573 | 28.77721 | 1953 | 2013 | 61 | Verification |
| A6H029 | Mogalakwena River @ Glen Alpine | 11292 | 23.18415 | 28.69964 | 1970 | 2013 | 44 | Verification |
| A6H032 | Dorps River @ Piet Potgietersrust | 174 | 24.16374 | 29.02917 | 1978 | 1980 | 3 | |
| A6H033 | Nyl River @ Moorddrift | 2404.2 | 24.24108 | 28.97653 | 1990 | 2013 | 24 | Verification |
| A6H035 | Mogalakwena River @ Leniesrus | 15845 | 22.55019 | 28.89752 | 1995 | 2013 | 19 | |
| A6H036 | Sterk River @ Appingen Dam | 1363 | 23.98141 | 28.69557 | 1995 | 2013 | 19 | Verification |
| A6H037 | Nyl River @ Vogelfontein | 1363 | 24.61524 | 28.69032 | 1997 | 2013 | 17 | |
| A6H038 | Nyl River @ Du Toits Kraal | | 24.56631 | 28.76353 | 1997 | 2013 | 17 | |
| A6H039 | Nyl River @ Middelfontein | | 24.69852 | 28.54818 | 1998 | 2013 | 16 | |
| A7H001 | Sand River @ Waterpoort | 7703 | 22.9091 | 29.61391 | 1957 | 2000 | 44 | Verification |
| A7H002 | Brak River @ Kaalplaats | 1867.5 | 22.95076 | 29.2472 | 1937 | 1947 | 11 | |

| Station no. | Name | Catchment area (km²) | Latitude | Longitude | Start | End | Years of data | Calibration, verification or unusable* |
|---|---|---|---|---|---|---|---|---|
| A7H003 | Sand River @ Zamenkomst | 6700 | 23.06742 | 29.57891 | 1947 | 1995 | 49 | Calibration |
| A7H004 | Limpopo River @ Beit Bridge | 201000 | 22.22471 | 29.98698 | 1955 | 1992 | 38 | |
| A7H006 | Sand River @ Zamenkomst | 6700 | 23.06742 | 29.57891 | 1947 | 1958 | 12 | |
| A7H007 | Sand River @ Pietersburg | 521.6 | 23.88295 | 29.43149 | 1991 | 2013 | 23 | |
| A7H008 | Limpopo River @ Beit Bridge | 202985 | 22.22727 | 29.99031 | 1992 | 2013 | 22 | |
| A7H009 | Sand River @ Dorothy | 12873 | 22.49135 | 29.98309 | 1993 | 2000 | 8 | |
| A7H010 | SAND RIVER AT WATERPOORT | 7712 | 22.91027 | 29.61093 | 2002 | 2013 | 12 | |
| A8H001 | Nzhelele River @ Kondoa | 543 | 22.793 | 30.07032 | 1932 | 1946 | 15 | |
| A8H002 | Mutamba River @ Bekaf | 490 | 22.80633 | 29.88892 | 1937 | 1947 | 11 | |
| A8H003 | Mutamba River @ Prince's Hill | 132 | 22.86744 | 29.79975 | 1938 | 1942 | 5 | |
| A8H004 | Nzhelele River @ Schuitdrift | 855 | 22.68412 | 30.0956 | 1938 | 1947 | 10 | |
| A8H005 | Mutamba River @ King's Kloof | 128 | 22.88688 | 29.7967 | 1960 | 1976 | 17 | |
| A8H008 | Nzhelele River @ Nairobi | 843 | 22.72578 | 30.0956 | 1948 | 2000 | 53 | |
| A8H009 | Luphephe River @ Nwanedi Nat. Res. | 157 | 22.63434 | 30.4019 | 1964 | 2013 | 50 | |
| A8H010 | Nwanedzi River @ Nwanedzi Nat. Res. | 109 | 22.6345 | 30.39878 | 1963 | 2013 | 51 | |
| A8H011 | Mutshedzi River @ Beaconsfield- W comp.of Mutshedzi Dam | 95 | 22.94299 | 30.16254 | 1991 | 2000 | 10 | |
| A8H014 | Mutshedzi River @ Beaconsfield- W comp.of Mutshedzi Dam | 329 | 22.93504 | 30.15727 | 2002 | 2013 | 12 | |
| A8H015 | nzelele at nairobi | | 22.72371 | 30.09435 | 2002 | 2013 | 12 | |
| **Reservoirs** | | | | | | | | |
| A4R001 | Mokolo River @ Mokolo Dam | 4319 | 23.98413 | 27.71902 | 1980 | 2014 | 35 | |
| A5R001 | Palala River @ Vischgat Dam | 2322 | 23.6322 | 28.15959 | 1968 | 2015 | 48 | Verification |
| A5R002 | Palala River @ Susandale Dam | 3537 | 23.38106 | 28.02191 | 1968 | 2014 | 47 | Verification |
| A6R001 | Sterk River @ Doorndraai Dam | 580 | 24.27983 | 28.77664 | 1953 | 2015 | 63 | Verification |
| A6R002 | Mogalakwena River @ Glen Alpine Dam | 11245 | 23.19189 | 28.69813 | 1967 | 2014 | 48 | Calibration |
| A6R003 | Little Nyl River @ Donkerpoort Dam | 89 | 24.669 | 28.32364 | 1978 | 1986 | 9 | Calibration |
| A6R004 | Dorps River @ Gert Combrink Dam | 174 | 24.16434 | 29.03008 | 1978 | 1990 | 13 | |

| Station no. | Name | Catchment area (km²) | Latitude | Longitude | Start | End | Years of data | Calibration, verification or unusable* |
|---|---|---|---|---|---|---|---|---|
| A7R002 | Hout River @ Houtriver Dam | 144 | 23.77217 | 29.22969 | 2009 | 2015 | 7 | Calibration |
| A8R001 | Nzhelele River @ Nzhelele Dam | 830 | 22.72471 | 30.09544 | 1948 | 2014 | 67 | Calibration |
| A8R002 | Luphephe River @ Luphephe Dam | 109 | 22.63499 | 30.39884 | 1964 | 2014 | 51 | Calibration |
| A8R003 | Nwanedzi River @ Nwanedzi Dam | 156 | 22.63445 | 30.40211 | 1963 | 2014 | 52 | Calibration |
| A8R004 | Mutshedzi River @ Mutshedzi Dam | 94 | 22.94571 | 30.164 | 1990 | 2014 | 25 | |
| **Canals** | | | | | | | | |
| A6H028 | Right Canal To Treatment Works @ Doorndraai | | 24.27984 | 28.77472 | 1977 | 2008 | 32 | |
| A6H030 | Right Irrigation@Canal @ Doorndraai | | 24.27901 | 28.77709 | 1954 | 2014 | 61 | |
| A8H017 | CANAL @ SCUIDTSDRIFT | | - | - | 2010 | 2014 | 5 | |
| A8H019 | Doreen Main Canal Tail End | | - | - | 2010 | 2014 | 5 | |
| A8H020 | N17 CANAL | | - | - | 2007 | 2014 | 8 | |
| A8H021 | Main Canal D Canal Take off @ Nzhelele Canal system | | - | - | 2013 | 2014 | 2 | |
| A8H022 | D Canal Take off @ Nzhelele Canal System | | - | - | 2013 | 2014 | 2 | |
| A8H023 | E Canal Take Off @ Nzhelele Canal system | | - | - | 2013 | 2014 | 2 | |
| A8H024 | B Canal Take off @ Nzhelele Canal System | | - | - | 2013 | 2014 | 2 | |
| A8H026 | C Canal Take off @ Nzhelele Canal System | | - | - | 2013 | 2014 | 2 | |
| **Pipelines** | | | | | | | | |
| A4H011 | Pipeline From Mokolo Dam @ Mokolo Nat Res | | 23.98274 | 27.71892 | 1980 | 2015 | 36 | |
| A6H031 | Pipeline To Dorp @ Piet Potgietersrust | | 24.16374 | 29.02917 | 1978 | 1980 | 3 | |
| A8H012 | Pipeline From Dam To Treatment Works @ Beaconsfield | | 22.93812 | 30.16048 | 1990 | 2014 | 25 | |

* *Gauges unusable indicated by blank spaces*

# Appendix F

# WRSM2000 calibration parameters and statistics

## Table F.1: Final WRSM2000 calibration parameter values

| Catchment and Quaternary (or sub-catchment) | | Calibration parameter | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POW | GPOW | HGSL | ST | FT | HGGW | ZMIN | ZMAX | PI | TL | R |
| Matlabas | A41A | 3 | 4.5 | 0 | 150 | 2 | 2.1 | 0 | 999 | 1.5 | 0.6 | 0.5 |
| | A41B | 3 | 5.5 | 0 | 150 | 2 | 2.1 | 0 | 999 | 1.5 | 0.6 | 0.5 |
| | A41C | 3 | 1 | 0 | 150 | 2 | 3.5 | 0 | 999 | 1.5 | 0.6 | 0.5 |
| | A41D | 3 | 1 | 0 | 150 | 0 | 2.9 | 0 | 999 | 1.5 | 0.6 | 0.5 |
| | A41E | 3 | 1 | 0 | 150 | 0 | 2.14 | 0 | 999 | 1.5 | 0.6 | 0.5 |
| | | | | | | | | | | | | |
| Mokolo | A42A | 3 | 2 | 20 | 170 | 8 | 13 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A42B | 3 | 2 | 15 | 170 | 8 | 9 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A42C | 3 | 2 | 15 | 170 | 8 | 9 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A42D | 2 | 2 | 15 | 50 | 3 | 15 | 999 | 999 | 1.5 | 0.8 | 0.5 |
| | A42E | 3 | 2 | 25 | 100 | 10 | 3 | 999 | 999 | 1.5 | 0.9 | 0.5 |
| | A42F | 3 | 2 | 25 | 90 | 5 | 3 | 999 | 999 | 1.5 | 0.9 | 0.5 |
| | A42G | | | | | | | | | | | |
| | A42H | 3 | 2 | 20 | 85 | 3 | 1 | 125 | 750 | 1.5 | 0.85 | 0.5 |
| | A42J | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Lephalala | A50A | 3 | 1.5 | 0 | 50 | 40 | 2 | 0 | 999 | 1.5 | 0.95 | 0.5 |
| | A50B | 3 | 1.5 | 0 | 50 | 40 | 2 | 0 | 999 | 1.5 | 0.95 | 0.5 |
| | A50C | 3 | 3 | 1 | 55 | 30 | 5 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A50D | 3 | 3 | 1 | 55 | 30 | 4 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A50E | 3 | 3 | 1 | 55 | 30 | 5 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A50F | 3 | 2.2 | 0 | 400 | 0 | 10.1 | 0 | 1500 | 1.5 | 0.25 | 0.5 |
| | A50G | 3 | 1 | 0 | 400 | 0 | 3 | 0 | 1500 | 1.5 | 0.25 | 0.5 |

| Catchment and Quaternary (or sub-catchment) | | Calibration parameter | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POW | GPOW | HGSL | ST | FT | HGGW | ZMIN | ZMAX | PI | TL | R |
| | A50H | 3 | 3 | 0 | 400 | 0 | 18 | 0 | 1500 | 1.5 | 0.25 | 0.5 |
| | A50J | 3 | 3 | 0 | 400 | 0 | 20 | 0 | 1500 | 1.5 | 0.25 | 0.5 |
| | | | | | | | | | | | | |
| Mogalakwena | A61A1 | 3 | 0.5 | 1 | 150 | 28 | 1 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61A2 | 3 | 0.5 | 0 | 150 | 28 | 18 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61A3 | 3 | 0.5 | 0 | 150 | 28 | 1 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61B1 | 3 | 3 | 0 | 60 | 10 | 0.5 | 999 | 999 | 1.5 | 0.8 | 0.2 |
| | A61B2 | 3 | 3 | 0 | 60 | 10 | 12 | 999 | 999 | 1.5 | 0.8 | 0.2 |
| | A61C1 | 3 | 3 | 0 | 230 | 3 | 2.5 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A61C2 | 3 | 3 | 0 | 230 | 3 | 2.5 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A61D1 | 3 | 4.5 | 0 | 165 | 3 | 12 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61D2 | 3 | 4.5 | 0 | 165 | 3 | 12 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61E1 | 3 | 4.5 | 0 | 165 | 3 | 13 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61E2 | 3 | 4.5 | 0 | 165 | 3 | 13 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61F | 3 | 4.5 | 0 | 165 | 3 | 13 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61G | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A61H | 2 | 0.5 | 0 | 75 | 1 | 3 | 0 | 999 | 1.5 | 0.25 | 0.5 |
| | A61J | 3 | 4.5 | 0 | 165 | 3 | 10.5 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62A | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62B | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62C | 3 | 4.5 | 2.5 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62D | 3 | 4.5 | 2.5 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62E | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62F | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |

| Catchment and Quaternary (or sub-catchment) | | Calibration parameter | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POW | GPOW | HGSL | ST | FT | HGGW | ZMIN | ZMAX | PI | TL | R |
| | A62G | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62H | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A62J | 3 | 4.5 | 0 | 165 | 3 | 10 | 999 | 999 | 1.5 | 0.25 | 0.5 |
| | A63A | 3 | 3 | 0 | 300 | 0 | 12 | 100 | 1000 | 1.5 | 0.25 | 0.8 |
| | A63B | 3 | 3 | 0 | 300 | 0 | 12 | 100 | 1000 | 1.5 | 0.25 | 0.8 |
| | A63C | 3 | 3 | 0 | 300 | 0 | 16 | 100 | 1000 | 1.5 | 0.25 | 0.8 |
| | A63D | 3 | 3 | 0 | 300 | 0 | 25 | 100 | 1000 | 1.5 | 0.25 | 0.5 |
| | A63E | 3 | 2.8 | 0 | 300 | 0 | 18 | 100 | 1000 | 1.5 | 0.25 | 0.5 |
| | | | | | | | | | | | | |
| Sand | A71A | 3 | 2 | 0 | 170 | 3.5 | 15 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71B | 3 | 2.2 | 0 | 170 | 3.5 | 12 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71C | 3 | 2.2 | 0 | 170 | 3.5 | 7 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71D | 3 | 3 | 0 | 170 | 3.5 | 4 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71E | 3 | 3 | 0 | 170 | 3.5 | 10 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71F | 3 | 3 | 0 | 170 | 3.5 | 10 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71G | 3 | 3 | 0 | 170 | 3.5 | 9 | 25 | 1350 | 1.5 | 0 | 0.1 |
| | A71H | 3 | 5.5 | 0 | 225 | 1 | 9 | 75 | 1500 | 1.5 | 0 | 0.5 |
| | A71J | 3 | 3 | 0 | 200 | 0 | 17 | 25 | 1250 | 1.5 | 0.25 | 0.5 |
| | A71K | 3 | 3 | 0 | 200 | 0 | 17 | 25 | 1000 | 1.5 | 0.25 | 0.5 |
| | A71L | 1.5 | 3 | 0 | 225 | 1 | 18 | 75 | 1500 | 1.5 | 0 | 0.5 |
| | A72A | 3 | 3 | 15 | 200 | 1 | 2 | 25 | 1250 | 1.5 | 0.25 | 0.5 |
| | A72B | 3 | 3 | 0 | 700 | 1 | 2 | 25 | 1250 | 1.5 | 0.25 | 0.5 |
| | | | | | | | | | | | | |

| Catchment and Quaternary (or sub-catchment) | | Calibration parameter | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POW | GPOW | HGSL | ST | FT | HGGW | ZMIN | ZMAX | PI | TL | R |
| Nzhelele | A80A | 3 | 1.5 | 0 | 390 | 25 | 3 | 50 | 1500 | 1.5 | 0.25 | 0 |
| | A80B | 3 | 3 | 0 | 390 | 25 | 11.7 | 50 | 1500 | 1.5 | 0.25 | 0 |
| | A80C | 3 | 3 | 0 | 390 | 25 | 0.1 | 50 | 1500 | 1.5 | 0.25 | 0 |
| | A80D | 3 | 3 | 0 | 390 | 25 | 2 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80E | 3 | 3 | 0 | 390 | 25 | 2 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80F | 3 | 3 | 0 | 390 | 25 | 0.1 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80G | 3 | 3 | 0 | 390 | 25 | 20 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80H1 | 2 | 2 | 0 | 165 | 23 | 2 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80H2 | 2 | 2 | 0 | 250 | 5 | 2 | 50 | 1000 | 1.5 | 0.25 | 0.5 |
| | A80J | 3 | 3 | 0 | 350 | 0 | 2 | 25 | 1250 | 1.5 | 0.25 | 0.5 |
| | | | | | | | | | | | | |

## Table F.2: Calibration statistics for the Matlabas River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A4H004 (1962-2010)** | | | |
| MAR | 32.73 | 31.46 | -3.88 |
| Mean (Log) | 0.97 | 1.2 | 23.71 |
| Std deviation | 42.08 | 40.77 | -3.11 |
| Log (Std Dev) | 1.02 | 0.53 | -48.04 |
| Seasonal index | 49.53 | 50.73 | 2.42 |

## Table F.3: Calibration statistics for the Mokolo River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A4H002 (1948-2010)** | | | |
| MAR | 74.52 | 76.6 | 2.79 |
| Mean (Log) | 1.51 | 1.53 | 1.32 |
| Standard Deviation (SD) | 83.69 | 104.12 | 24.41 |
| Log (SD) | 0.71 | 0.61 | -14.08 |
| Seasonal index | 37.57 | 45.65 | 21.51 |
| **Stream flow gauge A4H005 (1962-2010)** | | | |
| MAR | 178.89 | 175.4 | -1.95 |
| Mean (Log) | 1.65 | 1.88 | 13.94 |
| Standard Deviation (SD) | 210.48 | 226.94 | 7.82 |
| Log (SD) | 1.15 | 0.63 | -45.22 |
| Seasonal index | 40.63 | 50.89 | 25.25 |
| **Stream flow gauge A4H007 (1962-2010)** | | | |
| MAR | 10.58 | 10.57 | -0.09 |
| Mean (Log) | -0.02 | 0.06 | -400.00 |
| Standard Deviation (SD) | 16.74 | 17.65 | 5.44 |
| Log (SD) | 1.34 | 1.26 | -5.97 |
| Seasonal index | 48.56 | 48.36 | -0.41 |
| **Stream flow gauge A4H008 (1964-2010)** | | | |
| MAR | 51.38 | 50.74 | -1.25 |
| Mean (Log) | 1.39 | 1.43 | 2.88 |
| Standard Deviation (SD) | 53.2 | 53.96 | 1.43 |
| Log (SD) | 0.64 | 0.57 | -10.94 |
| Seasonal index | 38.81 | 47.73 | 22.98 |

## Table F.4: Calibration statistics for the Lephalala River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A5H004 (1961-2010)** | | | |
| MAR | 53.04 | 50.67 | -4.47 |
| Mean (Log) | 1.48 | 1.54 | 4.05 |
| Standard Deviation (SD) | 51.63 | 43.21 | -16.31 |
| Log (SD) | 0.5 | 0.4 | -20.00 |
| Seasonal index | 36.62 | 35.63 | -2.70 |
| **Stream flow gauge A5R001 (1968-2010)*** | | | |
| MAR | 146.39 | 100.83 | -31.12 |
| Mean (Log) | 1.68 | 1.80 | 7.14 |
| Standard Deviation (SD) | 143.70 | 96.58 | -32.79 |
| Log (SD) | 1.07 | 0.46 | -57.01 |
| Seasonal index | 37.87 | 37.81 | -0.16 |
| **Stream flow gauge A5R002 (1968-2010)*** | | | |
| MAR | 146.53 | 114.06 | -22.16 |
| Mean (Log) | 1.81 | 1.86 | 2.76 |
| Standard Deviation (SD) | 144.96 | 111.56 | -23.04 |
| Log (SD) | 0.84 | 0.44 | -47.62 |
| Seasonal index | 39.38 | 37.11 | -5.76 |

* *Gauges used for verification of calibrated stream flows*

## Table F.5: Calibration statistics for the Mogalakwena River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A6H009 (1960-1996)*** | | | |
| MAR | 82.9 | 90.85 | 9.59 |
| Mean (Log) | 1.45 | 1.36 | -6.21 |
| Standard Deviation (SD) | 102.91 | 134.2 | 30.41 |
| Log (SD) | 0.87 | 1.02 | 17.24 |
| Seasonal index | 46.92 | 48.14 | 2.60 |
| **Stream flow gauge A6H010 (1963-2010)** | | | |
| MAR | 2.48 | 2.48 | 0.00 |
| Mean (Log) | -0.02 | 0.04 | -300.00 |
| Standard Deviation (SD) | 2.87 | 3.05 | 6.27 |
| Log (SD) | 0.72 | 0.72 | 0.00 |
| Seasonal index | 42.36 | 46.48 | 9.73 |
| **Stream flow gauge A6H011 (1966-2010)** | | | |
| MAR | 4.77 | 4.83 | 1.26 |
| Mean (Log) | 0.47 | 0.63 | 34.04 |
| Standard Deviation (SD) | 4.65 | 2.71 | -41.72 |
| Log (SD) | 0.47 | 0.22 | -53.19 |
| Seasonal index | 28.05 | 29.58 | 5.45 |
| **Stream flow gauge A6H012 (1966-2010)** | | | |
| MAR | 7.23 | 7.25 | 0.28 |
| Mean (Log) | 0.61 | 0.68 | 11.48 |
| Standard Deviation (SD) | 6.01 | 6.11 | 1.66 |
| Log (SD) | 0.62 | 0.43 | -30.65 |
| Seasonal index | 42.56 | 42.50 | -0.14 |
| **Stream flow gauge A6H027 (1952-2010)*** | | | |
| MAR | 12.65 | 15.87 | 25.45 |
| Mean (Log) | 0.15 | -0.01 | -108.67 |
| Standard Deviation (SD) | 18.99 | 21.91 | 15.38 |
| Log (SD) | 1.20 | 1.66 | 38.33 |
| Seasonal index | 40.58 | 48.75 | 20.13 |
| **Stream flow gauge A6H029 (1968-2010)*** | | | |
| MAR | 111.65 | 101.73 | -8.88 |
| Mean (Log) | 1.65 | 1.10 | -33.33 |
| Standard Deviation (SD) | 170.09 | 159.47 | -6.24 |
| Log (SD) | 0.58 | 1.40 | 141.38 |
| Seasonal index | 41.02 | 39.14 | -4.58 |
| **Stream flow gauge A6H033 (2005-2010)*** | | | |
| MAR | 7.33 | 6.80 | -7.23 |
| Mean (Log) | -0.20 | -0.46 | 130.00 |
| Standard Deviation (SD) | 13.35 | 8.83 | -33.86 |

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| Log (SD) | 1.48 | 1.70 | 14.86 |
| Seasonal index | 58.73 | 50.84 | -13.43 |
| **Stream flow gauge A6H036 (1995-2010)*** | | | |
| MAR | 38.14 | 40.11 | 5.17 |
| Mean (Log) | 1.27 | 1.13 | -11.02 |
| Standard Deviation (SD) | 41.52 | 49.22 | 18.55 |
| Log (SD) | 0.69 | 0.84 | 21.74 |
| Seasonal index | 39.20 | 38.97 | -0.59 |
| **Stream flow gauge A6R001 (1955-2010)*** | | | |
| MAR | 21.30 | 28.24 | 32.58 |
| Mean (Log) | 1.09 | 1.28 | 17.43 |
| Standard Deviation (SD) | 20.04 | 23.68 | 18.16 |
| Log (SD) | 0.51 | 0.41 | -19.61 |
| Seasonal index | 35.88 | 40.08 | 11.71 |
| **Stream flow gauge A6R002 (1970-2010)** | | | |
| MAR | 111.48 | 110.40 | -0.97 |
| Mean (Log) | 1.58 | 1.55 | -1.90 |
| Standard Deviation (SD) | 163.36 | 161.09 | -1.39 |
| Log (SD) | 0.75 | 0.76 | 1.33 |
| Seasonal index | 46.07 | 37.51 | -18.58 |

* *Gauges used for verification of calibrated stream flows*

## Table F.6: Calibration statistics for the Sand River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A7H001 (1965-1999)*** | | | |
| MAR | 17.09 | 53.61 | 213.69 |
| Mean (Log) | 0.59 | 1.21 | 105.08 |
| Std deviation | 32.12 | 145.86 | 354.11 |
| Log (Std Dev) | 1.02 | 0.55 | -46.08 |
| Seasonal index | 49.79 | 65.93 | 32.42 |
| **Stream flow gauge A7H003 (1947-1994)** | | | |
| MAR | 21.67 | 20.91 | -3.51 |
| Mean (Log) | 0.70 | 0.98 | 40.00 |
| Std deviation | 43.82 | 41.11 | -6.18 |
| Log (Std Dev) | 1.10 | 0.56 | -49.09 |
| Seasonal index | 57.97 | 53.03 | -8.52 |

* *Gauges used for verification of calibrated stream flows*

## Table F.7: Calibration statistics for the Nzhelele River catchment

| Statistic | Observed | Simulated | % difference |
|---|---|---|---|
| **Stream flow gauge A8R001 (1970-2010)** | | | |
| MAR | 68.89 | 65.65 | -4.70 |
| Mean (Log) | 1.57 | 1.57 | 0.00 |
| Std deviation | 90.74 | 79.55 | -12.33 |
| Log (Std Dev) | 0.51 | 0.49 | -3.92 |
| Seasonal index | 41.06 | 41.95 | 2.17 |
| **Stream flow gauge A8R002 (1971-2010)** | | | |
| MAR | 19.5 | 20.41 | 4.67 |
| Mean (Log) | -0.01 | 1.09 | -11000.00 |
| Std deviation | 38.16 | 21.28 | -44.23 |
| Log (Std Dev) | 1.64 | 0.54 | -67.07 |
| Seasonal index | 40.76 | 36.28 | -10.99 |
| **Stream flow gauge A8R003 (1971-2010)** | | | |
| MAR | 8.75 | 9.49 | 8.46 |
| Mean (Log) | -0.43 | 0.51 | -218.60 |
| Std deviation | 16.31 | 13.84 | -15.14 |
| Log (Std Dev) | 1.55 | 0.93 | -40.00 |
| Seasonal index | 52.74 | 39.31 | -25.46 |

# Appendix G

## WRSM2000 calibration graphs

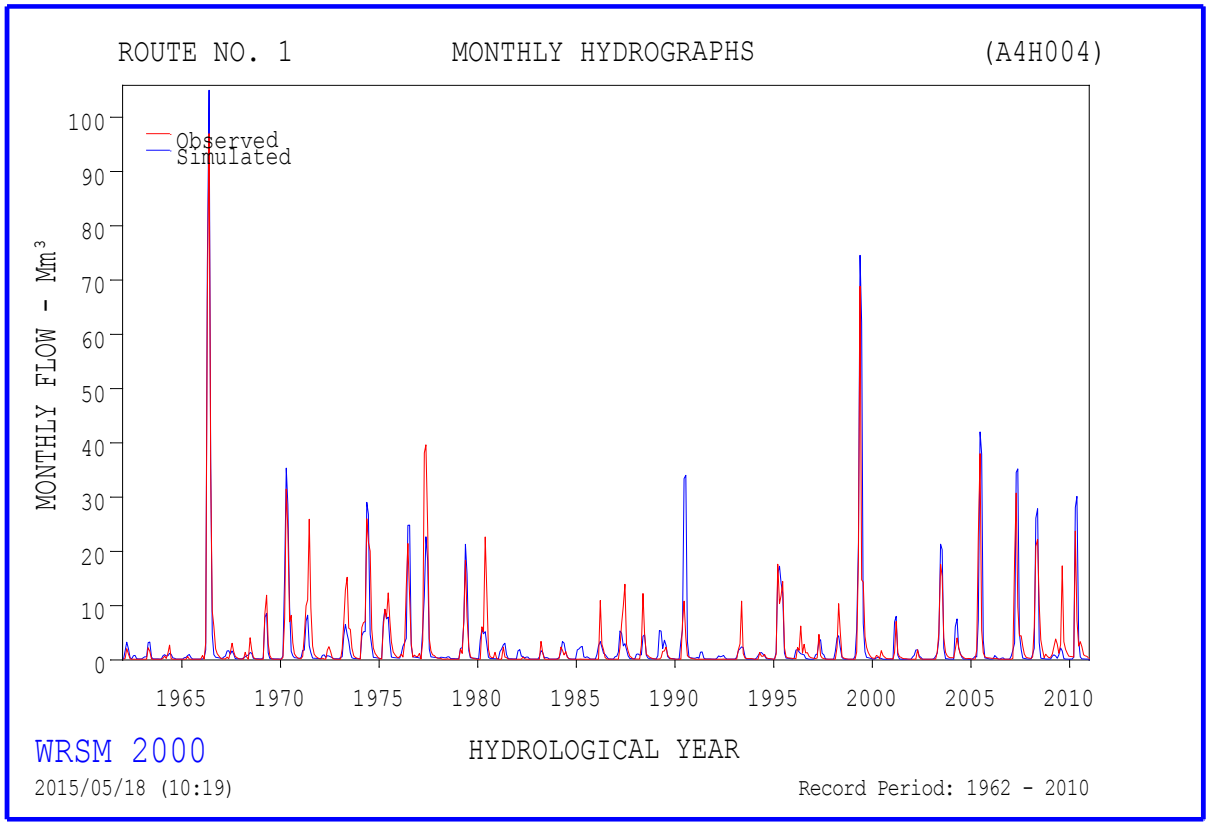



Figure G.1: A4H004 Observed and simulated monthly hydrograph

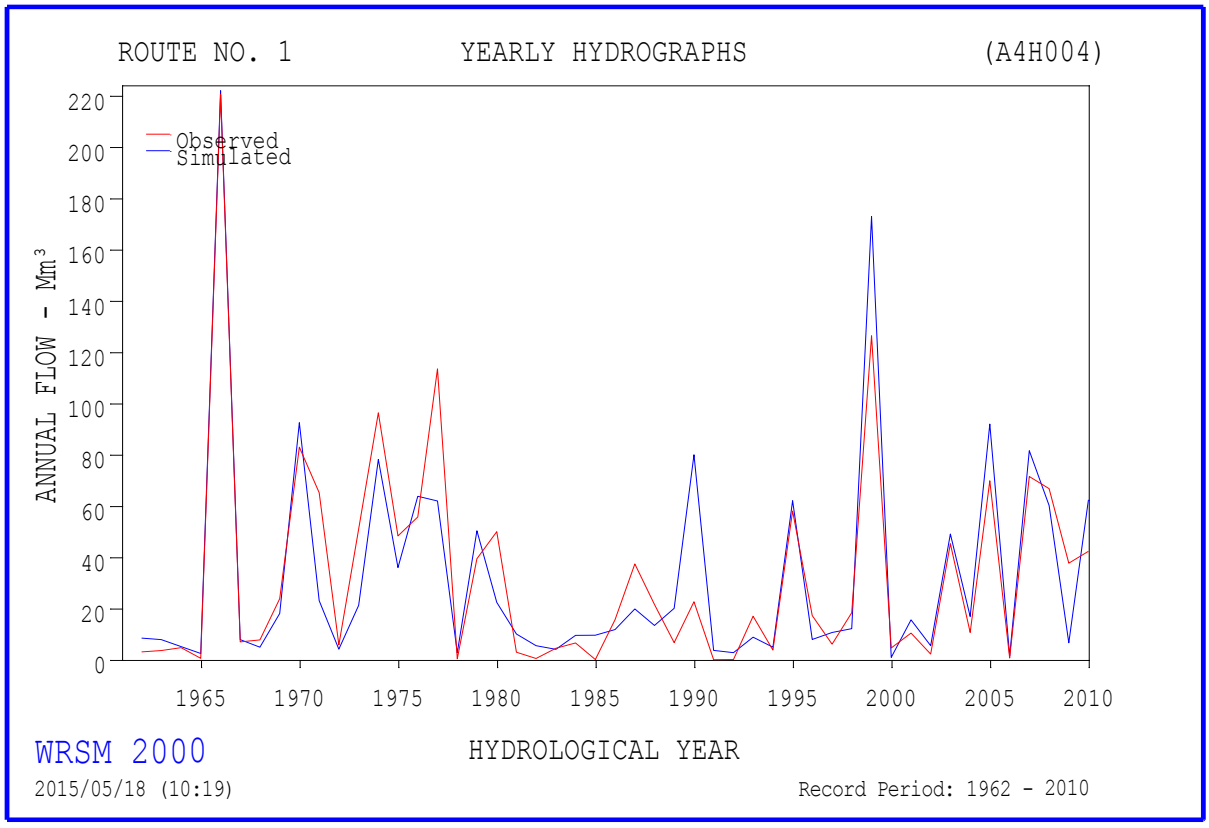



Figure G.2: A4H004 Observed and simulated annual hydrograph

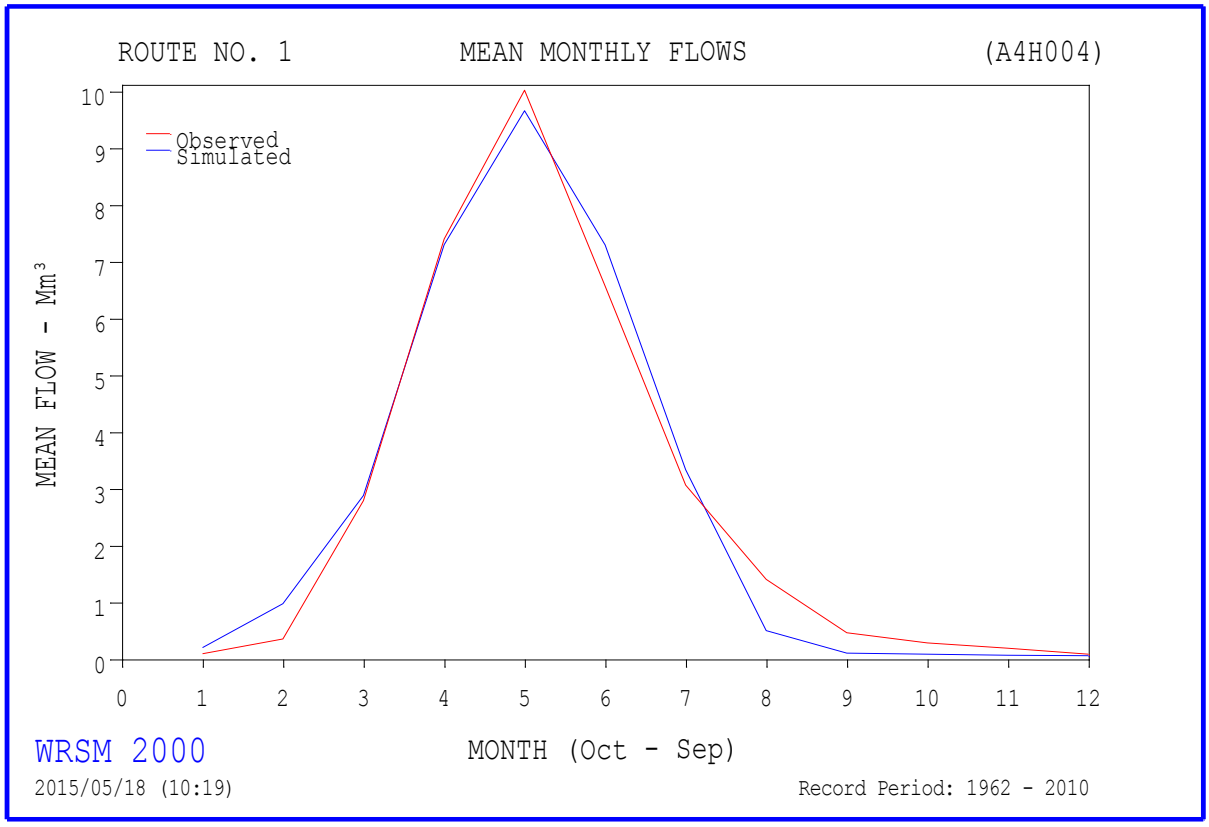



Figure G.3: A4H004 Observed and simulated mean monthly flows

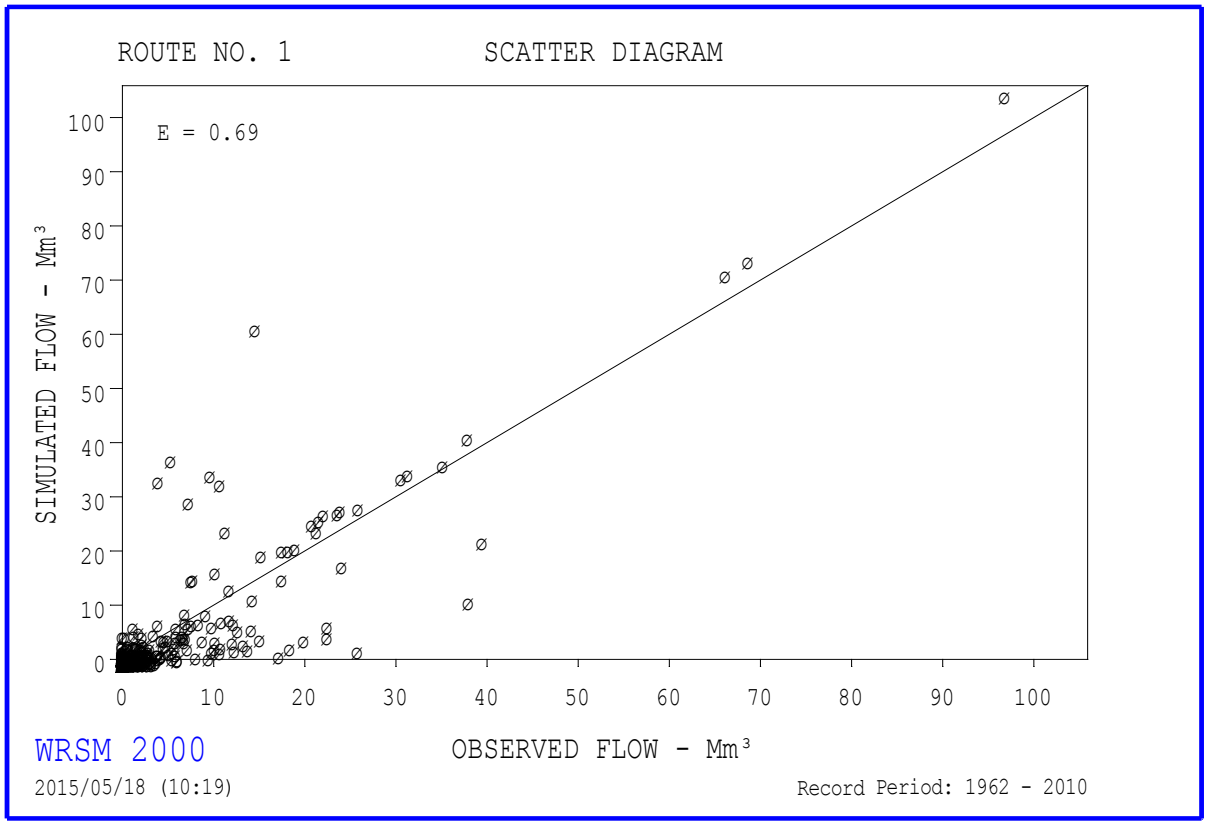



Figure G.4: A4H004 Observed and simulated scatter plot

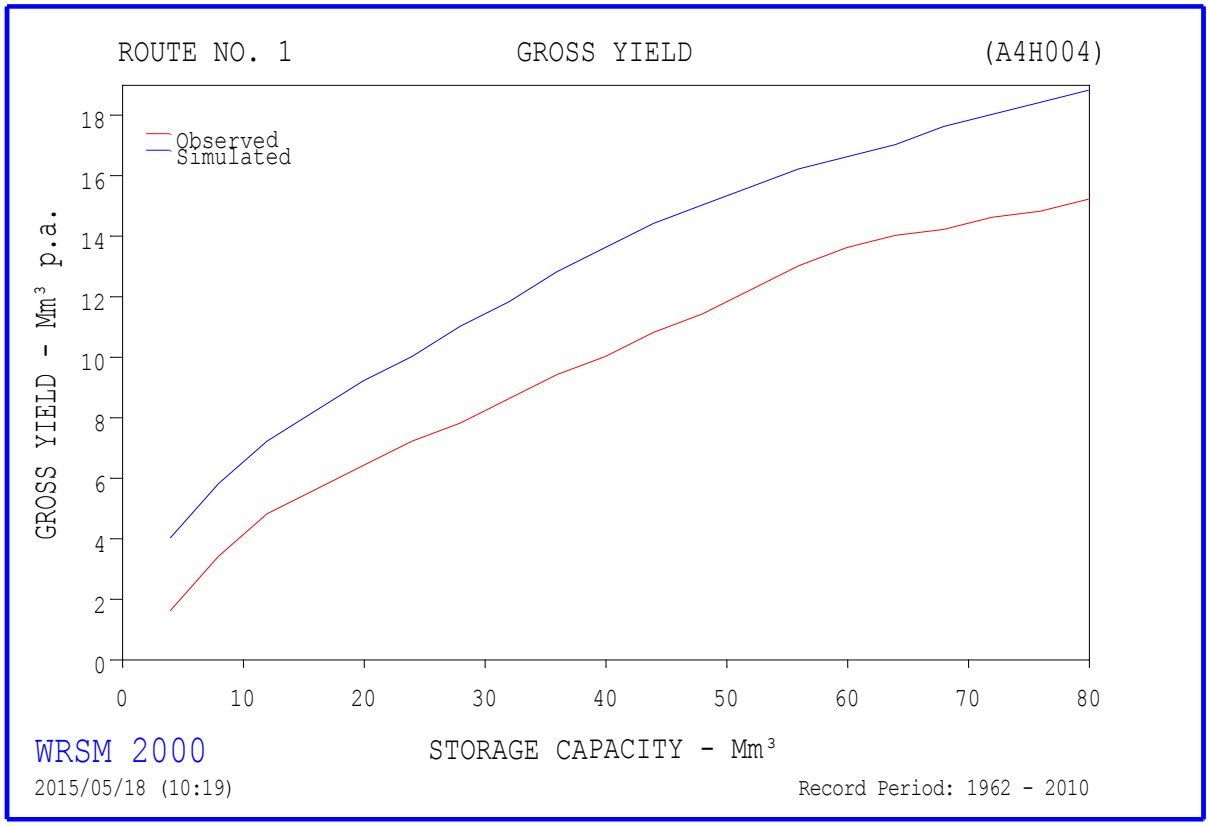



Figure G.5: A4H004 Observed and simulated gross yield of flows

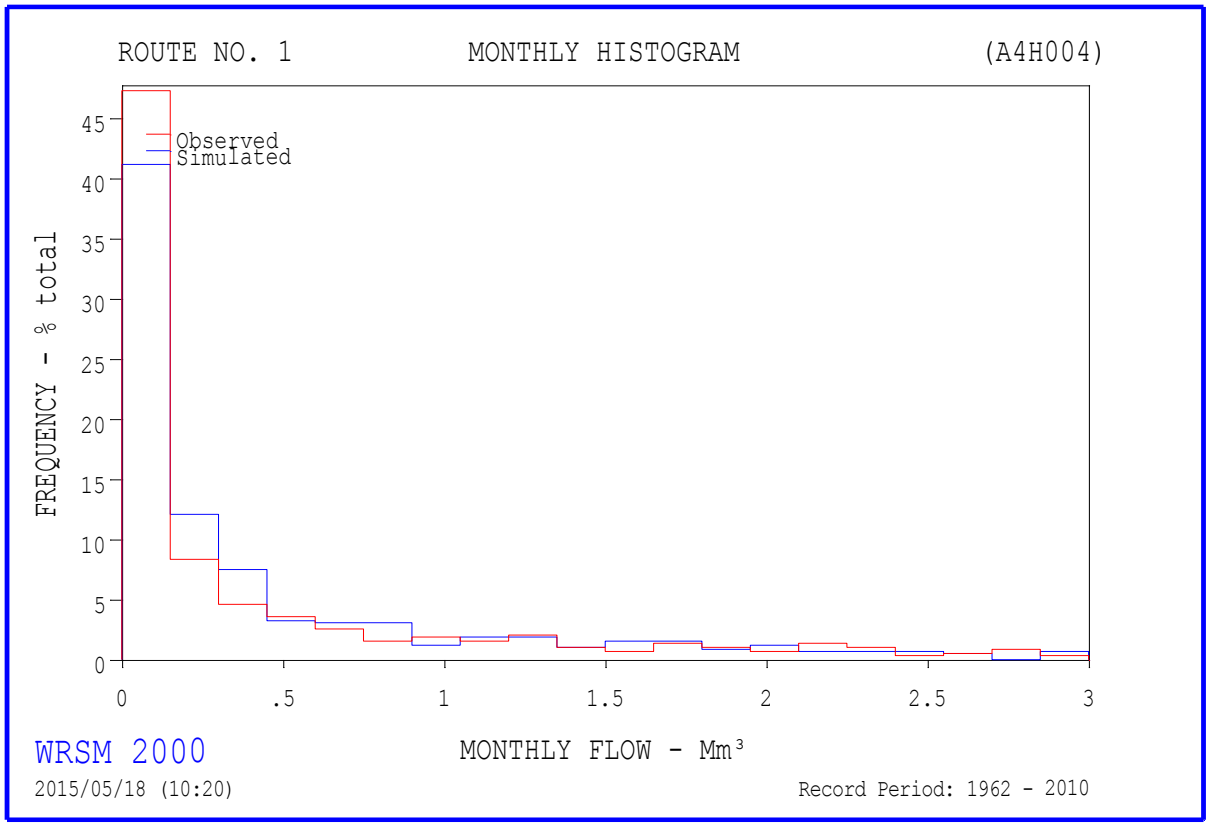



Figure G.6: A4H004 Observed and simulated histogram of flows

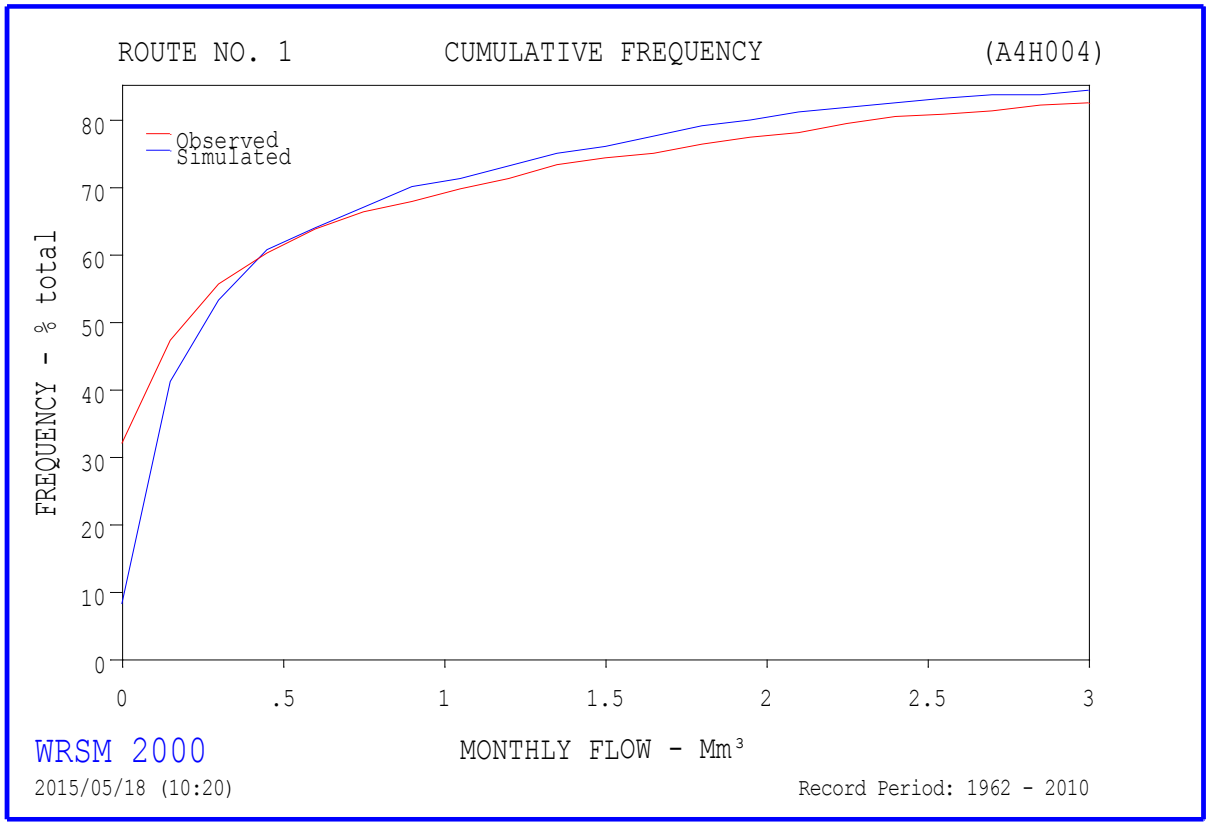



**Figure G.7: A4H004 Observed and simulated cumulative frequency flows**

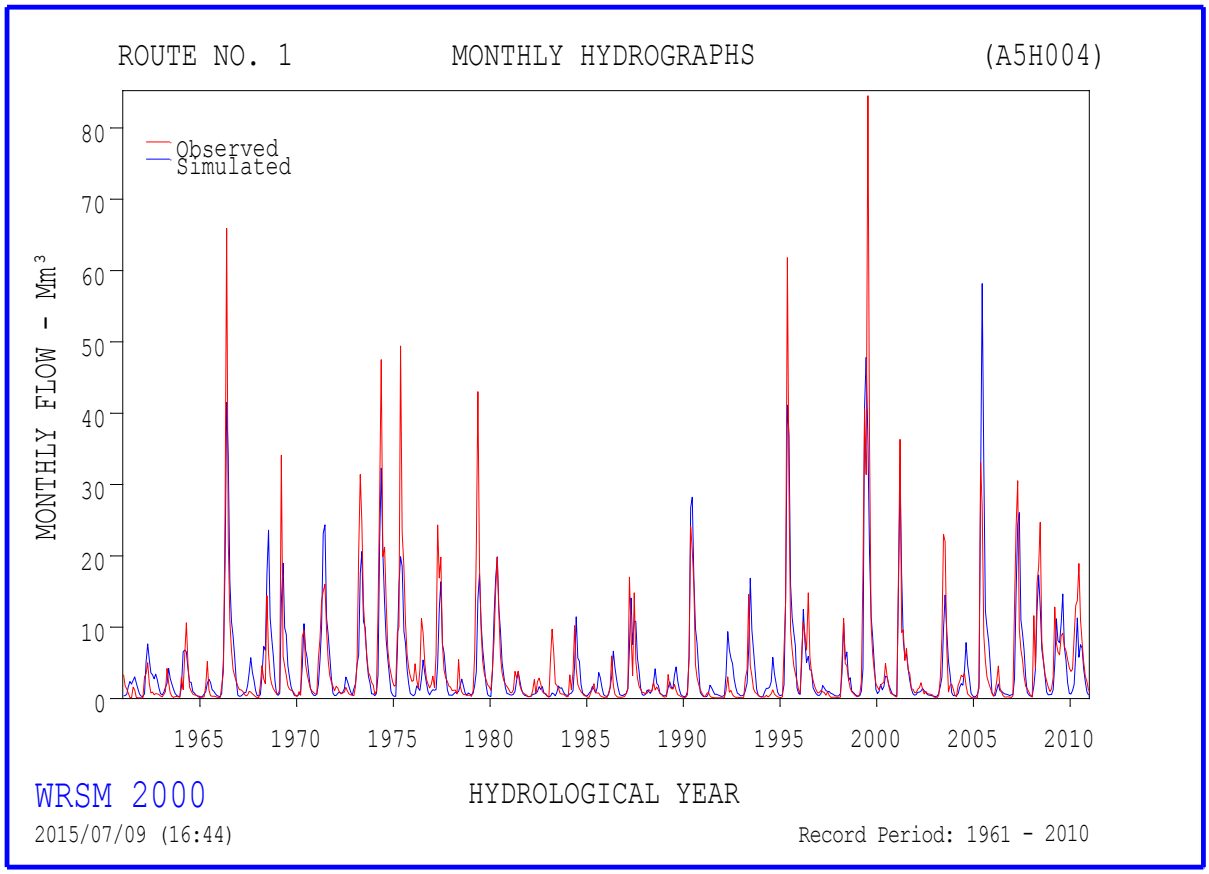



**Figure G.8: A5H004 Observed and simulated mean monthly flows**

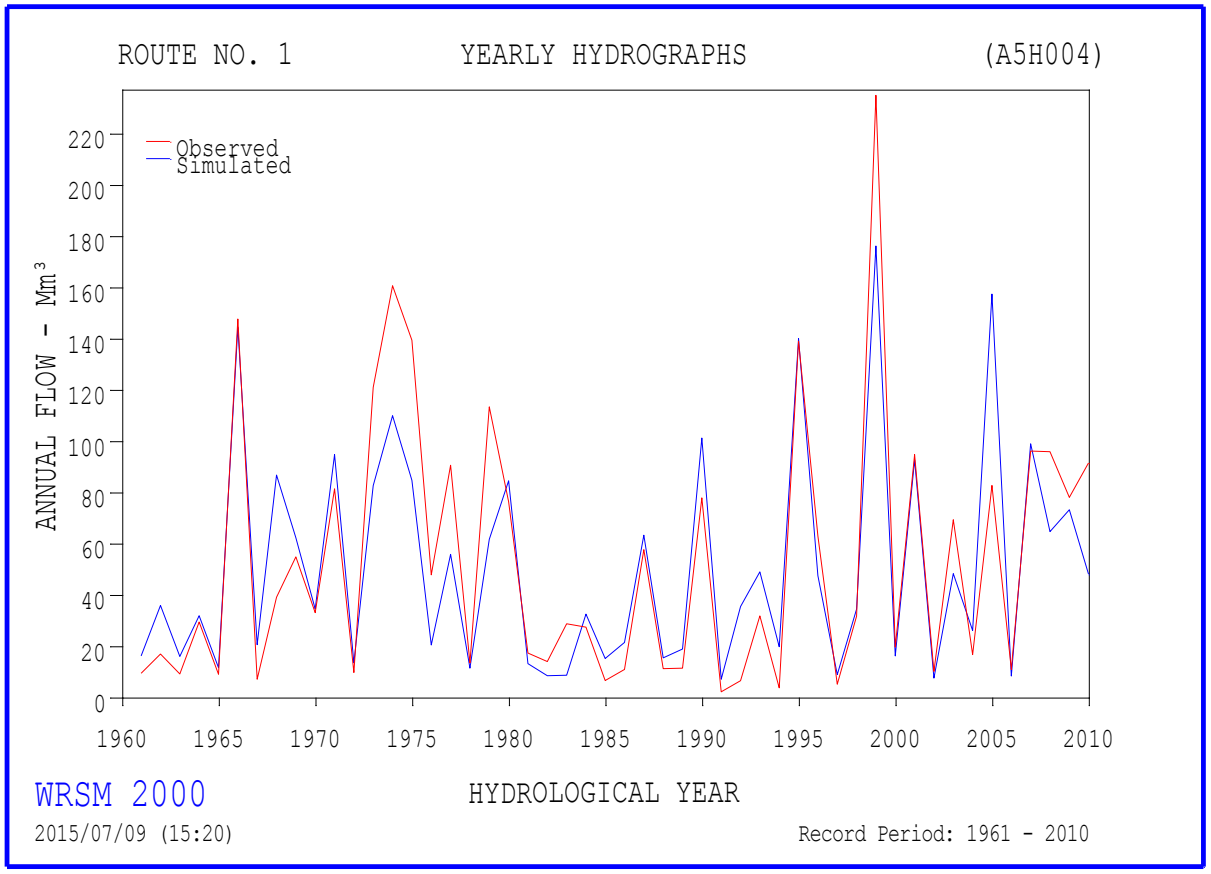



**Figure G.9: A5H004 Observed and simulated annual hydrograph**

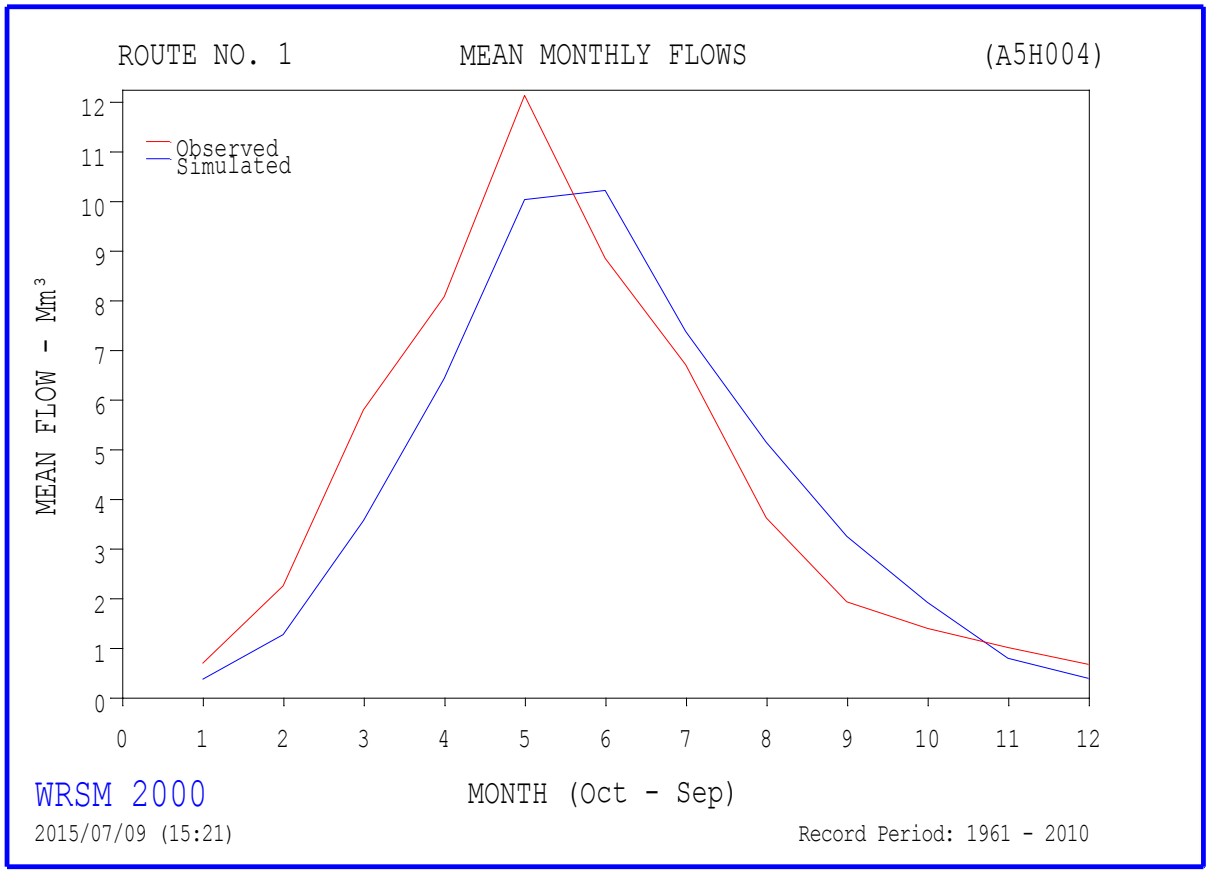



**Figure G.10: A5H004 Observed and simulated mean monthly flows**

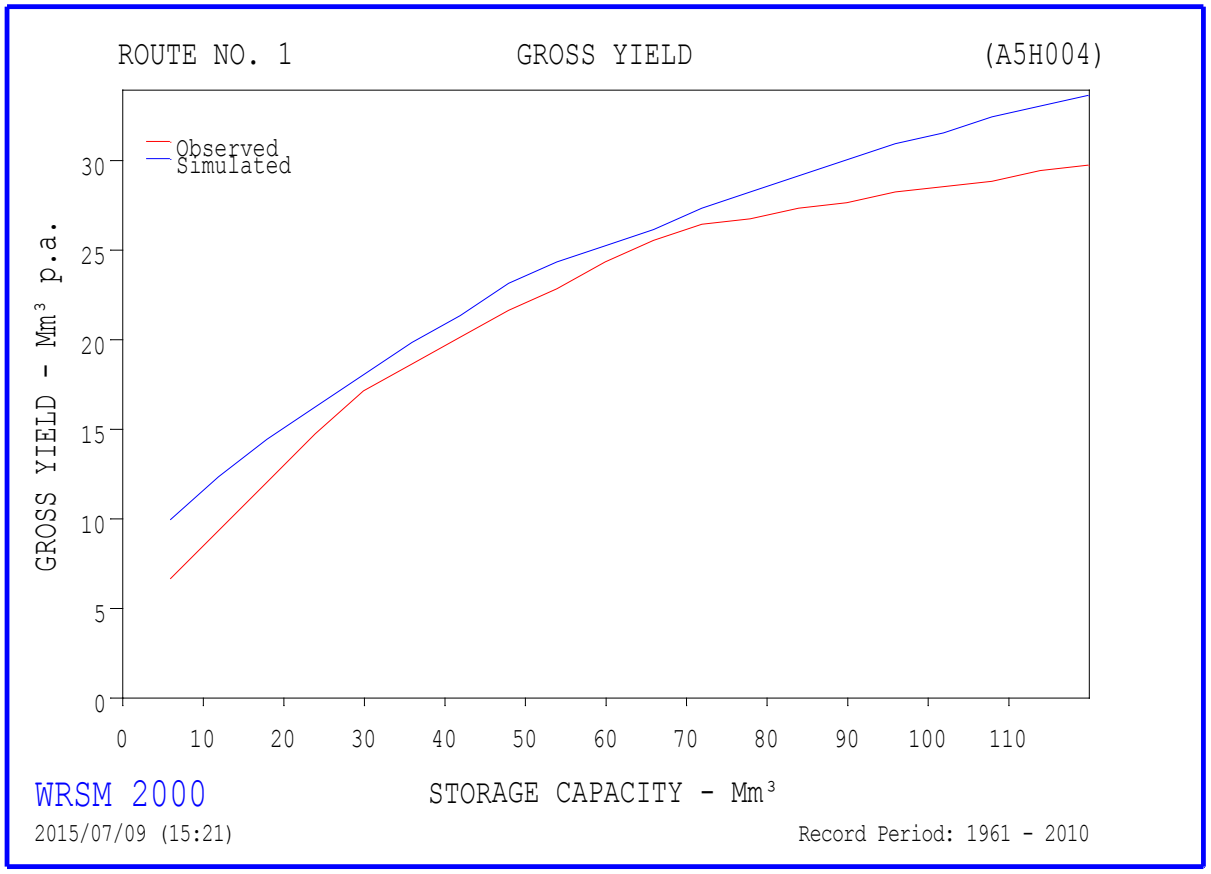



**Figure G.11: A5H004 Observed and simulated gross yield of flows**

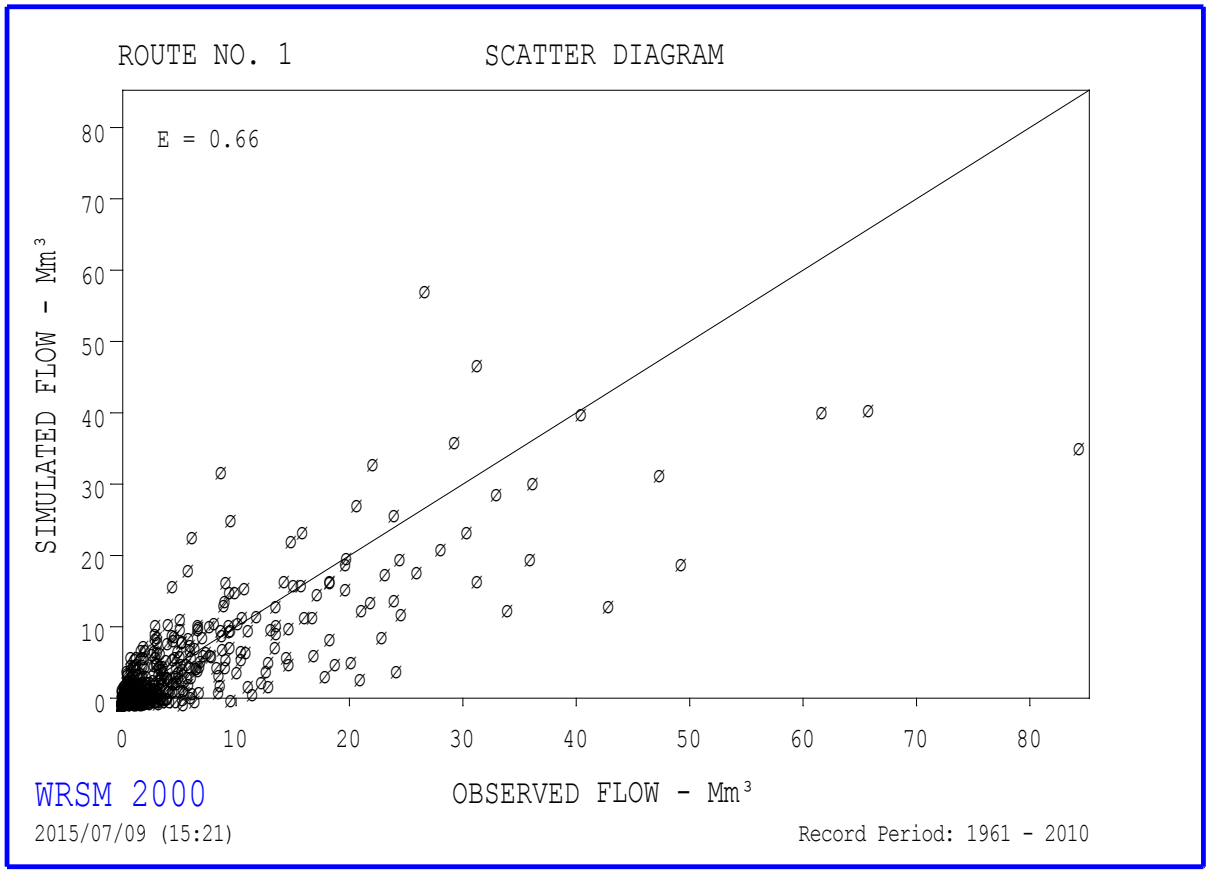



**Figure G.12: A5H004 Observed and simulated scatter**

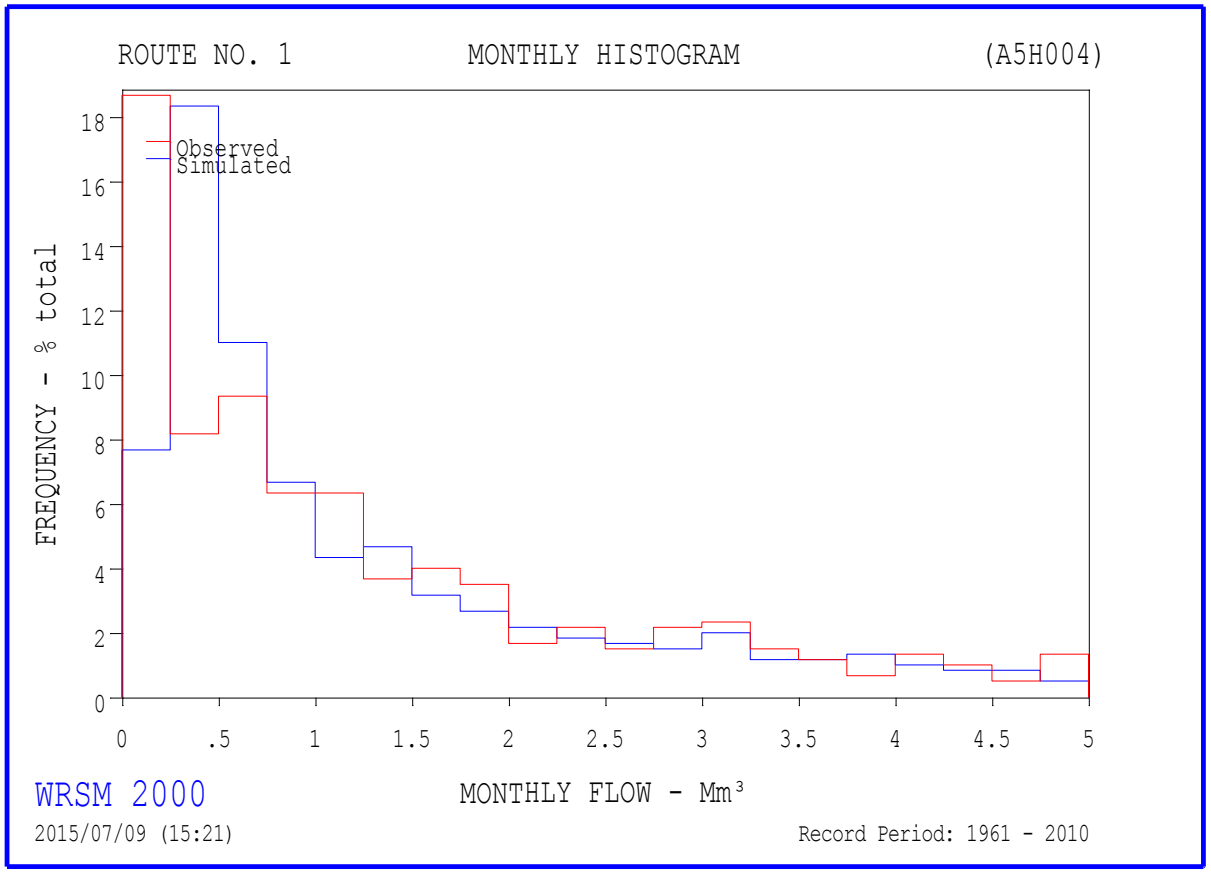



Figure G.13: A5H004 Observed and simulated histogram of flows

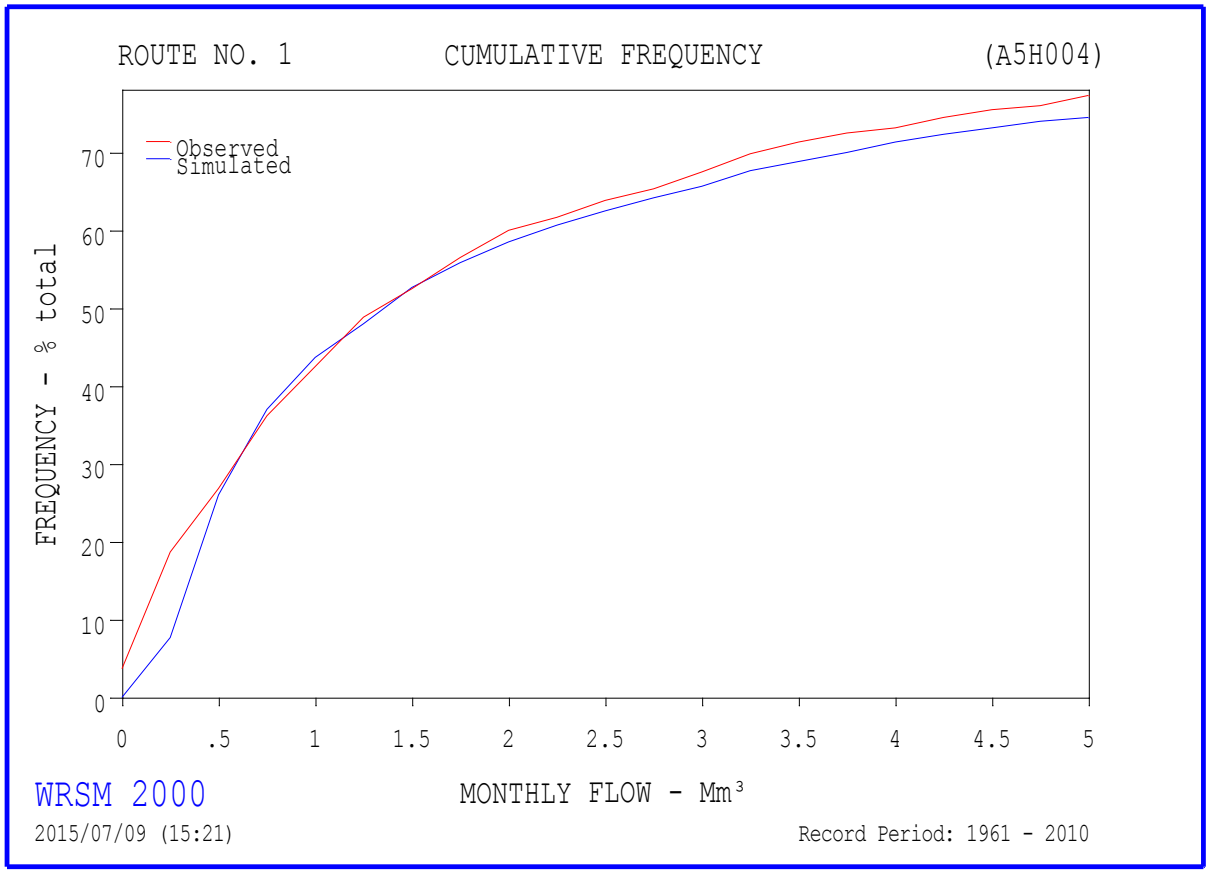



Figure G.14: A5H004 Observed and simulated cumulative frequency flows

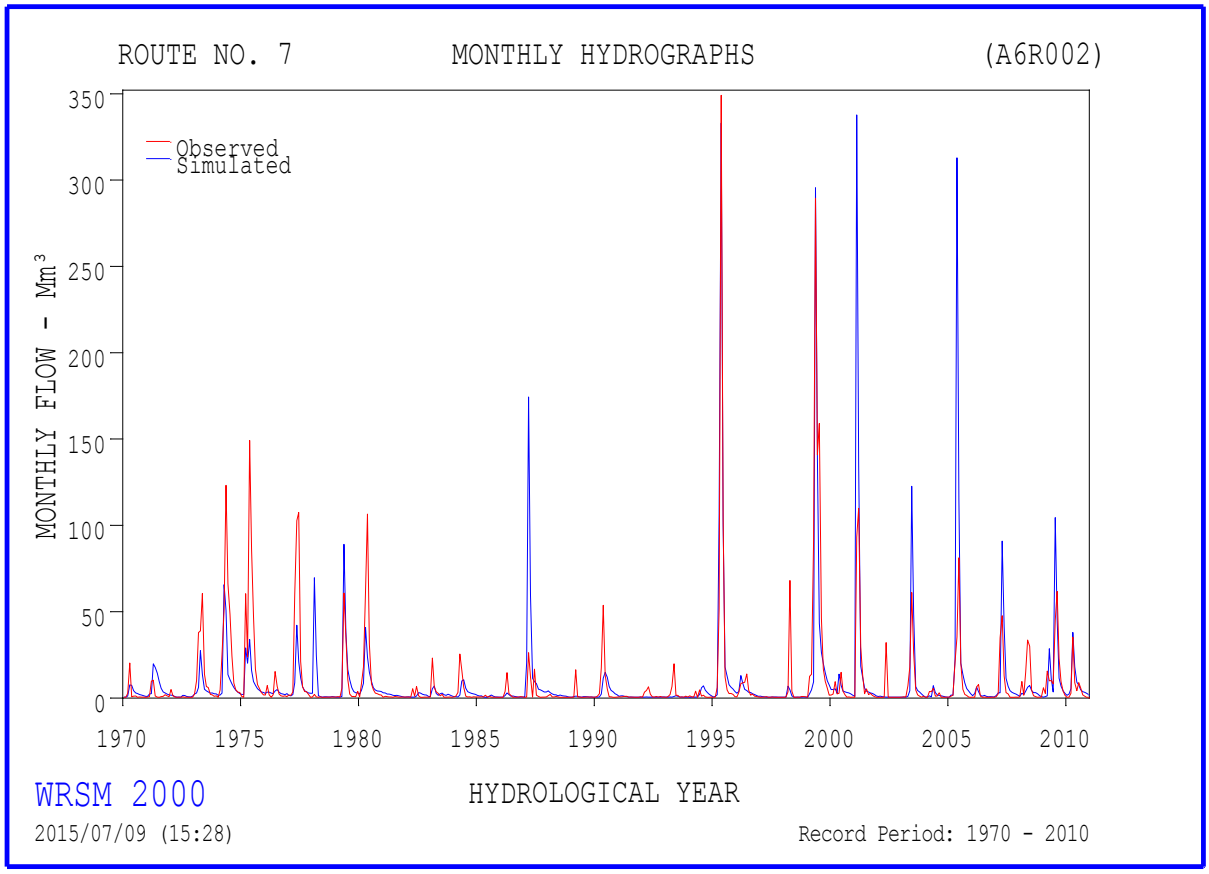



**Figure G.15: A6R002 Observed and simulated monthly hydrograph**

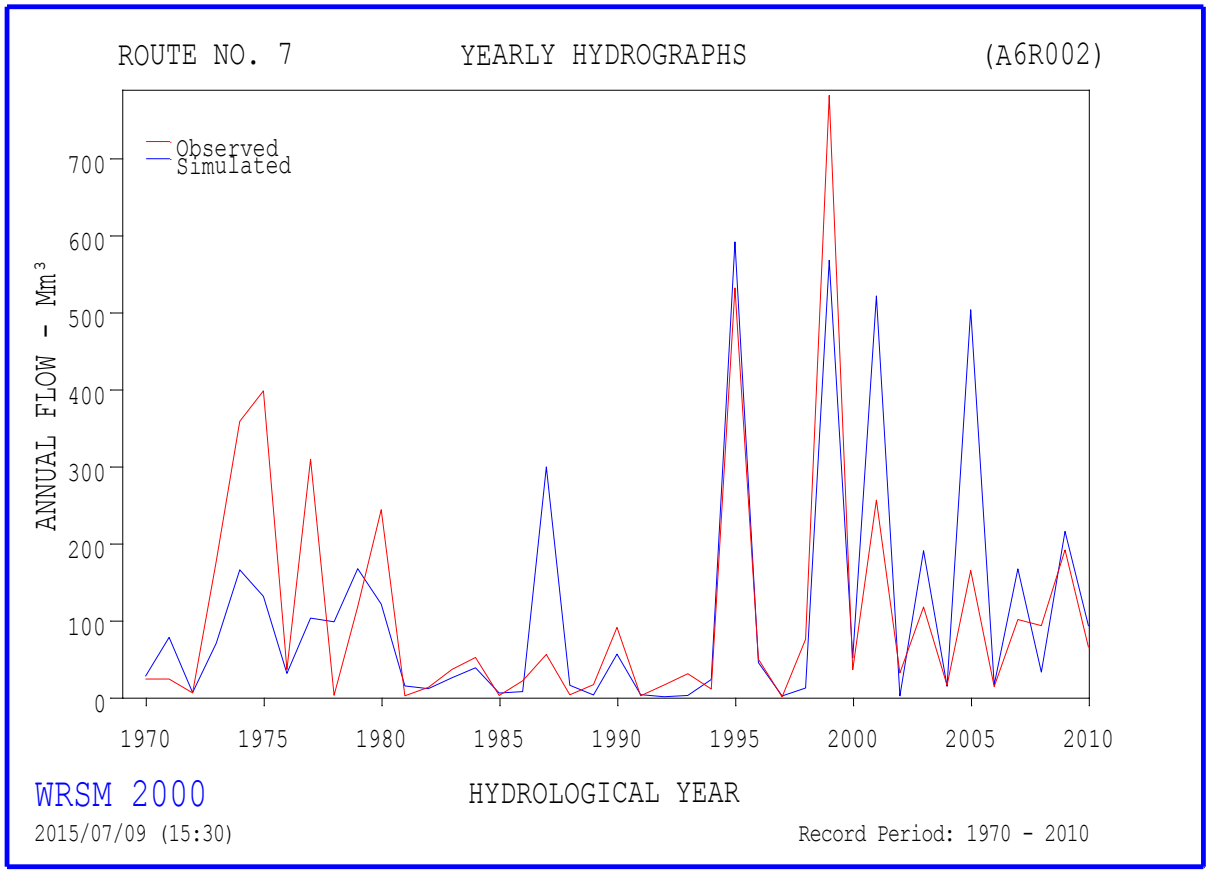



**Figure G.16: A6R002 Observed and simulated annual hydrograph**

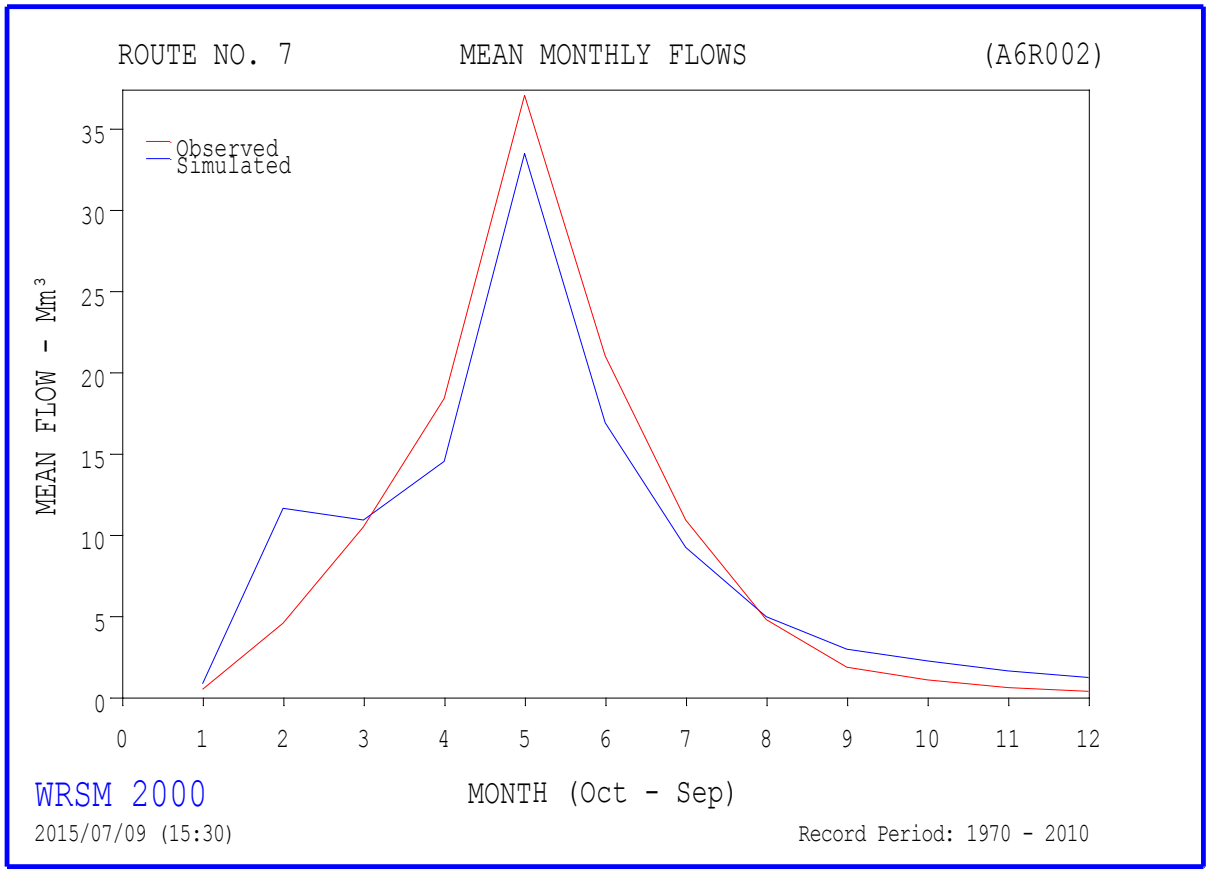



**Figure G.17: A6R002 Observed and simulated mean monthly flows**

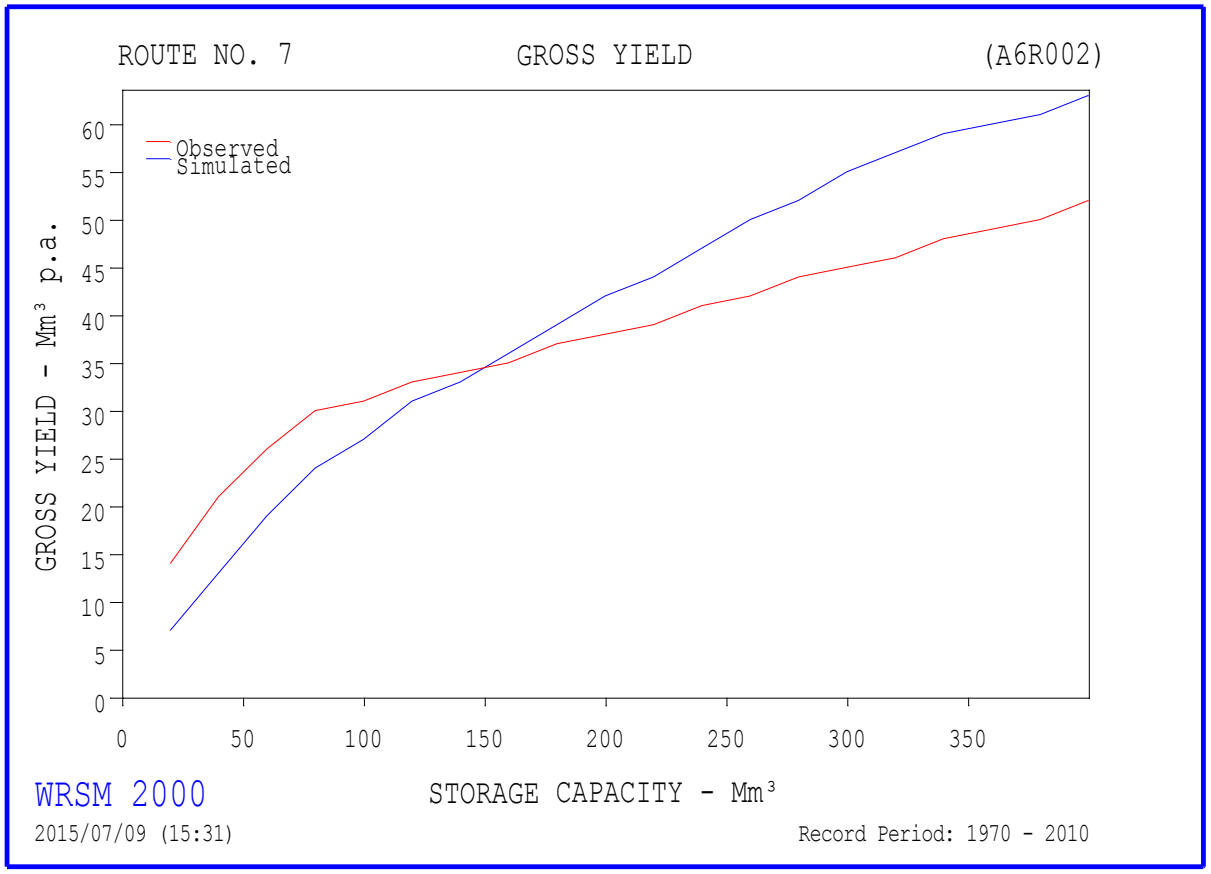



**Figure G.18: A6R002 Observed and simulated gross yield flows**

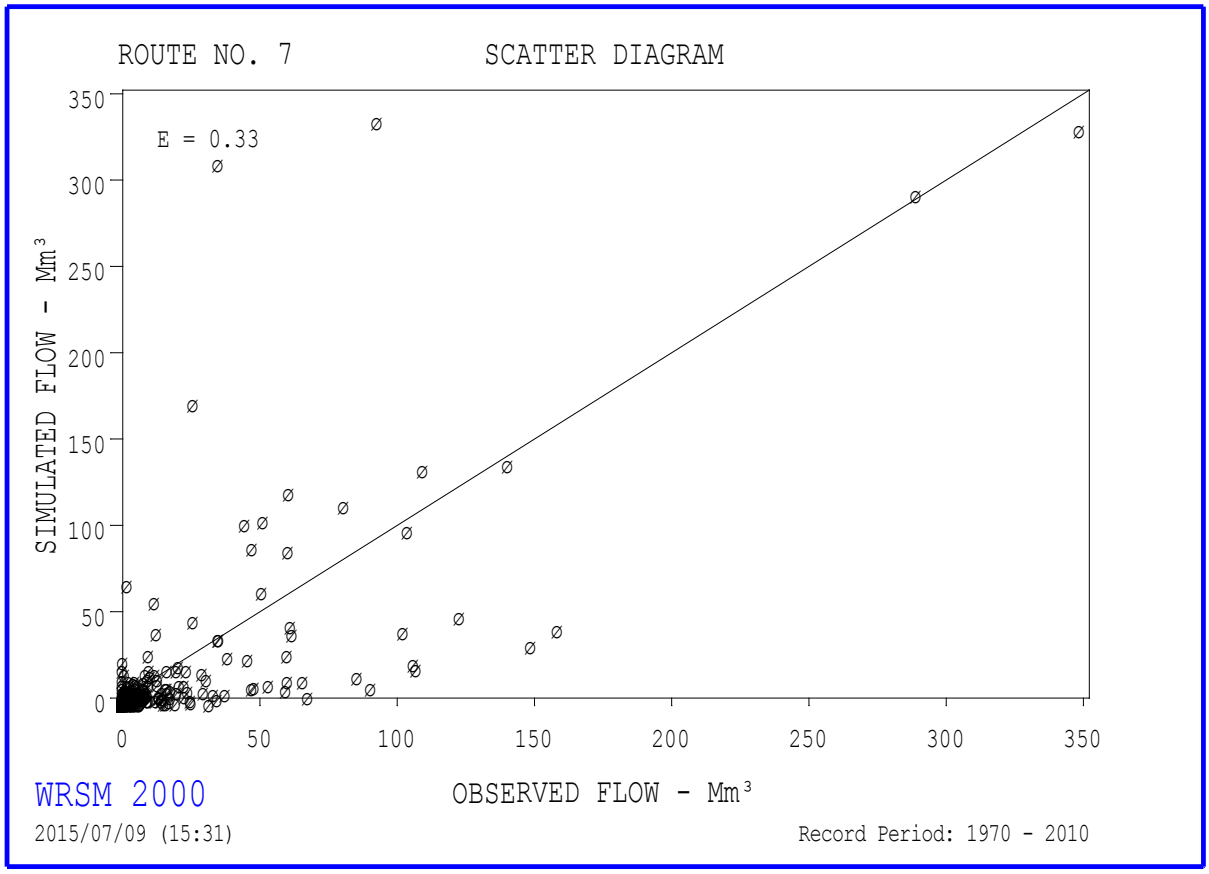



Figure G.19: A6R002 Observed and simulated scatter plot

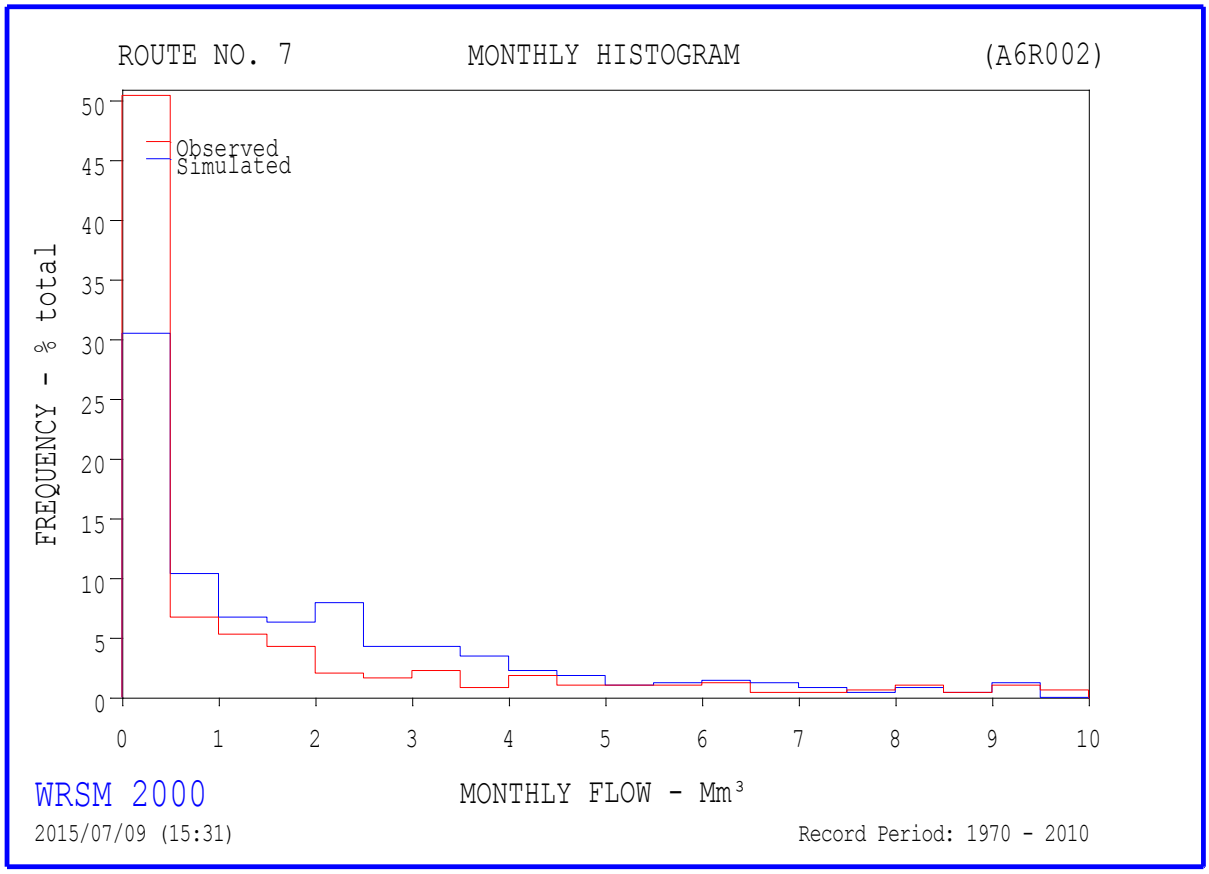



Figure G.20: A6R002 Observed and simulated histogram of flows

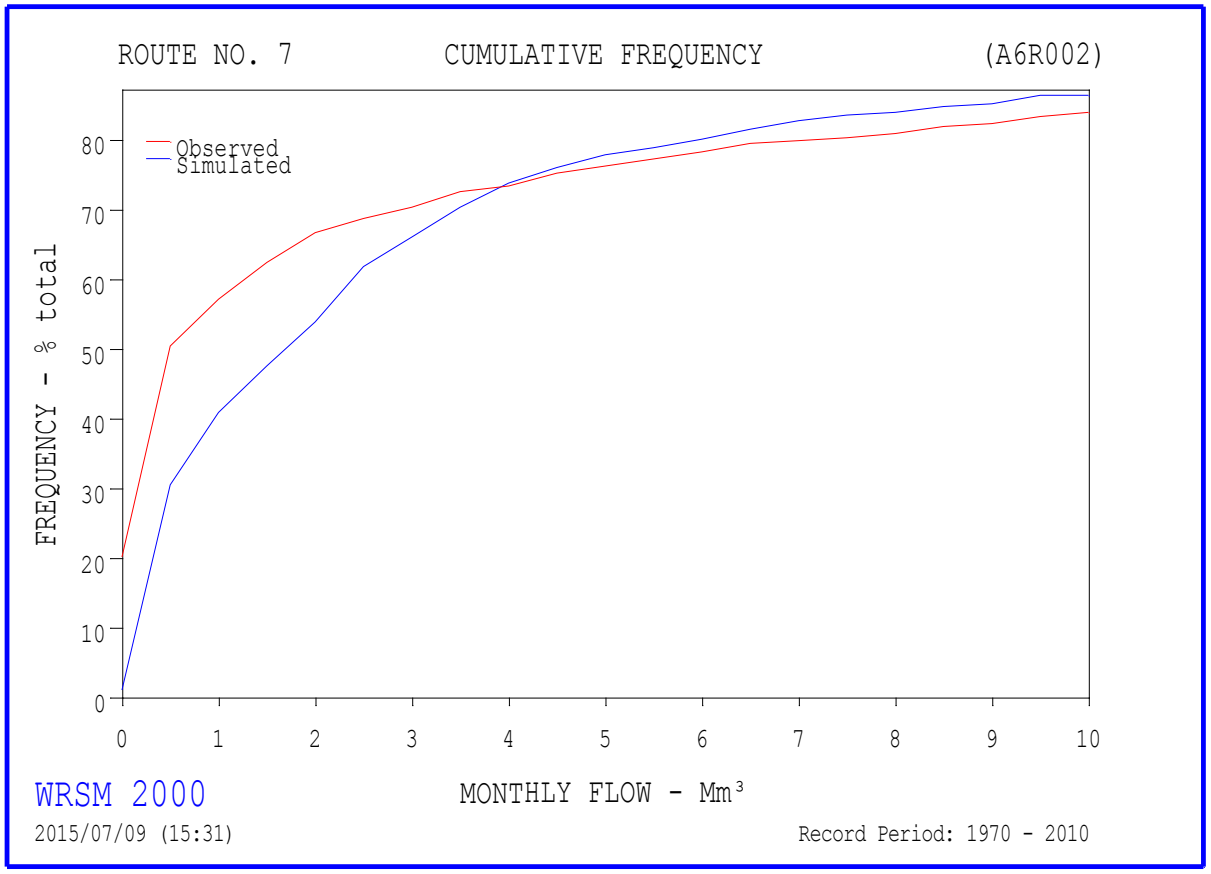



**Figure G.21: A6R002 Observed and simulated cumulative frequency flows**

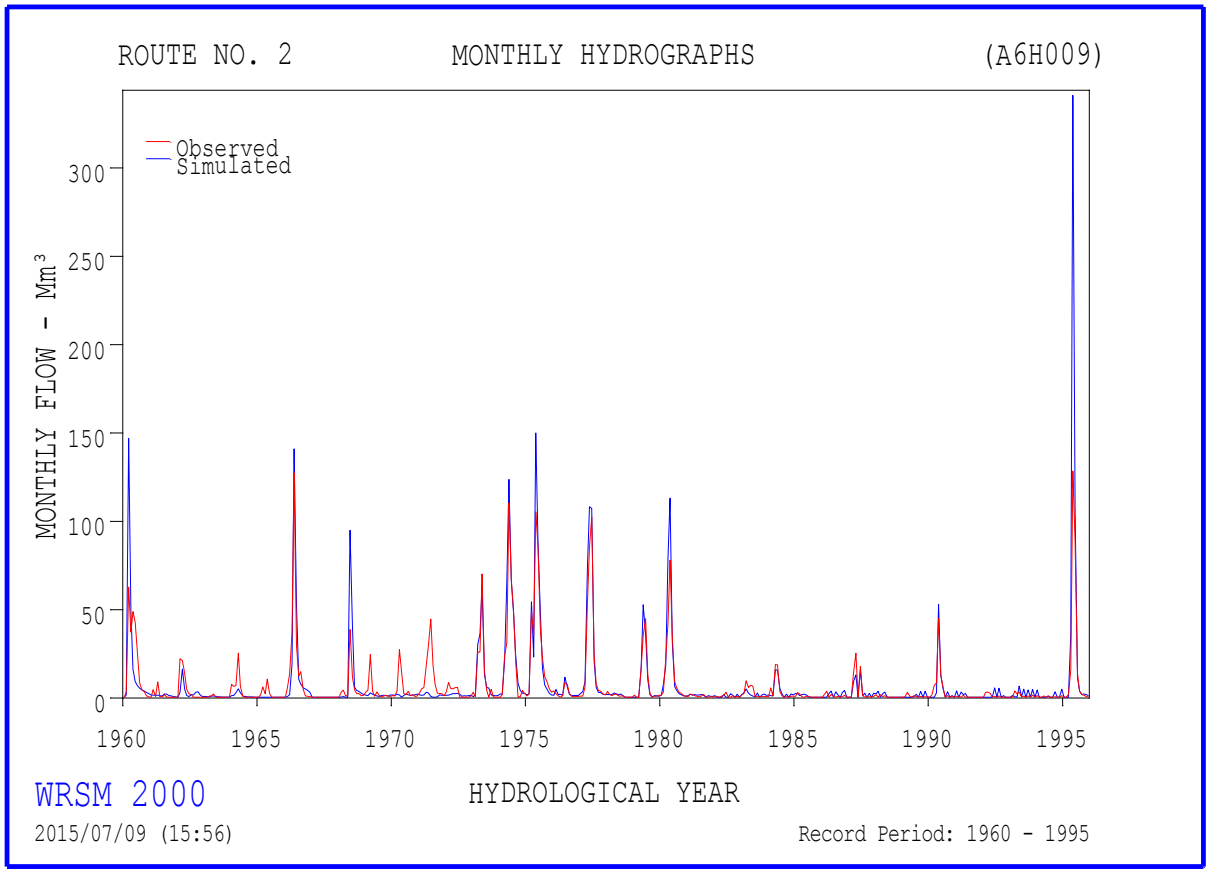



**Figure G.22: A6H009 Observed and simulated monthly hydrograph**

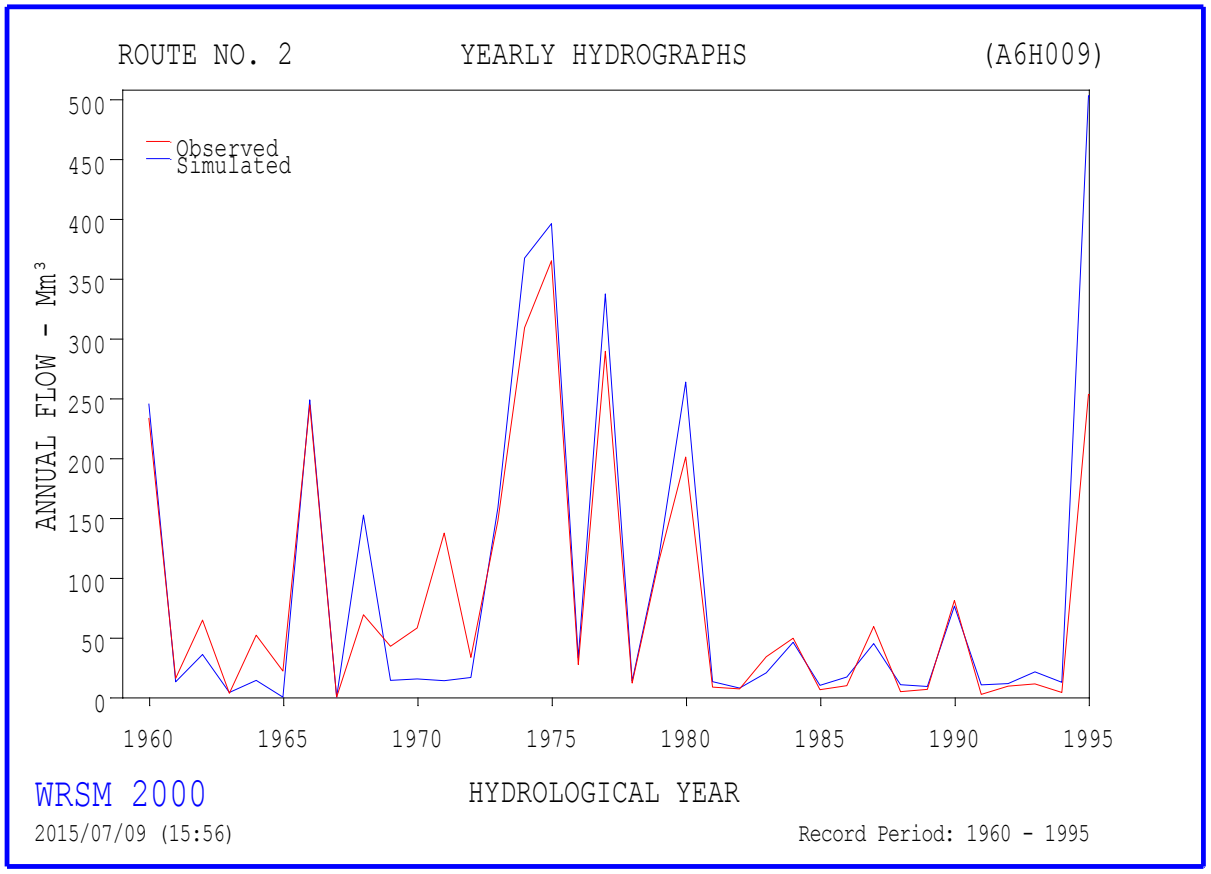



Figure G.23: A6H009 Observed and simulated annual hydrograph

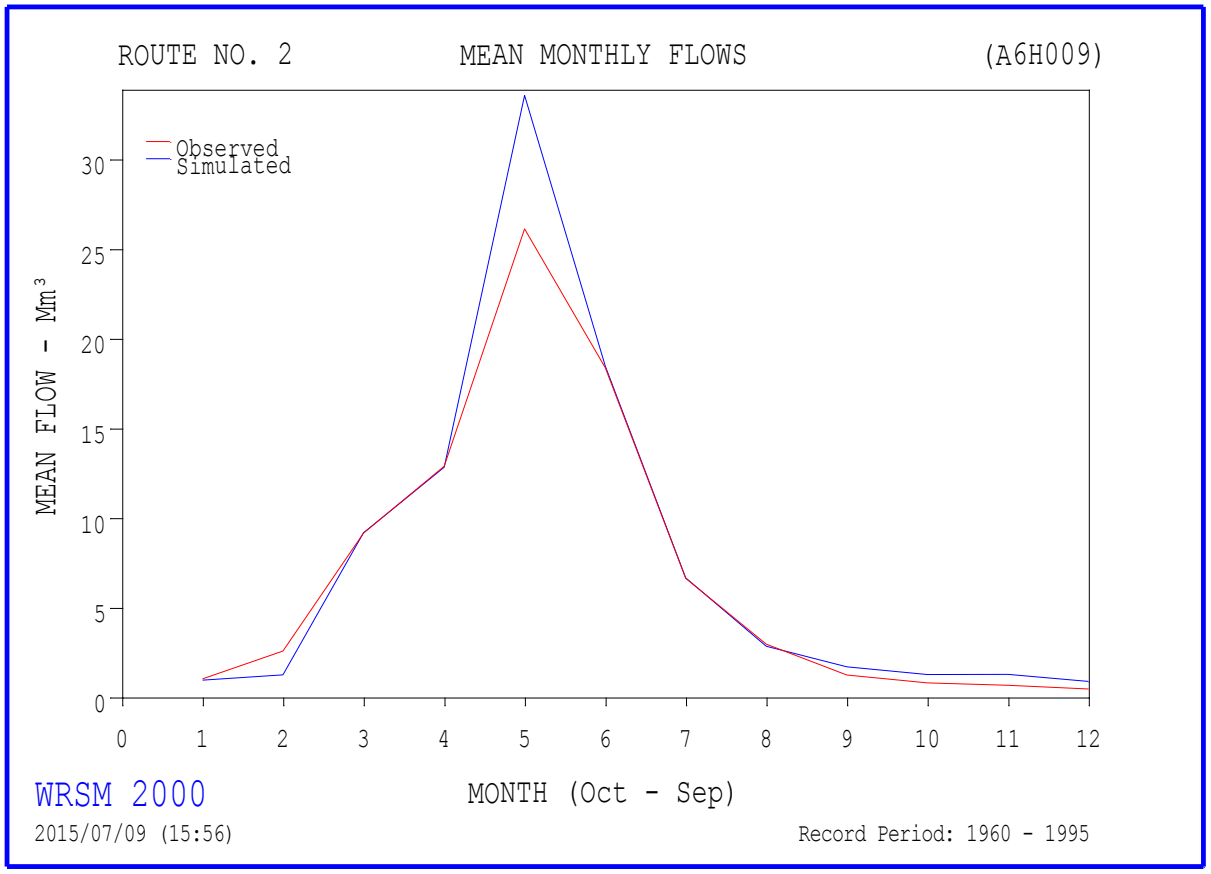



Figure G.24: A6H009 Observed and simulated mean monthly flows

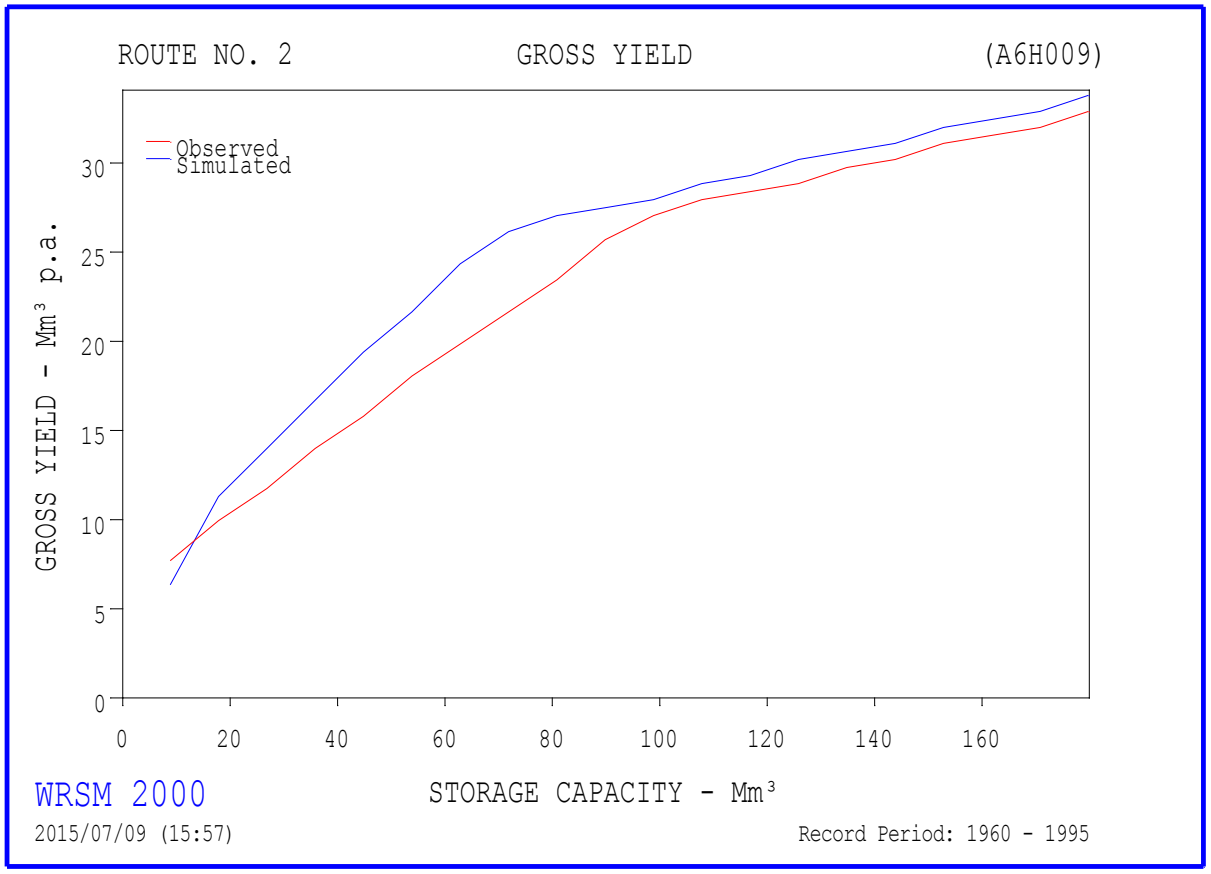



**Figure G.25: A6H009 Observed and simulated gross yield flows**

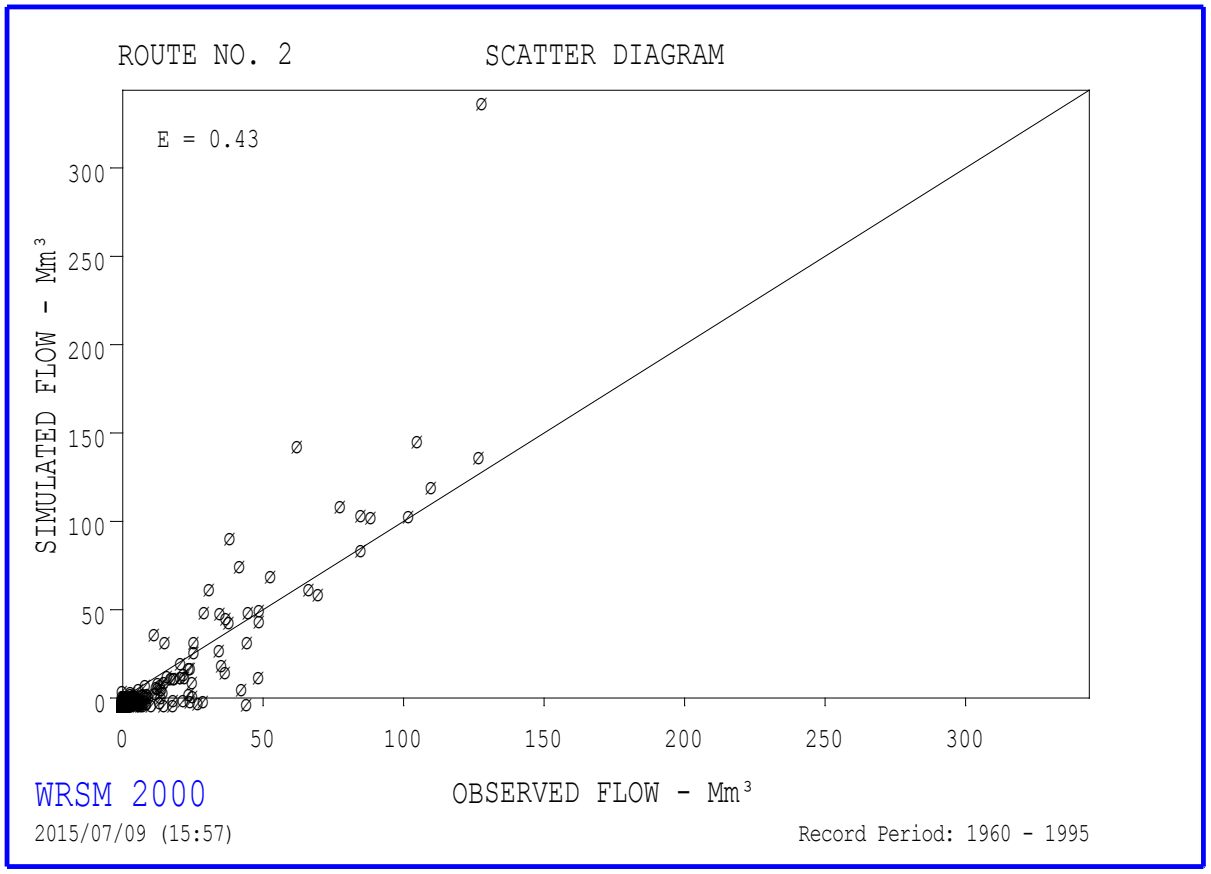



**Figure G.26: A6H009 Observed and simulated scatter plot**

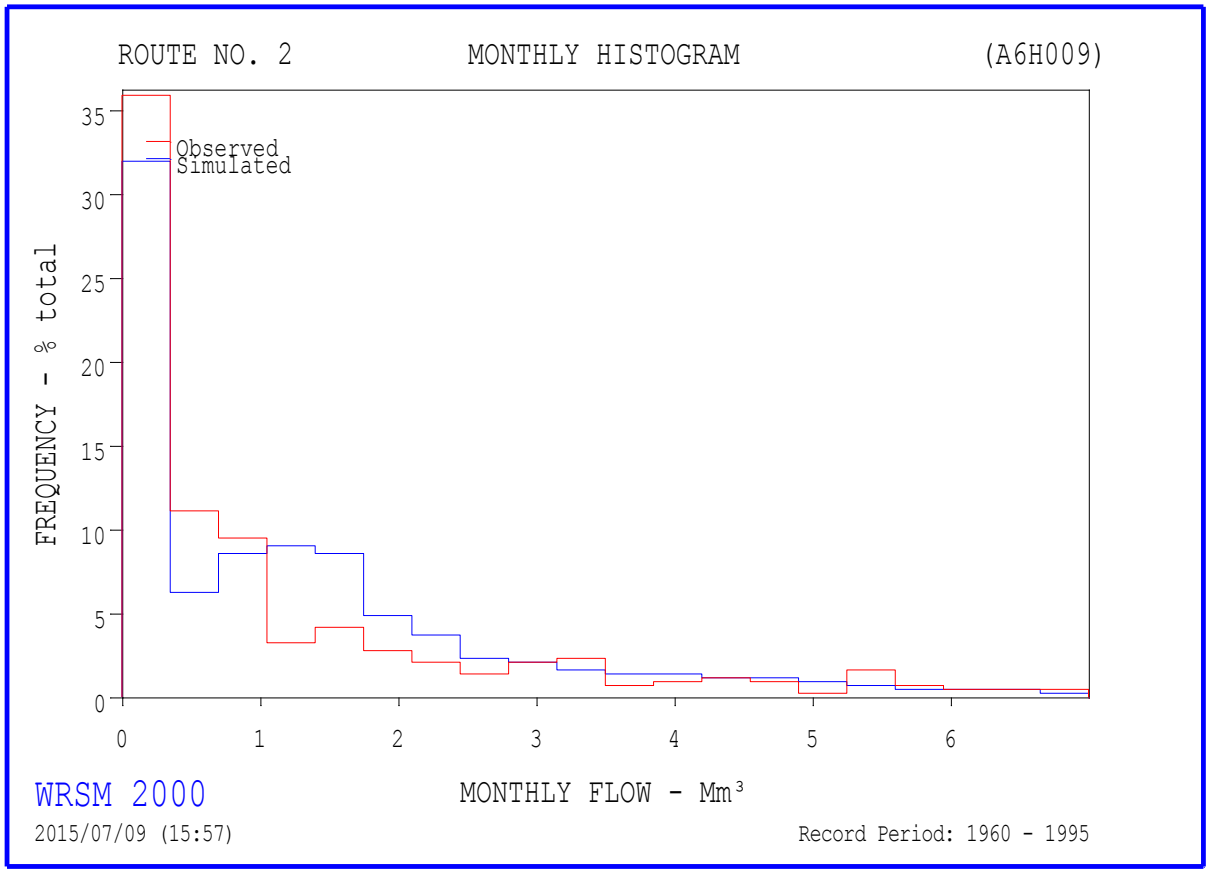



**Figure G.27: A6H009 Observed and simulated histogram of flows**

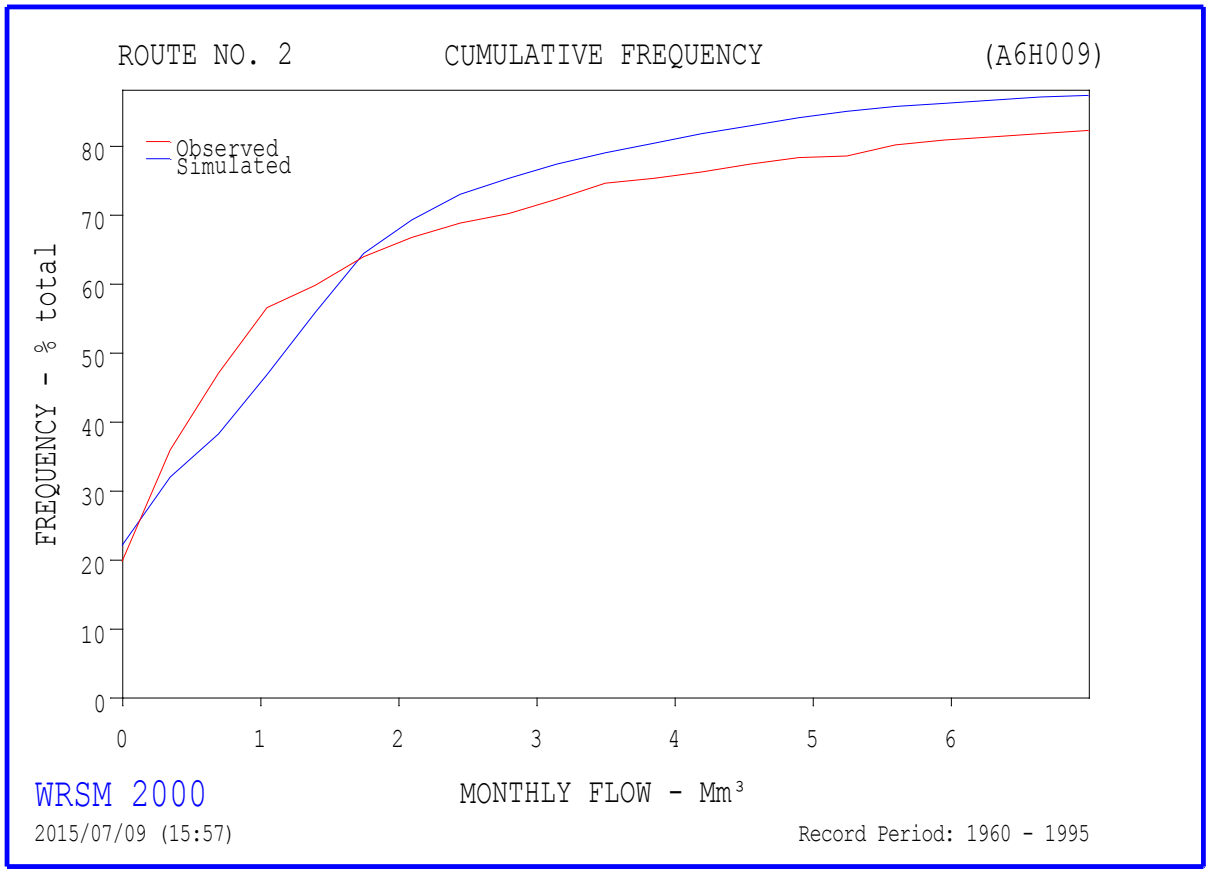



**Figure G.28: A6H009 Observed and simulated cumulative frequency flows**

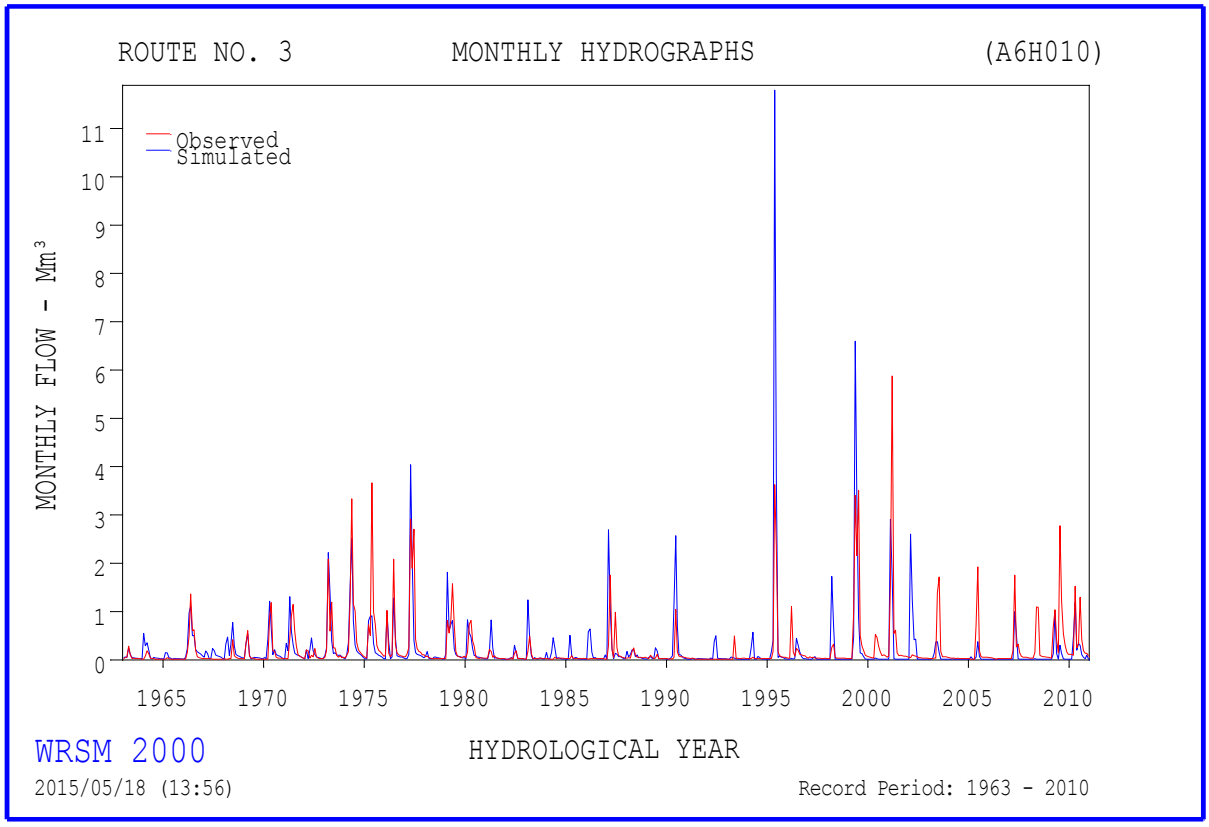



Figure G.29: A6H010 Observed and simulated monthly hydrograph

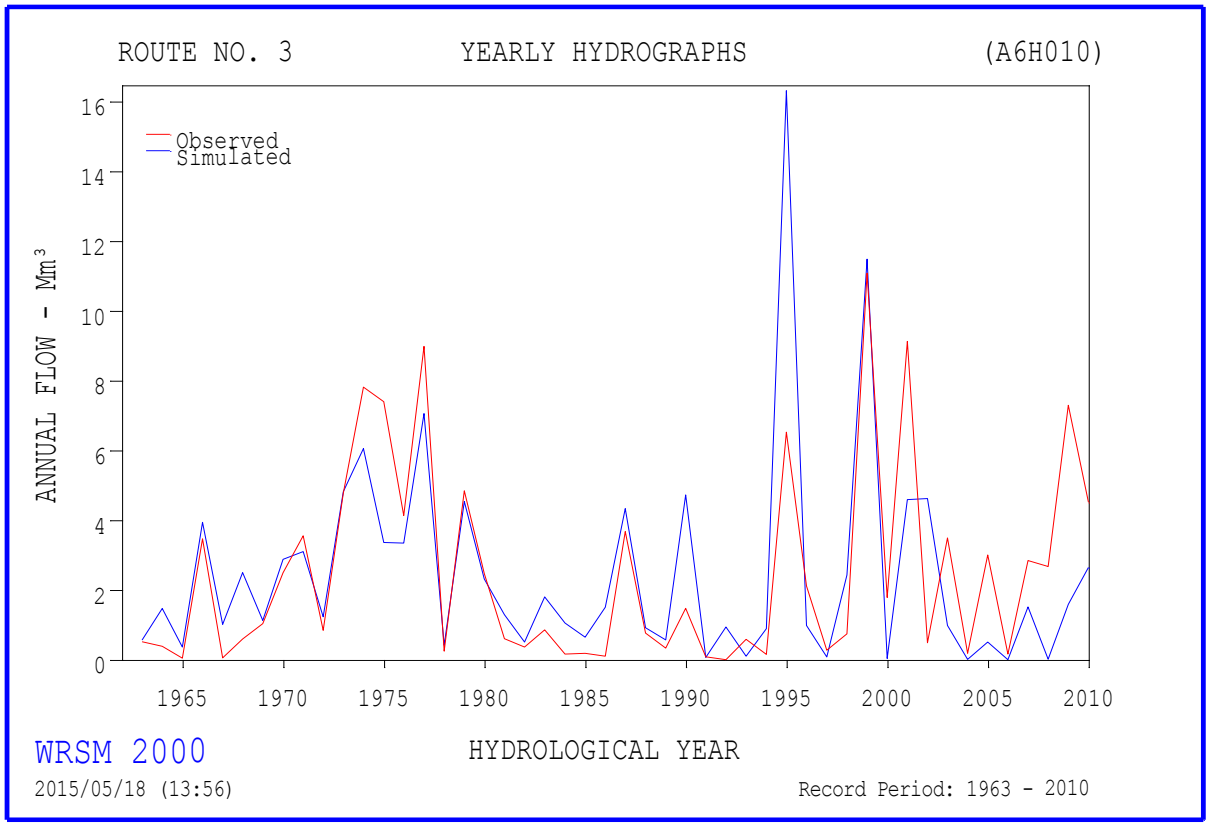



Figure G.30: A6H010 Observed and simulated annual hydrograph

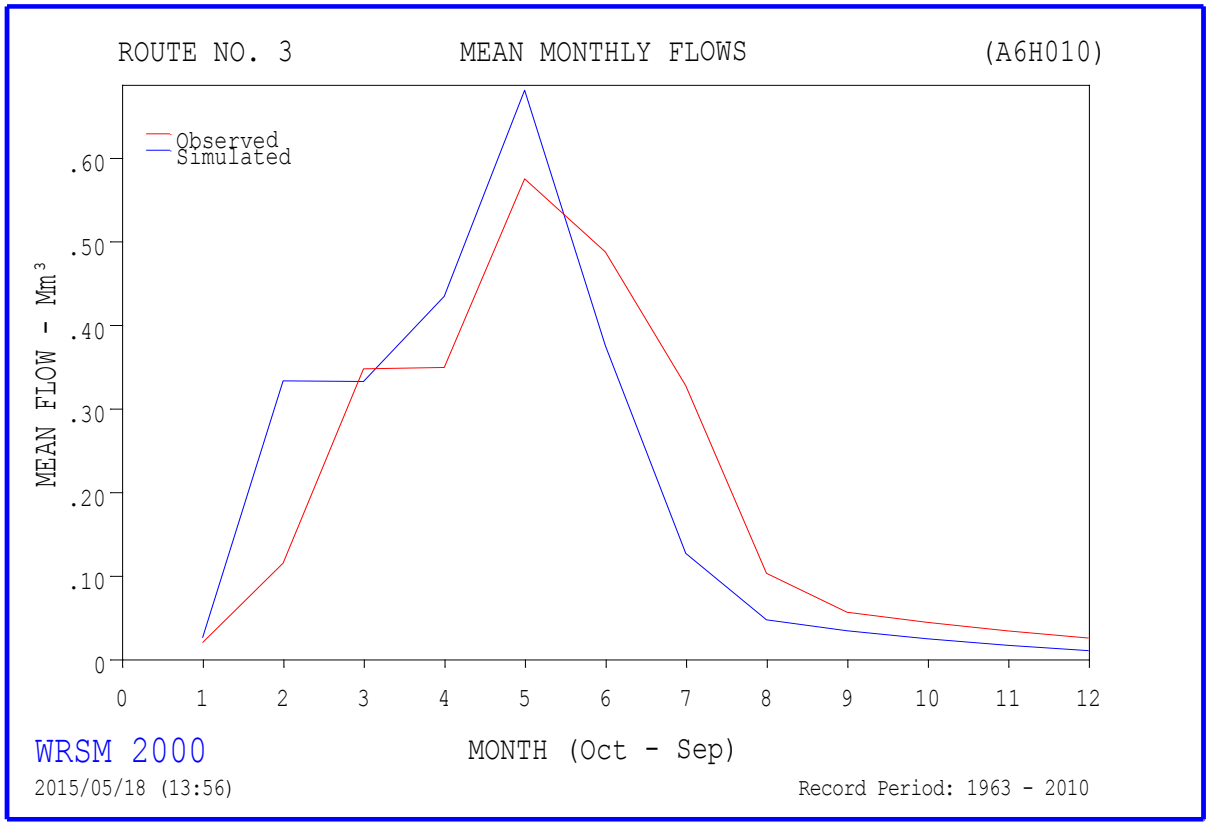



Figure G.31: A6H010 Observed and simulated mean monthly flows

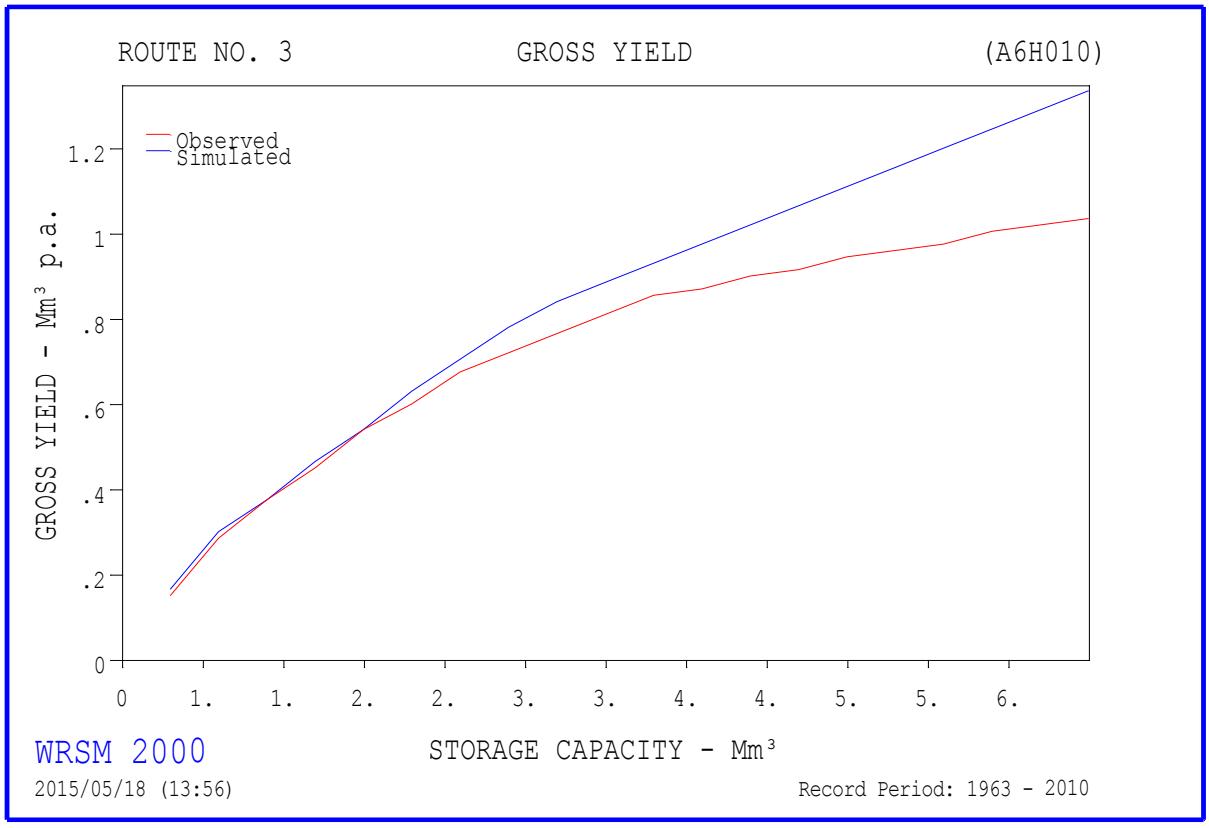



Figure G.32: A6H010 Observed and simulated gross yield flows

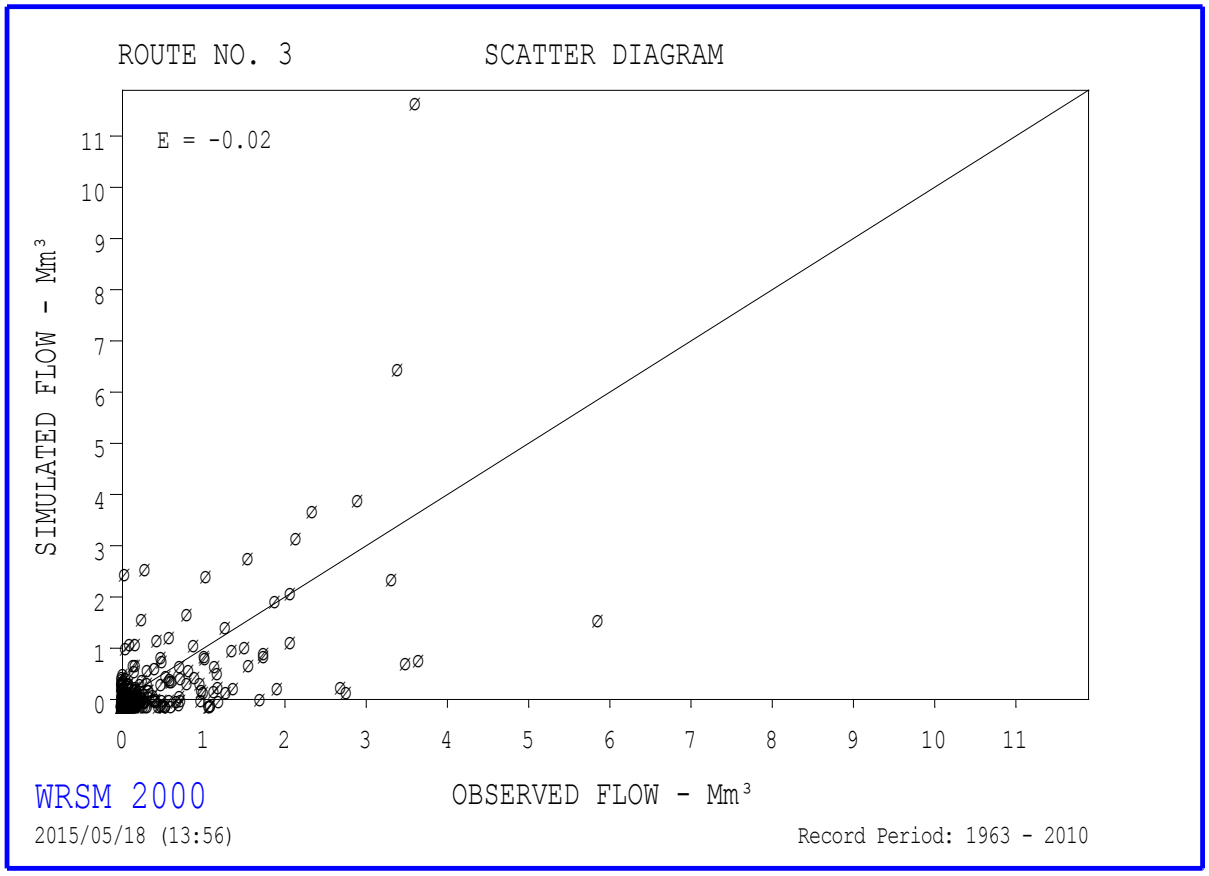



Figure G.33: A6H010 Observed and simulated scatter plot

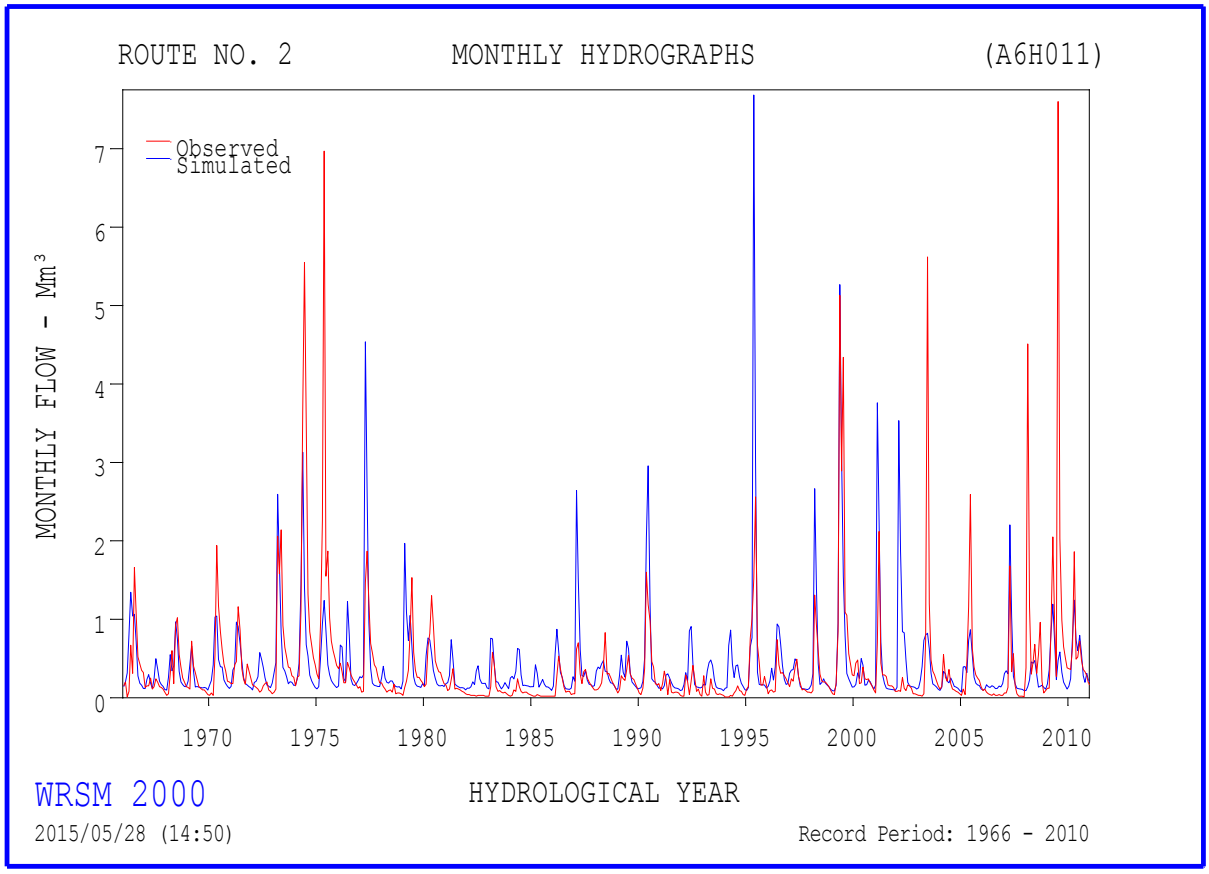



Figure G.34: A6H011 Observed and simulated monthly hydrograph

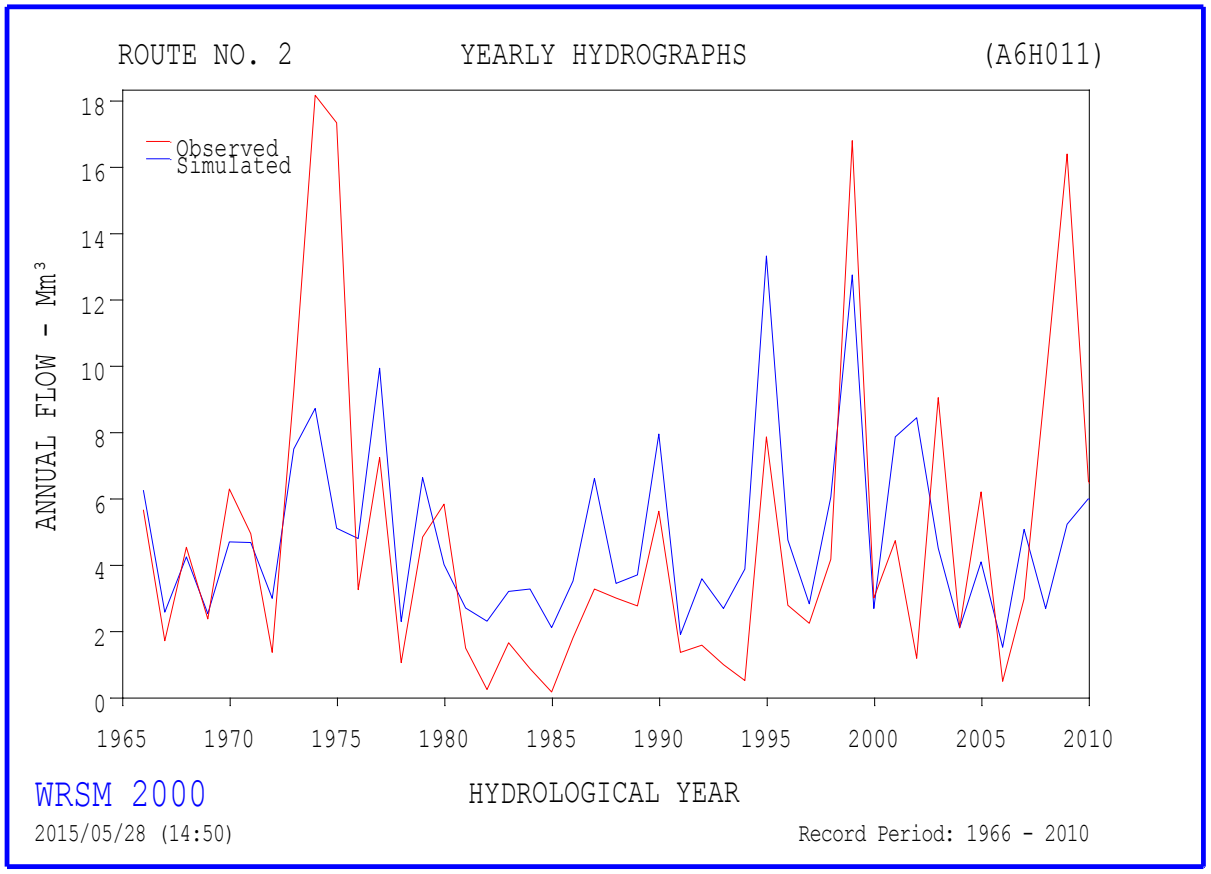



**Figure G.35: A6H011 Observed and simulated annual hydrograph**

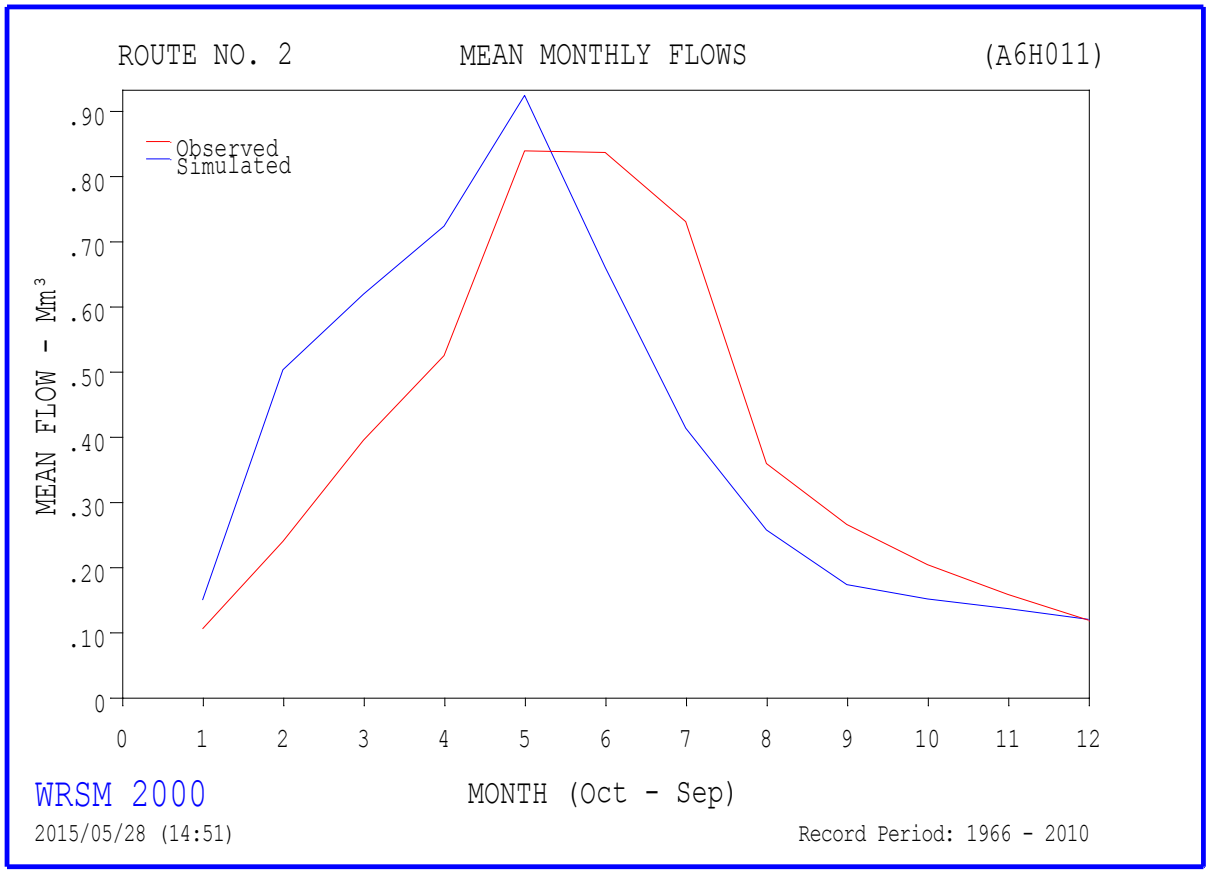



**Figure G.36: A6H011 Observed and simulated mean monthly flows**

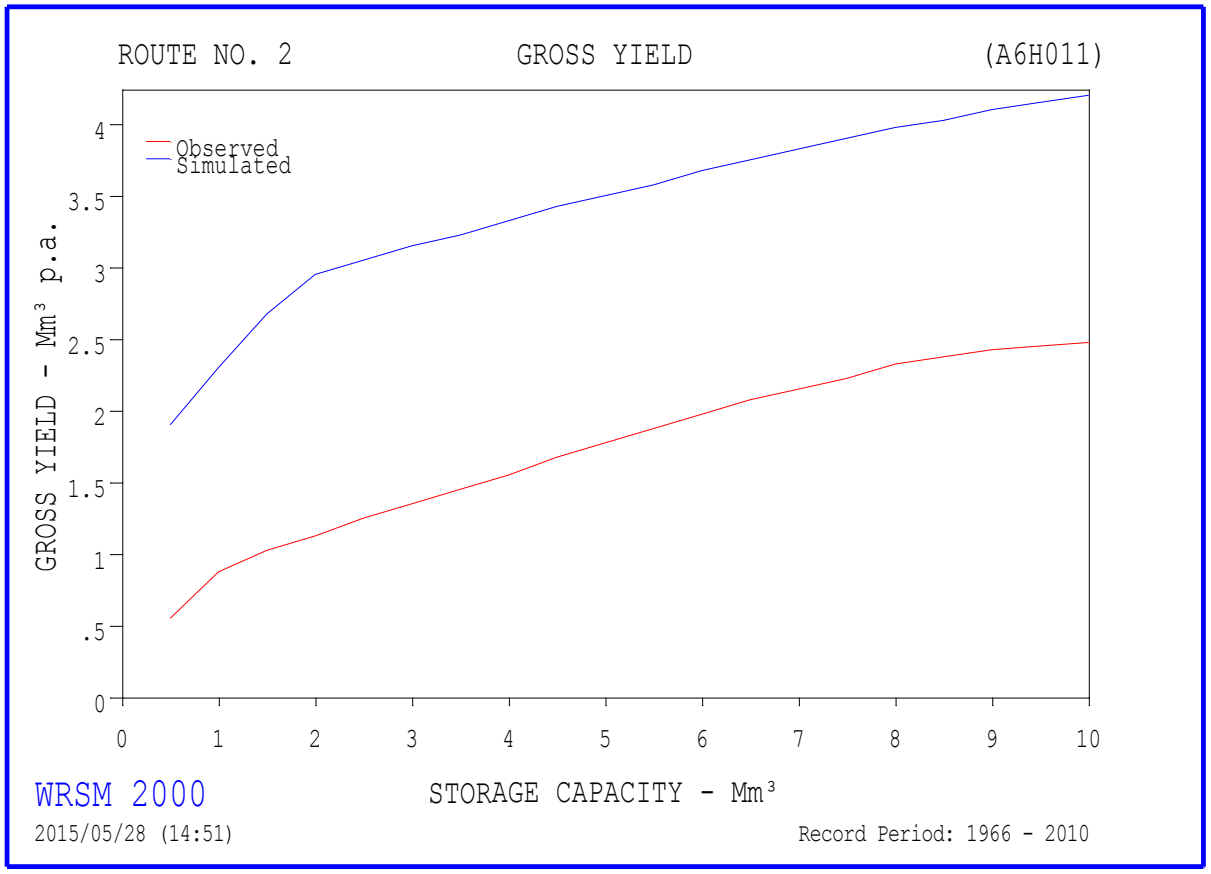



**Figure G.37: A6H011 Observed and simulated gross yield flows**

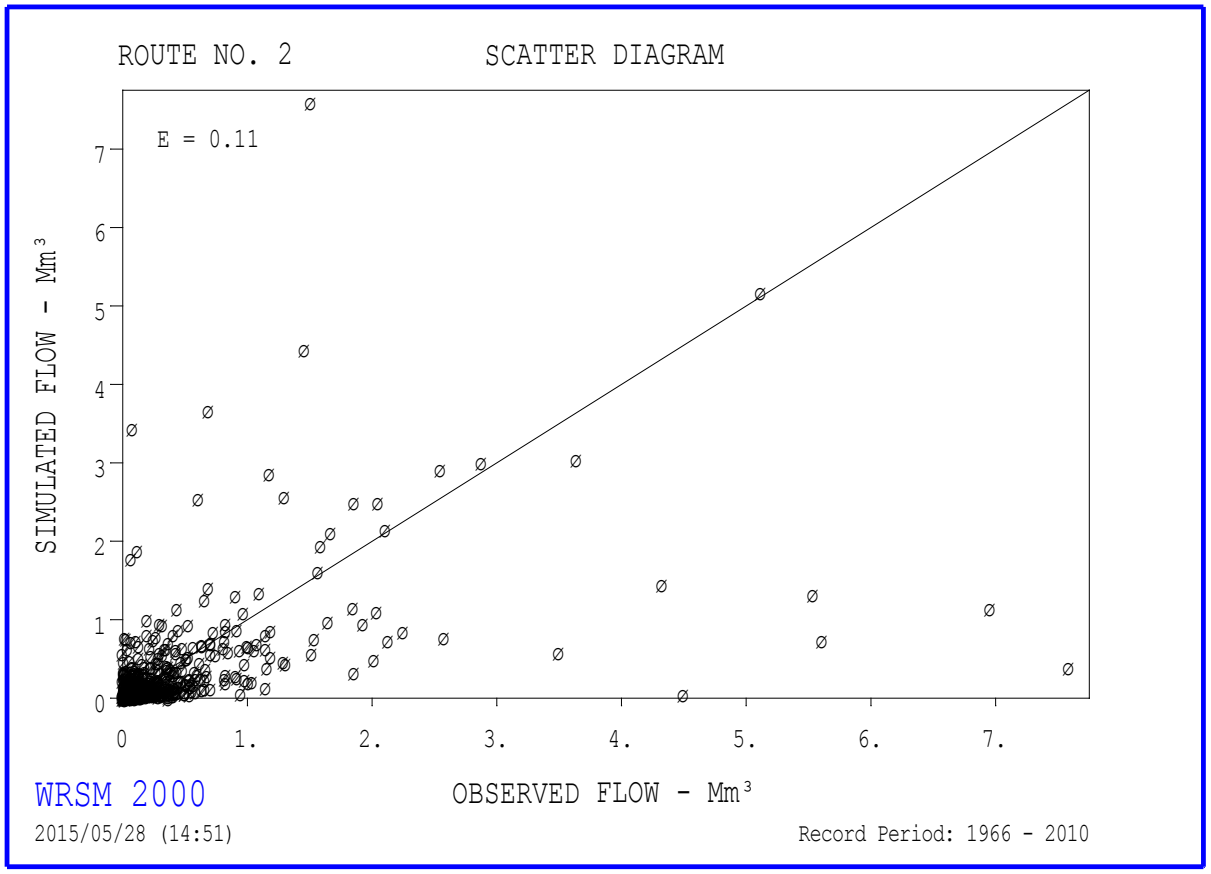



**Figure G.38: A6H011 Observed and simulated scatter plot**

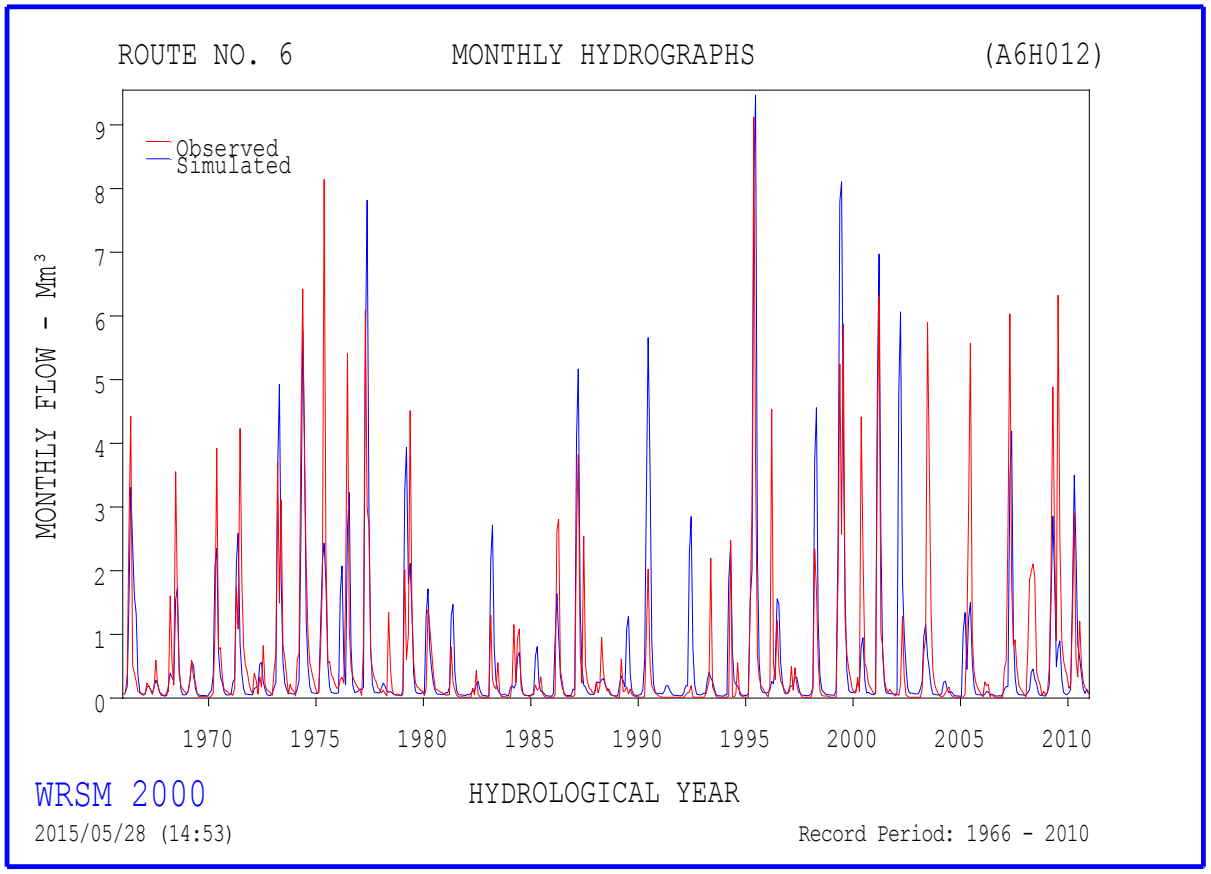



**Figure G.39: A6H012 Observed and simulated monthly hydrograph**

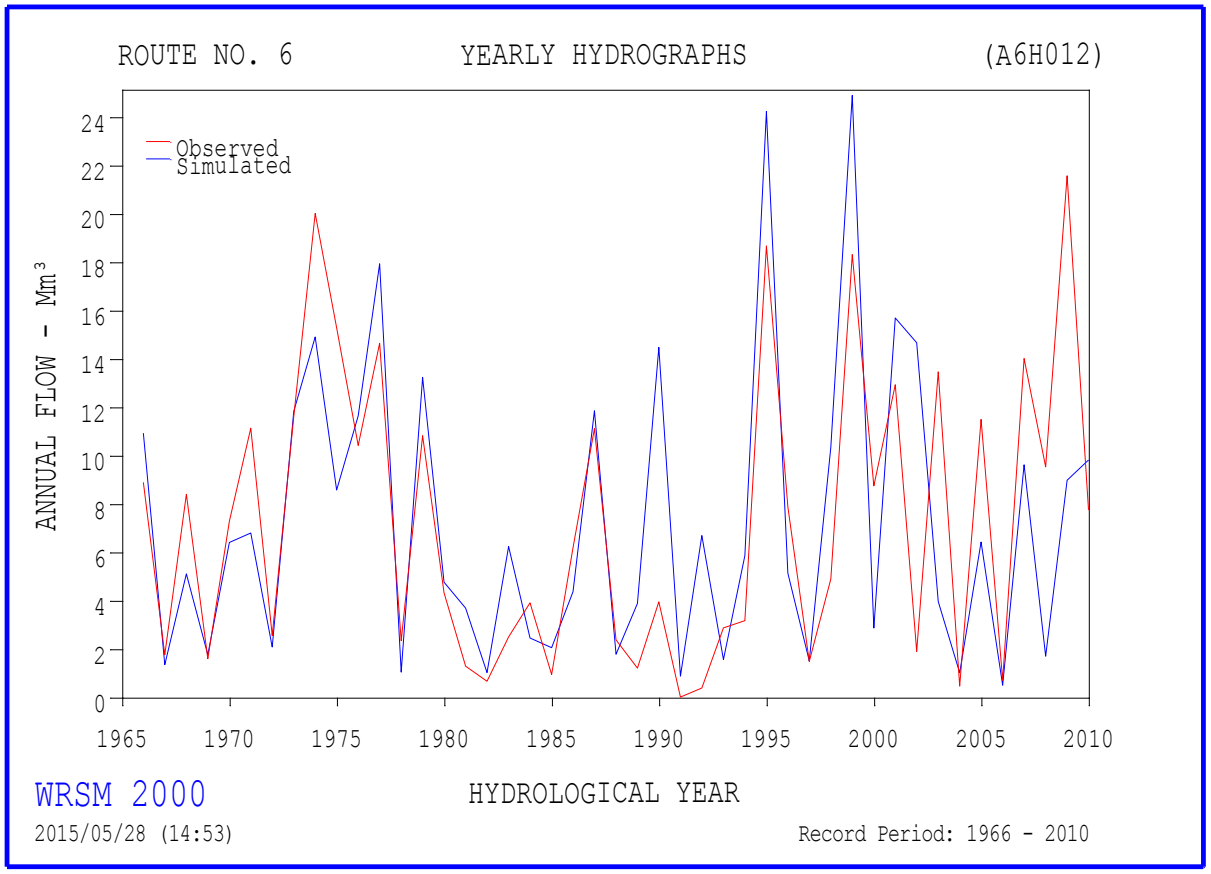



**Figure G.40: A6H012 Observed and simulated annual hydrograph**

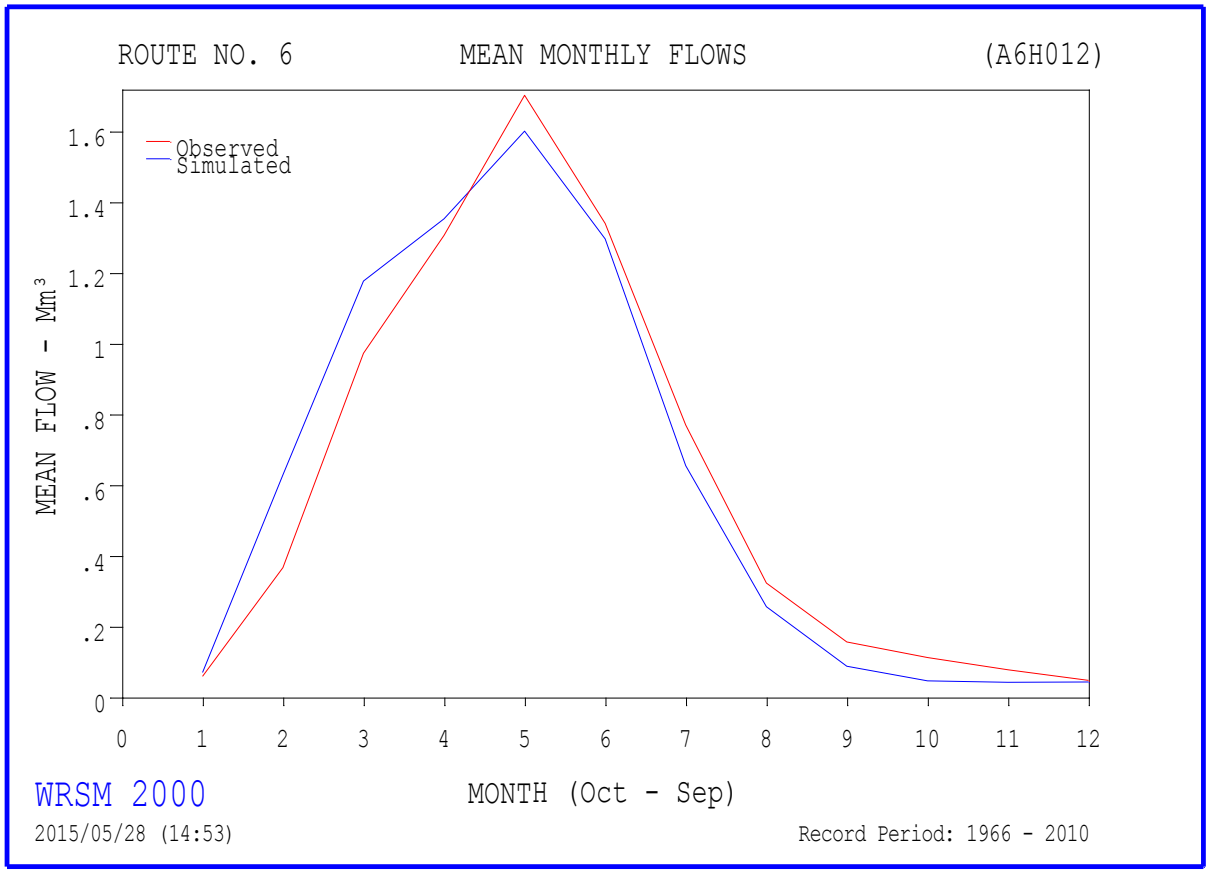



**Figure G.41: A6H012 Observed and simulated mean monthly flows**

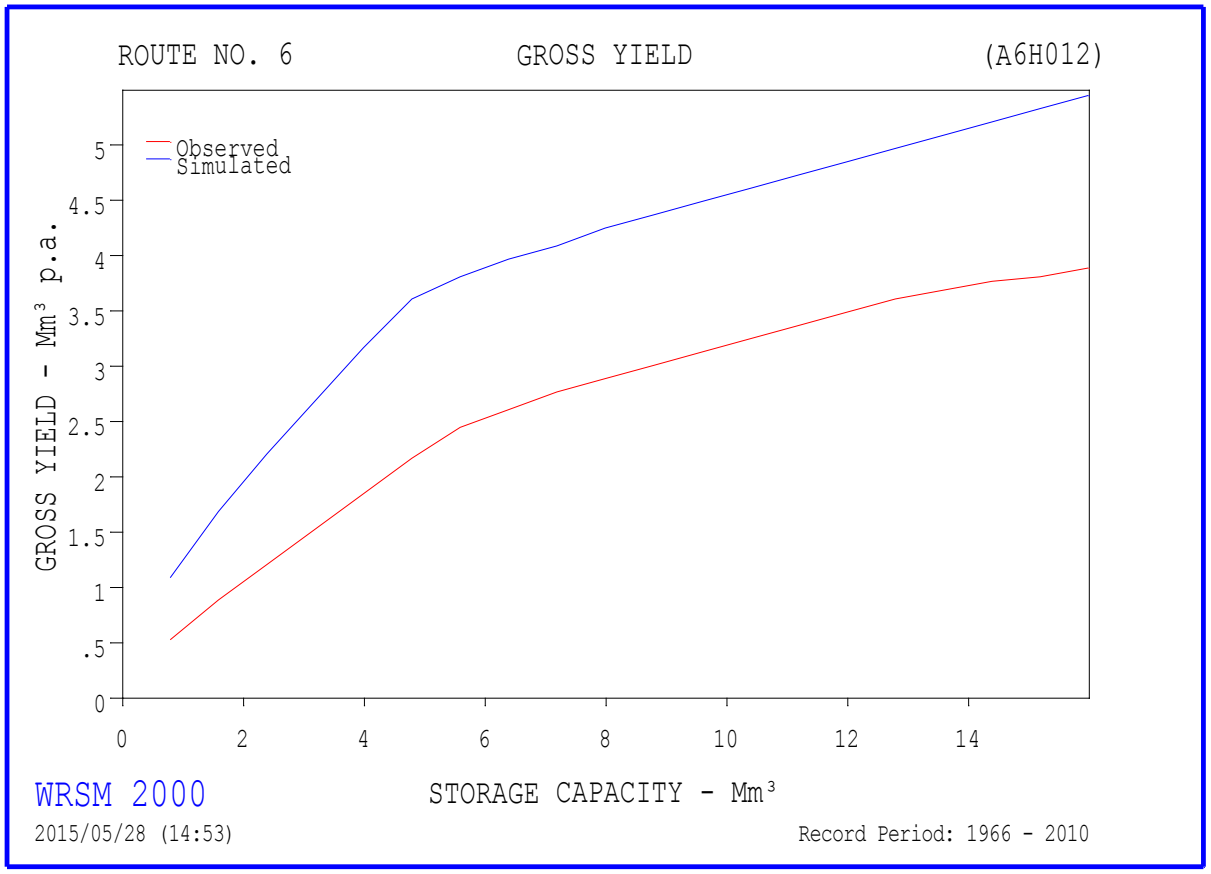



**Figure G.42: A6H012 Observed and simulated gross yield flows**

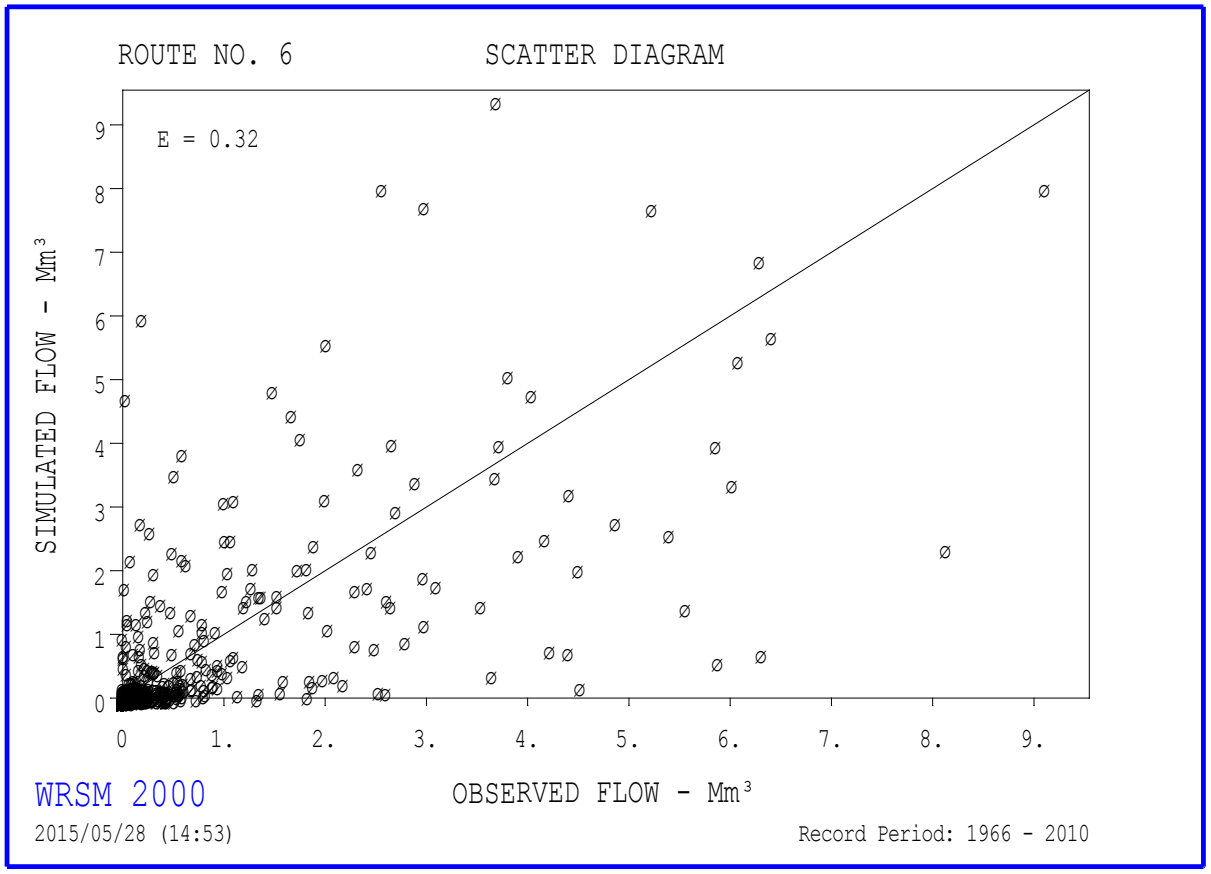



Figure G.43: A6H012 Observed and simulated scatter plot

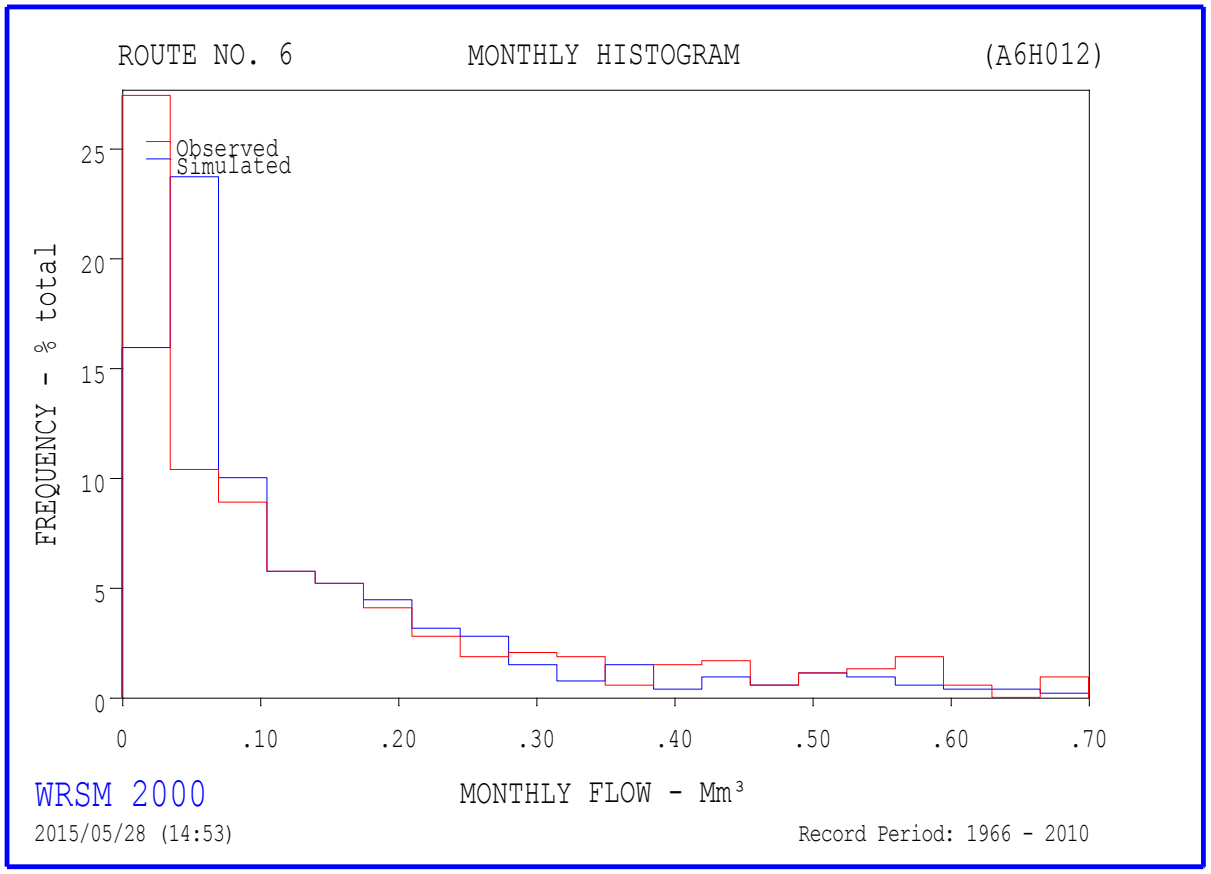



Figure G.44: A6H012 Observed and simulated histogram of flows

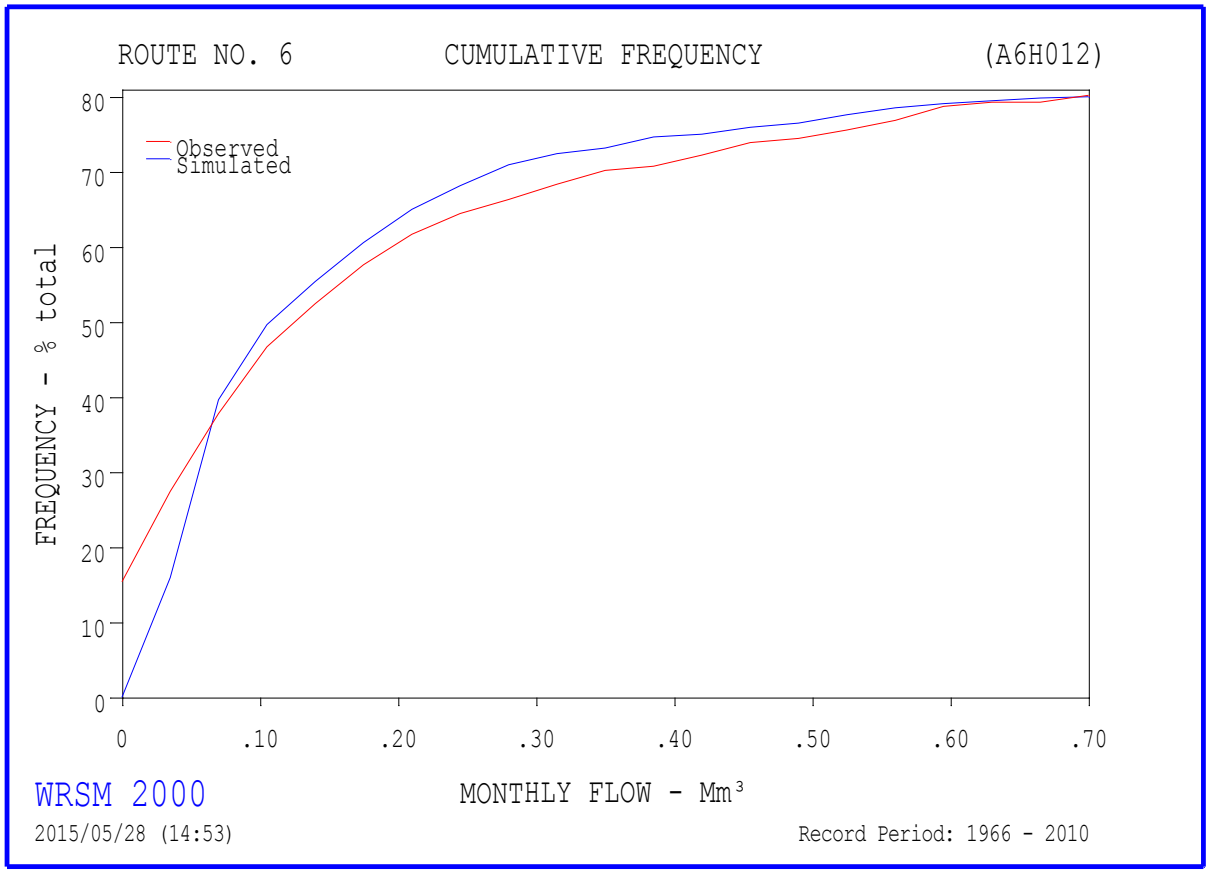



**Figure G.45: A6H012 Observed and simulated cumulative frequency flows**

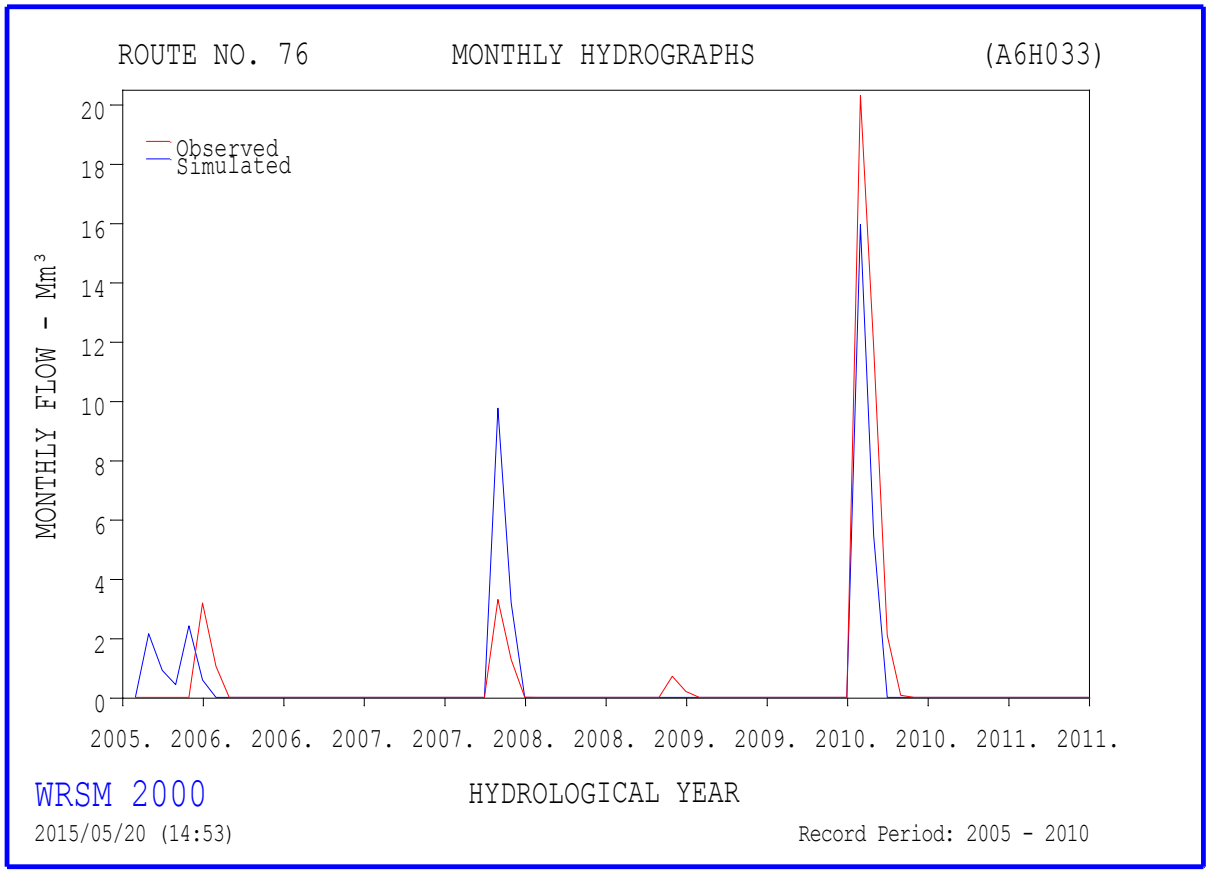



**Figure G.46: A6H033 Observed and simulated monthly hydrograph**

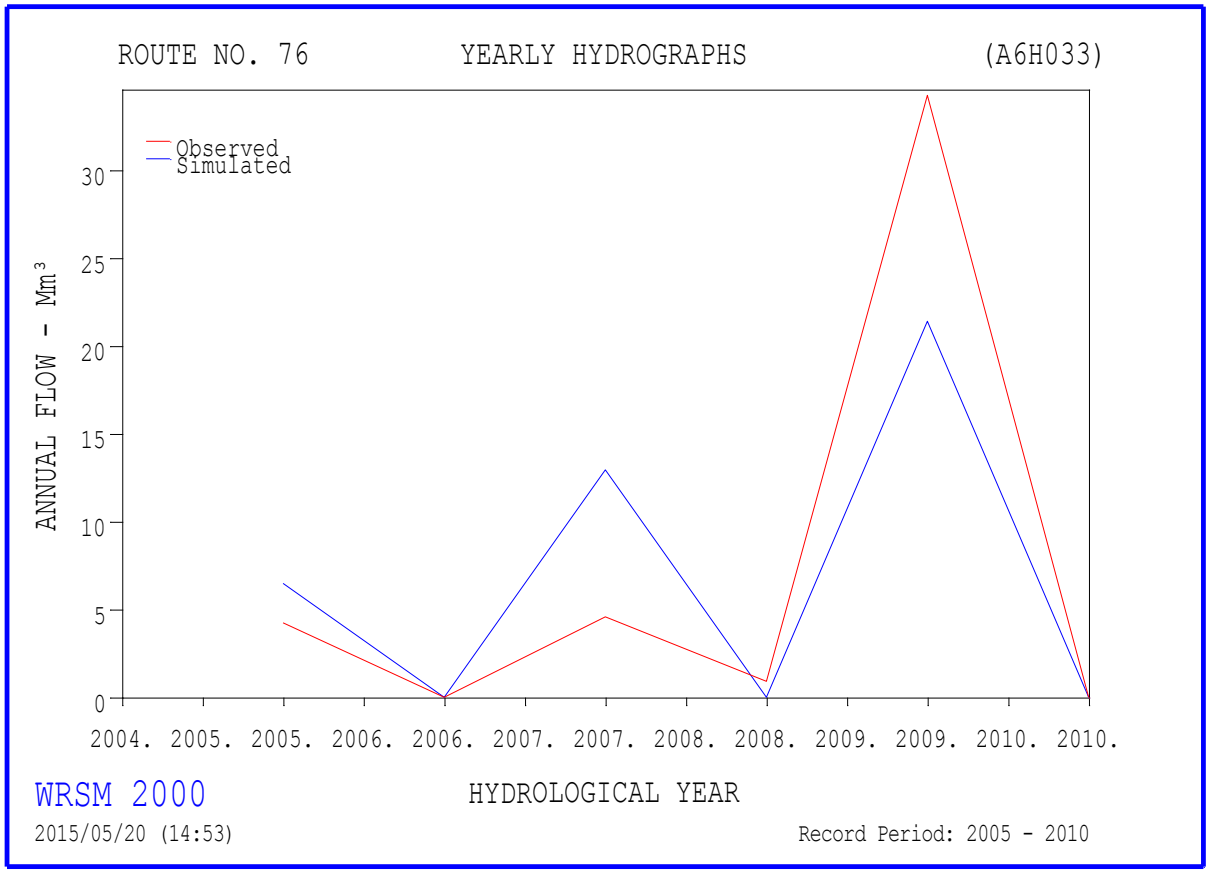



**Figure G.47: A6H033 Observed and simulated annual hydrograph**

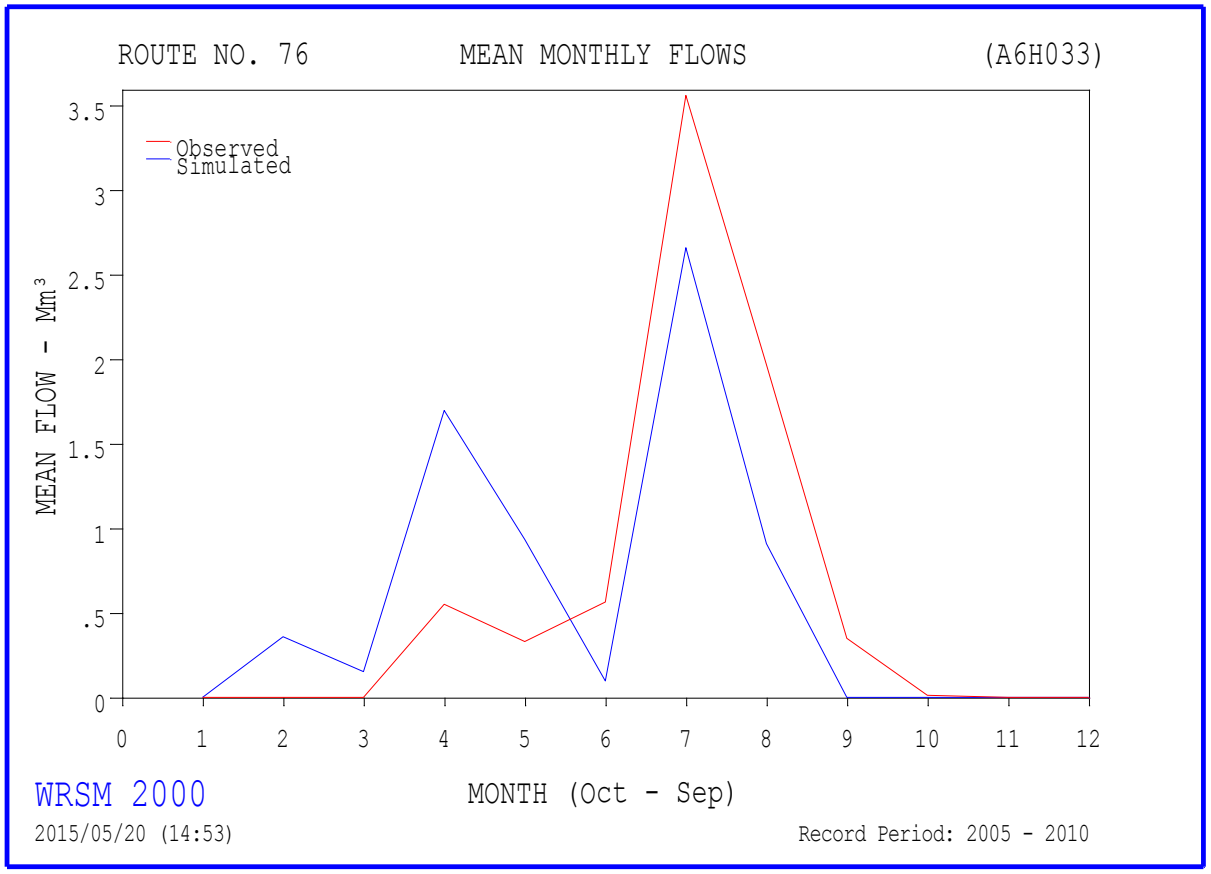



**Figure G.48: A6H033 Observed and simulated mean monthly flows**

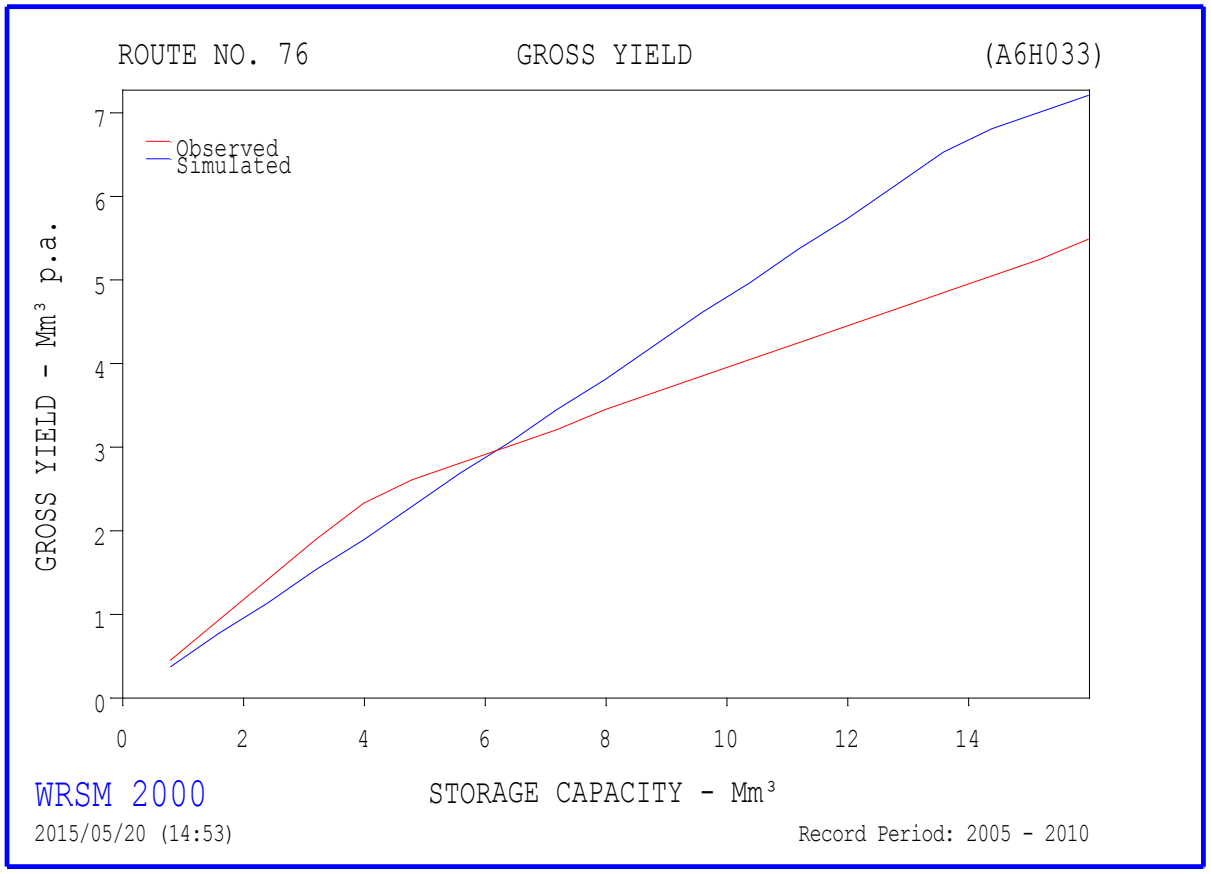



**Figure G.49: A6H033 Observed and simulated gross yield flows**

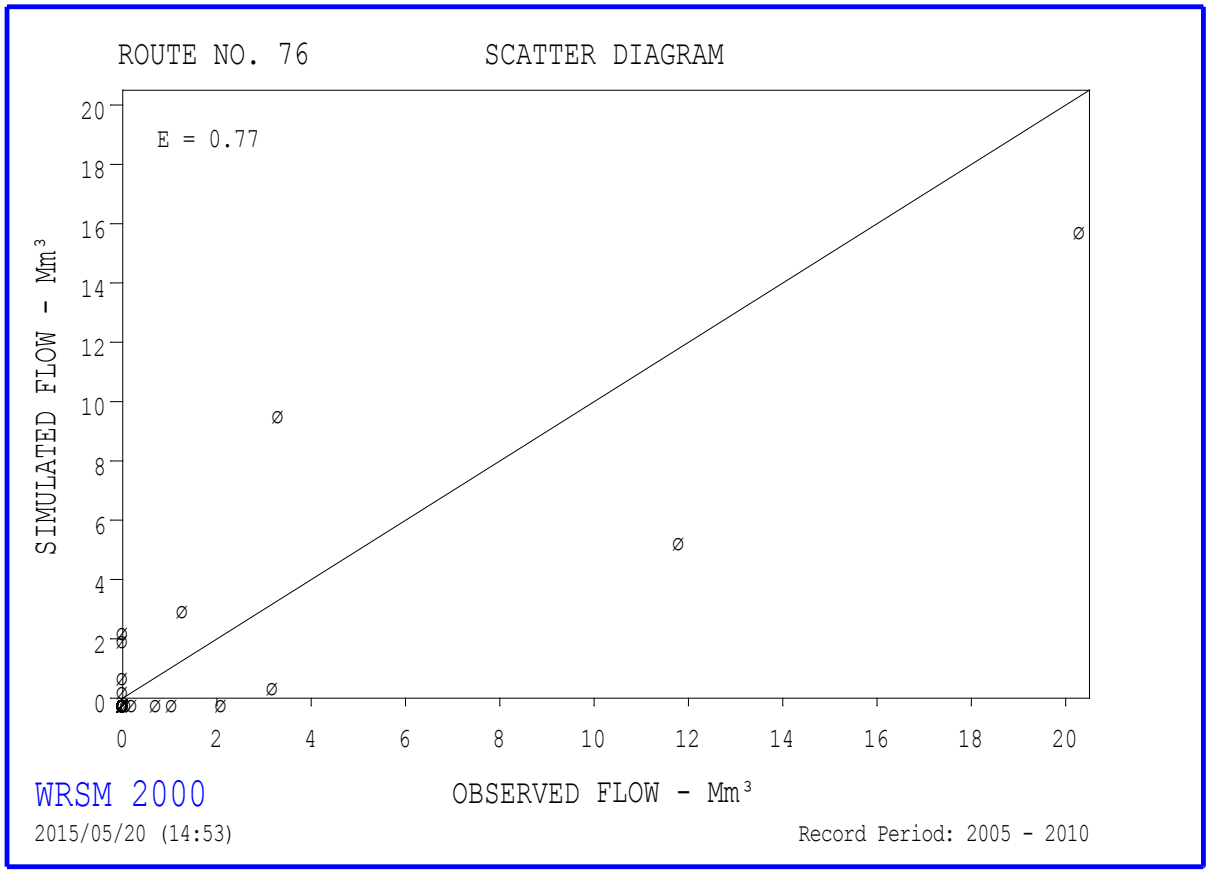



**Figure G.50: A6H033 Observed and simulated scatter plot**

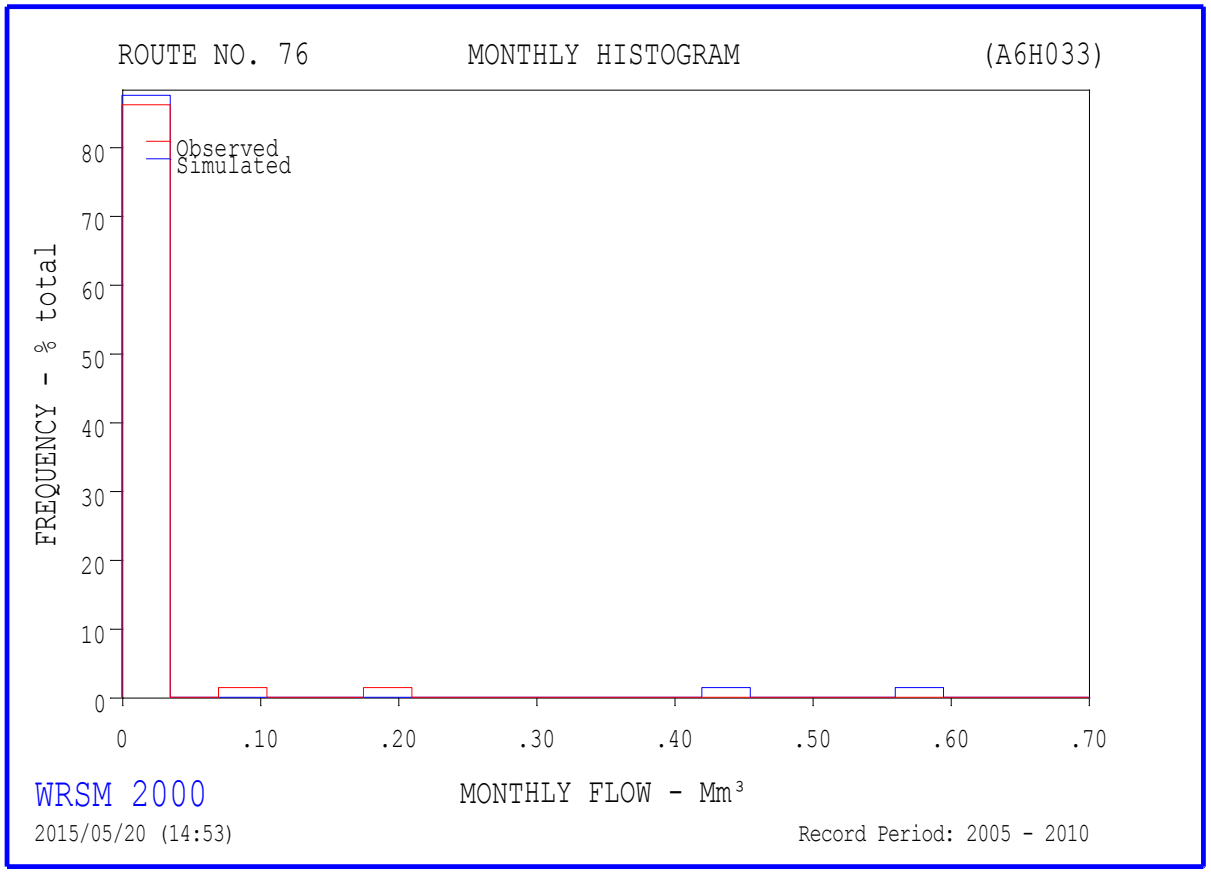



**Figure G.51: A6H033 Observed and simulated histogram of flows**

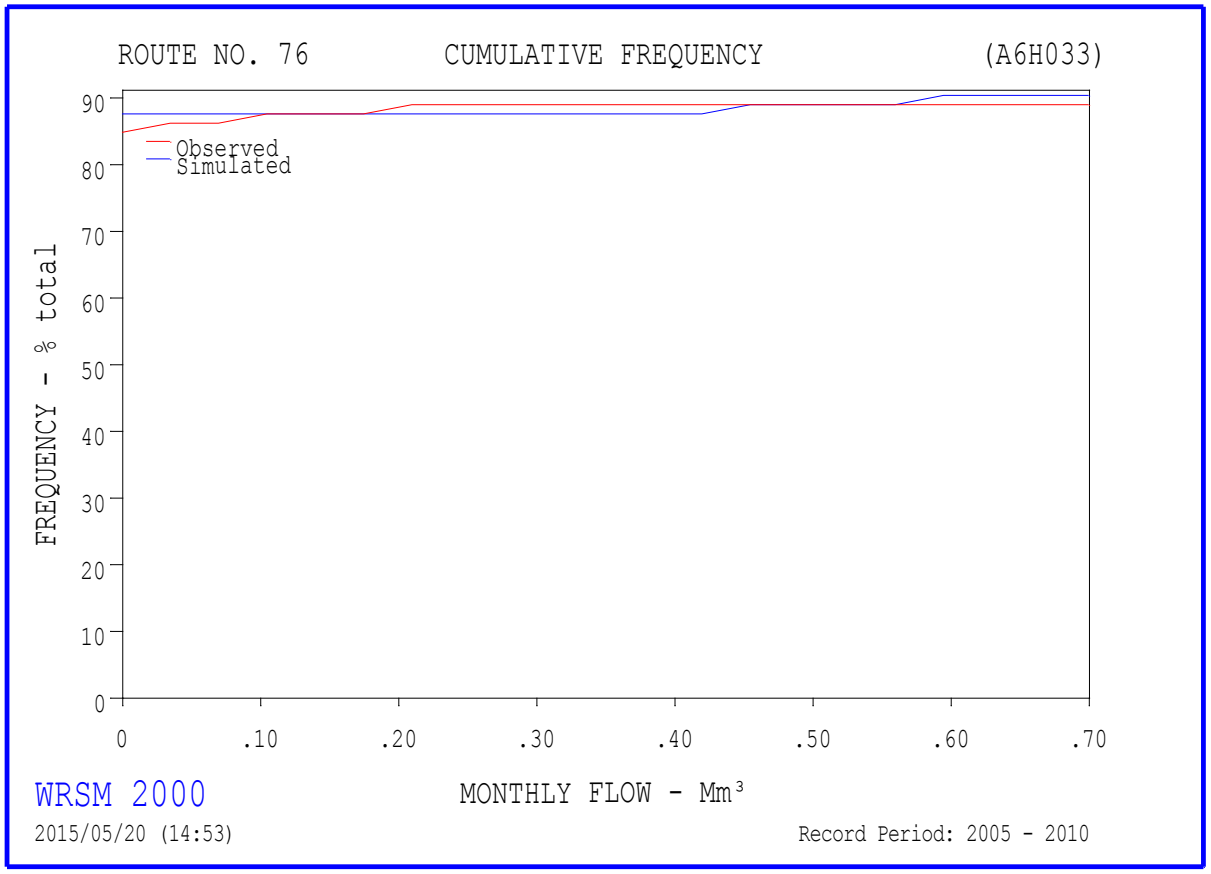



**Figure G.52: A6H033 Observed and simulated cumulative frequency flows**

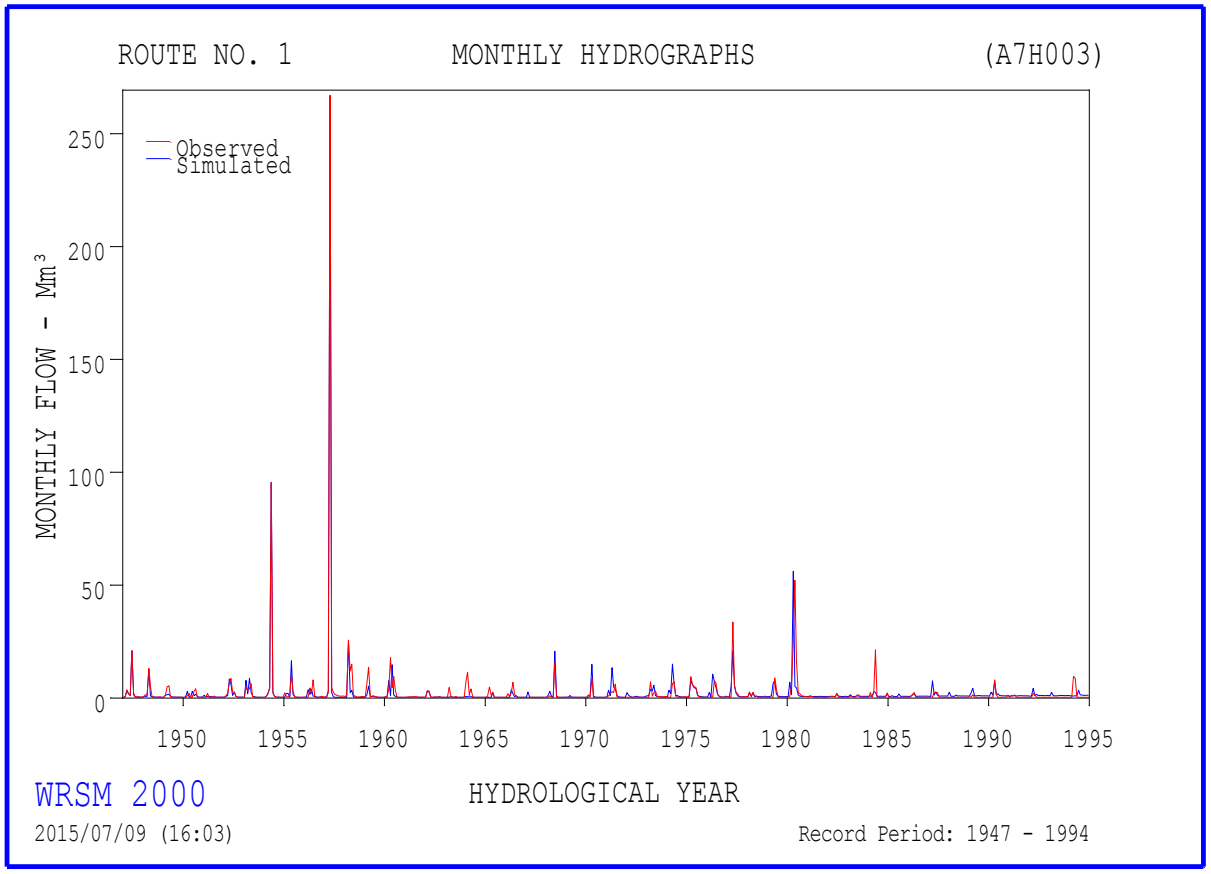



**Figure G.53: A7H003 Observed and simulated monthly hydrograph**

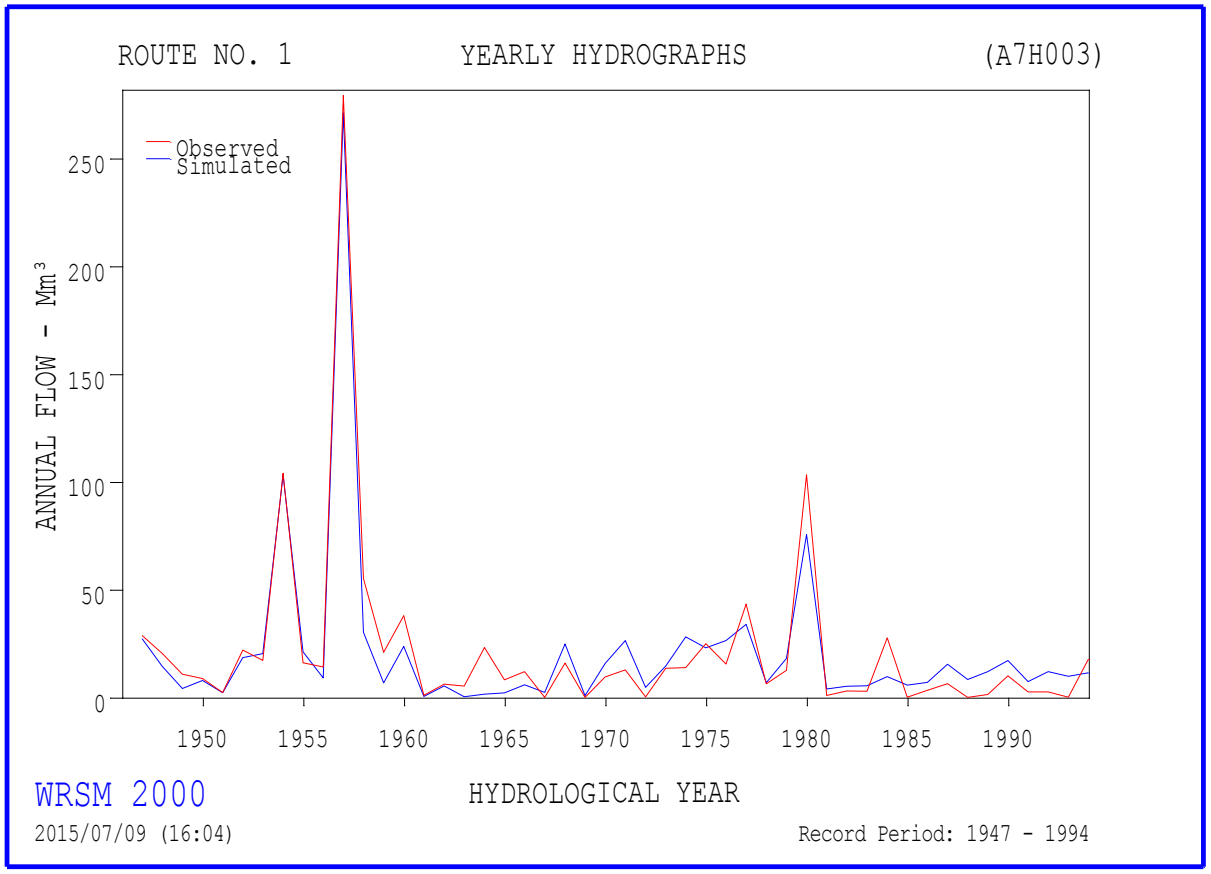



**Figure G.54: A7H003 Observed and simulated annual hydrograph**

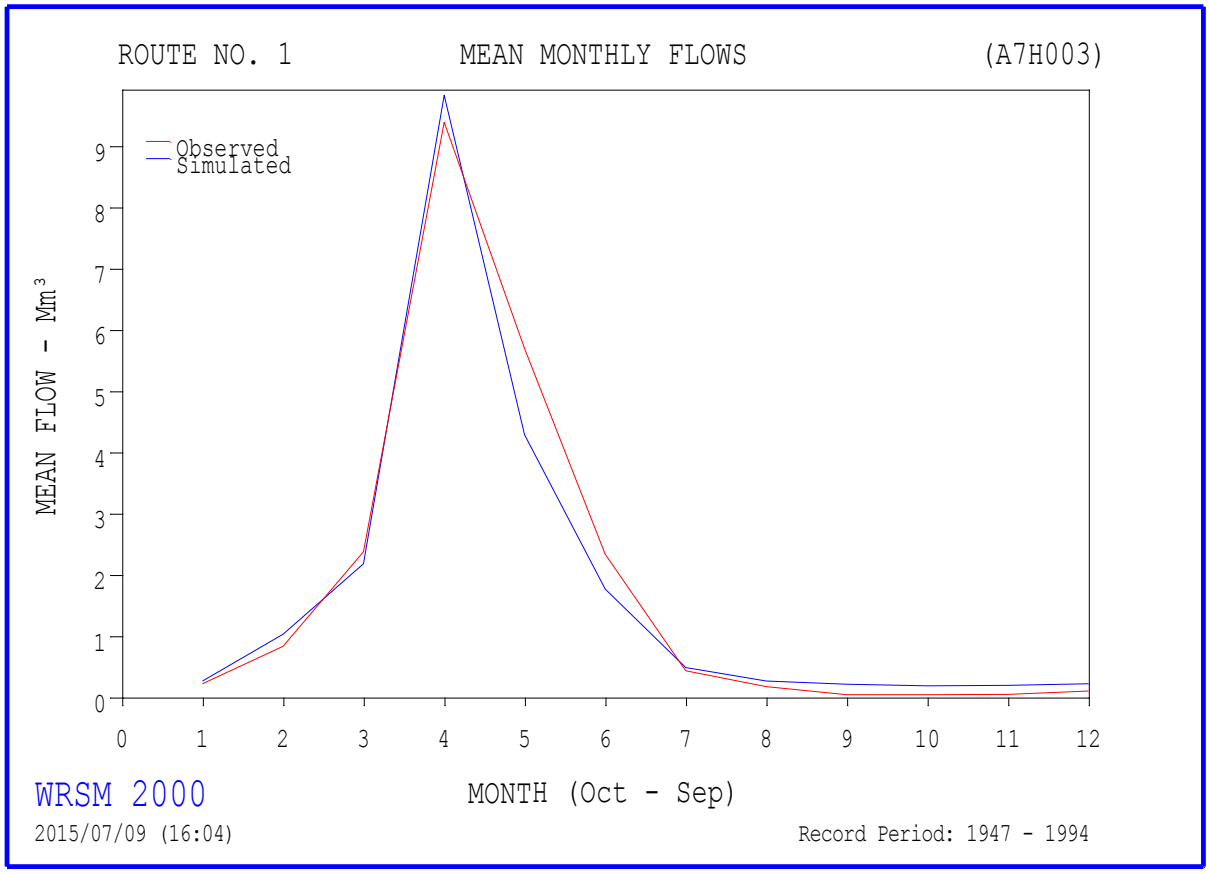



**Figure G.55: A7H003 Observed and simulated mean monthly flows**

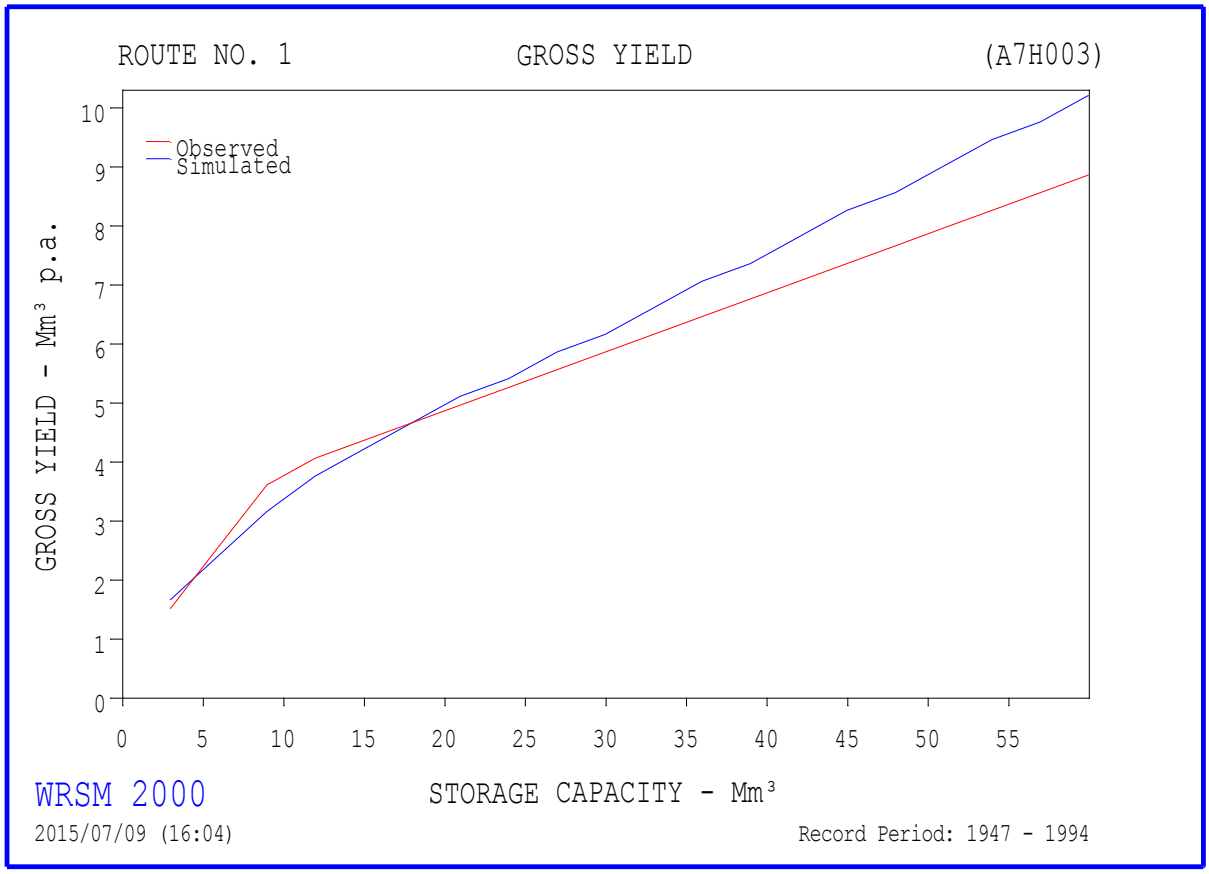



**Figure G.56: A7H003 Observed and simulated gross yield flows**

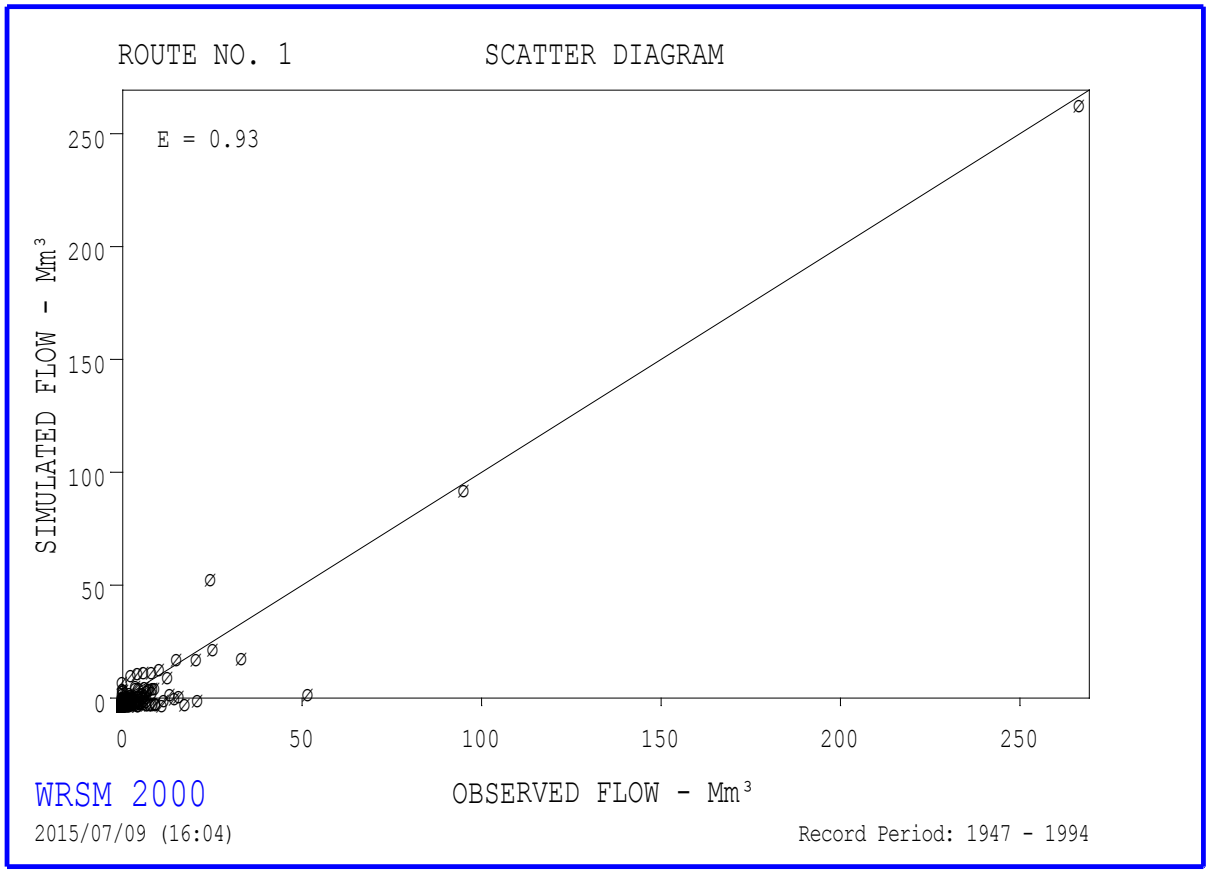



Figure G.57: A7H003 Observed and simulated scatter plot

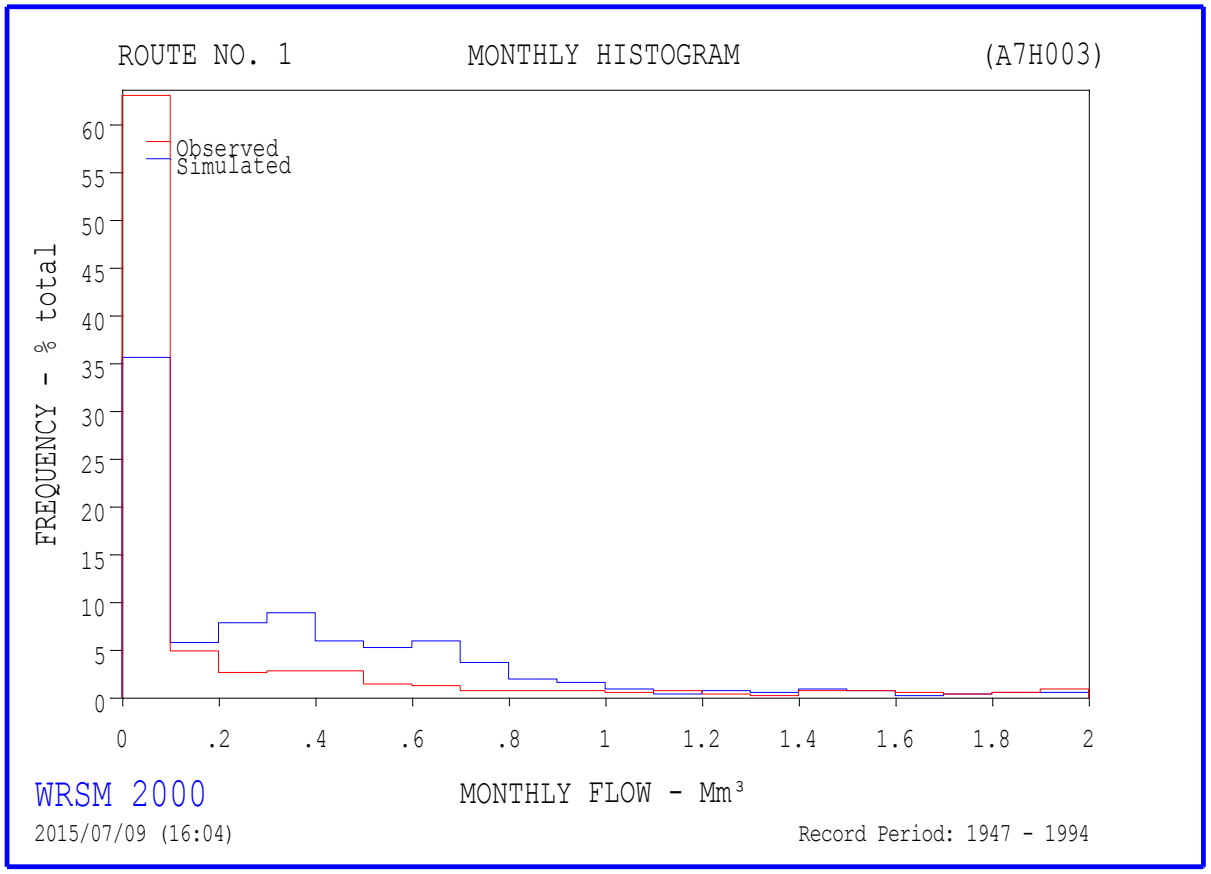



Figure G.58: A7H003 Observed and simulated histogram of flows

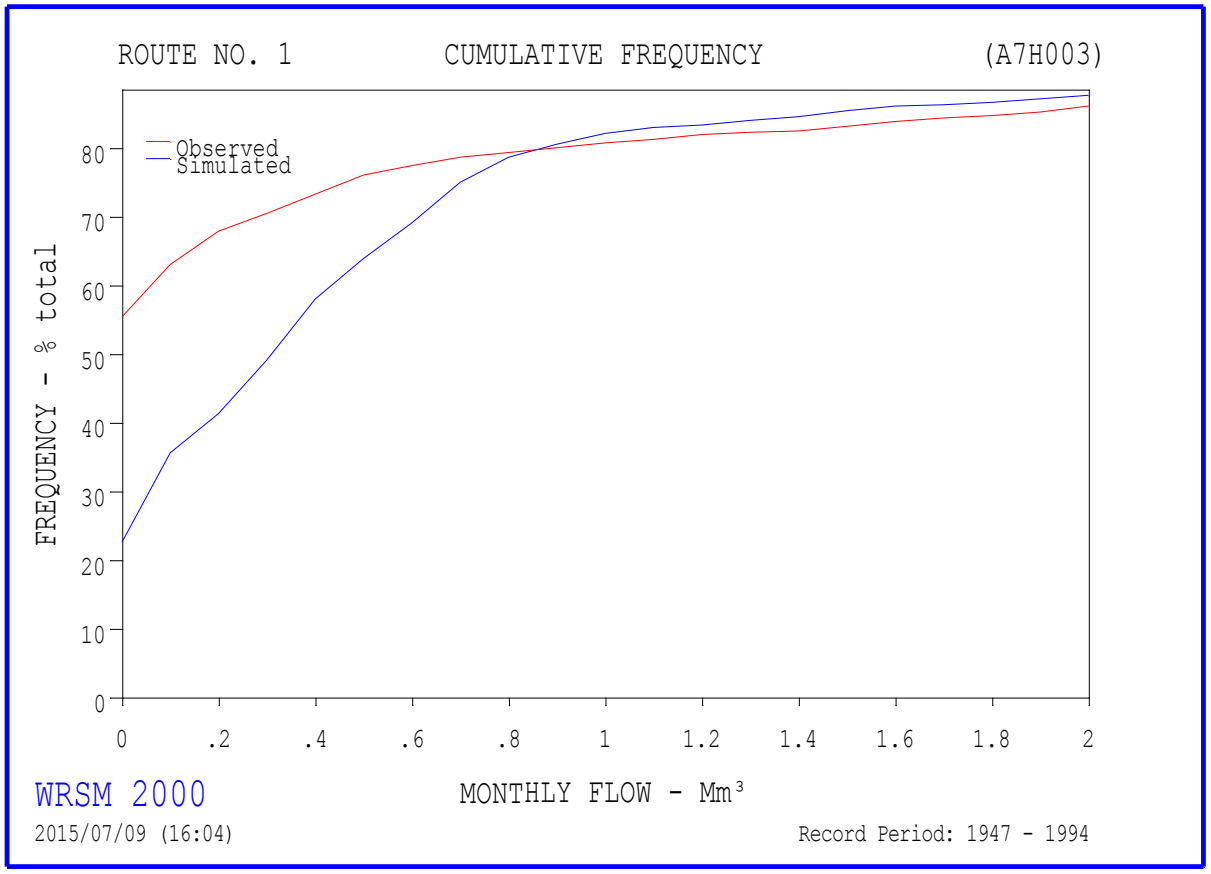



**Figure G.59: A7H003 Observed and simulated cumulative frequency flows**

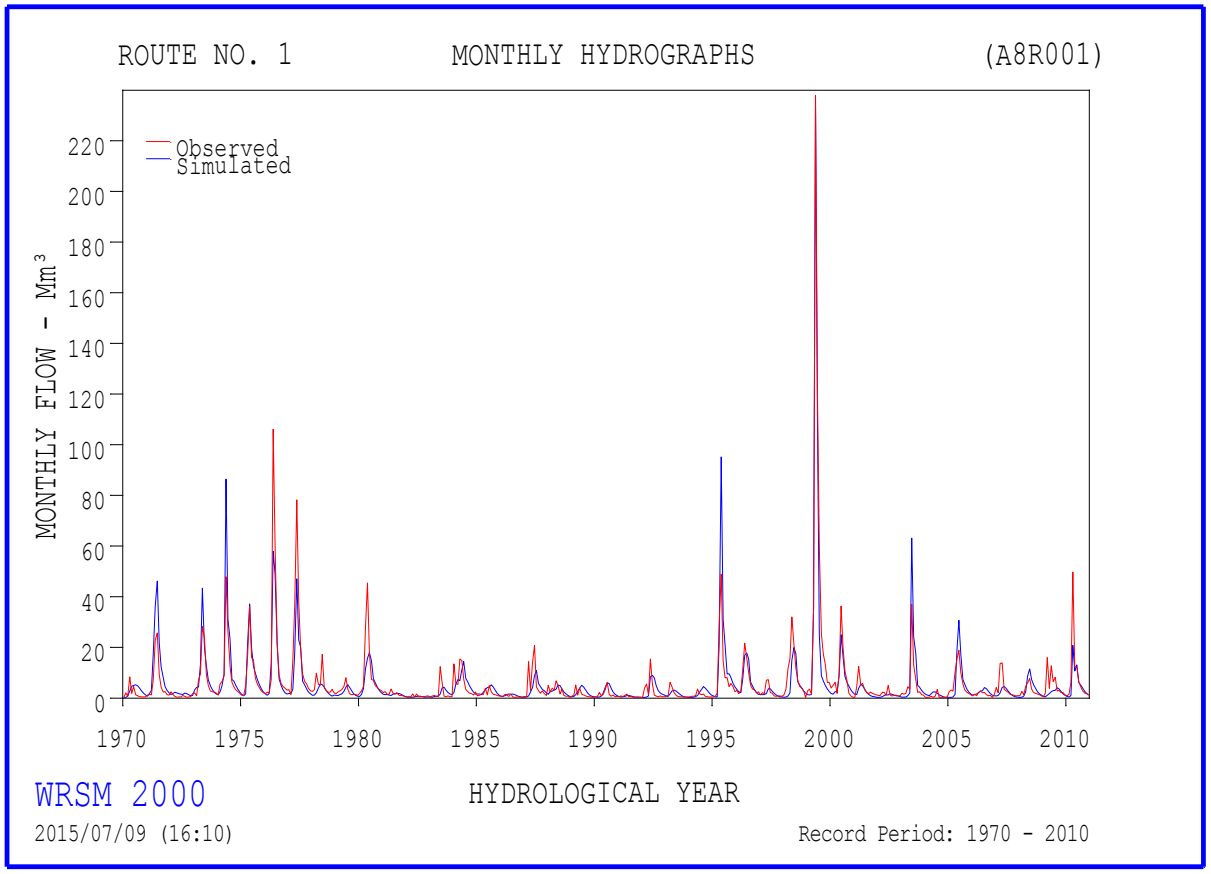



**Figure G.60: A8R001 Observed and simulated monthly hydrograph**

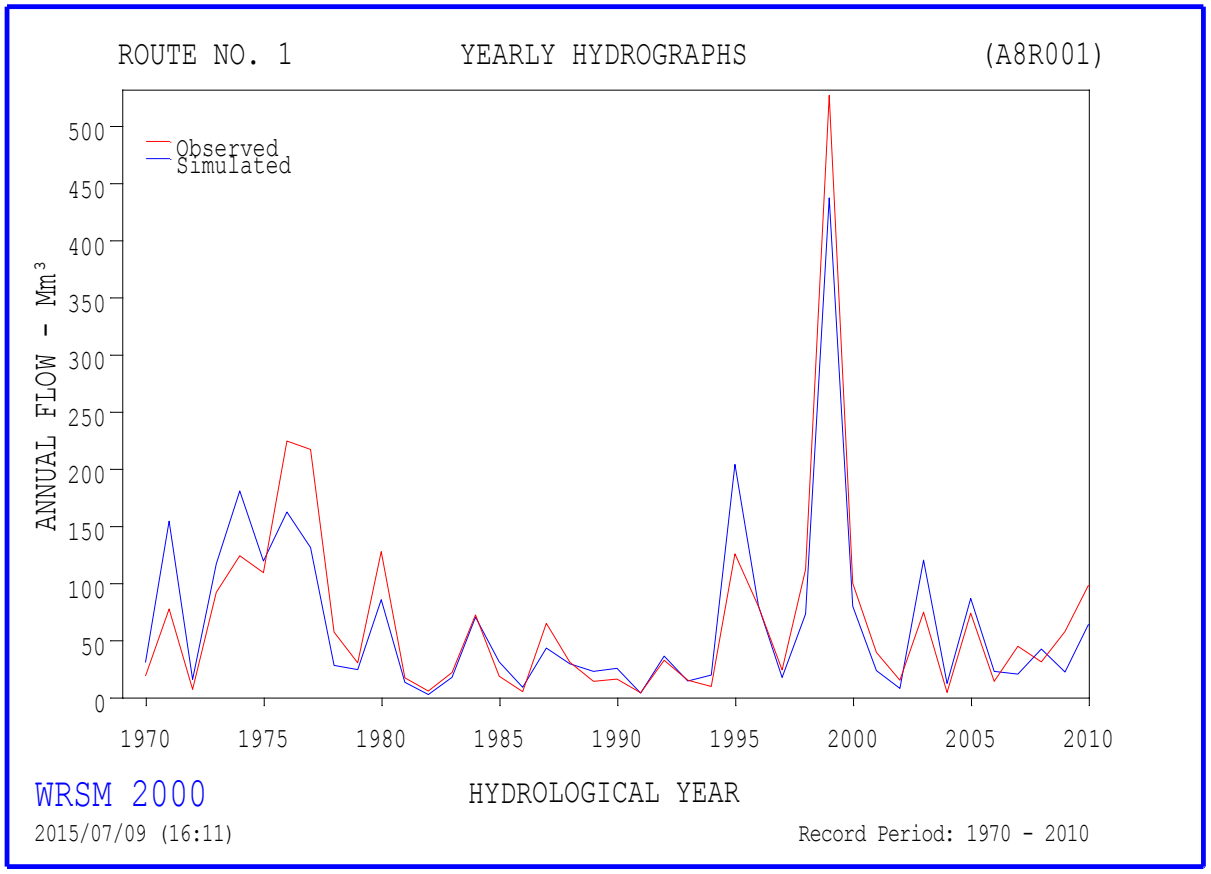



Figure G.61: A8R001 Observed and simulated annual hydrograph

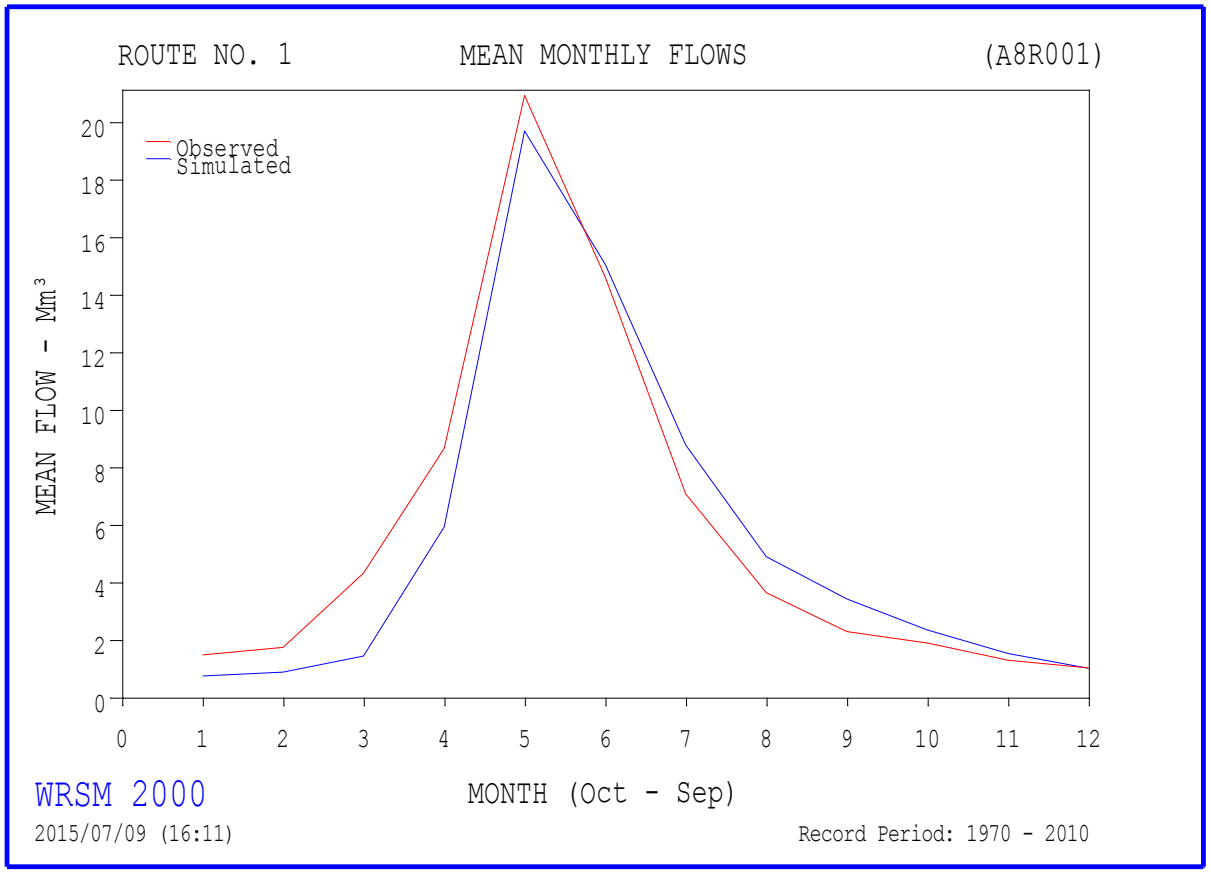



Figure G.62: A8R001 Observed and simulated mean monthly flows

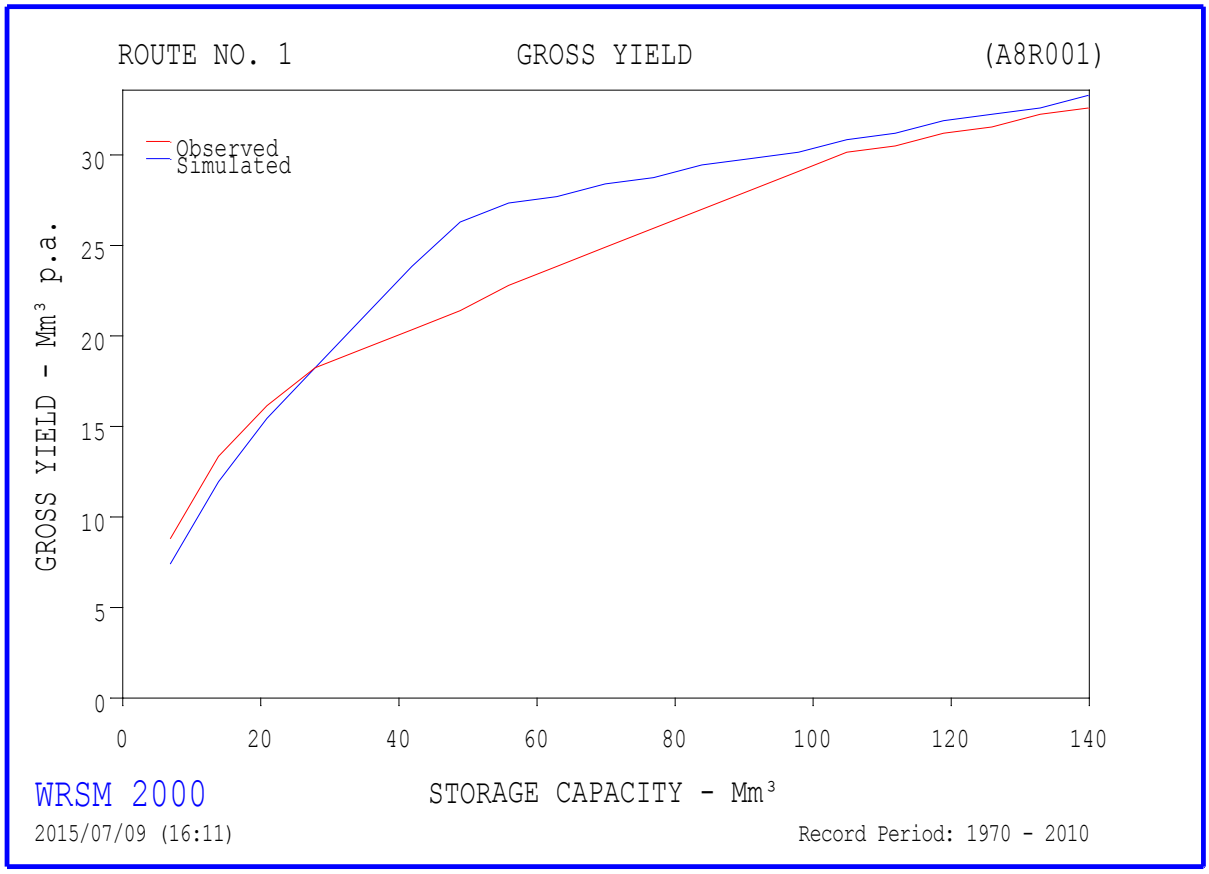



**Figure G.63: A8R001 Observed and simulated gross yield flows**

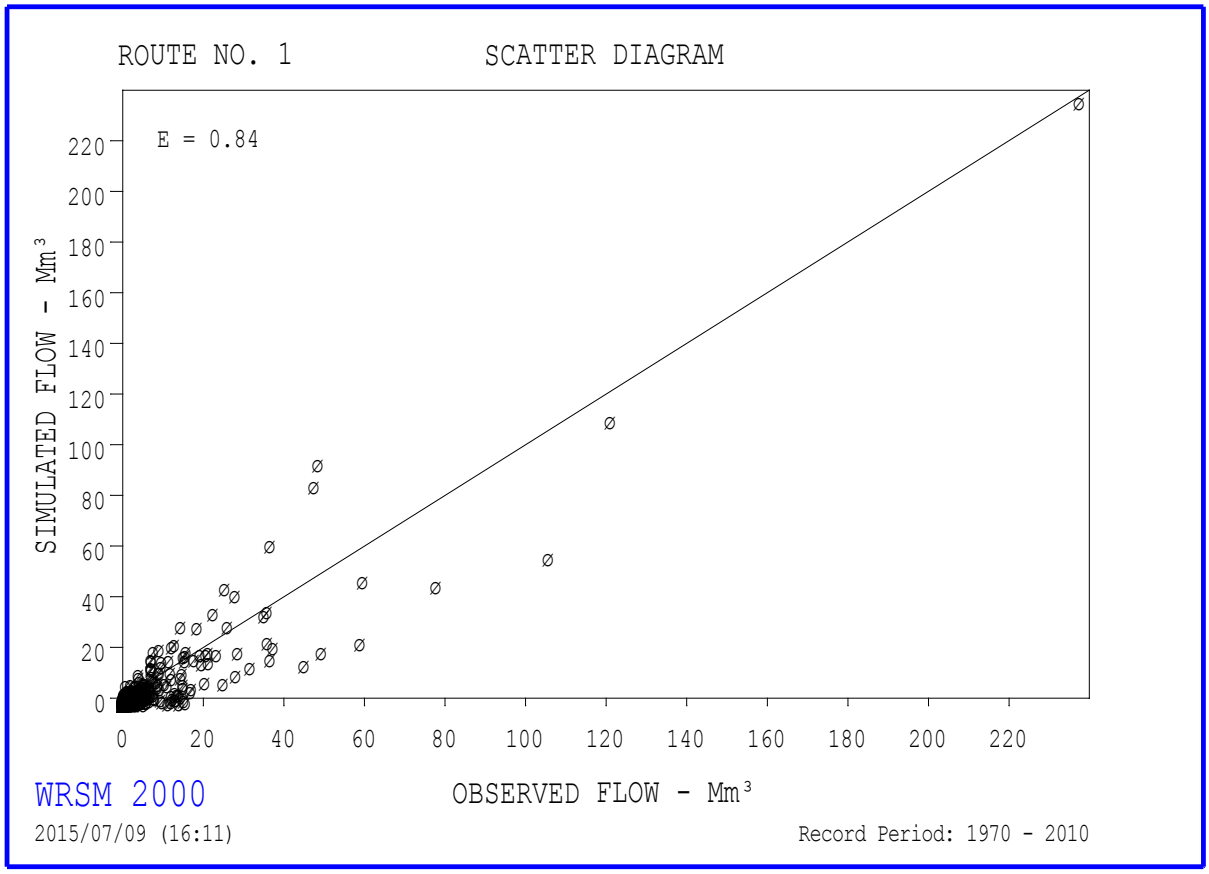



**Figure G.64: A8R001 Observed and simulated scatter plot**

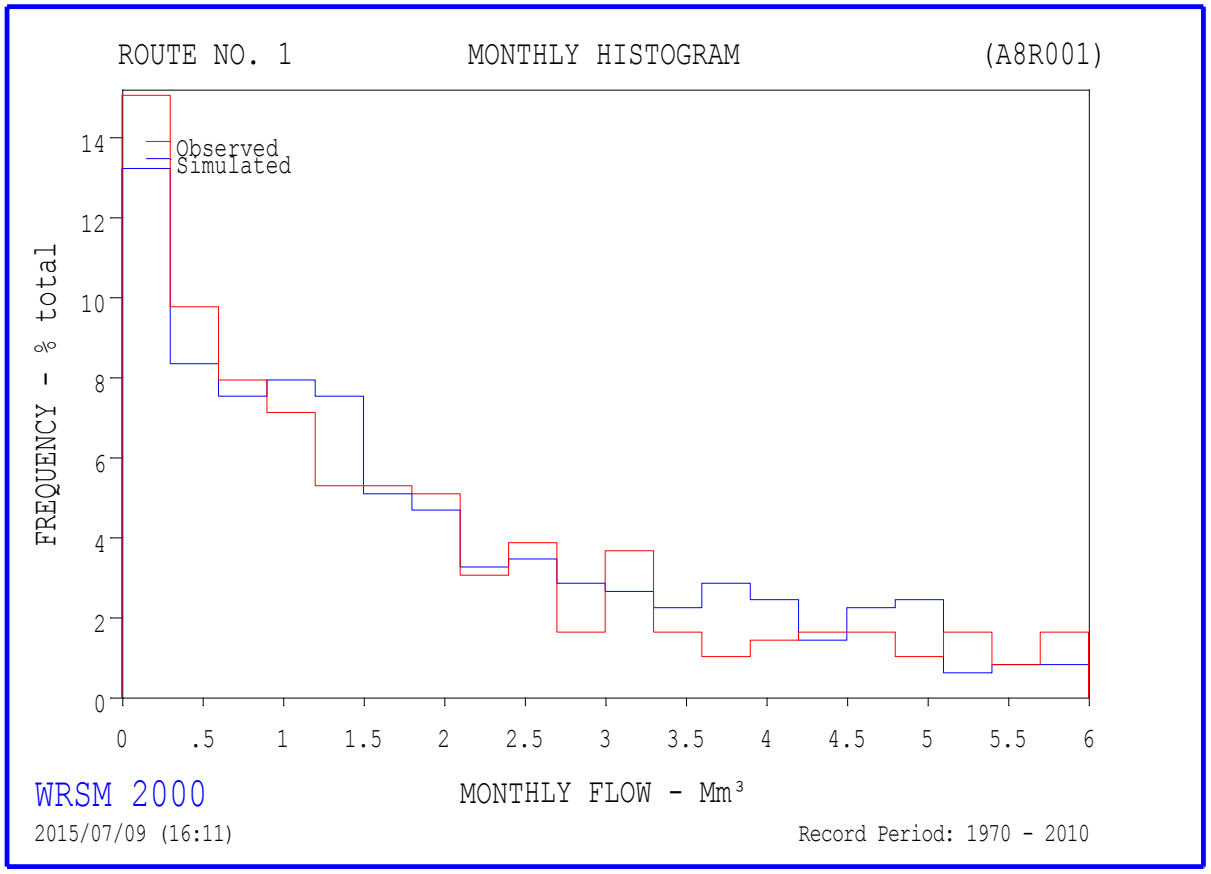



Figure G.65: A8R001 Observed and simulated histogram of flows

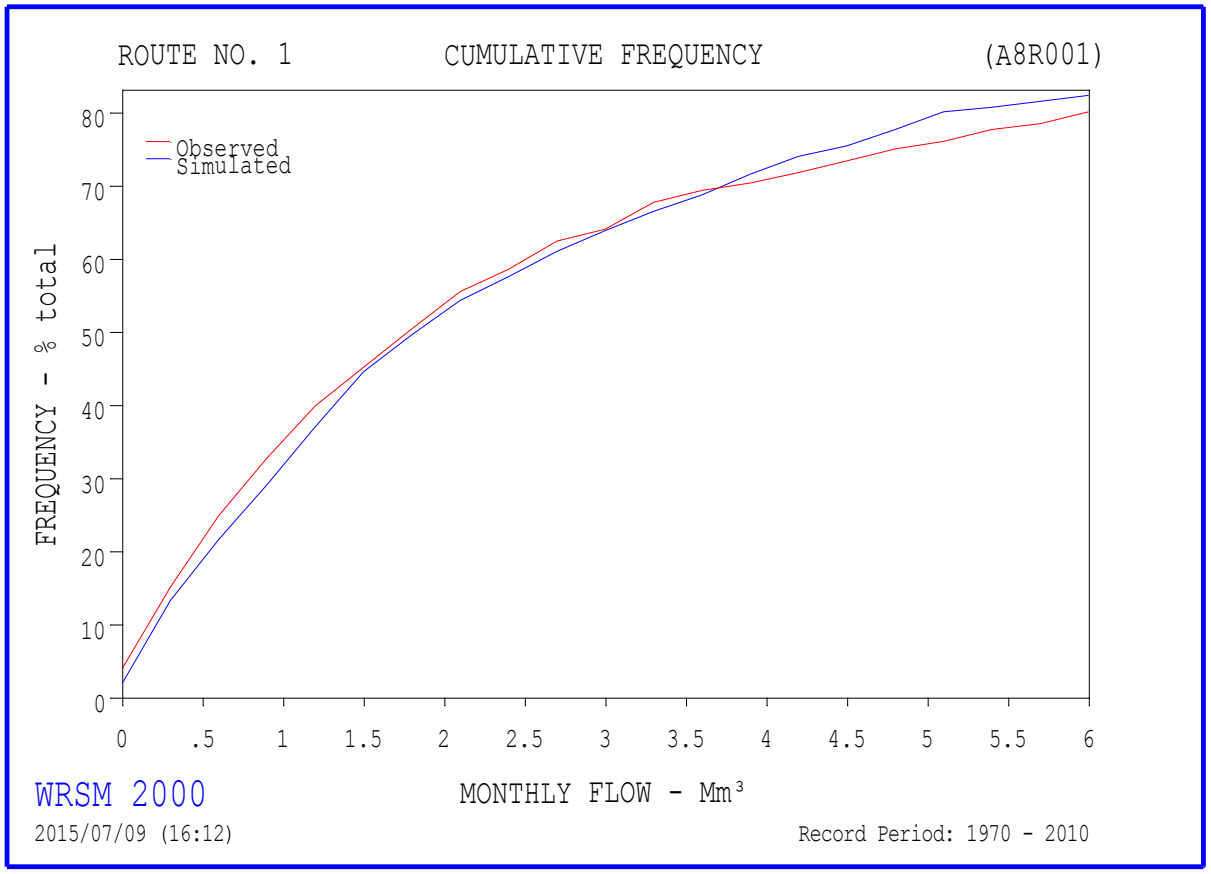



Figure G.66: A8R001 Observed and simulated cumulative frequency flows

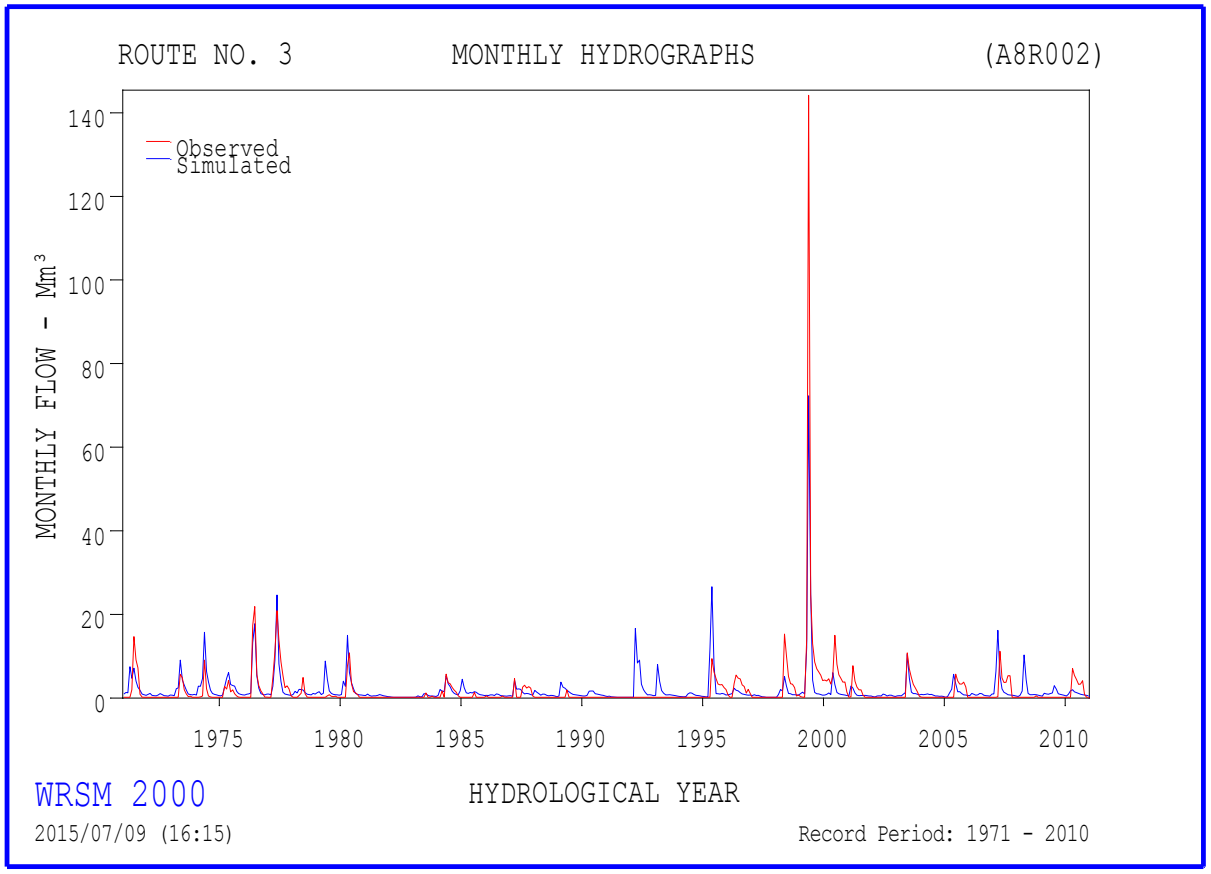



Figure G.67: A8R002 Observed and simulated monthly hydrograph

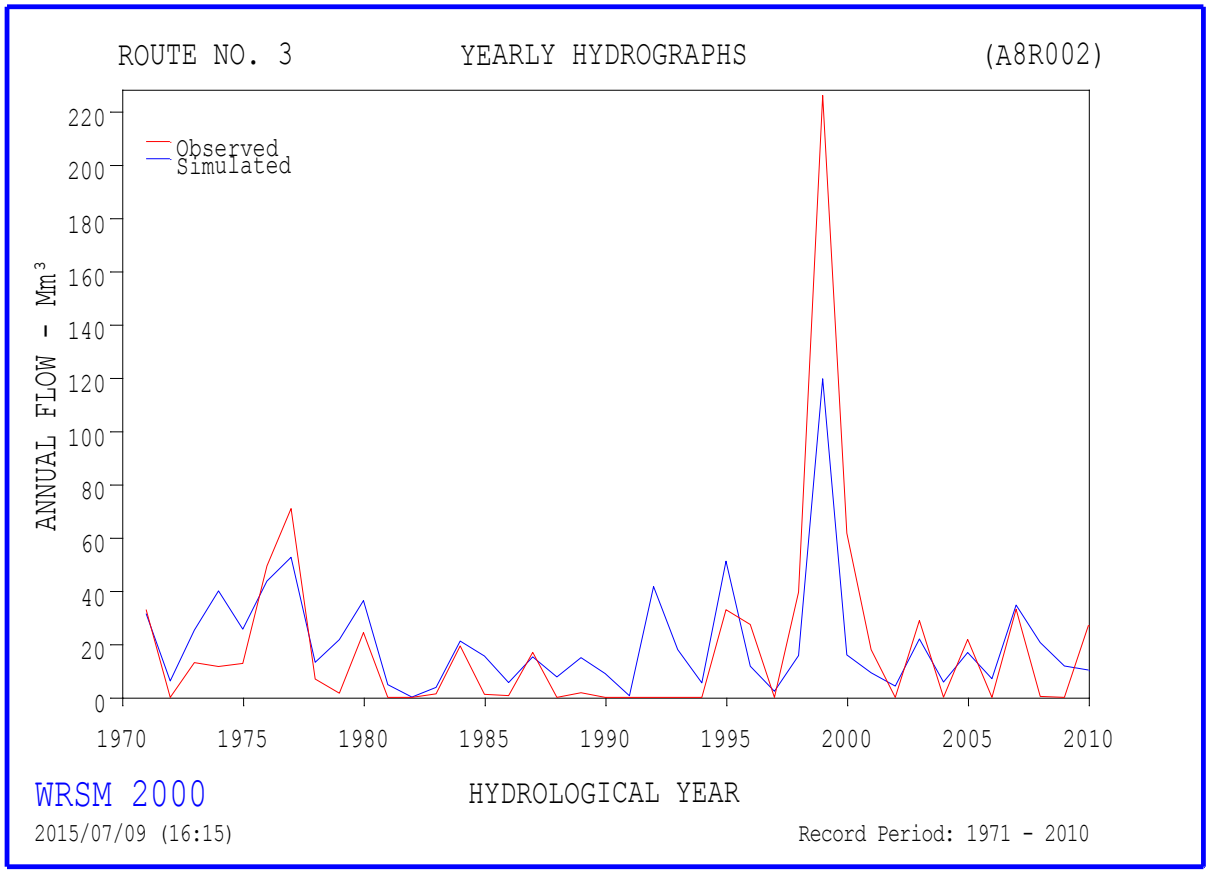



Figure G.68: A8R002 Observed and simulated annual hydrograph

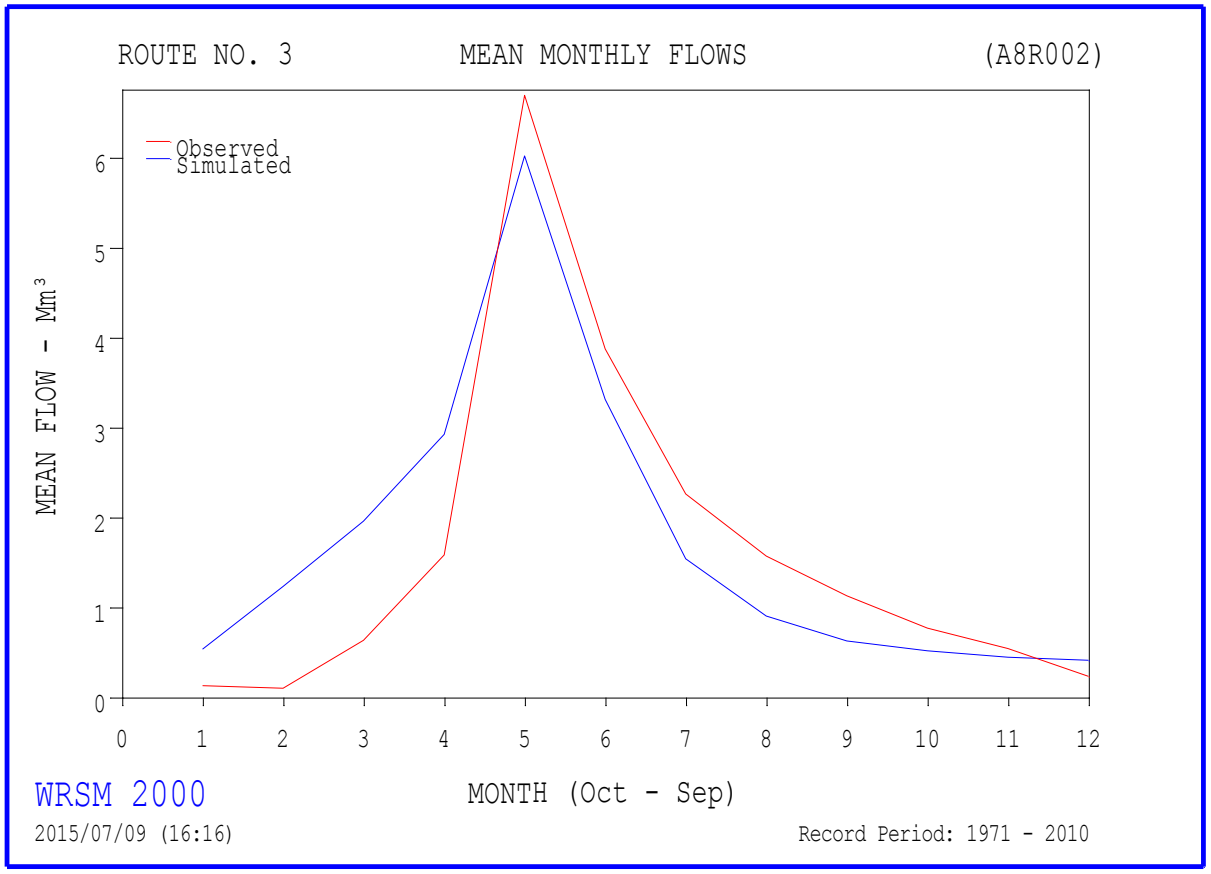



**Figure G.69: A8R002 Observed and simulated mean monthly flows**

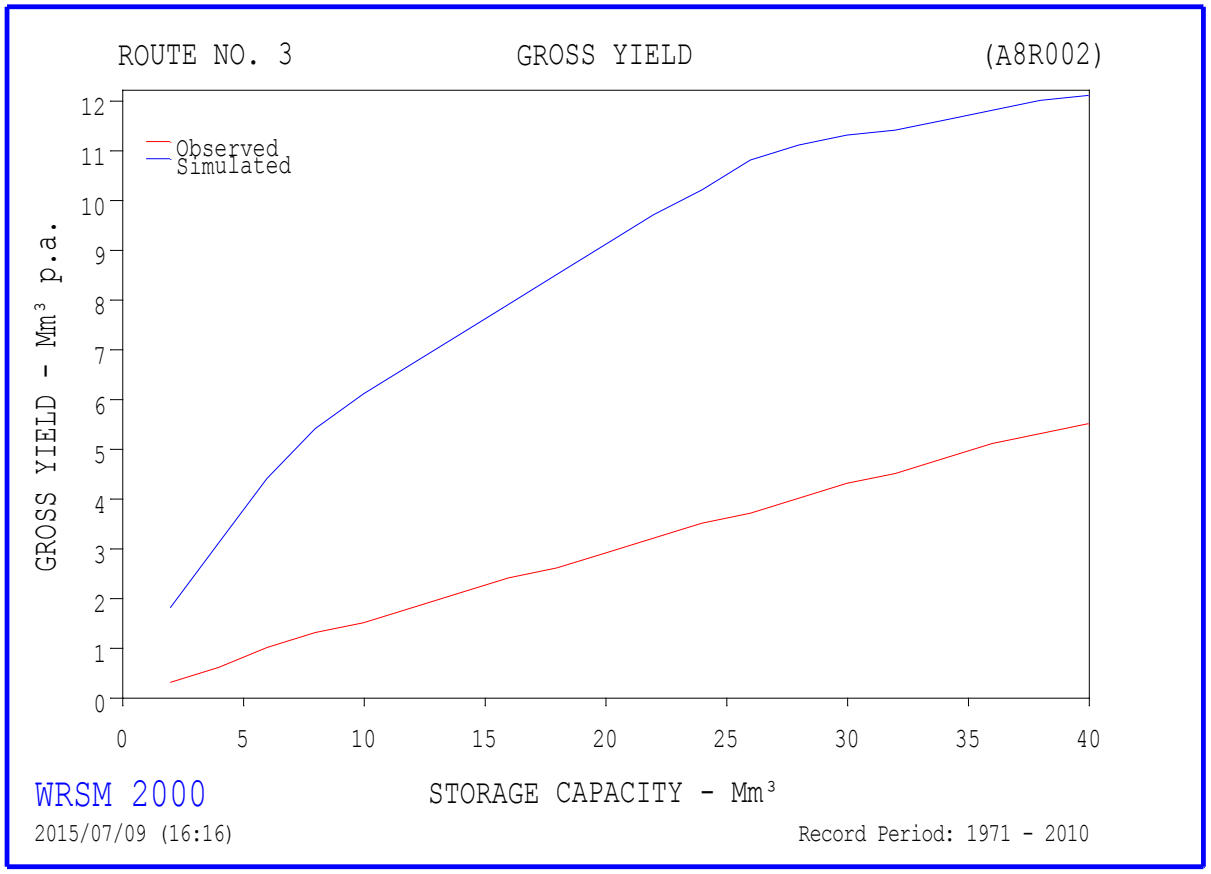



**Figure G.70: A8R002 Observed and simulated gross yield flows**

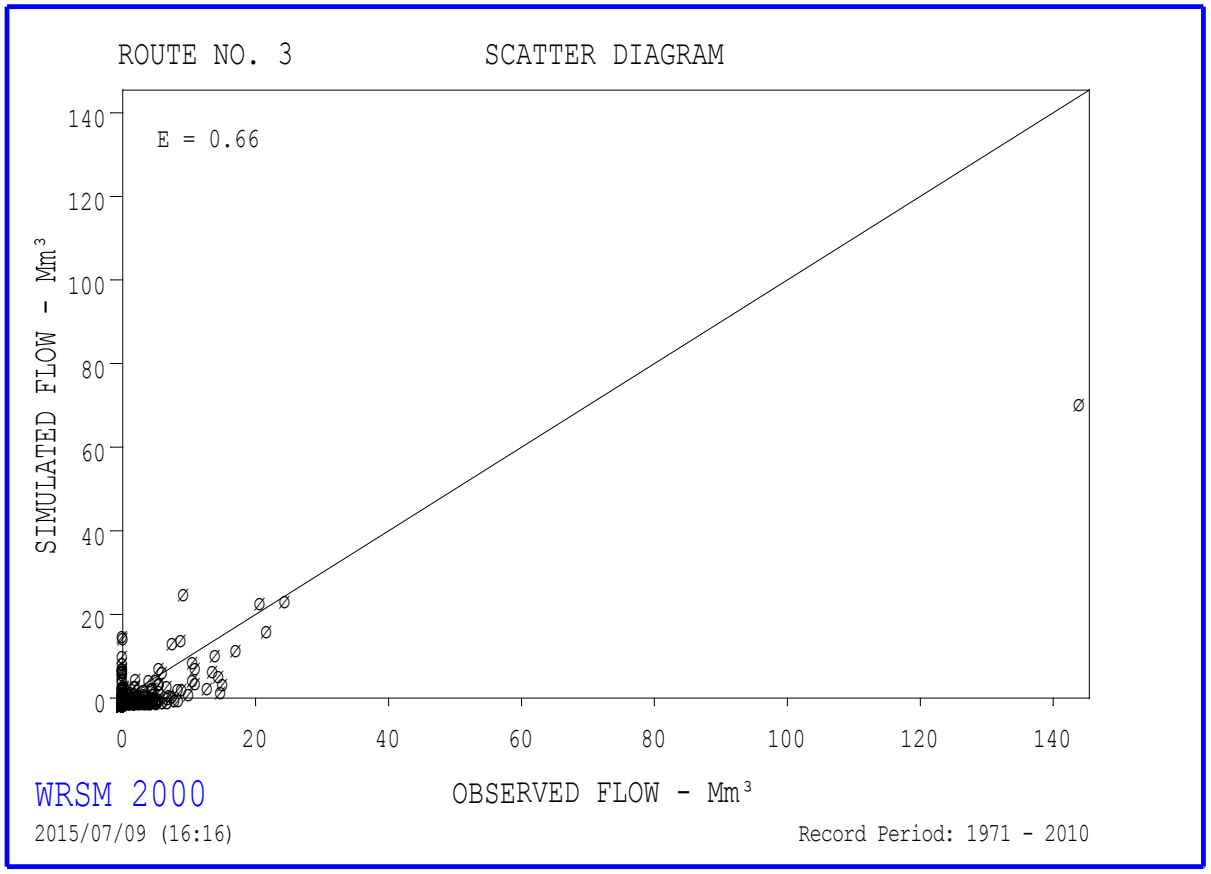



**Figure G.71: A8R002 Observed and simulated scatter plot**

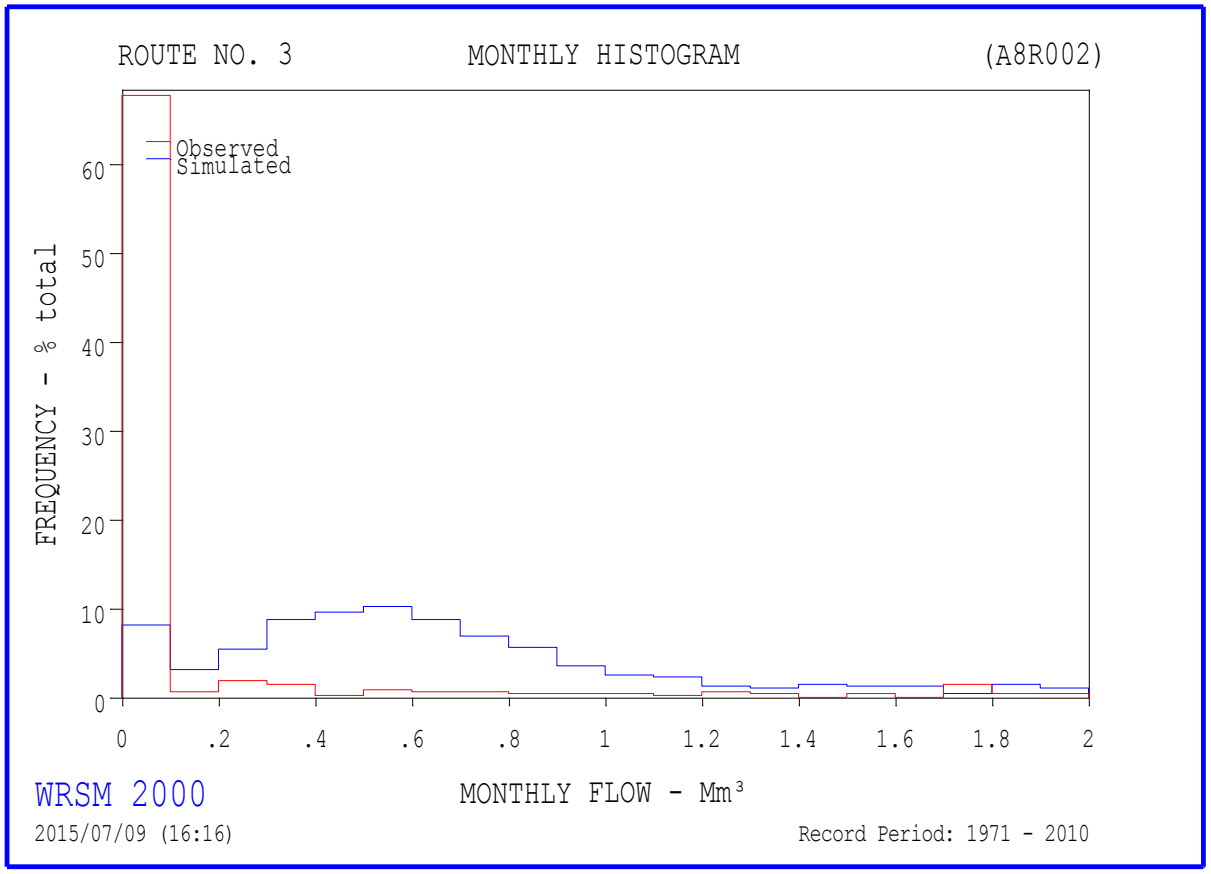



**Figure G.72: A8R002 Observed and simulated histogram of flows**

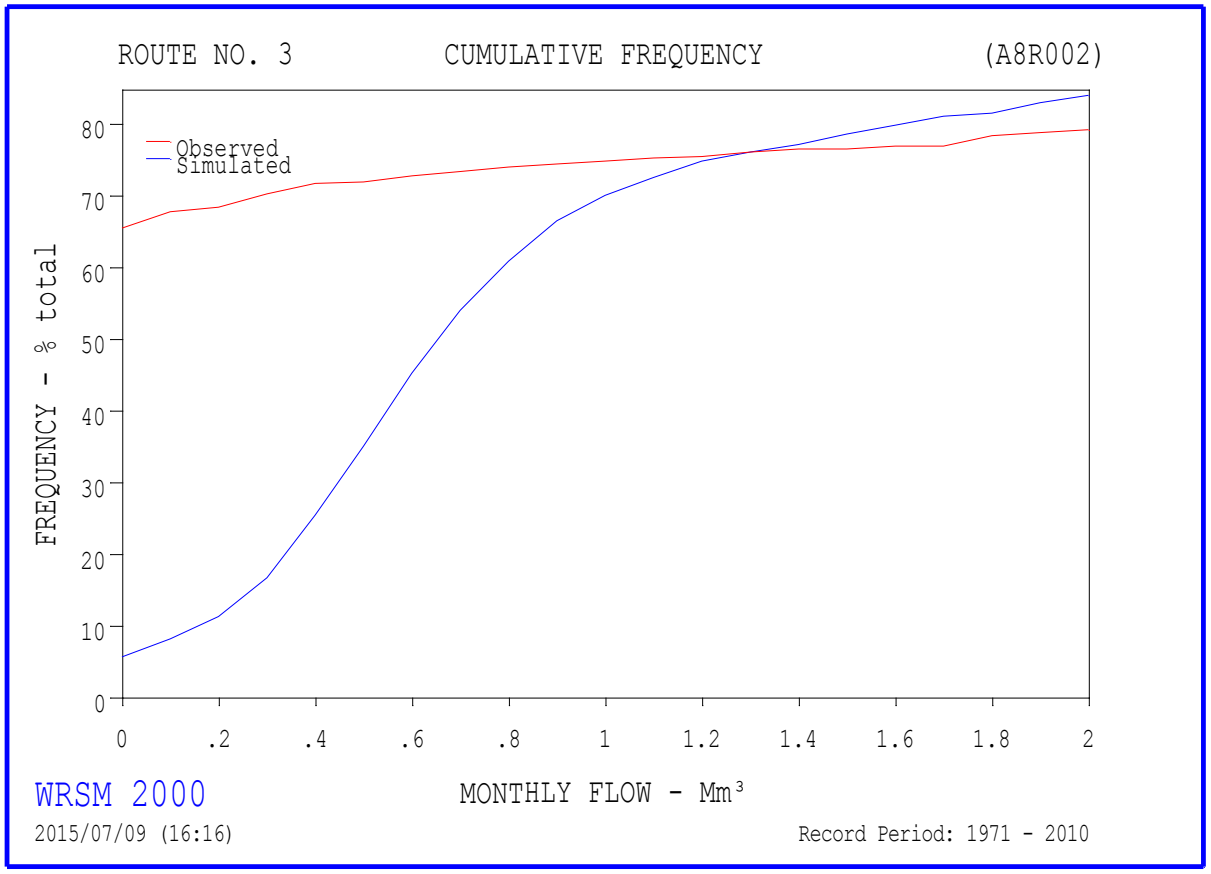



**Figure G.73: A8R002 Observed and simulated cumulative frequency flows**

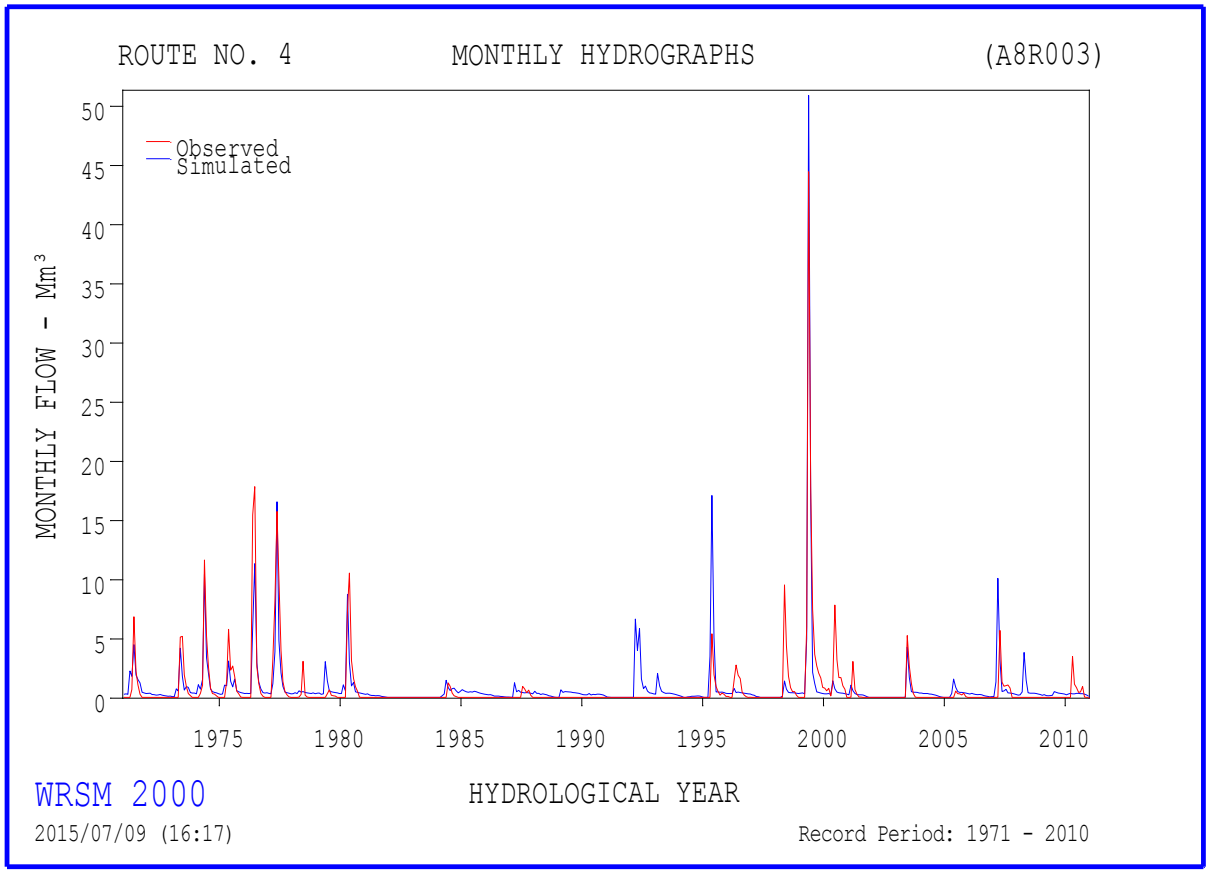



**Figure G.74: A8R003 Observed and simulated monthly hydrograph**

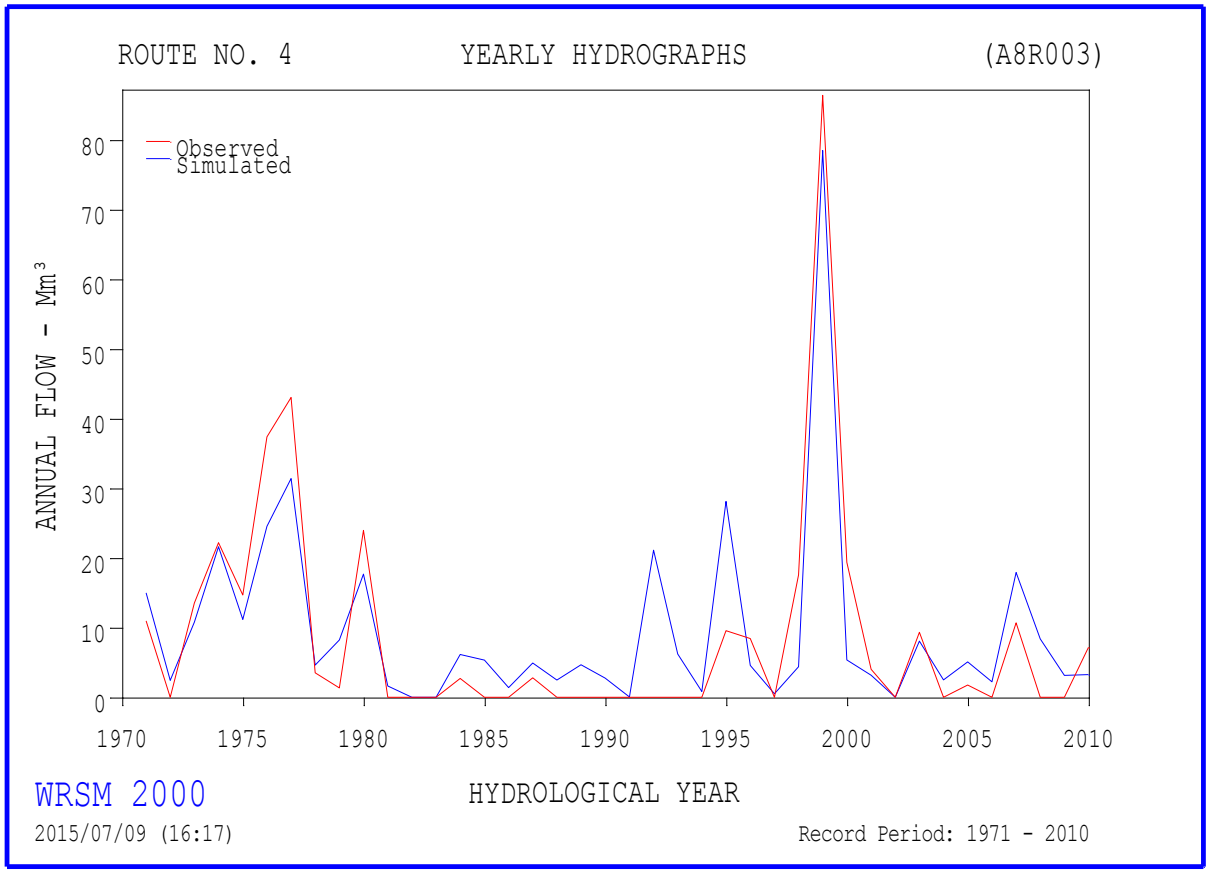



**Figure G.75: A8R003 Observed and simulated annual hydrograph**

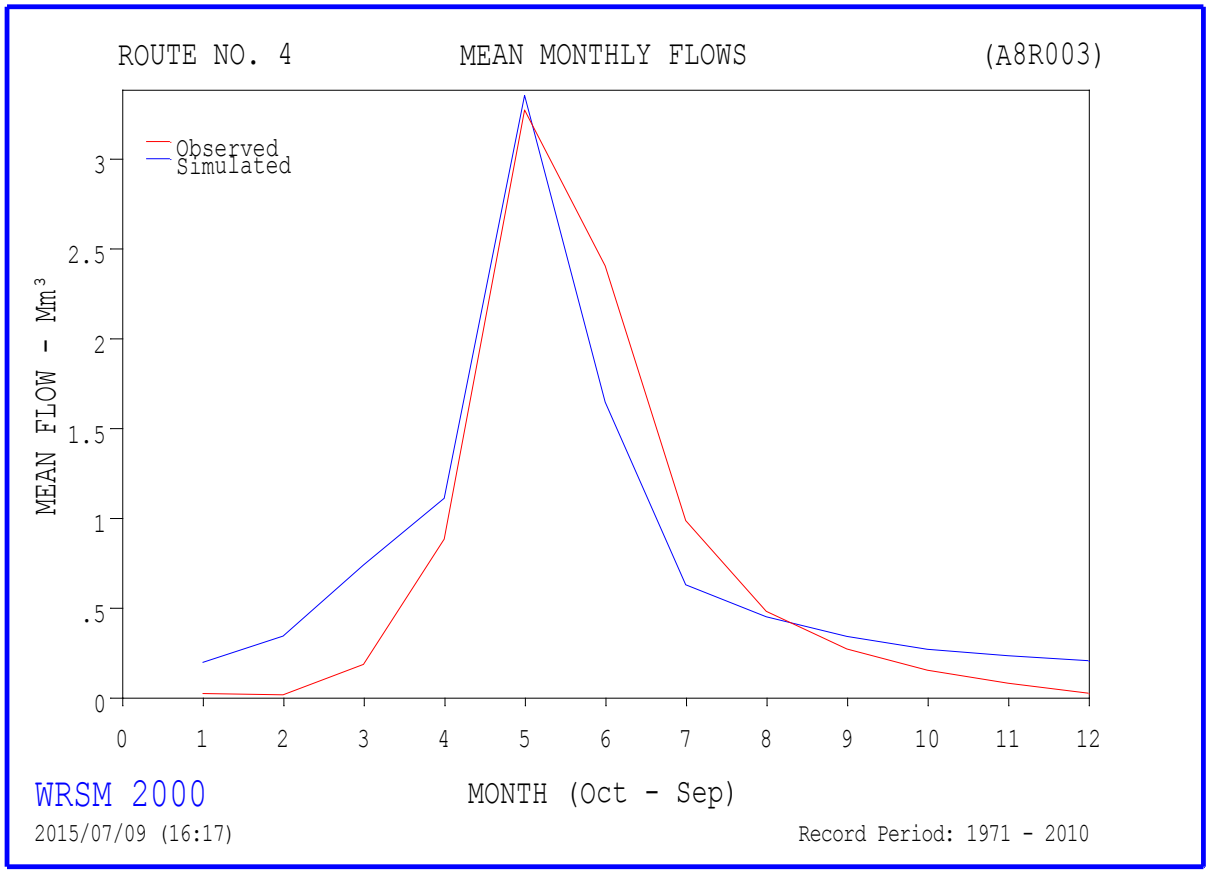



**Figure G.76: A8R003 Observed and simulated mean monthly flows**

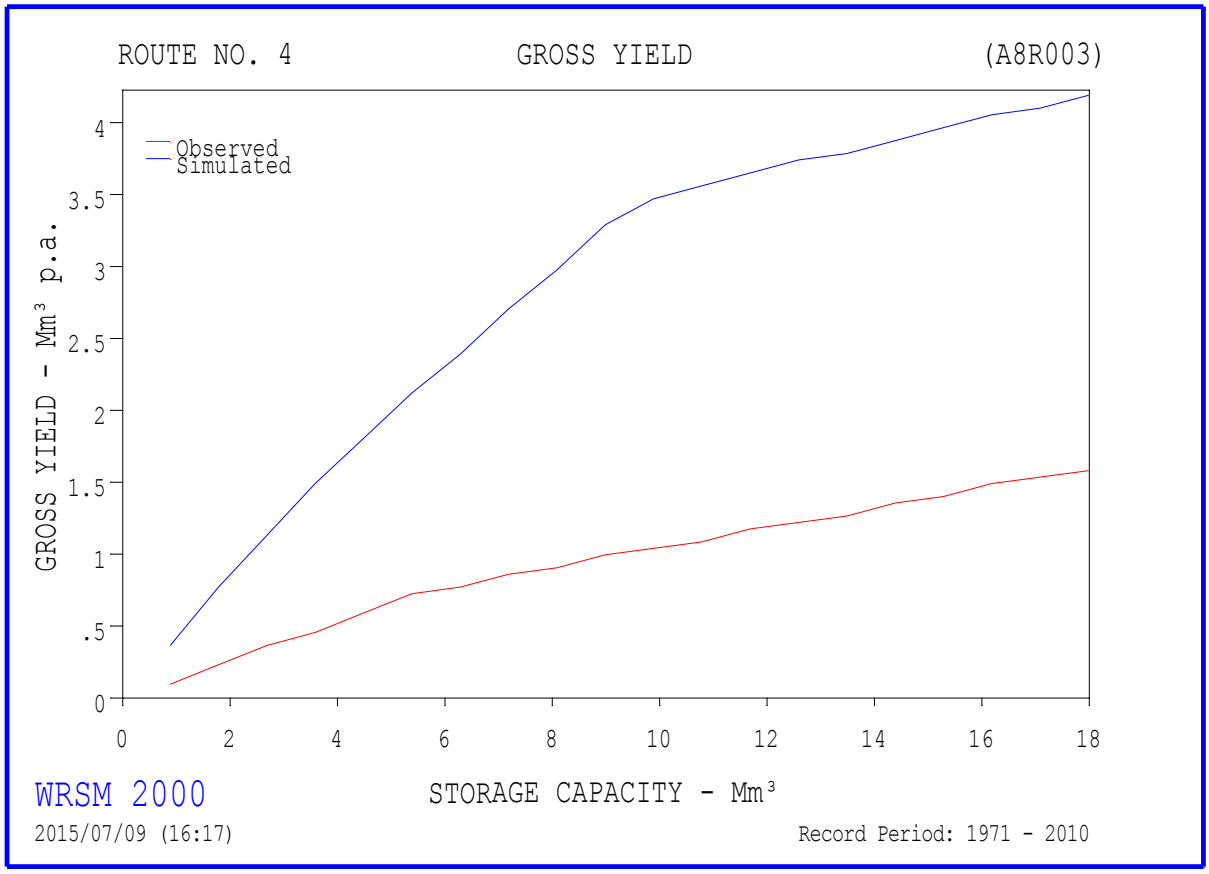



**Figure G.77: A8R003 Observed and simulated gross yield flows**

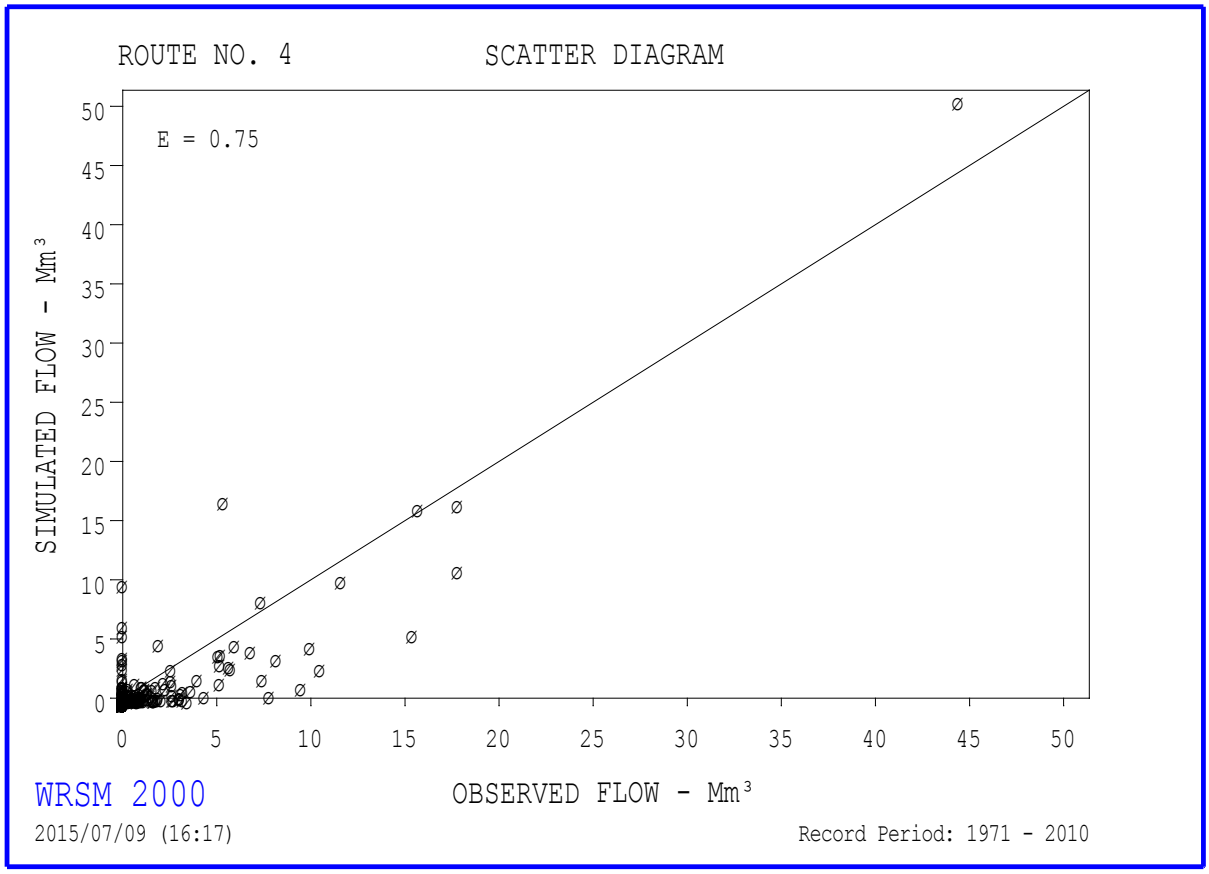



**Figure G.78: A8R003 Observed and simulated scatter plot**

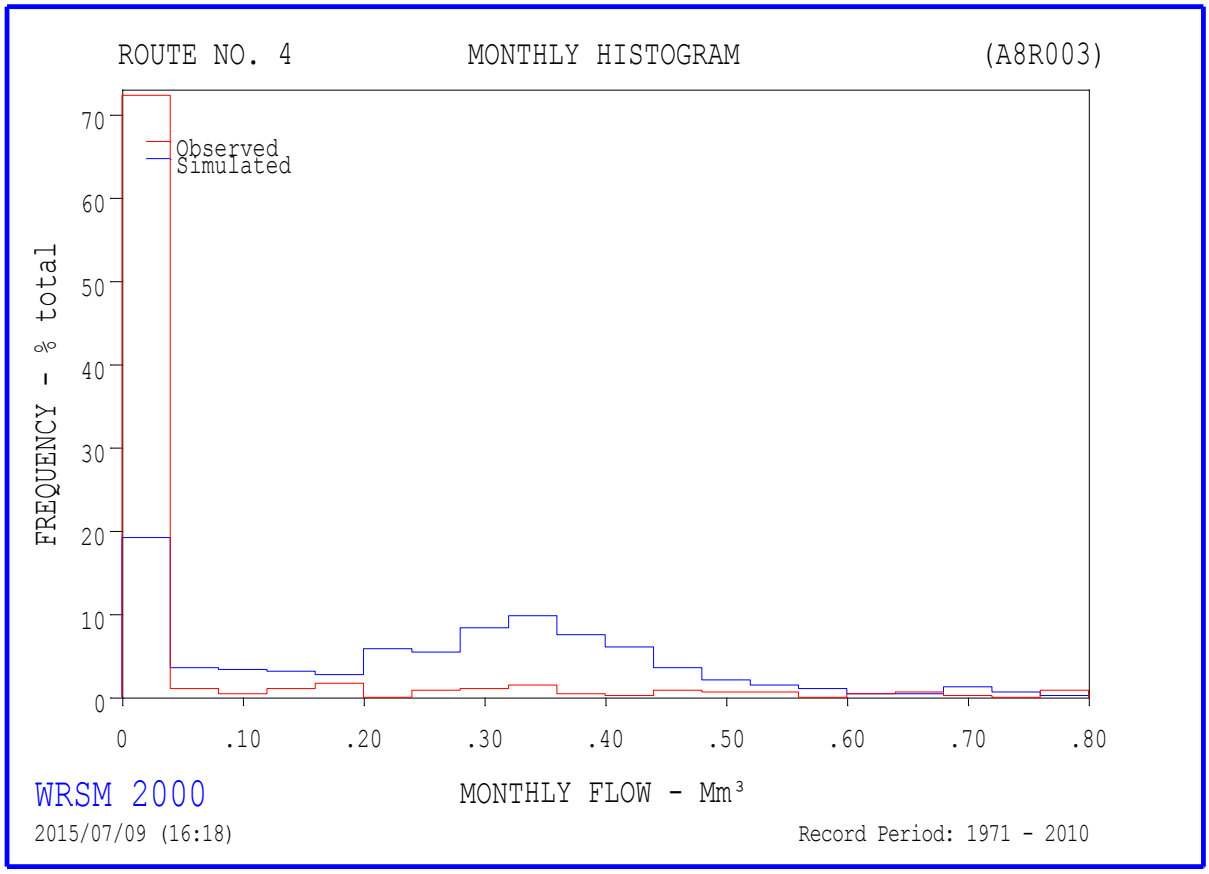



**Figure G.79: A8R003 Observed and simulated histogram of flows**

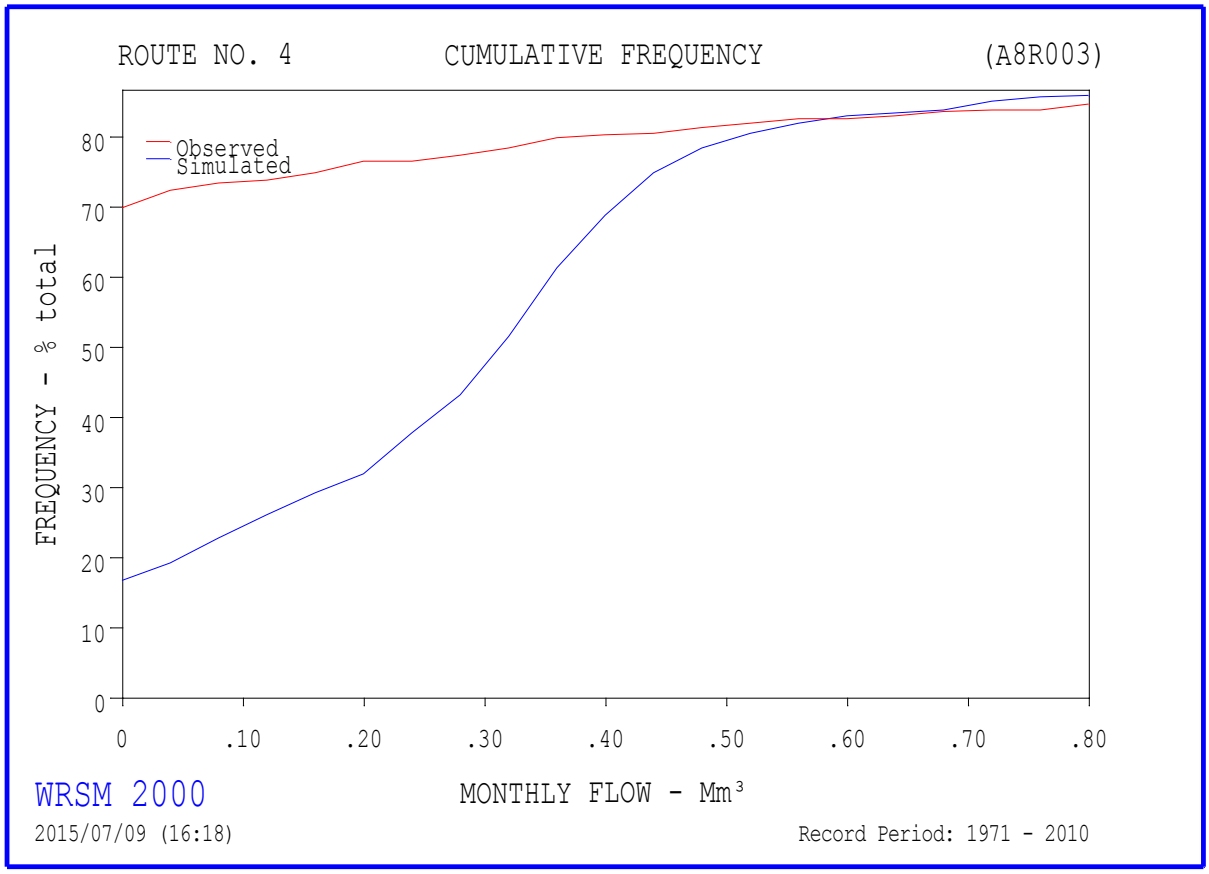



**Figure G.80: A8R003 Observed and simulated cumulative frequency flows**

# Appendix H

## Simulation results and comparison with other studies

## Table H.1: Statistics of simulated natural stream flow data for Limpopo WMA North

| Catchment/ Quaternary or sub-quaternary | | MAR (million $m^3$/a) | SD (million $m^3$/a) | CV |
|---|---|---|---|---|
| Matlabas | A41A | 18.80 | 23.75 | 1.35 |
| | A41B | 8.67 | 11.16 | 1.39 |
| | A41C | 11.25 | 20.07 | 1.79 |
| | A41D | 11.22 | 22.11 | 1.98 |
| | A41E | 5.73 | 11.73 | 2.06 |
| **Matlabas** | | **55.67** | **88.81** | **1.60** |
| Mokolo | A42A1 | 7.99 | 6.89 | 0.87 |
| | A42A2 | 9.49 | 8.18 | 0.87 |
| | A42A3 | 1.11 | 0.95 | 0.95 |
| | A42A4 | 5.79 | 5.30 | 0.92 |
| | A42B1 | 2.82 | 2.43 | 0.86 |
| | A42B2 | 11.24 | 9.66 | 0.86 |
| | A42B3 | 2.15 | 1.85 | 0.86 |
| | A42B4 | 3.79 | 3.26 | 0.86 |
| | A42B5 | 6.89 | 5.92 | 0.86 |
| | A42C1 | 3.51 | 2.98 | 0.85 |
| | A42C2 | 2.11 | 1.79 | 0.85 |
| | A42C3 | 20.70 | 17.55 | 0.85 |
| | A42C4 | 0.96 | 0.82 | 0.85 |
| | A42C5 | 1.18 | 1.00 | 0.85 |
| | A42C6 | 1.63 | 1.38 | 0.85 |
| | A42C7 | 2.76 | 2.36 | 0.86 |
| | A42C8 | 1.86 | 1.59 | 0.86 |
| | A42C9 | 2.25 | 1.94 | 0.87 |
| | A42D1 | 7.02 | 6.03 | 0.86 |
| | A42D2 | 3.02 | 2.59 | 0.86 |
| | A42D3 | 1.38 | 1.18 | 0.86 |
| | A42D4 | 13.35 | 11.46 | 0.86 |
| | A42D5 | 4.61 | 3.95 | 0.86 |
| | A42D6 | 2.24 | 1.92 | 0.86 |
| | A42D7 | 11.45 | 9.83 | 0.86 |
| | A42E1 | 9.22 | 11.40 | 1.24 |
| | A42E2 | 4.07 | 5.02 | 1.24 |
| | A42E3 | 2.67 | 3.30 | 1.24 |
| | A42E4 | 1.49 | 1.84 | 1.24 |
| | A42E5 | 1.97 | 2.43 | 1.24 |
| | A42E6 | 5.33 | 6.59 | 1.24 |
| | A42E7 | 3.71 | 4.59 | 1.24 |
| | A42E8 | 15.26 | 18.85 | 1.24 |

| Catchment/ Quaternary or sub-quaternary | | MAR (million $m^3$/a) | SD (million $m^3$/a) | CV |
|---|---|---|---|---|
| | A42F1 | 8.21 | 10.31 | 1.26 |
| | A42F2 | 1.72 | 2.16 | 1.26 |
| | A42F3 | 9.59 | 12.03 | 1.26 |
| | A42F4 | 14.84 | 18.63 | 1.26 |
| | A42G1 | 12.98 | 19.38 | 1.50 |
| | A42G2 | 2.73 | 4.09 | 1.50 |
| | A42G3 | 4.80 | 7.17 | 1.50 |
| | A42G4 | 12.84 | 19.18 | 1.50 |
| | A42H1 | 12.95 | 18.03 | 1.40 |
| | A42H2 | 3.79 | 5.26 | 1.40 |
| | A42H3 | 10.09 | 14.03 | 1.40 |
| | A42J1 | 4.11 | 4.78 | 1.17 |
| | A42J2 | 2.26 | 2.63 | 1.17 |
| **Mokolo** | | **275.95** | **304.53** | **1.10** |
| **Lephalala** | A50A | 32.33 | 22.31 | 0.69 |
| | A50B | 34.82 | 24.72 | 0.71 |
| | A50C | 14.62 | 16.55 | 1.14 |
| | A50D | 20.37 | 21.33 | 1.05 |
| | A50E | 19.03 | 16.59 | 0.88 |
| | A50F | 9.50 | 8.49 | 0.90 |
| | A50G | 4.09 | 6.55 | 1.58 |
| | A50H | 2.75 | 4.68 | 1.62 |
| | A50J | 4.75 | 6.50 | 1.36 |
| **Lephalala** | | **142.28** | **127.71** | **0.90** |
| **Mogalakwena** | A61A1 | 10.41 | 5.72 | 0.55 |
| | A61A2 | 8.92 | 4.91 | 0.55 |
| | A61A3 | 4.53 | 2.41 | 0.54 |
| | A61B1 | 6.60 | 5.72 | 0.87 |
| | A61B2 | 14.97 | 11.62 | 0.78 |
| | A61C1 | 3.32 | 2.65 | 0.80 |
| | A61C2 | 3.75 | 3.00 | 0.80 |
| | A61D1 | 3.43 | 3.68 | 1.11 |
| | A61D2 | 7.12 | 8.18 | 1.15 |
| | A61E1 | 2.23 | 2.84 | 1.28 |
| | A61E2 | 8.55 | 9.93 | 1.17 |
| | A61F | 19.46 | 26.49 | 1.37 |
| | A61G | 19.89 | 28.92 | 1.46 |
| | A61H | 39.91 | 26.69 | 0.67 |
| | A61J | 19.61 | 22.82 | 1.17 |
| | A62A | 14.17 | 18.68 | 1.33 |
| | A62B | 11.76 | 18.15 | 1.55 |

| Catchment/ Quaternary or sub-quaternary | | MAR (million $m^3/a$) | SD (million $m^3/a$) | CV |
|---|---|---|---|---|
| | A62C | 4.02 | 6.19 | 1.55 |
| | A62D | 4.49 | 7.31 | 1.59 |
| | A62E | 3.74 | 7.47 | 2.01 |
| | A62F | 4.70 | 9.55 | 2.04 |
| | A62G | 2.63 | 5.18 | 1.96 |
| | A62H | 4.12 | 8.24 | 2.01 |
| | A62J | 4.59 | 9.34 | 2.05 |
| | A63A | 6.24 | 25.71 | 4.09 |
| | A63B | 4.14 | 16.70 | 4.06 |
| | A63C | 3.02 | 11.20 | 3.90 |
| | A63D | 2.35 | 9.53 | 3.73 |
| | A63E | 3.53 | 13.28 | 3.79 |
| **Mogalakwena** | | **246.18** | **332.11** | **1.35** |
| **Sand** | A71A | 10.27 | 26.64 | 2.61 |
| | A71B | 7.27 | 19.42 | 2.69 |
| | A71C | 8.16 | 22.54 | 2.78 |
| | A71D | 3.94 | 11.23 | 2.86 |
| | A71E | 3.65 | 7.51 | 2.07 |
| | A71F | 2.29 | 4.57 | 2.01 |
| | A71G | 4.11 | 9.04 | 2.21 |
| | A71H | 8.10 | 24.62 | 3.03 |
| | A71J | 10.90 | 47.52 | 4.37 |
| | A71K | 9.75 | 48.23 | 4.97 |
| | A71L | 7.51 | 39.22 | 5.25 |
| | A72A | 7.81 | 14.74 | 1.87 |
| | A72B | 4.80 | 18.70 | 3.86 |
| **Sand** | | **88.55** | **293.99** | **3.32** |
| **Nzhelele** | A80A | 49.37 | 46.57 | 0.95 |
| | A80B | 16.64 | 19.69 | 1.19 |
| | A80C | 9.64 | 11.22 | 1.17 |
| | A80D | 7.03 | 8.75 | 1.25 |
| | A80E | 14.08 | 16.95 | 1.21 |
| | A80F | 2.89 | 8.21 | 2.70 |
| | A80G | 5.76 | 15.90 | 2.78 |
| | A80H1 | 21.98 | 18.62 | 0.85 |
| | A80H2 | 10.26 | 12.18 | 1.19 |
| | A80J | 2.36 | 5.94 | 2.53 |
| **Nzhelele** | | **140.00** | **164.03** | **1.17** |
| **Limpopo WMA North** | | **948.64** | **1311.18** | **1.38** |

## Table H.2: WRSM2000 simulation results

| Quaternary/ sub-quaternary | | Net area | This Study (1920-2010) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MAE | MAP | Aridity | IAP | AFF | NMAR-GW | NMAR | %MAP | Unit runoff |
| | | km$^2$ | mm | mm | (MAE/MAP) | million m$^3$/a | million m$^3$/a | million m$^3$/a | million m$^3$/a | % | mm |
| Mokolo | A41A | 613 | 1796 | 617 | 2.91 | - | - | 18.8 | 18.8 | 5% | 31 |
| | A41B | 359 | 1796 | 579 | 3.10 | - | - | 8.7 | 8.7 | 4% | 24 |
| | A41C | 785 | 1894 | 510 | 3.71 | - | - | 11.3 | 11.3 | 2% | 10 |
| | A41D | 1040 | 1946 | 490 | 3.97 | - | - | 11.3 | 11.2 | 1% | 6 |
| | A41E | 816 | 1946 | 436 | 4.46 | - | - | 5.7 | 5.7 | 1% | 3 |
| **Matlabas summary** | | **3613** | **1910** | **513** | | **0.0** | **0.0** | **56.3** | **55.7** | **3%** | **15** |
| Mokolo | A42A | 573 | 1748 | 643 | 2.72 | - | - | 24.4 | 24.4 | 7% | 43 |
| | A42B | 522 | 1797 | 662 | 2.72 | - | - | 26.9 | 26.9 | 8% | 52 |
| | A42C | 698 | 1765 | 658 | 2.68 | - | - | 37.0 | 37.0 | 8% | 53 |
| | A42D | 497 | 1799 | 669 | 2.69 | - | - | 43.1 | 43.1 | 13% | 87 |
| | A42E | 1007 | 1795 | 597 | 3.01 | - | - | 43.7 | 43.7 | 7% | 43 |
| | A42F | 1022 | 1879 | 570 | 3.30 | - | - | 34.4 | 34.4 | 6% | 34 |
| | A42G | 1207 | 1901 | 545 | 3.49 | - | - | 33.4 | 33.4 | 5% | 28 |
| | A42H | 1057 | 1910 | 516 | 3.70 | - | - | 26.8 | 26.8 | 5% | 25 |
| | A42J | 1027 | 1989 | 428 | 4.65 | - | - | 6.4 | 6.4 | 1% | 4 |
| **Mokolo summary** | | **7610** | **1859** | **569** | | **0.0** | **0.0** | **276.2** | **276.0** | **6%** | **36** |
| Lephalala | A50A | 300 | 1859 | 662 | 2.13 | 0.8 | - | 32.3 | 32.3 | **16%** | 108 |
| | A50B | 409 | 1412 | 607 | 2.42 | 0.1 | - | 34.8 | 34.8 | **14%** | 85 |
| | A50C | 365 | 1467 | 601 | 2.46 | 0.3 | - | 14.6 | 14.6 | **7%** | 40 |
| | A50D | 642 | 1481 | 556 | 2.74 | - | - | 20.4 | 20.4 | **6%** | 32 |
| | A50E | 633 | 1523 | 515 | 3.02 | - | - | 19.0 | 19.0 | **6%** | 30 |
| | A50F | 374 | 1557 | 494 | 3.20 | - | - | 9.5 | 9.5 | 5% | 25 |

| Quaternary/ sub-quaternary | | Net area | This Study (1920-2010) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MAE | MAP | Aridity | IAP | AFF | NMAR-GW | NMAR | %MAP | Unit runoff |
| | | km$^2$ | mm | mm | (MAE/MAP) | million m$^3$/a | million m$^3$/a | million m$^3$/a | million m$^3$/a | % | mm |
| | A50G | 639 | 1583 | 431 | 3.68 | - | - | 4.1 | 4.1 | 1% | 5 |
| | A50H | 643 | 1586 | 403 | 3.99 | - | - | 2.7 | 2.8 | 0% | 1 |
| | A50J | 1055 | 1609 | 387 | 4.17 | - | - | 3.8 | 4.8 | 1% | 4 |
| **Lephalala summary** | | **5060** | **1565** | **489** | | **1.2** | **0.0** | **141.3** | **142.3** | **6%** | **28** |
| **Mogalakwena** | A61A_1 | 168 | 1556 | 629 | 2.70 | 0.13 | - | 10.3 | 10.4 | **10%** | 61 |
| | A61A_2 | 143 | 1696 | 629 | 2.70 | 0.03 | - | 8.0 | 8.9 | **9%** | 56 |
| | A61A_3 | 73 | 1696 | 629 | 2.70 | - | - | 4.5 | 4.5 | **10%** | 62 |
| | A61B_1 | 120 | 1696 | 625 | 2.71 | 0.04 | - | 6.6 | 6.6 | 9% | 55 |
| | A61B_2 | 245 | 1696 | 607 | 2.79 | 0.18 | - | 14.8 | 15.0 | 10% | 60 |
| | A61C_1 | 170 | 1696 | 630 | 2.75 | 0.02 | - | 3.3 | 3.3 | 3% | 19 |
| | A61C_2 | 192 | 1733 | 603 | 2.87 | 0.01 | - | 2.1 | 3.8 | 2% | 11 |
| | A61D_1 | 143 | 1733 | 630 | 2.74 | 0.06 | - | 3.1 | 3.4 | 3% | 22 |
| | A61D_2 | 317 | 1729 | 604 | 2.86 | - | - | 4.6 | 7.1 | 2% | 15 |
| | A61E_1 | 124 | 1729 | 615 | 2.82 | - | - | 2.2 | 2.2 | 3% | 18 |
| | A61E_2 | 429 | 1732 | 587 | 2.95 | - | - | 4.4 | 8.5 | 2% | 10 |
| | A61F | 796 | 1732 | 597 | 3.01 | 0.68 | - | 17.2 | 19.5 | 4% | 22 |
| | A61G | 935 | 1796 | 585 | 3.07 | 0.11 | - | 18.0 | 19.9 | 3% | 19 |
| | A61H | 590 | 1796 | 636 | 2.67 | 1.11 | - | 38.1 | 39.9 | 10% | 65 |
| | A61J | 825 | 1696 | 631 | 2.76 | 0.16 | - | 17.8 | 19.6 | 3% | 22 |
| | A62A | 431 | 1744 | 610 | 2.95 | 0.05 | - | 13.4 | 14.2 | 5% | 31 |
| | A62B | 716 | 1800 | 529 | 3.50 | - | - | 10.6 | 11.8 | 3% | 15 |
| | A62C | 388 | 1850 | 478 | 3.97 | - | - | 2.7 | 4.0 | 1% | 7 |
| | A62D | 480 | 1900 | 489 | 3.89 | - | - | 4.0 | 4.5 | 2% | 8 |

| Quaternary/ sub-quaternary | | Net area | This Study (1920-2010) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MAE | MAP | Aridity | IAP | AFF | NMAR-GW | NMAR | %MAP | Unit runoff |
| | | km$^2$ | mm | mm | (MAE/MAP) | million m$^3$/a | million m$^3$/a | million m$^3$/a | million m$^3$/a | % | mm |
| | A62E | 627 | 1900 | 437 | 4.23 | - | - | 3.7 | 3.7 | 1% | 6 |
| | A62F | 625 | 1850 | 460 | 4.02 | - | - | 3.6 | 4.7 | 1% | 6 |
| | A62G | 539 | 1850 | 478 | 3.97 | - | - | 2.3 | 2.6 | 1% | 4 |
| | A62H | 879 | 1900 | 439 | 4.33 | - | - | 4.1 | 4.1 | 1% | 5 |
| | A62J | 937 | 1900 | 450 | 4.33 | - | - | 4.5 | 4.6 | 1% | 5 |
| | A63A | 1420 | 1950 | 433 | 4.50 | - | - | 6.0 | 6.2 | 1% | 4 |
| | A63B | 1505 | 1950 | 394 | 5.08 | - | - | 4.1 | 4.1 | 1% | 3 |
| | A63C | 1334 | 2000 | 378 | 5.42 | - | - | 3.0 | 3.0 | 1% | 2 |
| | A63D | 741 | 2050 | 412 | 4.85 | - | - | 2.3 | 2.4 | 1% | 3 |
| | A63E | 1992 | 2000 | 358 | 5.73 | - | - | 3.5 | 3.5 | 0% | 2 |
| **Mogalakwena summary** | | **17883** | **1890** | **483** | | **2.6** | **0.0** | **223.0** | **246.2** | **3%** | **12** |
| **Sand** | A71A | 1157 | 1894 | 466 | 2.92 | 0.3 | - | 9.1 | 10.3 | 2% | 9 |
| | A71B | 892 | 1360 | 448 | 2.90 | 0.1 | - | 6.1 | 7.3 | 2% | 8 |
| | A71C | 1347 | 1298 | 416 | 3.29 | 0.3 | 0.1 | 7.0 | 8.2 | 1% | 6 |
| | A71D | 902 | 1370 | 388 | 3.69 | 0.0 | - | 2.9 | 4.0 | 1% | 4 |
| | A71E | 902 | 1432 | 422 | 3.32 | 0.1 | - | 2.4 | 3.7 | 1% | 4 |
| | A71F | 690 | 1401 | 401 | 3.48 | 0.0 | - | 1.4 | 2.3 | 1% | 3 |
| | A71G | 885 | 1395 | 428 | 3.43 | 0.1 | - | 2.9 | 4.1 | 1% | 5 |
| | A71H | 894 | 1469 | 489 | 2.85 | 0.1 | 0.1 | 7.3 | 8.1 | 2% | 9 |
| | A71J | 905 | 1396 | 396 | 3.88 | - | - | 10.3 | 10.9 | 3% | 12 |
| | A71K | 1691 | 1538 | 305 | 5.33 | - | - | 9.7 | 9.8 | 2% | 6 |
| | A71L | 1765 | 1626 | 288 | 5.80 | - | - | 5.0 | 7.5 | 1% | 4 |
| | A72A | 1323 | 1672 | 466 | 3.23 | - | - | 7.7 | 7.8 | 1% | 6 |

| Quaternary/ sub-quaternary | | Net area | This Study (1920-2010) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MAE | MAP | Aridity | IAP | AFF | NMAR-GW | NMAR | %MAP | Unit runoff |
| | | km$^2$ | mm | mm | (MAE/MAP) | million m$^3$/a | million m$^3$/a | million m$^3$/a | million m$^3$/a | % | mm |
| | A72B | 1571 | 1503 | 344 | 4.65 | - | - | 4.8 | 4.8 | 1% | 4 |
| **Sand summary** | | **14621** | **1491** | **394** | | **1.0** | **0.2** | **76.6** | **88.6** | **2%** | **6** |
| **Nzhelele** | A80A | 291 | 1488 | 939 | 1.34 | - | 2.3 | 48.6 | 49.4 | 18% | 169 |
| | A80B | 255 | 1261 | 659 | 2.03 | 0.3 | 0.1 | 16.1 | 16.6 | 10% | 65 |
| | A80C | 298 | 1338 | 576 | 2.23 | 0.1 | - | 8.7 | 9.6 | 6% | 32 |
| | A80D | 129 | 1286 | 622 | 2.12 | - | - | 7.0 | 7.0 | 9% | 54 |
| | A80E | 250 | 1316 | 622 | 2.10 | 0.6 | - | 13.7 | 14.1 | 9% | 56 |
| | A80F | 491 | 1308 | 388 | 3.75 | - | - | 2.9 | 2.9 | 2% | 6 |
| | A80G | 1246 | 1456 | 330 | 4.73 | - | - | 5.6 | 5.8 | 1% | 5 |
| | A80H_1 | 156 | 1561 | 616 | 2.26 | 0.8 | - | 21.4 | 22.0 | 23% | 141 |
| | A80H_2 | 113 | 1394 | 616 | 2.26 | 0.4 | - | 9.5 | 10.3 | 15% | 91 |
| | A80J | 883 | 1394 | 290 | 5.51 | - | - | 2.3 | 2.4 | 1% | 3 |
| **Nzhelele summary** | | **4112** | **1467** | **455** | | **2.13** | **2.0** | **135.7** | **140.0** | **7%** | **34** |
| **Limpopo WMA North** | | **52900** | **1716** | **471** | | **7** | **2** | **908** | **949** | **4%** | **18** |

## Table H.3: Comparisons of results with WR2005

| Catchment and Quaternary or sub-quaternary | | 1920-2004 | | | | Percentage difference (%) |
|---|---|---|---|---|---|---|
| | | Natural MAR (million $m^3$/a) | | Unit runoff (mm/a) | | |
| | | This study | WR2005 | This study | WR2005 | |
| Matlabas | A41A | 17.7 | 20.5 | 29 | 30 | -15% |
| | A41B | 8.2 | 10.0 | 23 | 28 | -23% |
| | A41C | 11.5 | 7.0 | 10 | 6 | 39% |
| | A41D | 11.6 | 7.7 | 6 | 4 | 33% |
| | A41E | 6.0 | 5.3 | 3 | 3 | 12% |
| **Matlabas** | | **55** | **51** | **9** | **14** | **8%** |
| Mokolo | A42A | 25.5 | 24.16 | 44 | 42 | 5% |
| | A42B | 27.8 | 24.58 | 53 | 47 | 12% |
| | A42C | 37.5 | 32.22 | 54 | 46 | 14% |
| | A42D | 43.5 | 48.00 | 87 | 97 | -10% |
| | A42E | 43.9 | 39.48 | 44 | 39 | 10% |
| | A42F | 35.2 | 29.26 | 34 | 29 | 17% |
| | A42G | 34.1 | 35.40 | 28 | 29 | -4% |
| | A42H | 27.3 | 24.81 | 26 | 23 | 9% |
| | A42J | 6.3 | 5.81 | 6 | 3 | 8% |
| **Mokolo** | | **281** | **264** | **37** | **35** | **6%** |
| Lephalala | A50A | 31.4 | 30.2 | 104 | 101 | 4% |
| | A50B | 33.7 | 31.1 | 82 | 76 | 8% |
| | A50C | 14.0 | 18.1 | 38 | 50 | -29% |
| | A50D | 20.6 | 27.2 | 32 | 42 | -32% |
| | A50E | 19.2 | 18.1 | 30 | 29 | 6% |
| | A50F | 9.6 | 7.2 | 26 | 19 | 25% |
| | A50G | 4.3 | 4.0 | 7 | 5 | 6% |
| | A50H | 3.0 | 3.2 | 5 | 2 | -5% |
| | A50J | 4.9 | 4.3 | 5 | 3 | 13% |
| **Lephalala** | | **141** | **139** | **21** | **28** | **1%** |
| Mogalakwena | A61A_1 | 10.5 | 9.4 | 62 | 56 | 10% |
| | A61A_2 | 9.0 | 8.1 | 63 | 56 | 10% |
| | A61A_3 | 4.6 | 4.1 | 62 | 56 | 10% |
| | A61B_1 | 6.6 | 6.3 | 55 | 52 | 6% |
| | A61B_2 | 15.0 | 4.5 | 61 | 18 | 70% |
| | A61C_1 | 3.3 | 2.6 | 20 | 15 | 23% |
| | A61C_2 | 3.8 | 12.7 | 20 | 30 | -235% |
| | A61D_1 | 3.4 | 6.4 | 24 | 45 | -90% |
| | A61D_2 | 7.0 | 10.2 | 22 | 32 | -46% |
| | A61E_1 | 2.2 | 5.0 | 18 | 40 | -126% |
| | A61E_2 | 8.4 | 9.2 | 20 | 22 | -10% |
| | A61F | 17.9 | 15.9 | 23 | 20 | 12% |

| Catchment and Quaternary or sub-quaternary | | 1920-2004 | | | | Percentage difference (%) |
|---|---|---|---|---|---|---|
| | | Natural MAR (million $m^3$/a) | | Unit runoff (mm/a) | | |
| | | This study | WR2005 | This study | WR2005 | |
| | A61G | 18.3 | 15.3 | 20 | 16 | 16% |
| | A61H | 38.7 | 21.6 | 66 | 37 | 44% |
| | A61J | 18.5 | 31.9 | 22 | 39 | -73% |
| | A62A | 13.7 | 16.4 | 32 | 38 | -19% |
| | A62B | 11.4 | 15.0 | 16 | 21 | -31% |
| | A62C | 3.9 | 5.3 | 10 | 14 | -38% |
| | A62D | 4.3 | 7.2 | 9 | 12 | -66% |
| | A62E | 3.8 | 4.8 | 6 | 8 | -26% |
| | A62F | 4.9 | 5.7 | 8 | 9 | -17% |
| | A62G | 2.7 | 3.2 | 5 | 5 | -18% |
| | A62H | 4.2 | 5.7 | 5 | 6 | -34% |
| | A62J | 4.7 | 5.7 | 5 | 6 | -20% |
| | A63A | 6.4 | 12.7 | 4 | 7 | -100% |
| | A63B | 4.2 | 8.1 | 3 | 5 | -94% |
| | A63C | 4.5 | 6.3 | 3 | 5 | -39% |
| | A63D | 2.5 | 5.3 | 3 | 4 | -110% |
| | A63E | 3.5 | 8.2 | 2 | 4 | -131% |
| **Mogalakwena** | | **242** | **272** | **12** | **15** | **-13%** |
| **Sand** | A71A | 10.5 | 10.4 | 9 | 9 | 1% |
| | A71B | 7.5 | 7.4 | 8 | 8 | 1% |
| | A71C | 8.4 | 8.3 | 6 | 6 | 1% |
| | A71D | 4.0 | 4.0 | 4 | 4 | 1% |
| | A71E | 3.3 | 3.7 | 4 | 4 | -11% |
| | A71F | 2.1 | 2.3 | 3 | 3 | -10% |
| | A71G | 3.7 | 4.1 | 4 | 5 | -12% |
| | A71H | 8.5 | 9.7 | 9 | 9 | -14% |
| | A71J | 11.2 | 14.4 | 12 | 12 | -29% |
| | A71K | 10.1 | 10.0 | 6 | 6 | 1% |
| | A71L | 7.8 | 7.8 | 4 | 4 | 1% |
| | A72A | 7.2 | 9.1 | 5 | 5 | -27% |
| | A72B | 4.9 | 7.2 | 4 | 5 | -46% |
| **Sand** | | **89.2** | **98.3** | **6** | **7** | **-10%** |
| **Nzhelele** | A80A | 50.1 | 44.4 | 172 | 152 | 11% |
| | A80B | 17.0 | 11.8 | 67 | 46 | 31% |
| | A80C | 9.9 | 7.6 | 33 | 25 | 23% |
| | A80D | 7.2 | 5.9 | 56 | 45 | 19% |
| | A80E | 14.4 | 11.3 | 58 | 45 | 22% |
| | A80F | 3.0 | 3.4 | 6 | 5 | -12% |
| | A80G | 6.0 | 5.7 | 5 | 5 | 4% |
| | A80H_1 | 22.1 | 14.7 | 142 | 94 | 34% |

| Catchment and Quaternary or sub-quaternary | | 1920-2004 | | | | Percentage difference (%) |
|---|---|---|---|---|---|---|
| | | Natural MAR (million $m^3$/a) | | Unit runoff (mm/a) | | |
| | | This study | WR2005 | This study | WR2005 | |
| | A80H_2 | 10.4 | 6.9 | 92 | 61 | 34% |
| | A80J | 2.5 | 2.4 | 3 | 3 | 1% |
| **Nzhelele** | | **143** | **114** | **33** | **28** | **20%** |
| **Limpopo WMA North** | | **950** | **938** | **18** | **18** | **1%** |

## Table H.4: Hydrological confidence evaluation matrix and results

| Catchment and Quaternary | | Rainfall | | | Observed flow data | | | Water use and infrastructure | | | Total | | | Natural MAR (million $m^3/a$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Amount of point rainfall stations inside rainfall zone | Overall stationarity | Score | Position of downstream calibration gauge | Quality of downstream calibration gauge | Score | Farm and major dam, infrastructure data | Point demands | Irrigation | Score | Total | % | |
| **Matlabas** | A41A | 4.0 | 3.0 | 3.5 | 5.0 | 3.5 | 4.3 | 3.5 | 3.5 | 5.0 | 4.0 | 3.9 | 78 | 20.0 |
| | A41B | 4.0 | 3.0 | 3.5 | 5.0 | 3.5 | 4.3 | 3.5 | 3.5 | 5.0 | 4.0 | 3.9 | 78 | 8.0 |
| | A41C | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 3.5 | 5.0 | 4.0 | 2.7 | 53 | 11.3 |
| | A41D | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 3.5 | 5.0 | 4.0 | 2.7 | 53 | 11.2 |
| | A41E | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 3.5 | 5.0 | 4.0 | 2.7 | 53 | 5.7 |
| | | | | | | | | | | | | | | |
| **Mokolo** | A42A | 5.0 | 4.0 | 4.5 | 3.0 | 4.0 | 3.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 80 | 24.6 |
| | A42B | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 26.9 |
| | A42C | 5.0 | 4.0 | 4.5 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.3 | 87 | 37.0 |
| | A42D | 5.0 | 4.0 | 4.5 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.3 | 87 | 43.1 |
| | A42E | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 43.7 |
| | A42F | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 34.4 |
| | A42G | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.8 | 57 | 33.4 |
| | A42H | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.8 | 57 | 26.8 |
| | A42J | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.8 | 57 | 6.4 |
| | | | | | | | | | | | | | | |
| **Lephalala** | A50A | 4.0 | 3.0 | 3.5 | 4.0 | 3.5 | 3.8 | 3.5 | 4.0 | 4.0 | 3.8 | 3.7 | 74 | 32.3 |
| | A50B | 4.0 | 4.0 | 4.0 | 5.0 | 4.0 | 4.5 | 3.5 | 4.0 | 4.0 | 3.8 | 4.1 | 82 | 34.8 |
| | A50C | 4.0 | 4.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.6 | 52 | 14.6 |
| | A50D | 1.0 | 4.0 | 2.5 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.1 | 42 | 20.4 |

| Catchment and Quaternary | | Rainfall | | | Observed flow data | | | Water use and infrastructure | | | Total | | | Natural MAR (million $m^3/a$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Amount of point rainfall stations inside rainfall zone | Overall stationarity | Score | Position of downstream calibration gauge | Quality of downstream calibration gauge | Score | Farm and major dam, infrastructure data | Point demands | Irrigation | Score | Total | % | |
| | A50E | 1.0 | 4.0 | 2.5 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.1 | 42 | 19.0 |
| | A50F | 1.0 | 3.0 | 2.0 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 1.9 | 39 | 9.5 |
| | A50G | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.6 | 52 | 5.4 |
| | A50H | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.6 | 52 | 6.2 |
| | A50J | 5.0 | 3.0 | 4.0 | 0.0 | 0.0 | 0.0 | 3.5 | 4.0 | 4.0 | 3.8 | 2.6 | 52 | 5.8 |
| | | | | | | | | | | | | | | |
| **Mogalakwena** | A61A1 | 5.0 | 3.0 | 4.0 | 3.5 | 4.0 | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 3.9 | 78 | 10.4 |
| | A61A2 | 5.0 | 3.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 80 | 8.9 |
| | A61A3 | 5.0 | 3.0 | 4.0 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 4.5 |
| | A61B1 | 5.0 | 3.0 | 4.0 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 6.6 |
| | A61B2 | 5.0 | 3.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 80 | 15.0 |
| | A61C1 | 5.0 | 3.0 | 4.0 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.2 | 83 | 3.3 |
| | A61C2 | 5.0 | 3.0 | 4.0 | 4.5 | 4.0 | 4.3 | 4.0 | 4.0 | 4.0 | 4.0 | 4.1 | 82 | 8.3 |
| | A61D1 | 2.5 | 2.5 | 2.5 | 3.5 | 4.0 | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 3.4 | 68 | 3.4 |
| | A61D2 | 2.5 | 2.5 | 2.5 | 3.5 | 4.0 | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 3.4 | 68 | 7.1 |
| | A61E1 | 2.5 | 2.5 | 2.5 | 5.0 | 3.5 | 4.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.6 | 72 | 2.2 |
| | A61E2 | 2.5 | 2.5 | 2.5 | 5.0 | 3.5 | 4.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.6 | 72 | 8.5 |
| | A61F | 5.0 | 3.5 | 4.3 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.5 | 70 | 19.5 |
| | A61G | 5.0 | 3.5 | 4.3 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.5 | 70 | 19.9 |
| | A61H | 5.0 | 3.5 | 4.3 | 3.0 | 2.0 | 2.5 | 4.0 | 4.0 | 4.0 | 4.0 | 3.6 | 72 | 39.9 |
| | A61J | 5.0 | 3.5 | 4.3 | 2.0 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.4 | 68 | 19.6 |
| | A62A | 4.0 | 3.0 | 3.5 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.3 | 65 | 14.2 |

| Catchment and Quaternary | | Rainfall | | | Observed flow data | | | Water use and infrastructure | | | Total | | | Natural MAR (million $m^3/a$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Amount of point rainfall stations inside rainfall zone | Overall stationarity | Score | Position of downstream calibration gauge | Quality of downstream calibration gauge | Score | Farm and major dam, infrastructure data | Point demands | Irrigation | Score | Total | % | |
| | A62B | 4.0 | 3.0 | 3.5 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.3 | 65 | 11.8 |
| | A62C | 4.0 | 3.0 | 3.5 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.3 | 65 | 4.0 |
| | A62D | 4.0 | 3.0 | 3.5 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.3 | 65 | 5.9 |
| | A62E | 3.0 | 3.0 | 3.0 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.1 | 62 | 3.7 |
| | A62F | 3.0 | 3.0 | 3.0 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.1 | 62 | 4.7 |
| | A62G | 3.0 | 4.0 | 3.5 | 1.0 | 3.5 | 2.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.3 | 65 | 3.1 |
| | A62H | 3.0 | 4.0 | 3.5 | 4.0 | 3.5 | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 3.8 | 75 | 4.1 |
| | A62J | 3.0 | 4.0 | 3.5 | 5.0 | 3.5 | 4.3 | 4.0 | 4.0 | 4.0 | 4.0 | 3.9 | 78 | 4.6 |
| | A63A | 1.0 | 4.0 | 2.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.5 | 70 | 8.7 |
| | A63B | 1.0 | 4.0 | 2.5 | 5.0 | 4.0 | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 | 3.7 | 73 | 4.1 |
| | A63C | 1.0 | 4.0 | 2.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.2 | 43 | 4.5 |
| | A63D | 1.0 | 4.0 | 2.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.2 | 43 | 3.0 |
| | A63E | 1.0 | 4.0 | 2.5 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.2 | 43 | 3.6 |
| | | | | | | | | | | | | | | |
| **Sand** | A71A | 4.0 | 4.0 | 4.0 | 1.0 | 4.0 | 2.5 | 2.0 | 2.0 | 3.5 | 2.5 | 3.0 | 60 | 10.3 |
| | A71B | 4.0 | 4.0 | 4.0 | 1.0 | 4.0 | 2.5 | 2.0 | 2.0 | 3.5 | 2.5 | 3.0 | 60 | 7.3 |
| | A71C | 4.0 | 4.0 | 4.0 | 1.0 | 4.0 | 2.5 | 2.0 | 2.0 | 3.5 | 2.5 | 3.0 | 60 | 8.2 |
| | A71D | 4.0 | 4.0 | 4.0 | 2.0 | 4.0 | 3.0 | 2.0 | 2.0 | 3.5 | 2.5 | 3.2 | 63 | 4.0 |
| | A71E | 4.0 | 4.0 | 4.0 | 2.0 | 4.0 | 3.0 | 2.0 | 2.0 | 3.5 | 2.5 | 3.2 | 63 | 3.7 |
| | A71F | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 2.0 | 3.5 | 2.5 | 3.5 | 70 | 2.3 |
| | A71G | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 2.0 | 3.5 | 2.5 | 3.5 | 70 | 4.1 |
| | A71H | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 2.0 | 3.5 | 2.5 | 3.5 | 70 | 9.4 |

| Catchment and Quaternary | | Rainfall | | | Observed flow data | | | Water use and infrastructure | | | Total | | | Natural MAR (million $m^3/a$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Amount of point rainfall stations inside rainfall zone | Overall stationarity | Score | Position of downstream calibration gauge | Quality of downstream calibration gauge | Score | Farm and major dam, infrastructure data | Point demands | Irrigation | Score | Total | % | |
| | A71J | 3.0 | 3.5 | 3.3 | 4.0 | 0.0 | 2.0 | 2.0 | 2.0 | 3.5 | 2.5 | 2.6 | 52 | 14.2 |
| | A71K | 3.0 | 3.5 | 3.3 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.9 | 38 | 9.8 |
| | A71L | 3.0 | 3.5 | 3.3 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.9 | 38 | 7.5 |
| | A72A | 3.0 | 3.5 | 3.3 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.9 | 38 | 11.6 |
| | A72B | 3.0 | 3.5 | 3.3 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.9 | 38 | 6.0 |
| | | | | | | | | | | | | | | |
| **Nzhelele** | A80A | 5.0 | 4.0 | 4.5 | 3.0 | 3.5 | 3.3 | 2.0 | 2.0 | 3.5 | 2.5 | 3.4 | 68 | 49.4 |
| | A80B | 5.0 | 4.0 | 4.5 | 4.0 | 3.5 | 3.8 | 2.0 | 2.0 | 3.5 | 2.5 | 3.6 | 72 | 16.6 |
| | A80C | 5.0 | 4.0 | 4.5 | 4.0 | 3.5 | 3.8 | 2.0 | 2.0 | 3.5 | 2.5 | 3.6 | 72 | 9.6 |
| | A80D | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 2.3 | 47 | 7.0 |
| | A80E | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 2.3 | 47 | 14.1 |
| | A80F | 5.0 | 4.0 | 4.5 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 2.3 | 47 | 4.0 |
| | A80G | 3.0 | 2.5 | 2.8 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.8 | 35 | 5.8 |
| | A80H1 | 3.0 | 2.5 | 2.8 | 5.0 | 3.5 | 4.3 | 2.0 | 2.0 | 3.5 | 2.5 | 3.2 | 63 | 22.0 |
| | A80H2 | 3.0 | 2.5 | 2.8 | 5.0 | 3.5 | 4.3 | 2.0 | 2.0 | 3.5 | 2.5 | 3.2 | 63 | 10.3 |
| | A80J | 3.0 | 2.5 | 2.8 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 3.5 | 2.5 | 1.8 | 35 | 2.4 |
| **AVERAGE** | | **3.8** | **3.5** | **3.7** | **2.2** | **2.4** | **2.3** | **3.3** | **3.4** | **3.9** | **3.5** | **3.2** | **TOTAL** | **977.2** |

# Appendix I

## Natural monthly stream flow data