Hydrologic Assessment of Headworks Utilisation Factor's (HUFs)

March 2012

Seqwater

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Abbreviations

AA	Announced Allocation
CWSA	Critical Water Supply Arrangements
DERM	Department of Environment and Resource Management
HPA	High Priority Allocation
HUF	Headworks Utilisation Factors
IQQM	Integrated Quality and Quantity Model
IROL	Interim Resource Operations License
MPA	Medium Priority Allocation
QBWSA	Queensland Bulk Water Supply Authority
ROL	Resource Operations License
ROP	Resource Operations Plan
WRP	Water Resource Plans
WSS	Water Supply Scheme

Executive summary

Parsons Brinkerhoff was engaged by the Queensland Bulk Water Supply Authority (QBWSA), trading as Seqwater, to determine Headworks Utilisation Factors (HUF's) for the apportioning of Seqwater's bulk water asset costs between water entitlement priority groups for Seqwater's water supply schemes. A hydrologic assessment using the HUF's method outlined in SunWater's technical paper was adopted for the determination of a percentage of headwork utilisation for each water allocation priority group in each scheme assessed.

The technical methodology for deriving HUF's within a scheme (SunWater Technical Paper Part B, 2010) was adopted and is shown in Appendices A and B. The values of key input data and the details of scheme specific data relevant to the computation of the HUF's for each water supply scheme are also shown in Appendices A and B.

The report presents the parameter assumptions, data, and results derived from the HUF's assessment, and based on this sets out conclusions on the appropriateness of the HUF to each water supply scheme assessed. The summary results of the values of the HUF's for each water entitlement priority group in each of the four water supply schemes are presented in Table 1-1 below.

Table 1-1 Summary of results derived from the HUF assessment for 15-year drought period

Drought Period	Drought period with minimum inflows		Drought period without minimum inflows	
	MPA (%)	HPA (%)	MPA (%)	HPA(%)
Logan River	26	74	16	84
Mary Valley	60	40	26	74
Warrill Valley	15	85	11	89
Central Brisbane	69	31	69	31

The main conclusions drawn from this study are as follows:

- For the Central Brisbane water supply scheme, the HUF method is not applicable. The HUF allocates nearly 70% of the benefit of the storage to Medium Priority Allocation (MPA) holders, which is a perverse result considering that only 2% of allocations are MPA. The HUF is not applicable for the Central Brisbane scheme because of the different formulation of the water sharing rules for the scheme and due to the very high reliability of the system resulting in a low proportion of the storage volume being allocated to High Priority Allocation (HPA) holders.

- An alternative method of determining apportionment of bulk water asset costs for the Central Brisbane scheme is based on the ratio between MPA and HPA factored by the cut-off percentage (i.e. $\left(\frac{7041}{279000}\right) \times (100 - 14.9) = 2\%$ for MPA and 98% for HPA). This is a much closer reflection of the actual benefits gained from the storage by MPA and HPA holders.

- HUF's calculated for the Logan, Warrill and Mary Valley only appear reasonable when minimum historical inflows are removed from the analysis. Excluding minimum inflows provides a more realistic reflection of the benefit MPA and HPA holders gain from the storage when assessed using the HUF calculation.

- The duration of drought periods has only a minor impact in most of the schemes.

1. Introduction

QBWSA, trading as Seqwater, commissioned Parsons Brinckerhoff to undertake the determination of headworks utilisation factors (HUFs) for the Mary Valley, Central Brisbane, Warrill Valley and Logan River water supply schemes. These water supply schemes, managed by Seqwater, provide a relatively reliable supply to both high priority and medium priority water users. This is reflected in the modelling results produced by the Department of Environment and Resource Management (DERM, 2009) for the Mary Basin Water Resource Plan (WRP) and Resource Operation Plan (ROP).

Figure 1-1 shows the location of headworks in relation to the river systems. The following headwork storages are located in the following watercourses:

- Borumba Dam, located on the Yabba Creek, is the major water storage for the upper Mary Valley water supply scheme. Seqwater is the Resource Operations Licence holder for the upper Mary River water supply scheme.
- Maroon Dam, located on the Burnett Creek, is a storage that supplements water supply from the Logan River. Seqwater is the Resource Operations Licence holder for the Logan River water supply scheme.
- Moogerah Dam, located on the Reynolds Creek, is the major water storage for the Warrill Valley. Seqwater is the Resource Operations Licence holder for the Warrill Valley water supply scheme.
- Somerset and Wivenhoe Dams, located on the Stanley and Brisbane Rivers respectively, provide the major water supply for South East Queensland. Seqwater is the Resource Operations Licence holder for the Central Brisbane water supply scheme.

Parsons Brinckerhoff has reviewed the water allocations of these four water supply schemes using either Irols, IQQM or ROPs and also reviewed IQQM models for each water supply scheme through the quantification of each parameter of the river system model.

The objective of this study was to determine the HUF's for each of the four schemes to provide a basis for the allocation of the relevant capital costs associated with Seqwater's bulk water assets to either MPA or HPA holders. The study involved:

- determination of the volumes and priority groups of water entitlements within the scheme
- identification of Critical Water Supply Arrangements (CSWA) for the scheme including storage cut-off rules
- review of ROP requirements in relation to conversion rates and environmental flows
- determination of storage performance of headworks in terms of probability
- adopting the revised SunWater technical paper methodology.

The results of the HUF assessment are presented in the main body of this report and Appendix B.

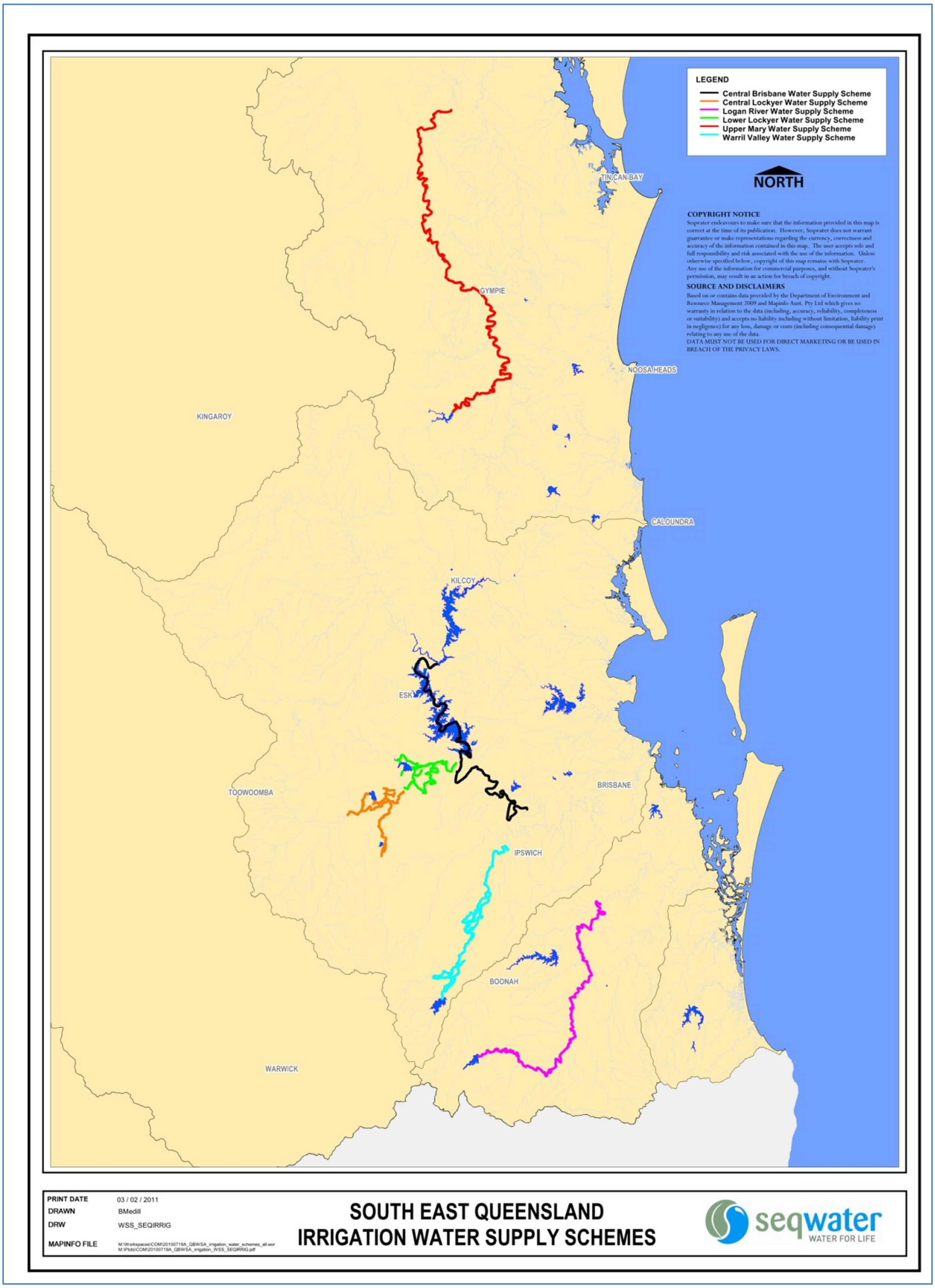


Figure 1-1 Location of the Seqwater Water Supply Scheme

2. Data availabilities and tools

The parameters and assumptions for the HUFs and sensitivity analysis are summarised in this section.

2.1 Tools and guidelines

The following information and tools are used in this study:

1. IQQM model results to determine the drought periods and assess the storage volumes of each storage across the historical period.
2. Interim Resource Operation Licence (IROL) and Resource Operation Plan (ROP).
3. Announced Allocation (AA) spreadsheet tool (water sharing arrangements).
4. Headworks Utilisation Factors – Technical Paper by SunWater (2010).

2.2 Water allocation data and drought period

Water allocation data used in this study are sourced primarily from the IROL for Warrill Valley, ROPs and IQQM for Logan River, Mary Valley and Central Brisbane. Small differences are noted when comparing each of the three sources however, these discrepancies do not affect the overall results of HUF percentage for each water group in the scheme.

Table 2-1 highlights the water entitlements across the different schemes that were obtained from the resource operation plan and interim resource operation licence of each scheme.

Table 2-1 Summary of the Water Entitlements for each scheme

Scheme	HPA (ML/a)	MPA (ML/a)
Logan River	9856	13557
Mary Valley	10254	21845
Central Brisbane	279000	7041
Warrill Valley	9450	20536**

***Medium priority distribution loss water allocation of 3,714 ML/a was not included in the calculation of the revised HUF parameters.*

Loss WAE in the Warrill Valley Water Supply Scheme is not associated with a distribution network or discrete sub-section of a WSS. Rather, the loss allocation relates to system losses, and is more akin to a transmission loss that is normally shared among all water allocation holders. Parsons Brinckerhoff also understands that the HUF calculation is to be used for pricing purposes, and it is appropriate that the HUF only includes those water entitlements that will attract costs for pricing purposes. This means that the distribution loss of 3,741ML (medium priority) have been excluded from the HUF calculation.

Table 2-2 and Table 2-3 present the drought periods for each scheme under different determination methods (storage volumes and inflows). This data was used to assess the hydrologic conditions in order to determine the HUF's for the different schemes under different conditions.

Table 2-2 Drought Periods for each scheme determined by storage volumes

Scheme	Drought Period		
	10 year	15 year	20 year
Logan River	1918 - 1927	1912 - 1926	1907 - 1926
Mary Valley	1936 - 1945	1932 - 1946	1932 - 1952
Central Brisbane	1900 - 1909	1900 - 1914	1901 - 1920
Warrill Valley	1911 - 1920	1906 - 1920	1901 - 1920

Table 2-3 Drought periods for each scheme determined by inflows

Scheme	Drought Period		
	10 year	15 year	20 year
Logan River	1911 - 1920	1911 - 1925	1906 - 1925
Mary Valley	1935 - 1944	1931 - 1945	1929 - 1948
Central Brisbane	1935 - 1944	1931 - 1945	1899 - 1918
Warrill Valley	1916 - 1925	1911 - 1925	1901 - 1920

2.3 Parameters and assumptions used

The parameters and assumptions are summarised in Table 2-4.

Table 2-4 Storage data

Scheme	Headwork Storage	Full Supply Volume (ML)	Dead Storage Volume (ML)
Logan River[1]	Maroon Dam	44319	2190
Mary Valley	Borumba Dam	46000	1200
Central Brisbane	Somerset and Wivenhoe Dams	1545050	8886
Warrill Valley[2]	Moogerah Dam	83700	1200

[1]Only Maroon Dam was considered in this assessment as other storages in the scheme are principally for urban water purposes.

[2]For Warrill Valley, only Moogerah Dam was considered as weirs capacities are negligible when compared to Moogerah Dam dead storage.

3. Methodology

The process followed is that which is outlined in the 'revised Headworks Utilisation Factors Technical Paper', prepared by SunWater Limited, revised 16 May 2011 and Queensland Competition Authority recommendations. The methodological framework, as shown in Figure 3-1, developed for this process is as follows:

- Identify the water entitlement groupings (volumes and priority groups) for each water supply scheme through IROLs and ROPs (including the potential conversion between priority groups where applicable).
- Undertake hydrologic modelling for each scheme using Announced Allocation models to estimate the exchange conversion factor between MPA to HPA.
- Determine the extent to which water sharing rules, critical water sharing rules and other operational requirements give the different water entitlement priority groups exclusive or shared access to components of storage capacity.
- Assess the hydrologic performance of each headworks storage using the IQQM models, to determine the probabilities of each component of headworks storage being accessible to the relevant water entitlement priority group during periods of low storage (under critical water sharing rules).
- Determine the HUF's derived from the above process using the SunWater method. The calculations have been based on 10, 15 and 20 year drought periods for comparative analysis.

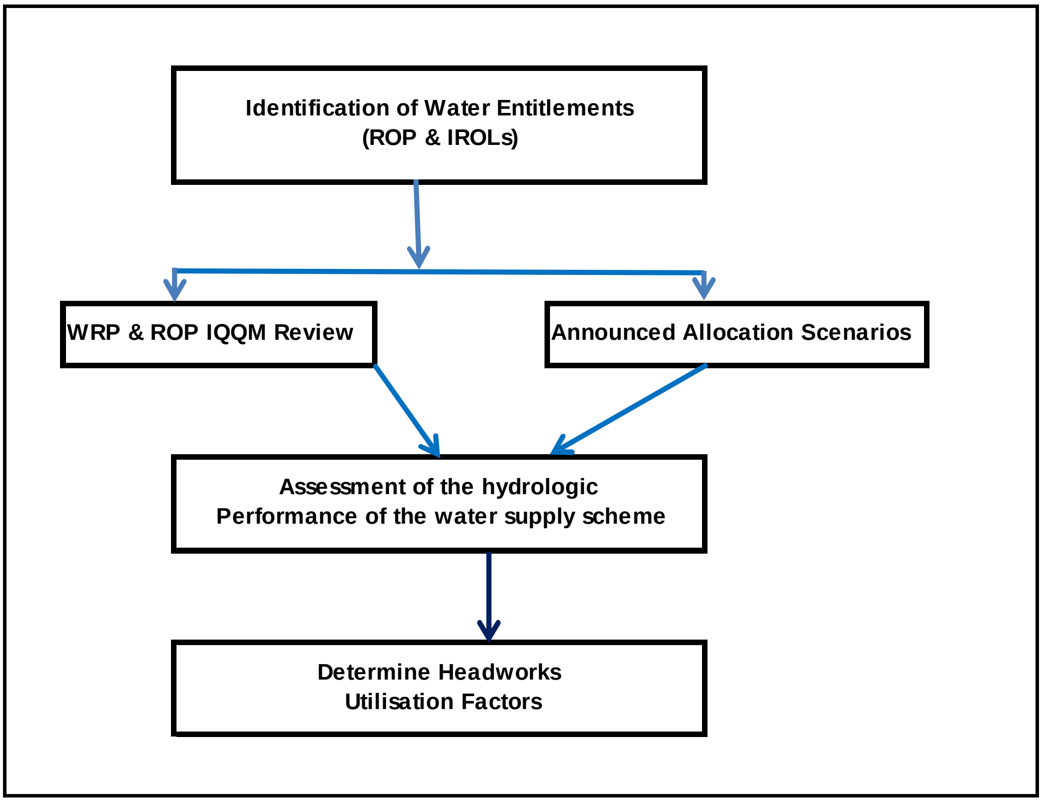


Figure 3-1 Methodological framework

4. Assumptions and limitations

The parameters and assumptions used in the assessment of the HUFs for the four schemes (Logan River, Upper Mary Valley, Warrill Valley and Central Brisbane) are summarised in this section.

4.1 Logan River

The Integrated Quantity Quality Model (IQQM) for the Logan River system was used in this study to determine the ten, fifteen and twenty year critical period and to assess the probabilities that each component of Maroon Dam is accessed by each water entitlement priority group during the period of critical supply shortage. The model used is based on a full use of entitlements case including environmental flow release rules, information about water supply storages, nominal allocations, and seasonal demand. The simulation uses over 113 years of historical climate data (1890-2003). This model was run for two cases (with and without historical minimum inflows).

The Announced Allocation Program which applies the water sharing rules was used to determine:

- The volume of scheme storage below which the water sharing rules effectively make water unavailable to medium priority water entitlements due to reservation for high priority entitlements.
- The volume of scheme storage required to provide 100% AA for medium priority at the commencement of the water year.
- Calculation based on applying water sharing rules ***with projected inflows (historical minimum inflows) assumed to be zero.***

a) Storage details

The capacities and dead storage (unusable) volumes of the storages in the Logan River system are given in Table 4-1. For this assessment only Maroon Dam is considered in the calculation.

Table 4-1: Storage capacity and dead storage volumes

Storage Name	AMTD (km)	Capacity at FSL (ML)	Dead Storage (ML)
Maroon Dam	***23.5***	***44,319***	***2,190***
Bromelton Weir	113.2	390	50
Cedar Grove Weir	81.3	1,144	100
South Mclean Weir	71.8	155	10
BOSS	100	8,678	1,131

Per section 2.3 only Maroon Dam is included in the assessment.

b) Nominal volumes

The nominal allocations that have been assumed are given in Table 4-2.

Table 4-2: Nominal water allocations

Water Entitlement group	Water Allocation (ML/a)
Medium Priority	13,557
High Priority	9,856

c) Water Sharing Rules

The water sharing rules equation used to determine the announced allocation for each priority group for use in defining the share of water available to be taken under water allocations in that priority group is:

$$AA_{MP} = \frac{(UV + IN + DIV - RE - TOA - HPA)}{MPA} \times 100$$

Where:

UV is the useable volume of Maroon Dam only; IN is the assumed minimum tributary inflows into the weirs; RE is the reserve volume set aside for supplying HPA in future months; TOA is the allowance for the river transmission and operation losses; DIV is the volume of water used in the current water year; and HPA and MPA are high and medium priority allocation.

4.2 Mary Valley

The IQQM for the Mary River system was used in this study to determine the ten, fifteen and twenty year critical period and to assess the probabilities that each component of Borumba Dam is accessed by each water entitlement priority group during the period of critical supply shortage. The model used is based on a full use of entitlements case including environmental flow release rules, information about water supply storages, nominal allocations, and seasonal demand. The simulation uses over 109 years of historical climate data (1890-1999). This model was run for two cases (with and without historical minimum inflows).

The Announced Allocation Program which applies the water sharing rules was used to determine:

- The volume of scheme storage below which the water sharing rules effectively make water unavailable to medium priority water entitlements by reserving for high priority entitlements.
- The volume of scheme storage required to provide 100% AA for medium priority at the commencement of the water year.
- Calculation based on applying water sharing rules ***with projected inflows (historical minimum inflows) assumed to be zero.***

a) Storage details

The capacities and dead storage (unusable) volumes of the storages in the Mary River System are given in Table 4-3.

Table 4-3: Storage capacity and dead storage volumes

Storage Name	AMTD (km)	Capacity at FSL (ML)	Dead Storage (ML)
Borumba Dam	23.5	44,319	2,190

b) Nominal volumes

The nominal allocations that have been assumed are given in Table 4-4.

Table 4-4: Nominal water allocations

Water Entitlement group	Water Allocation (ML/a)
Medium Priority	21,845
High Priority	10,254

c) Water Sharing Rules

The water sharing rules equation used to determine the announced allocation for each priority group for use in defining the share of water available to be taken under water allocations in that priority group is:

$$AA_{MP} = \frac{(UV + IN + DIV - RE - TOA - HPA)}{MPA} \times 100$$

Where:

UV is the useable volume of Borumba Dam only; IN is the assumed minimum tributary inflows into the Mary River; RE is the reserve volume set aside for supplying HPA in future months (Cut-off volume of 10500 ML); TOA is the allowance for the river transmission and operation losses; DIV is the volume of water used in the current water year; and HPA and MPA are high and medium priority allocation.

4.3 Warrill Valley

The IQQM for the Warrill Valley system was used in this study to determine the ten, fifteen and twenty year critical period and to assess the probabilities that each component of Moogerah Dam is accessed by each water entitlement priority group during the period of critical supply shortage. The model used is based on a full use of entitlements case including environmental flow release rules, information about water supply storages, nominal allocations, and seasonal demand. The simulation uses over 110 years of historical climate data (1890-2000). This model was run for two cases (with and without historical minimum inflows).

The Announced Allocation Program which applies the water sharing rules was used to determine:

- The volume of scheme storage below which the water sharing rules effectively make water unavailable to medium priority water entitlements by reserving for high priority entitlements.
- The volume of scheme storage required to provide 100% AA for medium priority at the commencement of the water year.
- Calculation based on applying water sharing rules ***with projected inflows (historical minimum inflows) assumed to be zero.***

a) Storage details

The capacities and dead storage (unusable) volumes of the storages in the Warrill Valley System are given in Table 4-5.

Table 4-5: Storage capacity and dead storage volumes

Storage Name	AMTD (km)	Capacity at FSL (ML)	Dead Storage (ML)
Moogerah Dam	15.3	83,700	1,200
Aratula Weir	60.0	50	5
Warrill Ck Weir	51.4	110	14
Churchbank Weir	3.2	170	20

Per section 2.3 only Moogerah Dam is included in the assessment

b) Nominal volumes

The nominal allocations that have been assumed are given in Table 4-6.

Table 4-6: Nominal water allocations

Water Entitlement group	Water Allocation (ML/a)
Medium Priority	20,536
Medium Priority Distribution losses	3,714
High Priority	9,450

c) Water Sharing Rules

The water sharing rules equation used to determine the announced allocation for each priority group for use in defining the share of water available to be taken under water allocations in that priority group is:

$$AA_{MP} = \frac{(UV + IN + DIV - RE - TOA - HPA)}{MPA} \times 100$$

Where:

UV is the useable volume of Moogerah Dam only; IN is the assumed minimum tributary inflows into the weirs; RE is the reserve volume set aside for supplying HPA in future months; TOA is the allowance for the river transmission and operation losses; DIV is the volume of water used in the current water year; and HPA and MPA are high and medium priority allocation.

4.4 Central Brisbane

The IQQM for the Central Brisbane River system was used in this study. The DERM case is a full use of entitlements case including environmental flow release rules, information about water supply storages, nominal allocations, and seasonal demand. The simulation uses over 109 years of historical climate data (1890-2000).

a) Storage details

The capacities and dead storage (unusable) volumes of the storages in the Central Brisbane River System are given in Table 4-7.

Table 4-7: Storage capacity and dead storage volumes

Storage Name	AMTD (km)	Capacity at FSL (ML)	Dead Storage (ML)
Wivenhoe Dam	150.2	1,165,200	4,886
Somerset Dam	7.4	379,850	4000

b) Nominal volumes

The nominal allocations that have been assumed are given in Table 4-8.

Table 4-8: Nominal water allocations

Water Entitlement group	Water Allocation (ML/a)
Medium Priority	7,041
High Priority	279,000

c) Water Sharing Rules

The announced allocation for medium priority water allocations in the Central Brisbane River Water Supply Scheme is the announced allocation percentage stated in Table 4-9, corresponding to the combined percentage of useable volume in Wivenhoe and Somerset dams.

Table 4-9: Medium priority announced allocation by combined storage volume

Combined Percentage of Useable Volume in Wivenhoe and Somerset dams (CPUVS) (%)	**Announced allocation for medium priority water allocation (AA_{MP}) (% of nominal volume)**
0 to 14.9	0
15 to 24.9	15
25 to 29.9	25
30 to 34.9	40
35 to 39.9	55
40 to 44.9	70
45 to 49.9	85
50 to 100	100

The combined percentage of useable volume in Wivenhoe and Somerset dams must be calculated using the following formula:

$$CPUVS = \frac{UVWivenhoe + UVSomerset}{CUFSV} x100$$

- UV Wivenhoe is the useable volume of Wivenhoe Dam
- UV Somerset is the useable volume of Somerset Dam

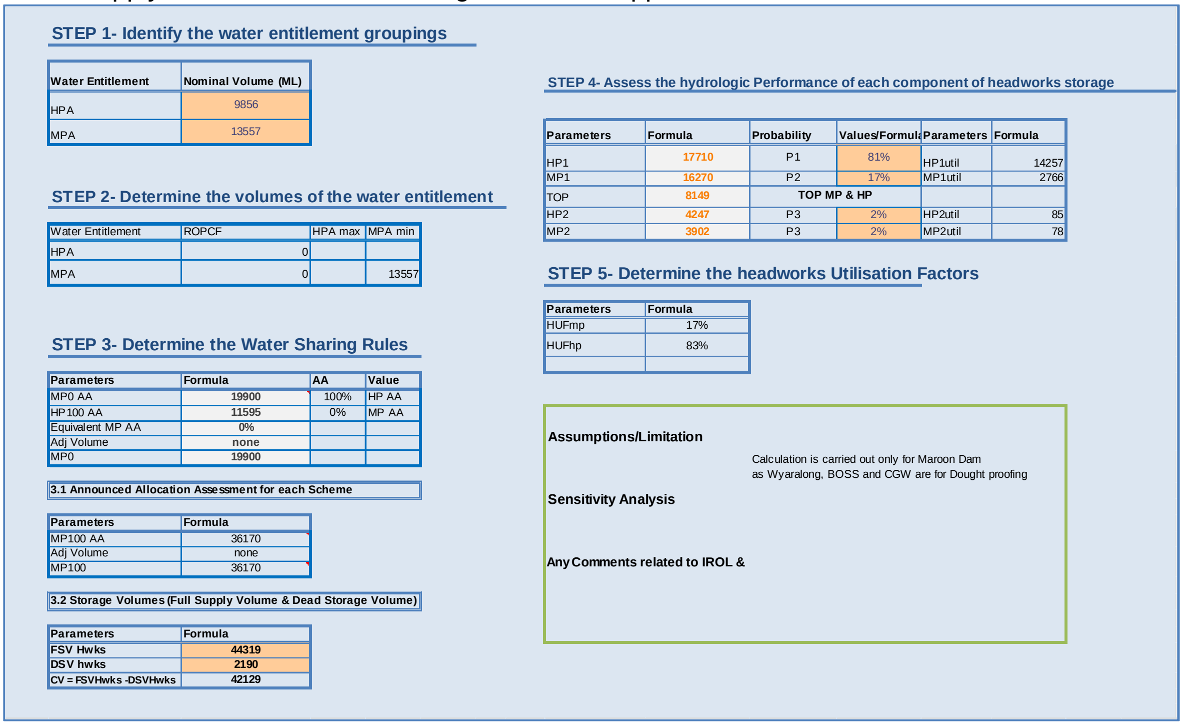
The announced allocation for the Central Brisbane consists of dividing the available storage into horizontal levels, which represent the capacity of storage available to meet the water demands. The AA for Central Brisbane provides high security for medium priority water users.

5. Results

This section presents a summary of the values of HUF's that have been calculated for each water entitlement priority group in each water supply scheme.

5.1 Logan River

The main parameters used for the calculation of the level of service for the Logan River Water Supply Scheme are shown in Figure 5-1 and Appendices A and B.



STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	19900	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	19900		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	36170
Adj Volume	none
MP100	36170

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	44319
DSV hwks	2190
CV = FSVHwks -DSVHwks	42129

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	17710	P1	81%	HP1util	14257
MP1	16270	P2	17%	MP1util	2766
TOP	8149	TOP MP & HP			
HP2	4247	P3	2%	HP2util	85
MP2	3902	P3	2%	MP2util	78

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	17%
HUFhp	83%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure 5-1. Parameters and assumptions used in the calculation

The results of the analysis are summarised in Table 5-1.

Table 5-1 Summary of HUF's for Logan River

Drought Period	Drought Period with minimum inflows		Drought Period without minimum Inflows	
	MPA (%)	HPA (%)	MPA (%)	HPA(%)
10 year	21	79	13	87
15 year	26	74	***16***	***84***
20 year	29	71	20	80

Table 5-1 shows that a decrease in HUF for MPA when historical minimum inflows are not included in the Announced Allocation formula. The decrease in HUF is in the order of 38% (10-year), and 38% for 15-year and 31% for 20-year drought period.

The change in the HUF from removing inflows reflects that MPA holders gain much more from stream inflows than HPA holders. This is because:

- HPA holders have priority access to water in the storage, and their security of supply is dependent on the volume in the storage.
- MPA holders receive a large proportion of their water from streamflow provided by the tributaries (Running and Christmas Creeks) and the upper Logan River rather than from storage releases, meaning that the storage volume is significantly higher than it would be in the absence of stream inflows. The AA formula reflects this as the useable volume (UV) includes annual inflows of 2,384 ML, resulting in generally high AAmp values.
- When stream flows are removed from the model the storage volumes are a lot lower meaning that MPA cut-off is reached more often and a smaller proportion of the storage is attributed to MPA holders.

5.2 Mary Valley

The main parameters used for the calculation of the level of service for the Mary Valley Water Supply Scheme are shown in Appendices A and B. The results are summarised in Table 5-2.

Table 5-2 Summary of HUF's for Mary Valley

Drought Period	Drought Period with minimum inflows		Drought Period without minimum Inflows	
	MPA (%)	HPA (%)	MPA (%)	HPA(%)
10 year	61	39	22	78
15 year	*60*	*40*	***26***	***74***
20 year	61	39	35	65

Table 5-2 shows that a large decrease in HUF for MPA when historical minimum inflows are not included in the Announced Allocation formula. The decrease in HUF is in the order of 64% (10-year), 57% for 15-year, and 43% for 20-year drought period.

The change in the HUF from removing inflows reflects that MPA holders gain much more from stream inflows than HPA holders. This is because:

- HPA holders have priority access to water in the storage, and their security of supply is dependent on the volume in the storage.
- MPA holders receive a large proportion of their water from streamflow rather than from storage releases, meaning that the storage volume is significantly higher than it would be in the absence of stream inflows. The AA formula reflects this as the useable volume (UV) includes annual inflows of 11,000 ML, resulting in generally high AAmp values.
- When stream flows are removed from the model the storage volumes are a lot lower meaning that MPA cut-off is reached more often and a smaller proportion of the storage is attributed to MPA holders.

A hydrologic modelling study "Flow Quantification for three water supply schemes" was carried out by Parsons Brinckerhoff for Seqwater (2009) showed that MPA users sourced their water supply mostly from river flow which exceeds water sourced from Borumba Dam. MPA supply is estimated to be improved by a maximum of 9.6% through the presence of the storage infrastructure. This key finding is also supported by the large volume of streamflows (11,000 ML/a) allocated to the calculation of AA for MP users.

5.3 Warrill Valley

The main parameters used for the calculation of the level of service for the Mary Valley Water Supply Scheme are shown in Appendices A and B. The results are summarised in Table 5-3.

Table 5-3 Summary of HUF's for Warrill Valley

Drought Period	Drought Period with minimum inflows		Drought Period without minimum Inflows	
	MPA (%)	HPA (%)	MPA (%)	HPA(%)
10 year	14	86	11	89
15 year	15	85	***<u>11</u>***	***<u>89</u>***
20 year	15	85	11	89

The key finding to be drawn from the above table is that minimum inflows have not decreased the HUF percentage as much as for the Mary Valley and Logan River systems. Table 5-3 shows a small decrease in HUF for MPA when historical minimum inflows are not included in the Announced Allocation formula. There is no change for the drought period of 10-year and the decrease in HUF is in the order of 27% for the 15-year and for the 20-year drought periods. The HPA users are not impacted as they rely only on the dam performance. However, MPA users are slightly impacted by the system inflows provided by the tributaries and the upper Warrill Creek. The AA formula as shown in Section 4.1(c) adds minimum inflows (volume of 2,800 ML) as an addition to the UV of the Moogerah Dam and causes increased AA percentages and the increased access share to the storage for MPA holders. The MPA share of benefits fall from 15 to 14% could be partly explained by the proportion of inflows to the MP water allocation of 24,250 ML and a large volume of transmission operation losses in the system.

A hydrologic modelling study "Flow Quantification for three water supply schemes" was carried out by Parsons Brinckerhoff for Seqwater (2009) showed that MPA users sourced their water supply mostly from river flow which exceeds water sourced from Moogerah Dam. MPA supply is estimated to be improved by a maximum of 3% through the presence of the storage infrastructure.

5.4 Central Brisbane

The main parameters used for the calculation of the level of service for the Central Brisbane Water Supply Scheme are shown in Appendices A and B. The results are summarised in Table 5-4.

Table 5-4 summarises the HUF's results for different schemes under the different conditions assessed (refer to Appendix A and B for further detail).

The Level of Service using the Headworks Utilisation Factors for each water supply scheme is presented below.

Table 5-4 Summary of HUF's for Central Brisbane

Drought Period	Drought Period from storage volumes		Drought Period from Inflows	
	MPA (%)	HPA (%)	MPA (%)	HPA (%)
10 year	67	33	71	29
15 year	69	31	71	29
20 year	69	31	69	31

This table outlines the results of analysis for each of the three drought periods for each of the 2 scenarios – with storage volumes and with inflows. Stream flows have little impact on the results for the Central Brisbane system, mainly as the storage volume is so large and the watercourse downstream of the storage is relatively short.

The HUF allocates nearly 70% of the benefit of the storage to MPA holders. This is a perverse result because this is principally an urban water system where nearly 98% of the allocations are for urban water supply. The main reasons for the HUF result are:

- The HPA entitlement is relatively low versus the storage volume, given the very high reliability of HPA. The performance of HPA in the scheme is 100% reliability and is well above the WASO performance indicator set in the WRP, and in practice a smaller storage would suffice to meet WASO requirement. Given the balance of storage volume available is assumed to relate to MPA, a high proportion of the storage volume is allocated to MPA under the HUF.

- Under the water sharing rules, the cut-off volume for MPA is very low (14.9%) and the dam has never reached this cut-off level in the historical period. Also the storage is always above 50% capacity during the 15 year drought period. These two factors mean a relatively very large proportion of the storage is allocated to MPA under the HUF.

Figure 5-2 shows the storage performance for the combined Wivenhoe and Somerset Dams for the 15 year drought.

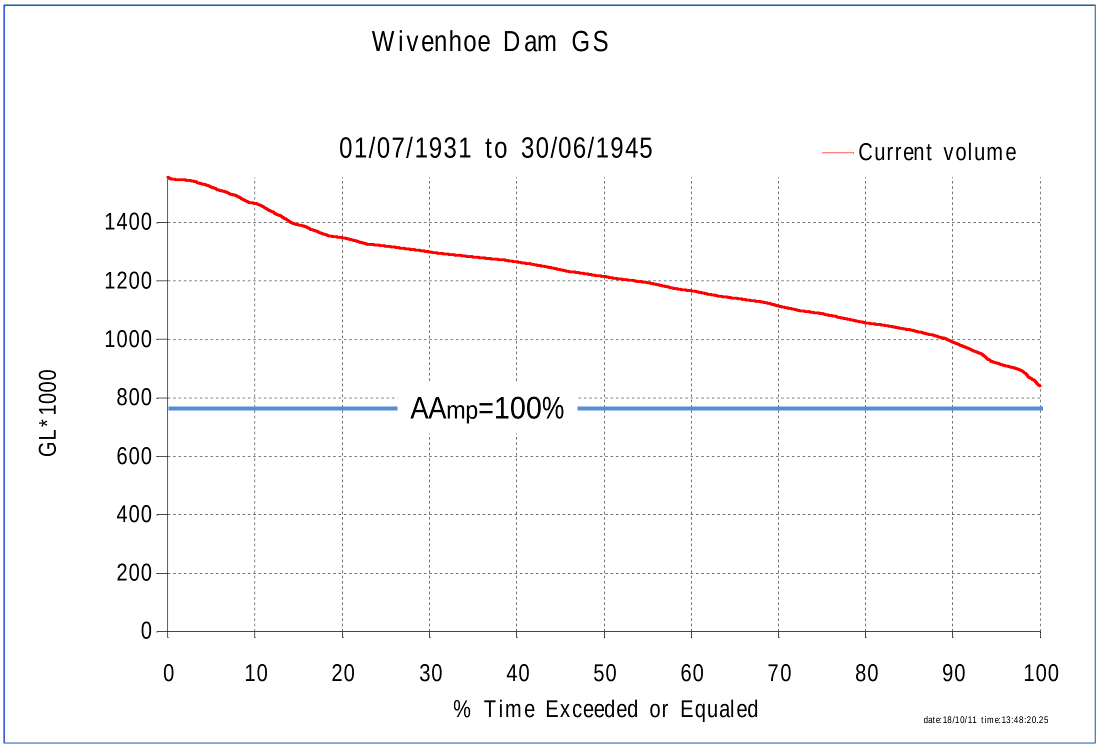


Figure 5-2. Somerset and Wivenhoe Dams Performance (15 year drought period)

The key finding to be drawn from this is that the HUF method is not applicable to the Central Brisbane Water Supply Scheme due to its water sharing rules structure and that there is always a significant storage volume in the analysed period. In short, the HUF method does not account for HPA that have extremely high reliability and exceed the WASO to such an extent. This is evidenced by the fact that the HUF percentage for MPA is higher than the MPA's share of total water entitlement in the scheme – this should not occur as the WASO for MPA is lower than HPA.

An alternative method for this scheme can be calculated based on the ratio between MPA and HPA factored by the cut-off percentage (i.e. $\left(\frac{7041}{279000}\right) \times (100 - 14.9) = 2\%$ for MPA and 98% for HPA). This is a much closer reflection of the maximum sharing of benefit gained from the storage by MPA and HPA holders. Indeed the actual percentage of storage relating to MPA is likely to be lower than 2% given the operation of the water sharing rules.

6. Conclusions

The main conclusions drawn from this study are as follows:

1. For the Central Brisbane, the HUF method is not applicable for the following reasons:

   a. The calculations have allocated too high a proportion of storage volume to the medium priority allocation (MPA).

   b. The calculations do not account for the very high reliability of HPA caused by the small MP water allocation versus high storage capacity.

   c. The HUF method is not developed to account for the Central Brisbane water sharing rules that differ from all other water sharing rules in the state.

   d. The HUF percentage for MPA is higher than the MPA's share of the total water entitlements.

   e. The cut-off volume for MPA (AAMP = 0%) is very low and the dam has never reached this cut-off level in the historical period.

   f. Under the 15 year drought period, the storage volume is well above 50% capacity of the combined storage capacities of the dams.

2. For the Logan, Warrill and Mary Valley, the HUF method provides reasonable results under the no minimum historical flows scenario in the AA and IQQM calculations as the minimum inflows increased the percentage of MPA access to the infrastructure. The HUF results for the three water supply schemes show a higher ratio for MPA than HPA when minimum inflows are considered.

3. A sensitivity analysis was carried out to assess the effect of changing the duration of the critical water supply arrangement by performing HUF calculations using 10, 15 and 20 year critical periods. The summary results of the HUF's are presented in the tables in the result section. According to SunWater's method, a 15 year critical period was considered as the duration of standard period. Comparing the 10 and 20 year critical periods show both the Logan River and Warrill Valley HUF values for MPA varied by 20% for a 10 year critical period. For a 20 year critical period, the Logan River and Mary Valley HUF values for MPA varied by 12% and 2%, respectively. There was no change for Central Brisbane and Warrill Valley for this period.

Appendix A

HUF results using drought periods derived from storage volumes

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	**46000**
DSV hwks	**1200**
CV = FSVHwks -DSVHwks	**44800**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	91%	HP1util	8465
MP1	32451	P2	41%	MP1util	13305
TOP	3047	**TOP MP & HP**			
HP2	679	P3	0%	HP2util	0
MP2	2368	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	61%
HUFhp	39%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 1. Mary Valley Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	**46000**
DSV hwks	**1200**
CV = FSVHwks -DSVHwks	**44800**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	89%	HP1util	8279
MP1	32451	P2	39%	MP1util	12656
TOP	3047	**TOP MP & HP**			
HP2	679	P3	0%	HP2util	0
MP2	2368	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	60%
HUFhp	40%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 2. Mary Valley Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	**46000**
DSV hwks	**1200**
CV = FSVHwks -DSVHwks	**44800**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	92%	HP1util	8511
MP1	32451	P2	42%	MP1util	13467
TOP	3047	**TOP MP & HP**			
HP2	679	P3	0%	HP2util	0
MP2	2368	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	61%
HUFhp	39%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 3. Mary Valley Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	63%	HP1util	9521
MP1	16337	P2	15%	MP1util	2451
TOP	10559	**TOP MP & HP**			
HP2	5095	P3	3%	HP2util	153
MP2	5464	P3	3%	MP2util	164

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	21%
HUFhp	79%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure A- 4. Logan River Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	71%	HP1util	10815
MP1	16337	P2	23%	MP1util	3676
TOP	10559	**TOP MP & HP**			
HP2	5095	P3	2%	HP2util	102
MP2	5464	P3	2%	MP2util	109

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	26%
HUFhp	74%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure A- 5. Logan River Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	74%	HP1util	11272
MP1	16337	P2	28%	MP1util	4493
TOP	10559	TOP MP & HP			
HP2	5095	P3	4%	HP2util	204
MP2	5464	P3	4%	MP2util	219

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	29%
HUFhp	71%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure A- 6. Logan River Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	54%	HP1util	7918
MP1	32000	P2	4%	MP1util	1120
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	12%
HUFhp	88%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 7. Warrill Valley Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	54%	HP1util	8051
MP1	32000	P2	5%	MP1util	1440
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	15%
HUFhp	85%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 8. Warrill Valley Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	54%	HP1util	8051
MP1	32000	P2	5%	MP1util	1440
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	15%
HUFhp	85%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 9. Warrill Valley Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	1545050
DSV hwks	8886
CV = FSVHwks -DSVHwks	1536164

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	220002	P1	100%	HP1util	220002
MP1	539194	P2	77%	MP1util	415179
TOP	776968	TOP MP & HP			
HP2	225152	P3	28%	HP2util	63043
MP2	551816	P3	28%	MP2util	154508

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	67%
HUFhp	33%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 10. Central Brisbane Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	1545050
DSV hwks	8886
CV = FSVHwks -DSVHwks	1536164

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	220002	P1	100%	HP1util	220002
MP1	539194	P2	85%	MP1util	458315
TOP	776968	TOP MP & HP			
HP2	225152	P3	35%	HP2util	77677
MP2	551816	P3	35%	MP2util	190377

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	69%
HUFhp	31%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 11. Central Brisbane Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	1545050
DSV hwks	8886
CV = FSVHwks -DSVHwks	1536164

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	220002	P1	100%	HP1util	220002
MP1	539194	P2	90%	MP1util	482579
TOP	776968	TOP MP & HP			
HP2	225152	P3	39%	HP2util	87809
MP2	551816	P3	39%	MP2util	215208

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	69%
HUFhp	31%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure A- 12. Central Brisbane Water Supply Scheme – Twenty (20) year Critical Period

Appendix B

HUF results using drought periods derived from inflows

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	46000
DSV hwks	1200
CV = FSVHwks -DSVHwks	44800

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	94%	HP1util	8744
MP1	32451	P2	44%	MP1util	14278
TOP	3047	TOP MP & HP			
HP2	679	P3	0%	HP2util	0
MP2	2368	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	62%
HUFhp	38%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 1. Mary Valley Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	**46000**
DSV hwks	**1200**
CV = FSVHwks -DSVHwks	**44800**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	92%	HP1util	8511
MP1	32451	P2	44%	MP1util	14278
TOP	3047	**TOP MP & HP**			
HP2	679	P3	2%	HP2util	14
MP2	2368	P3	2%	MP2util	47

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	63%
HUFhp	37%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 2. Mary Valley Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	10254
MPA	21845

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0	10284	
MPA	0	34755	21845

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	10502	100%	HP AA
HP100 AA	20220	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	10502		
MP0	10502		

Parameters	Formula
MP100 AA	42953
Adj Volume	none
MP100	42953

Parameters	Formula
FSV Hwks	**46000**
DSV hwks	**1200**
CV = FSVHwks -DSVHwks	**44800**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	9302	P1	92%	HP1util	8511
MP1	32451	P2	48%	MP1util	15576
TOP	3047	**TOP MP & HP**			
HP2	679	P3	7%	HP2util	48
MP2	2368	P3	7%	MP2util	166

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	65%
HUFhp	35%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 3. Mary Valley Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	89%	HP1util	13481
MP1	16337	P2	45%	MP1util	7352
TOP	10559	TOP MP & HP			
HP2	5095	P3	6%	HP2util	306
MP2	5464	P3	6%	MP2util	328

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	36%
HUFhp	64%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure B- 4. Logan River Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	82%	HP1util	12491
MP1	16337	P2	40%	MP1util	6453
TOP	10559	**TOP MP & HP**			
HP2	5095	P3	8%	HP2util	408
MP2	5464	P3	8%	MP2util	437

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	35%
HUFhp	65%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure B- 5. Logan River Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9856
MPA	13557

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		13557

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	17423	100%	HP AA
HP100 AA	11595	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	17423		

3.1 Announced Allocation Assessment for each Scheme

Parameters	Formula
MP100 AA	33760
Adj Volume	none
MP100	33760

3.2 Storage Volumes (Full Supply Volume & Dead Storage Volume)

Parameters	Formula
FSV Hwks	**44319**
DSV hwks	**2190**
CV = FSVHwks -DSVHwks	**42129**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	15233	P1	85%	HP1util	12948
MP1	16337	P2	40%	MP1util	6535
TOP	10559	TOP MP & HP			
HP2	5095	P3	6%	HP2util	280
MP2	5464	P3	6%	MP2util	301

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	34%
HUFhp	66%

Assumptions/Limitation

Calculation is carried out only for Maroon Dam
as Wyaralong, BOSS and CGW are for Dought proofing

Sensitivity Analysis

Any Comments related to IROL &

Figure B- 6. Logan River Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	57%	HP1util	8436
MP1	32000	P2	7%	MP1util	2240
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	21%
HUFhp	79%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 7. Warrill Valley Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	56%	HP1util	8214
MP1	32000	P2	6%	MP1util	1760
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	18%
HUFhp	82%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 8. Warrill Valley Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	9450
MPA	24250

STEP 2- Determine the volumes of the water entitlement Groupings

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		24250

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	16000	100%	HP AA
HP100 AA	16000	0%	MP AA
Equivalent MP AA	0%		
Adj Volume	none		
MP0	16000		

Parameters	Formula
MP100 AA	48000
Adj Volume	none
MP100	48000

Parameters	Formula
FSV Hwks	83700
DSV hwks	1200
CV = FSVHwks -DSVHwks	82500

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	14800	P1	55%	HP1util	8066
MP1	32000	P2	5%	MP1util	1440
TOP	35700	TOP MP & HP			
HP2	11290	P3	0%	HP2util	0
MP2	24410	P3	0%	MP2util	0

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	15%
HUFhp	85%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 9. Warrill Valley Water Supply Scheme – Twenty (20) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	1165200
DSV hwks	4886
CV = FSVHwks -DSVHwks	1160314

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	224002	P1	100%	HP1util	224002
MP1	539194	P2	100%	MP1util	539194
TOP	397118	TOP MP & HP			
HP2	116556	P3	50%	HP2util	58278
MP2	280562	P3	50%	MP2util	140281

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	71%
HUFhp	29%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 10. Central Brisbane Water Supply Scheme – Ten (10) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	**1165200**
DSV hwks	**4886**
CV = FSVHwks -DSVHwks	**1160314**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	224002	P1	100%	HP1util	224002
MP1	539194	P2	100%	MP1util	539194
TOP	397118	**TOP MP & HP**			
HP2	116556	P3	50%	HP2util	58278
MP2	280562	P3	50%	MP2util	140281

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	71%
HUFhp	29%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 11. Central Brisbane Water Supply Scheme – Fifteen (15) year Critical Period

STEP 1- Identify the water entitlement groupings

Water Entitlement	Nominal Volume (ML)
HPA	279000
MPA	7041

STEP 2- Determine the volumes of the water entitlement

Water Entitlement	ROPCF	HPA max	MPA min
HPA	0		
MPA	0		7041

STEP 3- Determine the Water Sharing Rules

Parameters	Formula	AA	Value
MP0 AA	228888	62%	HP AA
HP100 AA	394600	15%	MP AA
Equivalent MP AA	15%		
Adj Volume	none		
MP0	228888		

Parameters	Formula
MP100 AA	768082
Adj Volume	none
MP100	768082

Parameters	Formula
FSV Hwks	**1545050**
DSV hwks	**8886**
CV = FSVHwks -DSVHwks	**1536164**

STEP 4- Assess the hydrologic Performance of each component of headworks storage

Parameters	Formula	Probability	Values/Formula	Parameters	Formula
HP1	220002	P1	100%	HP1util	220002
MP1	539194	P2	90%	MP1util	482579
TOP	776968	**TOP MP & HP**			
HP2	225152	P3	39%	HP2util	87809
MP2	551816	P3	39%	MP2util	215208

STEP 5- Determine the headworks Utilisation Factors

Parameters	Formula
HUFmp	69%
HUFhp	31%

Assumptions/Limitation

Sensitivity Analysis

Any Comments related to IROL & ROP

Figure B- 12. Central Brisbane Water Supply Scheme – Twenty (10) year Critical Period

Appendix C

IQQM ranked storage volume outputs using drought periods derived from storage volumes

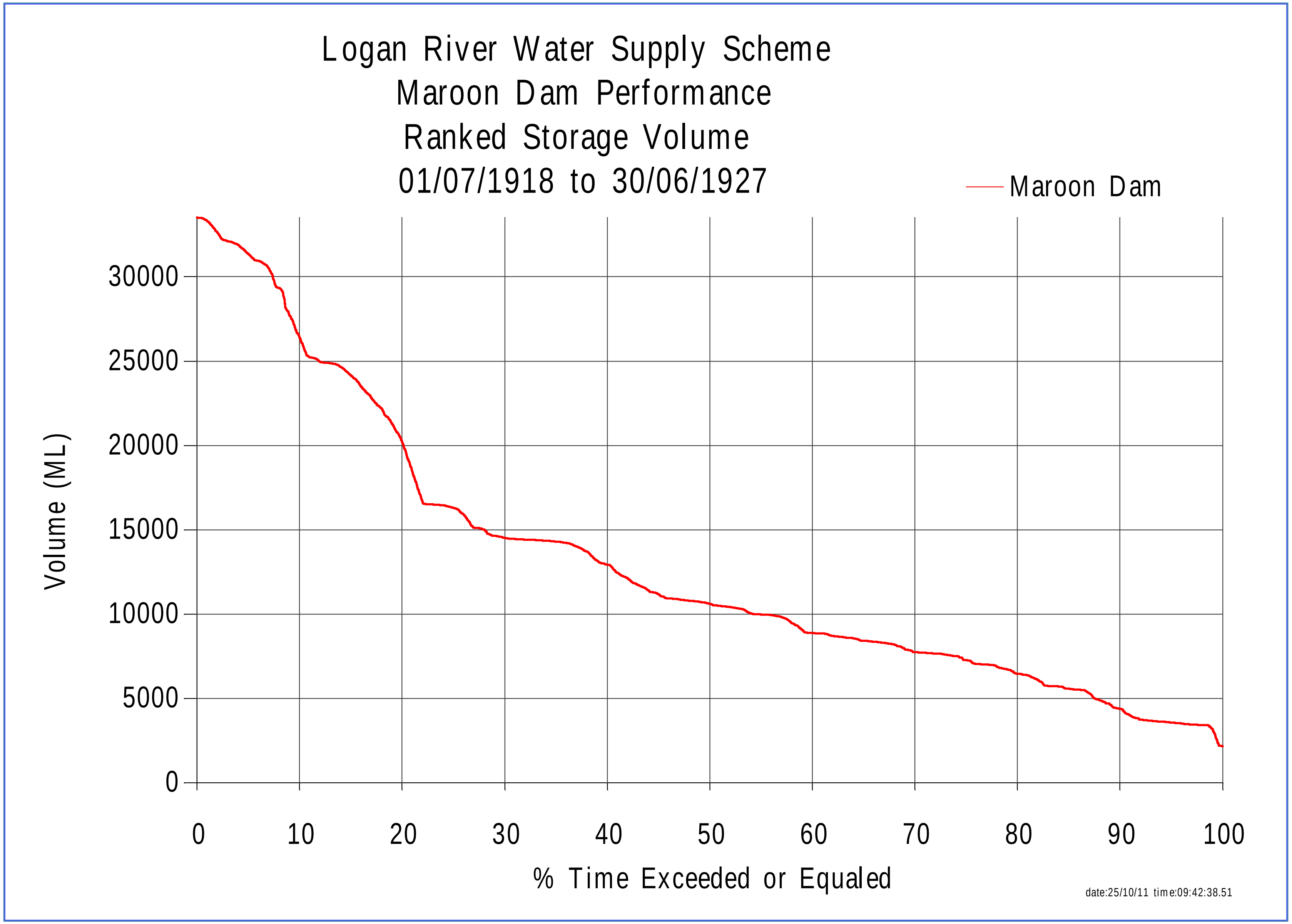


Figure C- 1 Exceedance plot used for Logan River – 10 years drought (period 1918 – 1927)

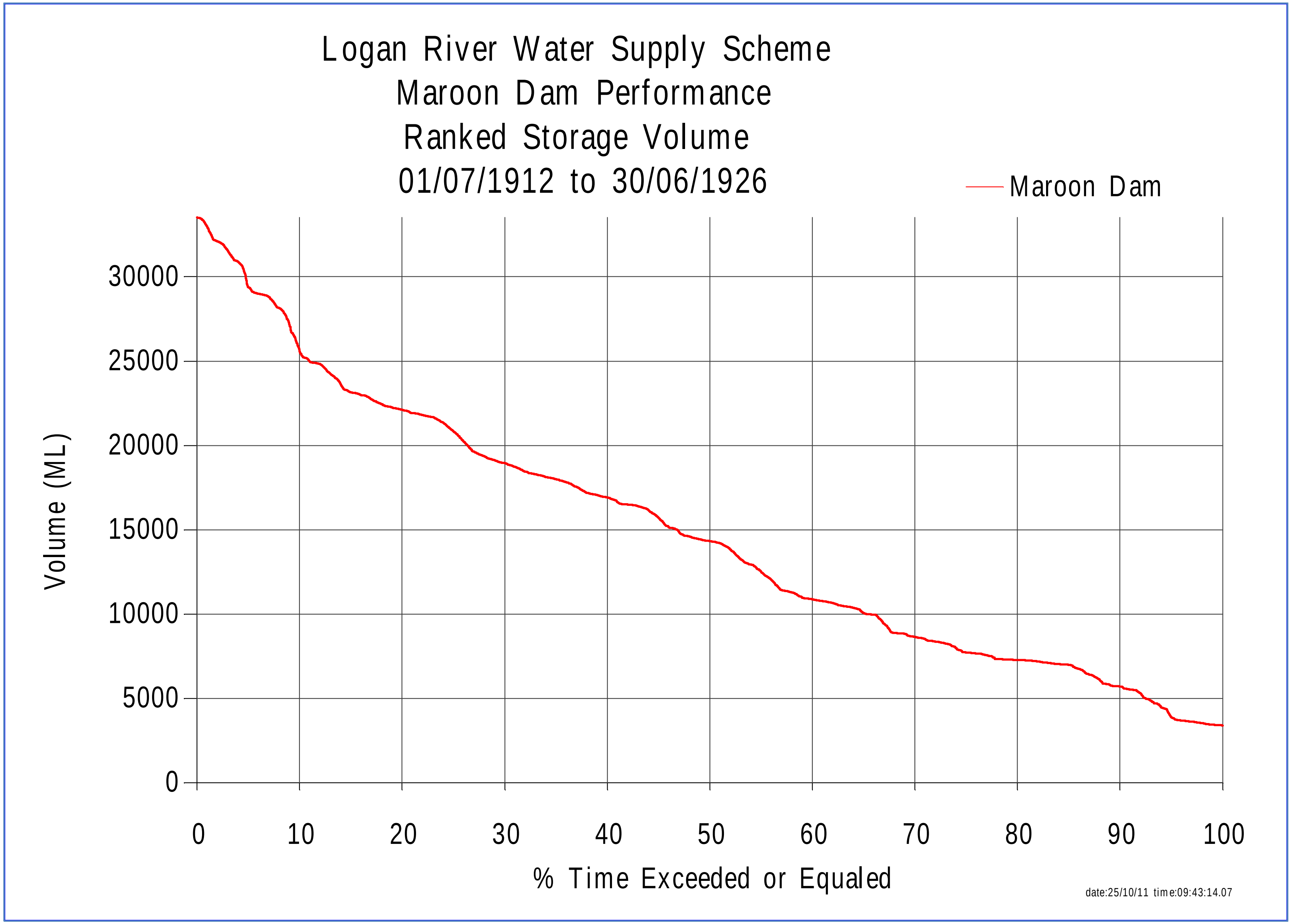


Figure C- 2 Exceedance plot used for Logan River – 15 years drought (period 1912 – 1926)

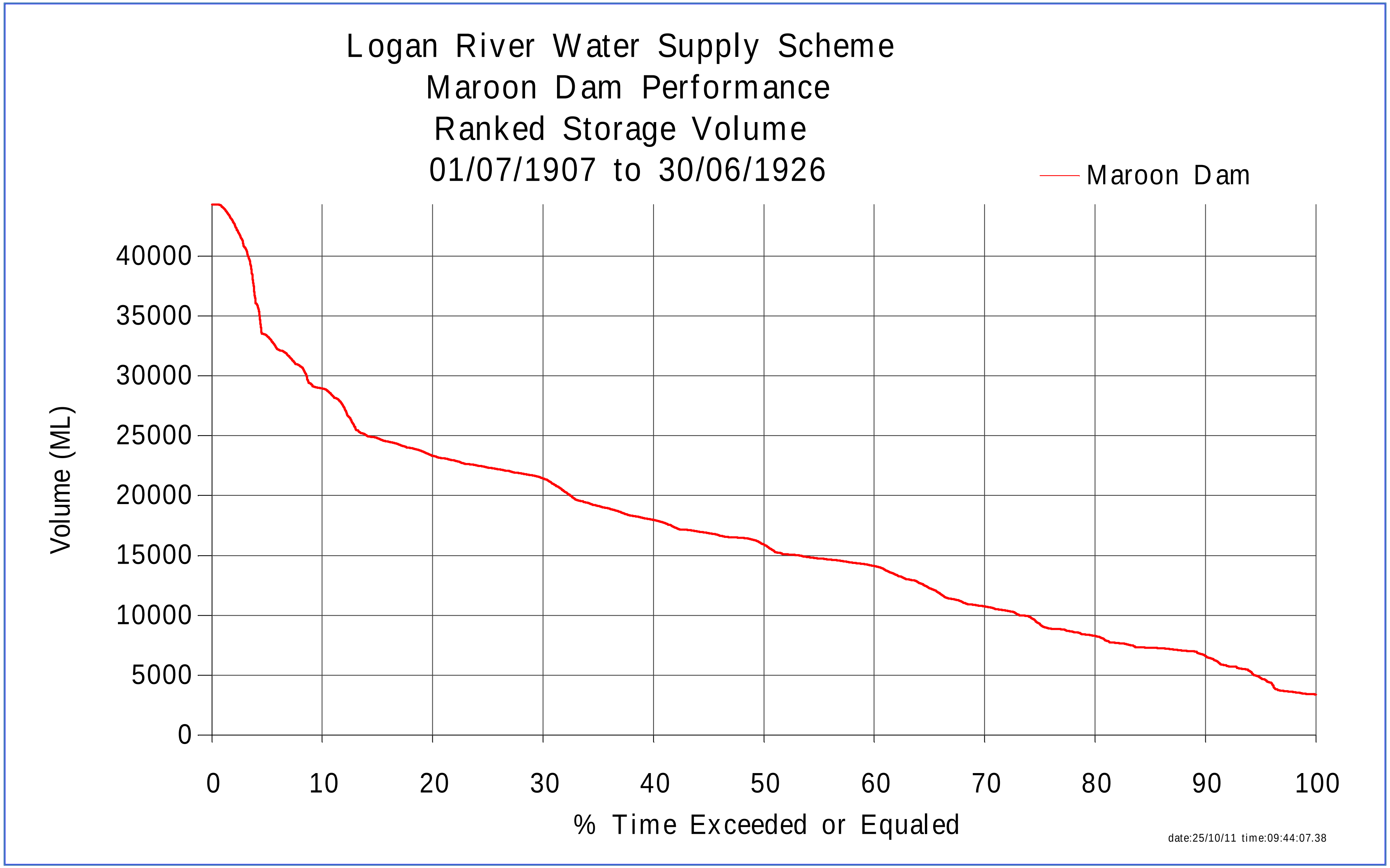


Figure C- 3 **Exceedance plot used for Logan River – 20 years drought (period 1907 – 1926**

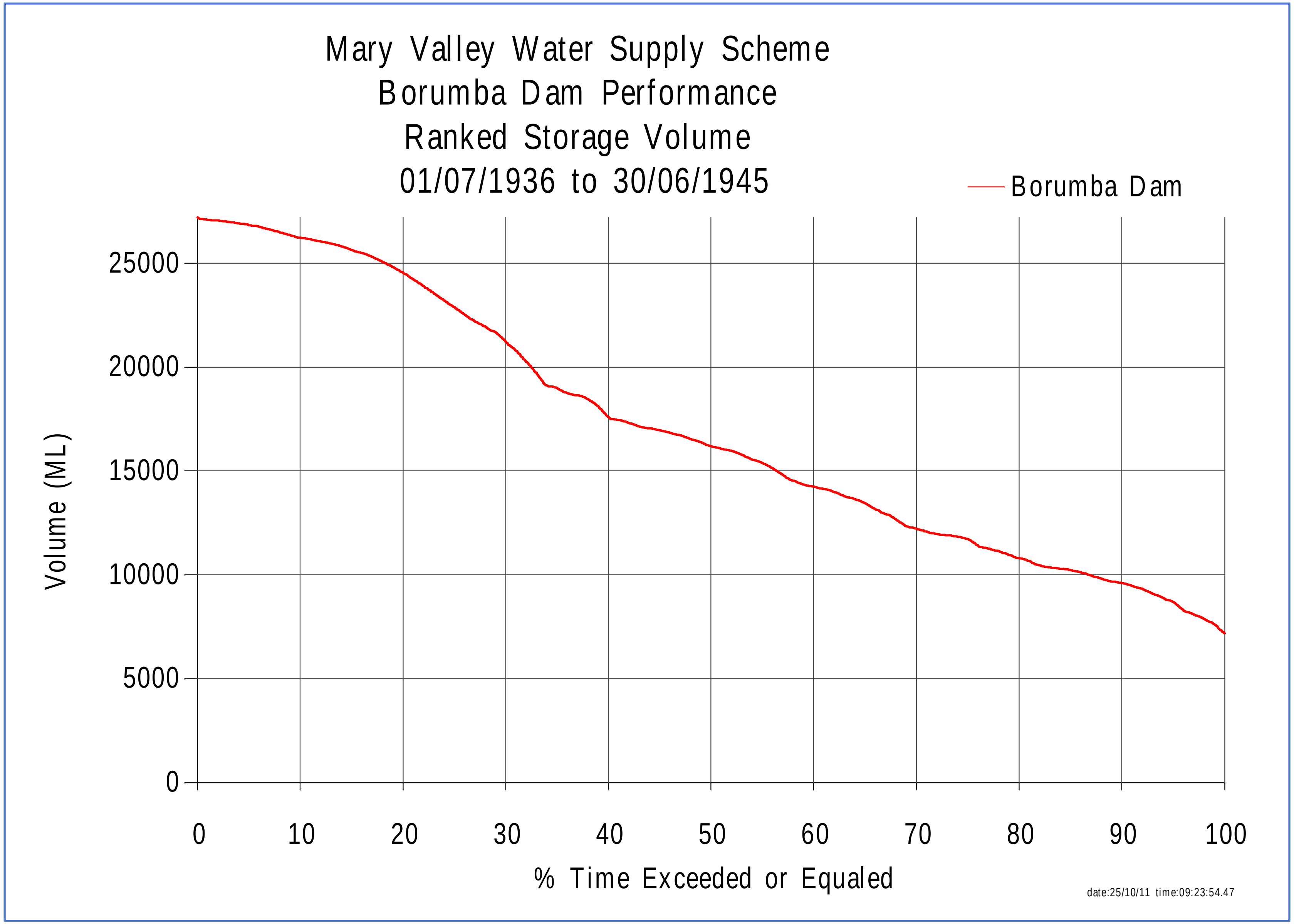


Figure C- 4 **Exceedance plot used for** Mary Valley – 10 years (period 1936 – 1945)

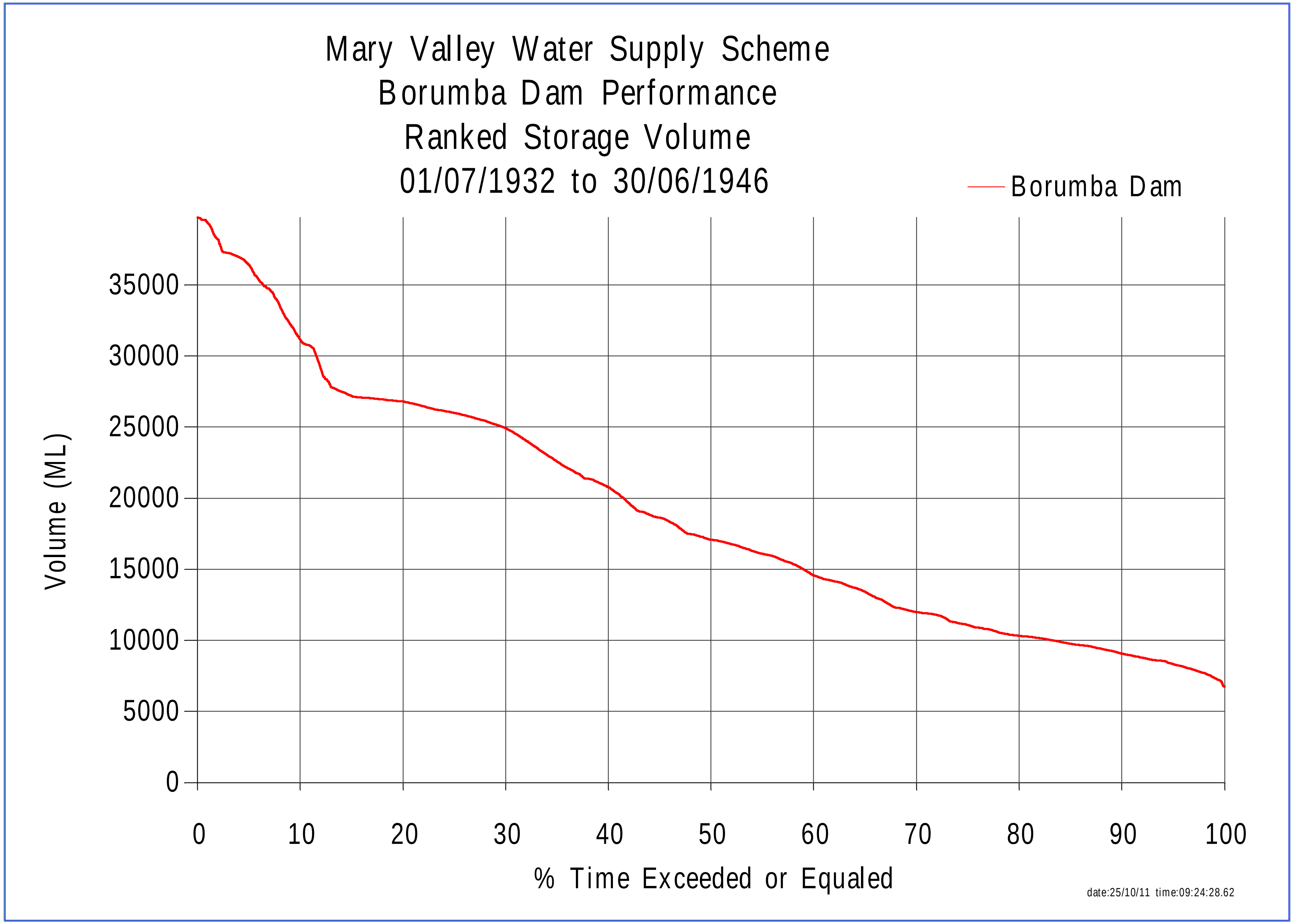


Figure C- 5 **Exceedance plot used for Mary Valley – 15 years drought (period 1932 – 1946**)

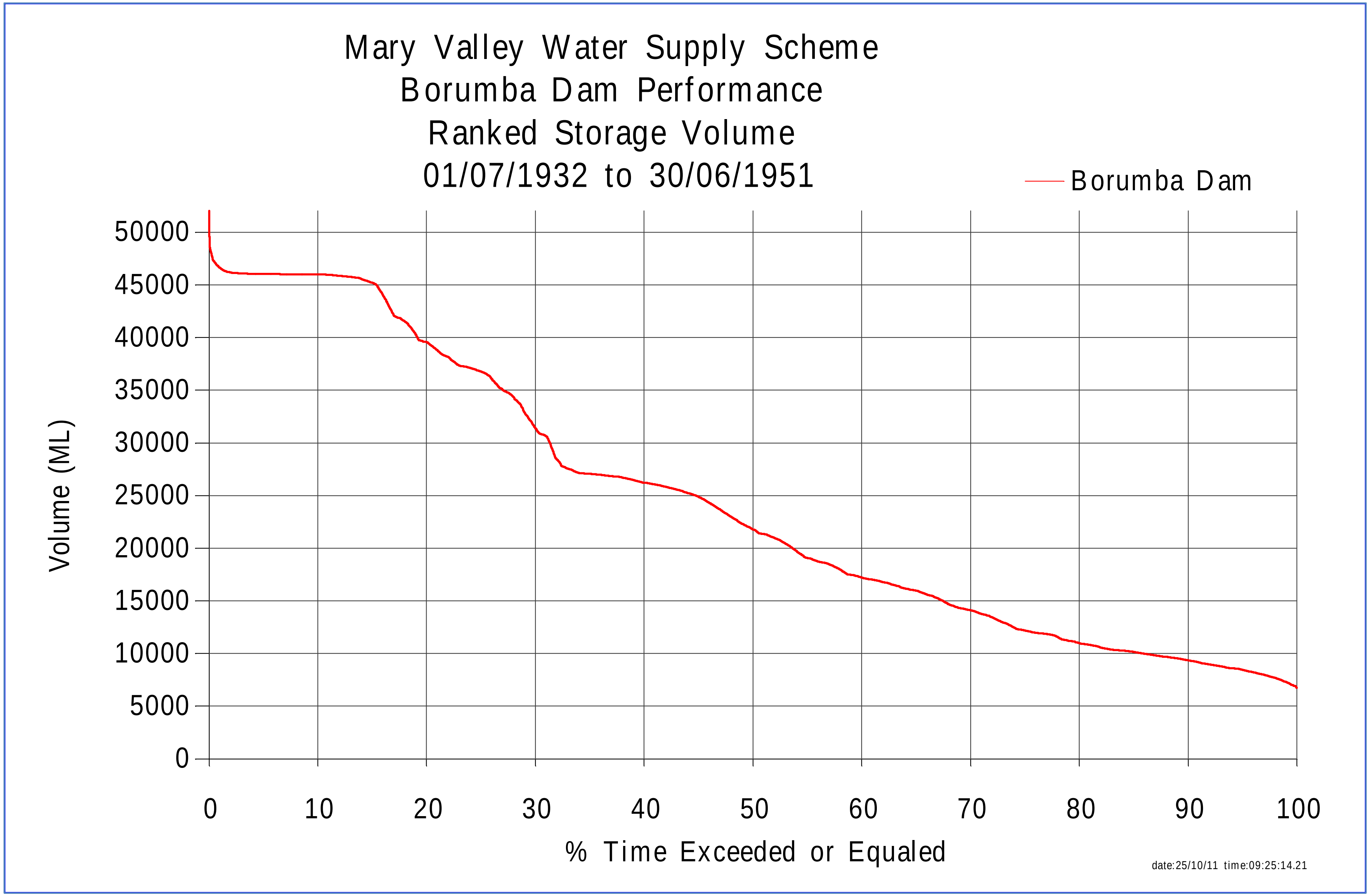


Figure C- 6 **Exceedance plot used for Mary Valley – 20 years drought (period 1932 – 1951**)

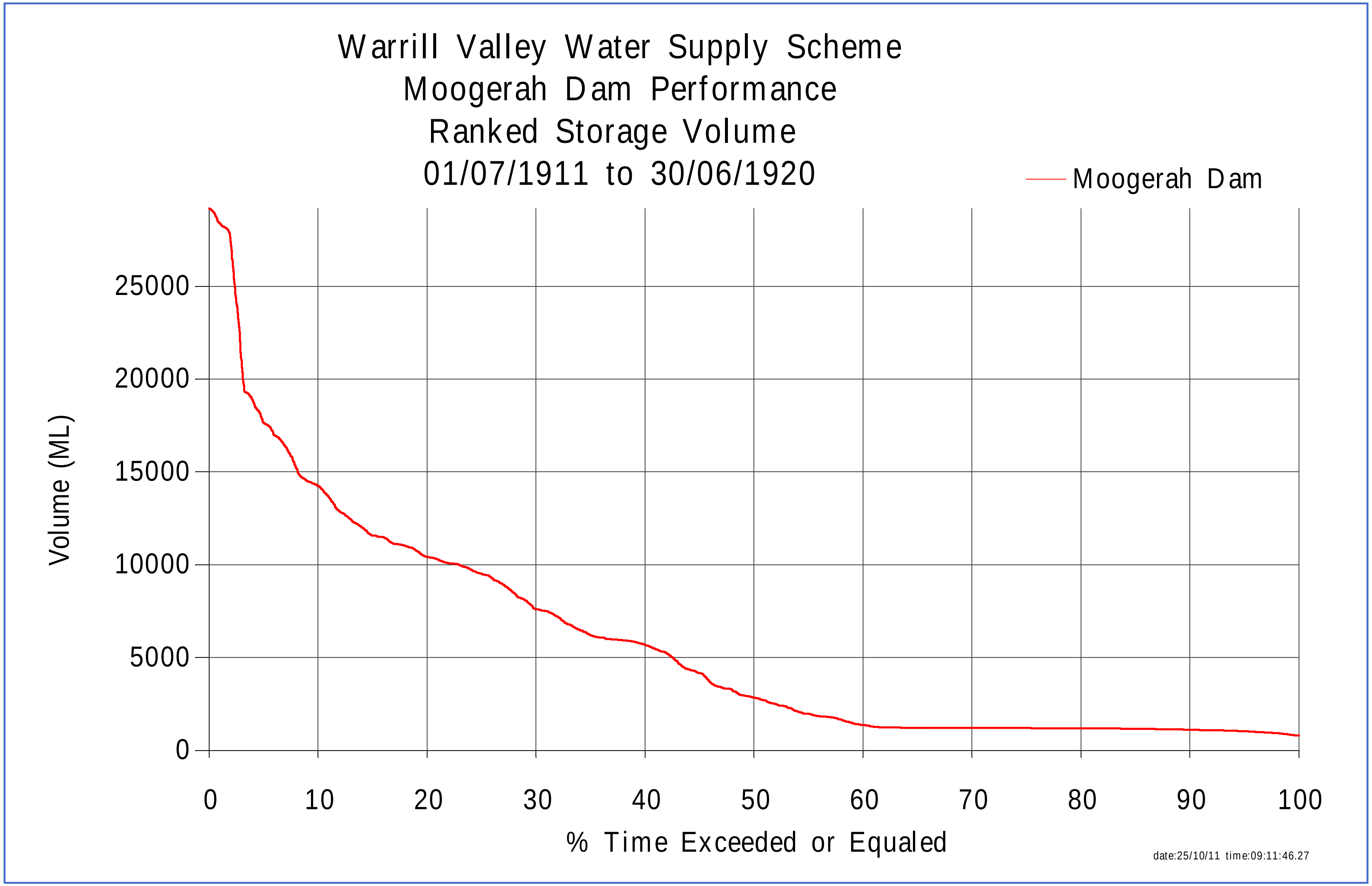


Figure C- 7 **Exceedance plot used for Warrill Valley – 10 years drought (period 1911 – 1920**)

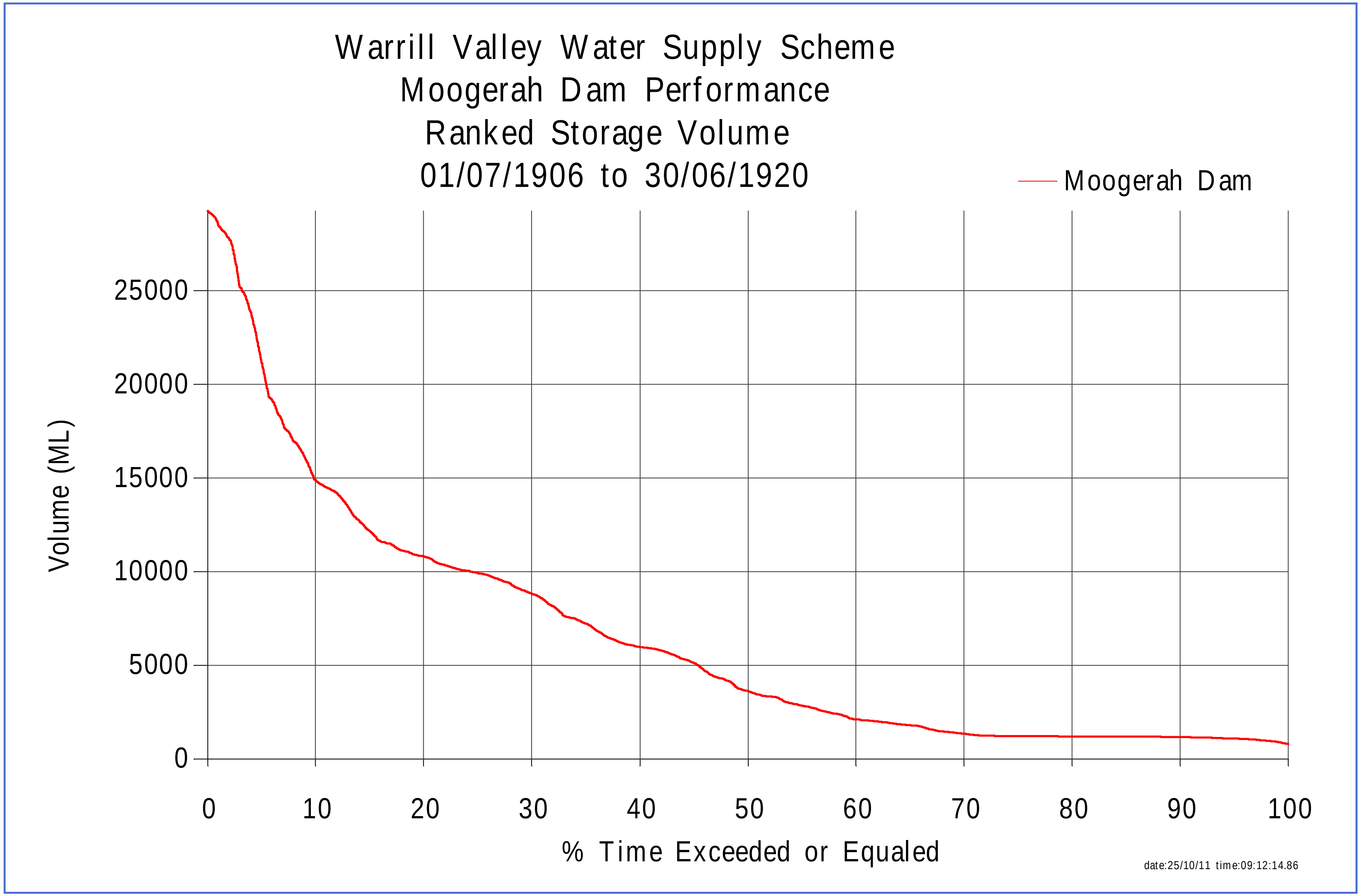


Figure C- 8 **Exceedance plot used for Warrill Valley – 15 years drought (period 1906 – 1920**)

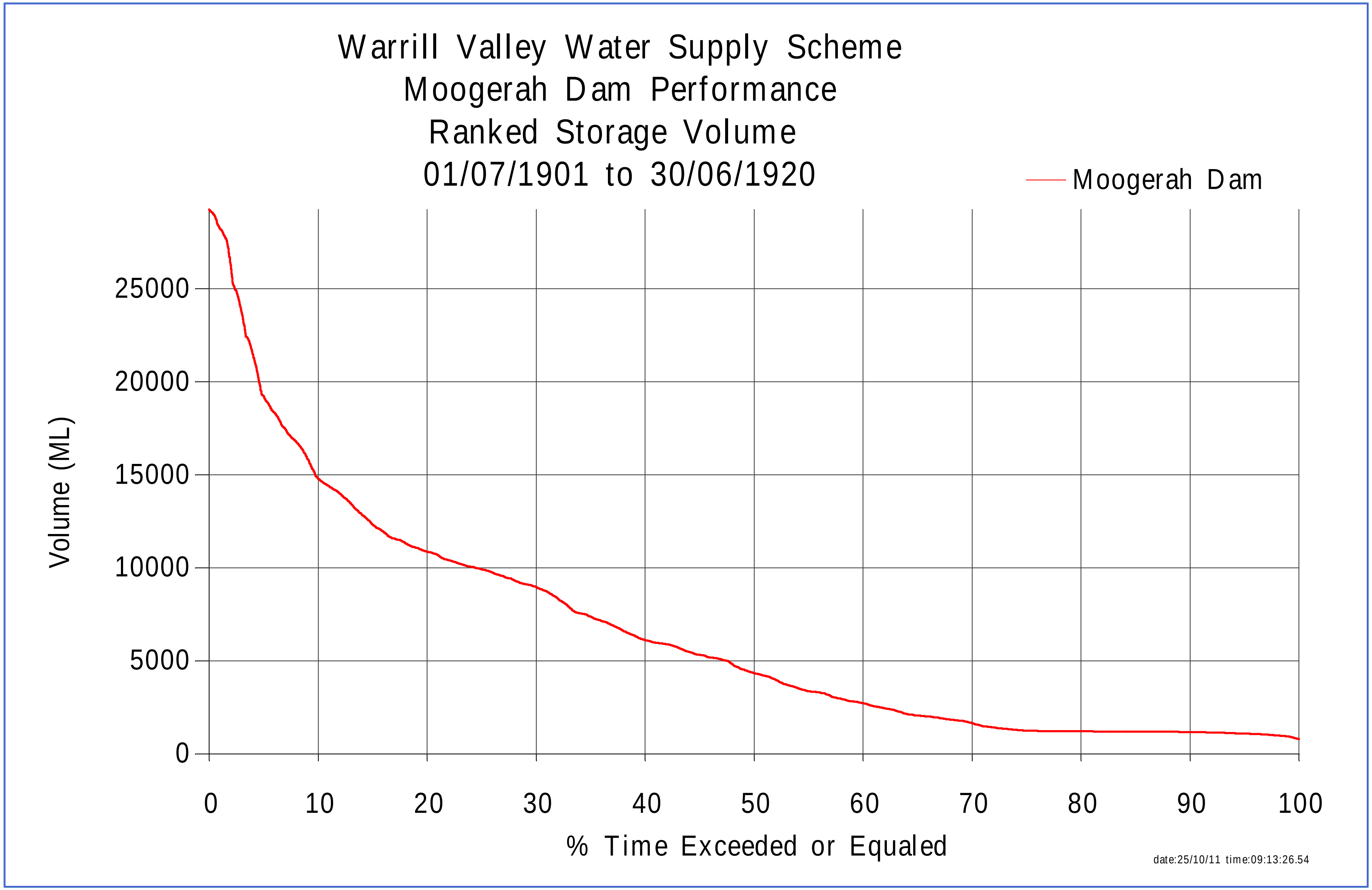


Figure C- 9 **Exceedance plot used for Warrill Valley – 20 years drought (period 1901 – 1920**)

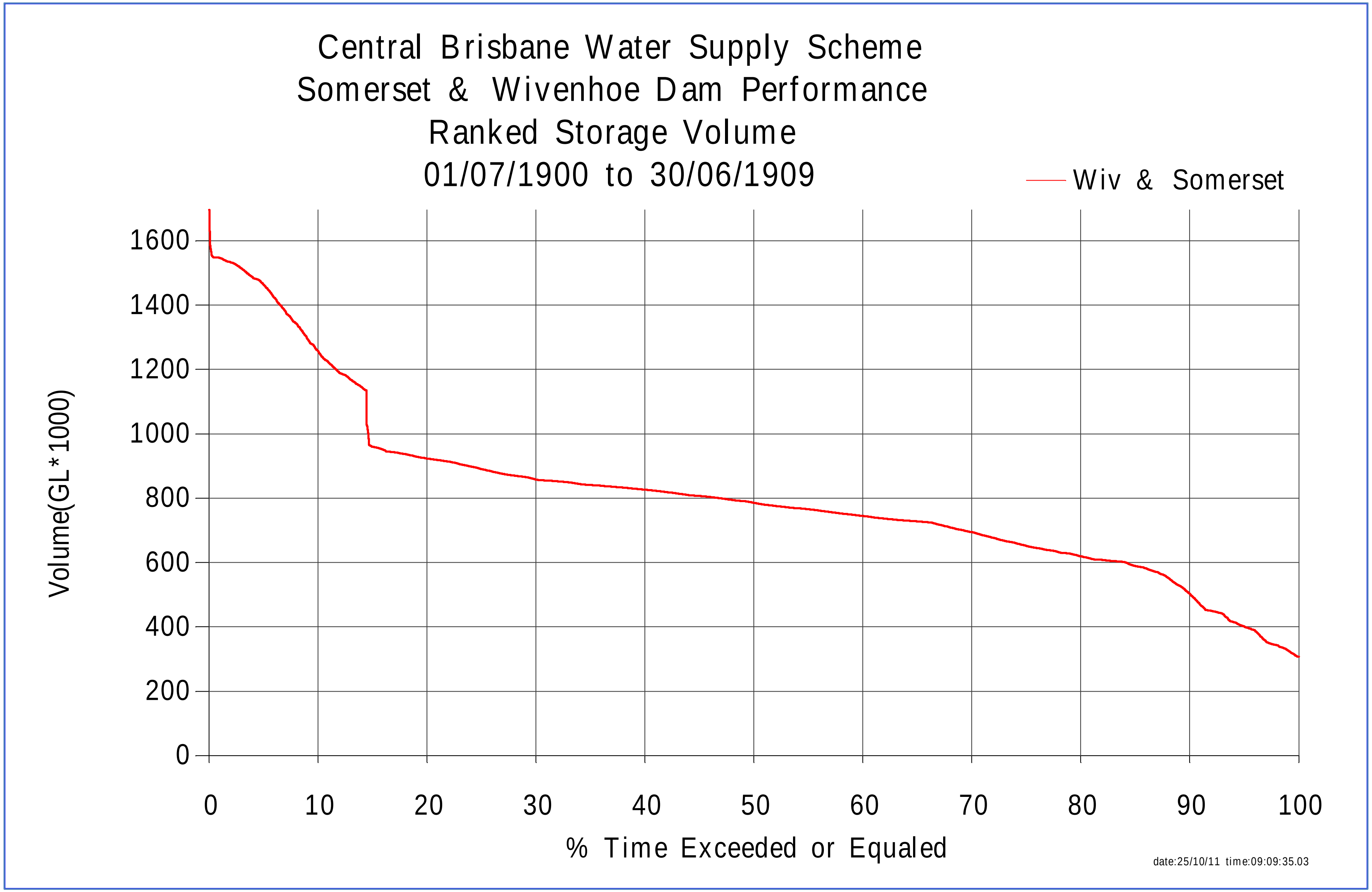


Figure C- 10 **Exceedance plot used for Central Brisbane – 10 years drought (period 1900 – 1909**)

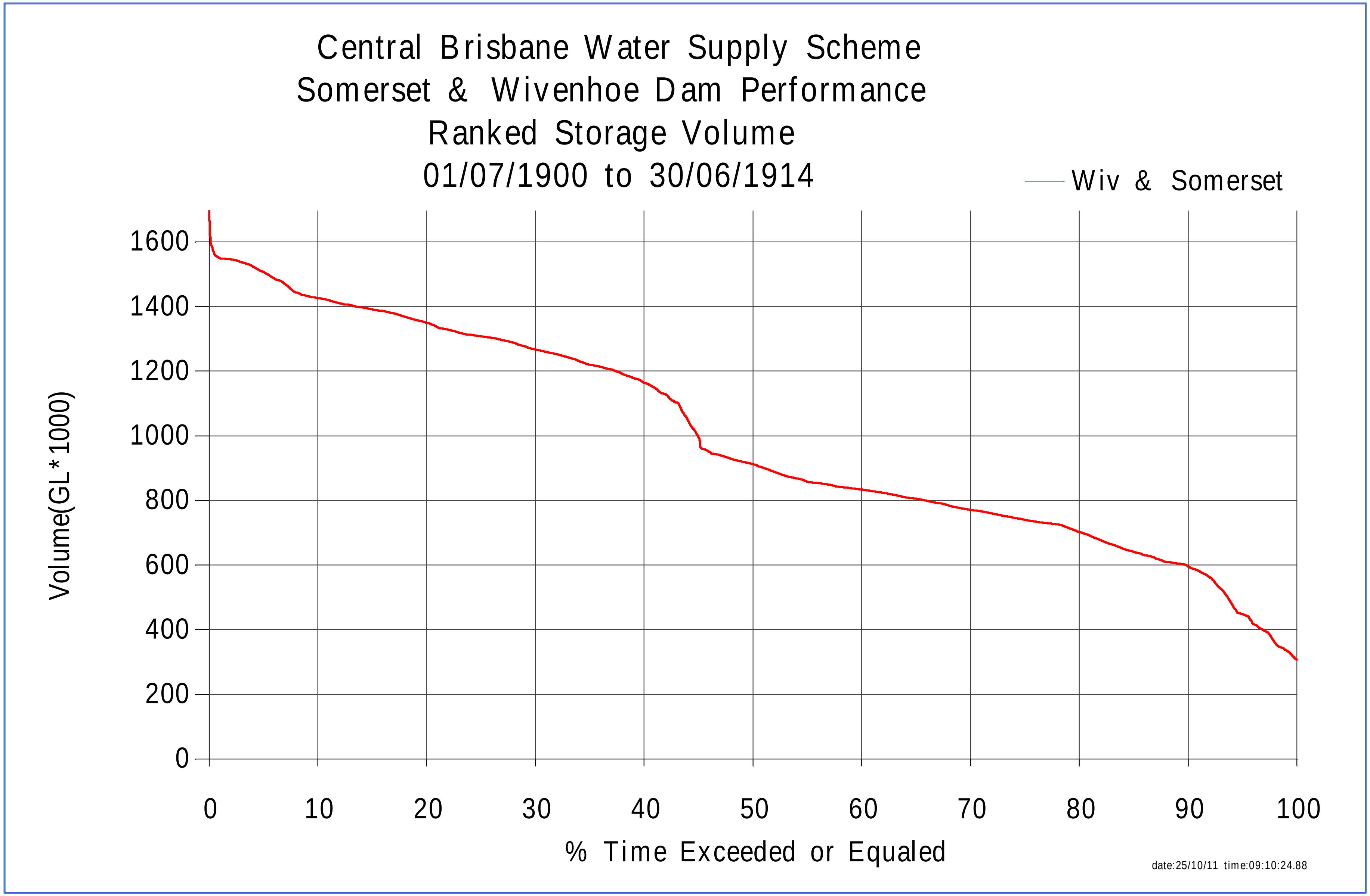


Figure C- 11 **Exceedance plot used for Central Brisbane – 15 years drought (period 1900 – 1914**)

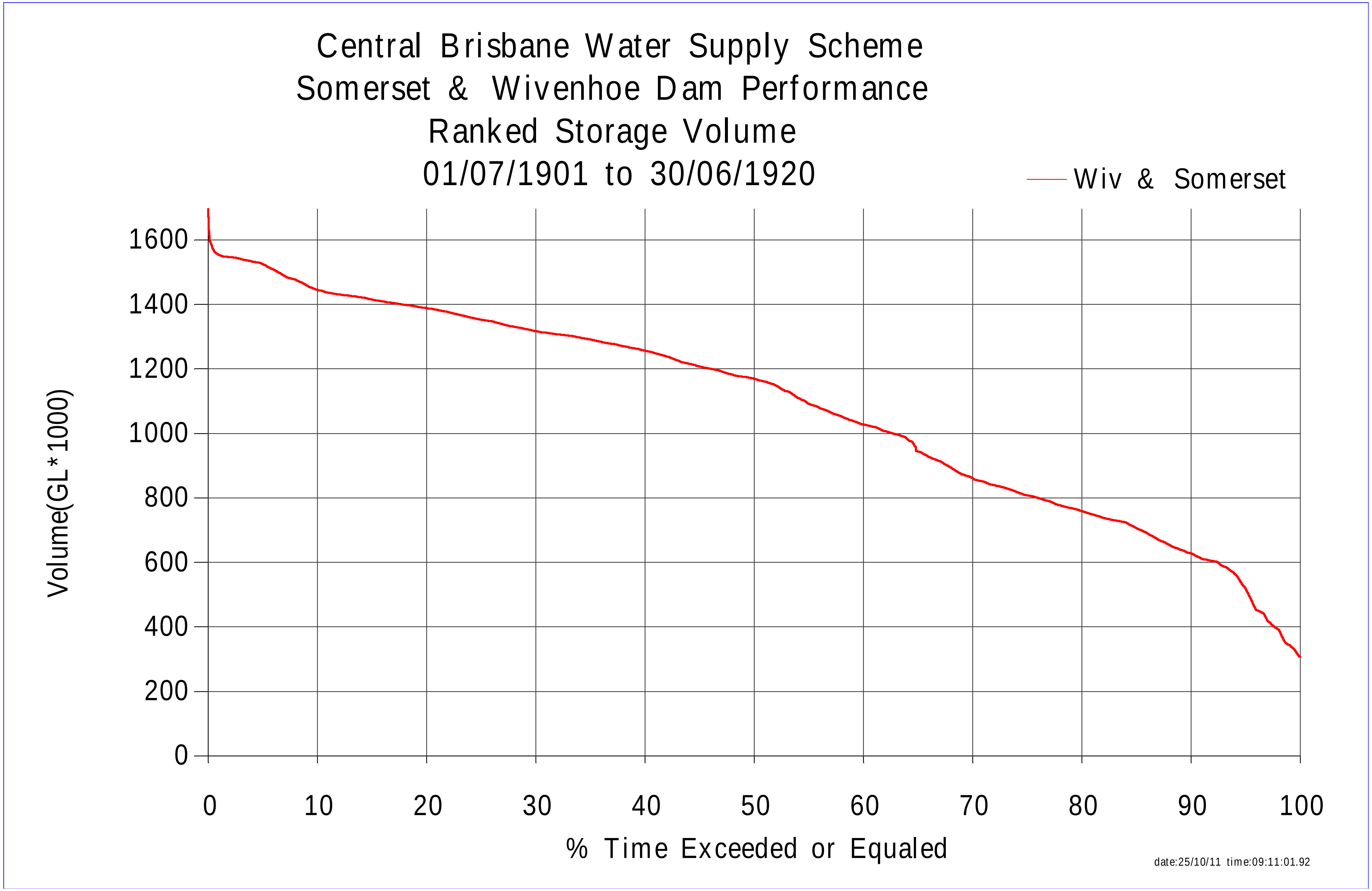


Figure C- 12 **Exceedance plot used for Central Brisbane – 20 years drought (period 1901 – 1920**)

Appendix D

IQQM ranked storage volume outputs using drought periods derived from inflows

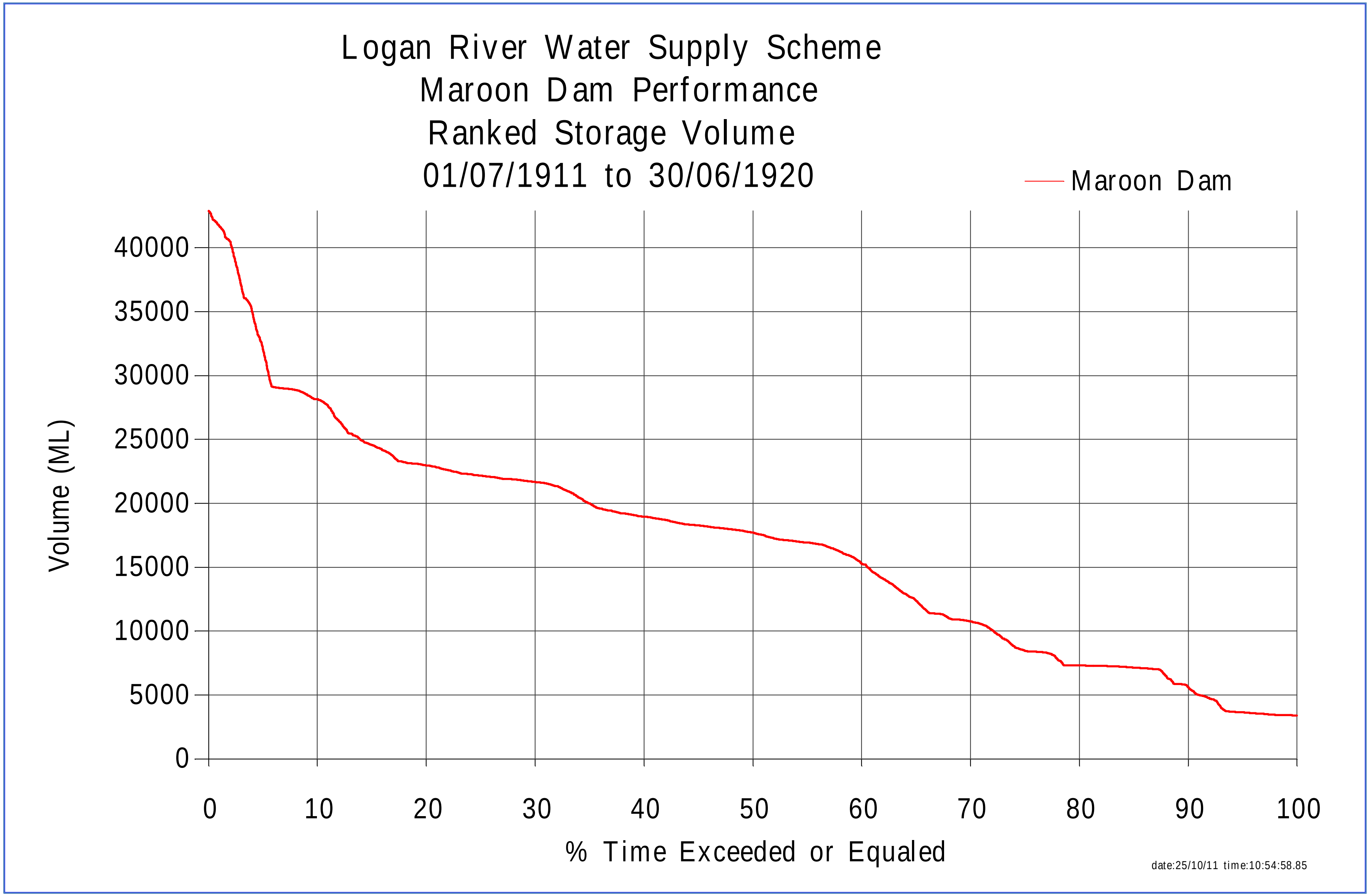


Figure D- 1. Exceedance plot used for Logan River – 10 years drought (period 1911 – 1920)

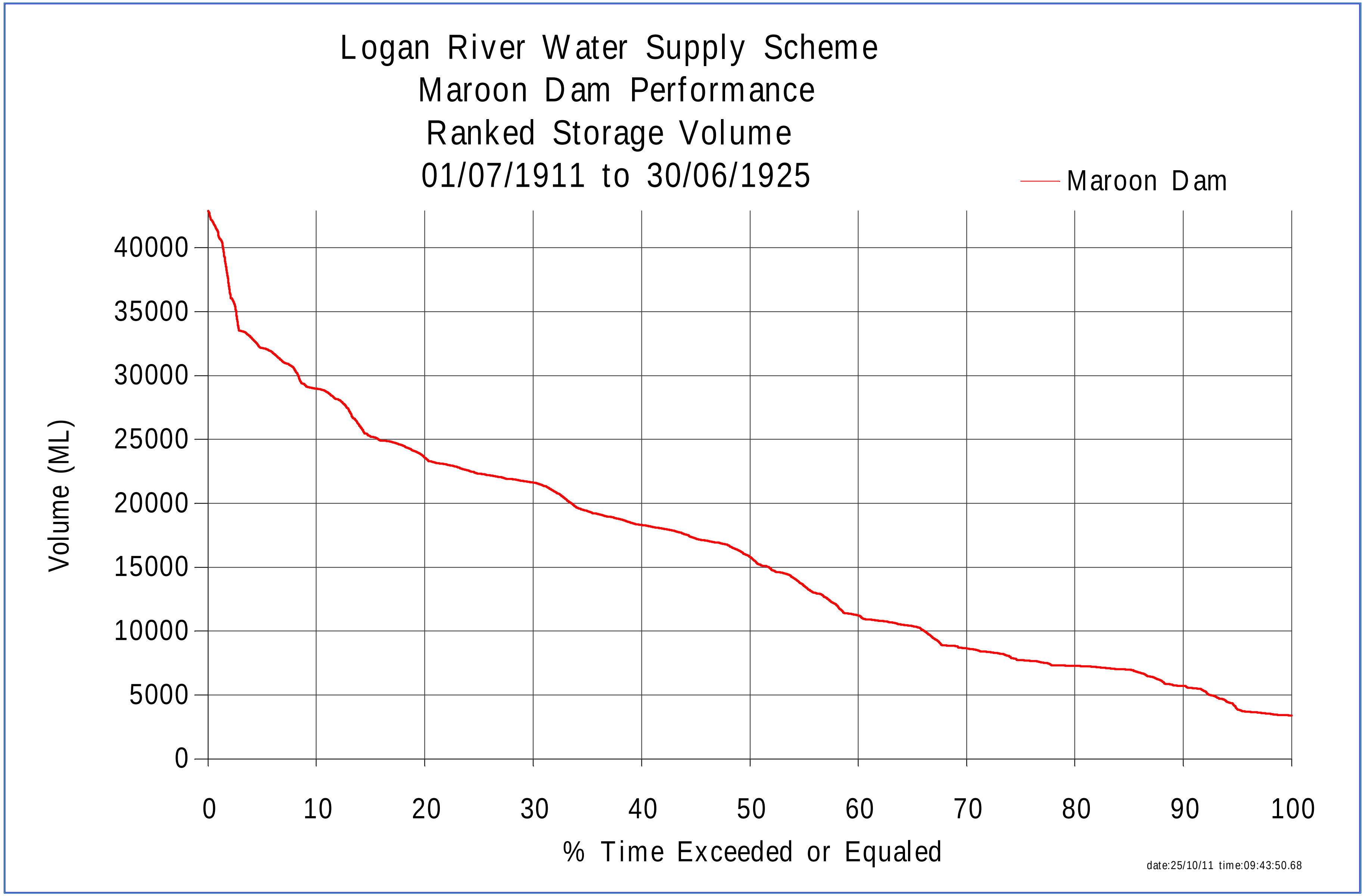


Figure D- 2. **Exceedance plot used for Logan River – 15 years drought (period 1911 – 1925**)

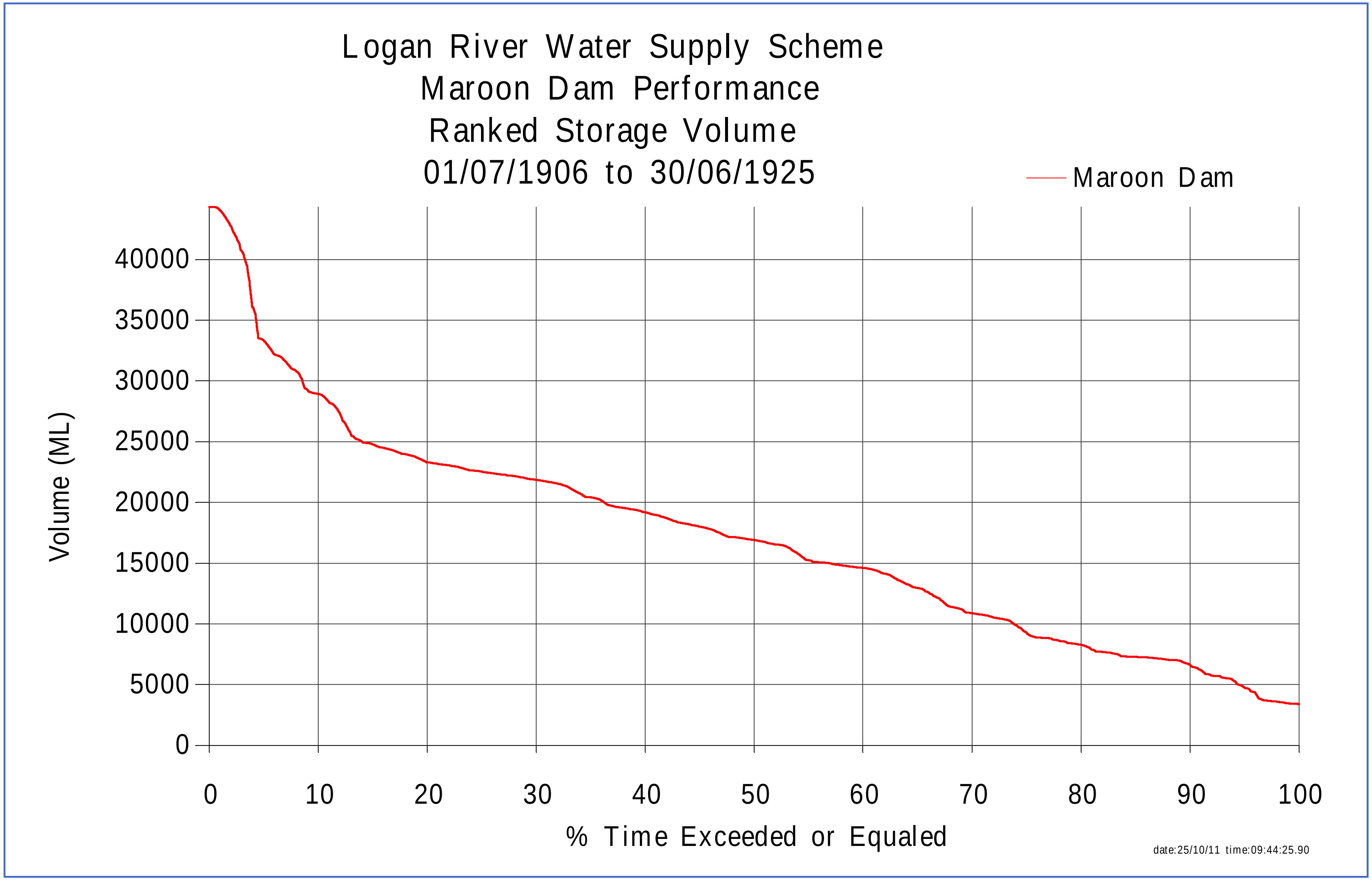


Figure D- 3. **Exceedance plot used for Logan River – 20 years drought (period 1906 – 1925**)

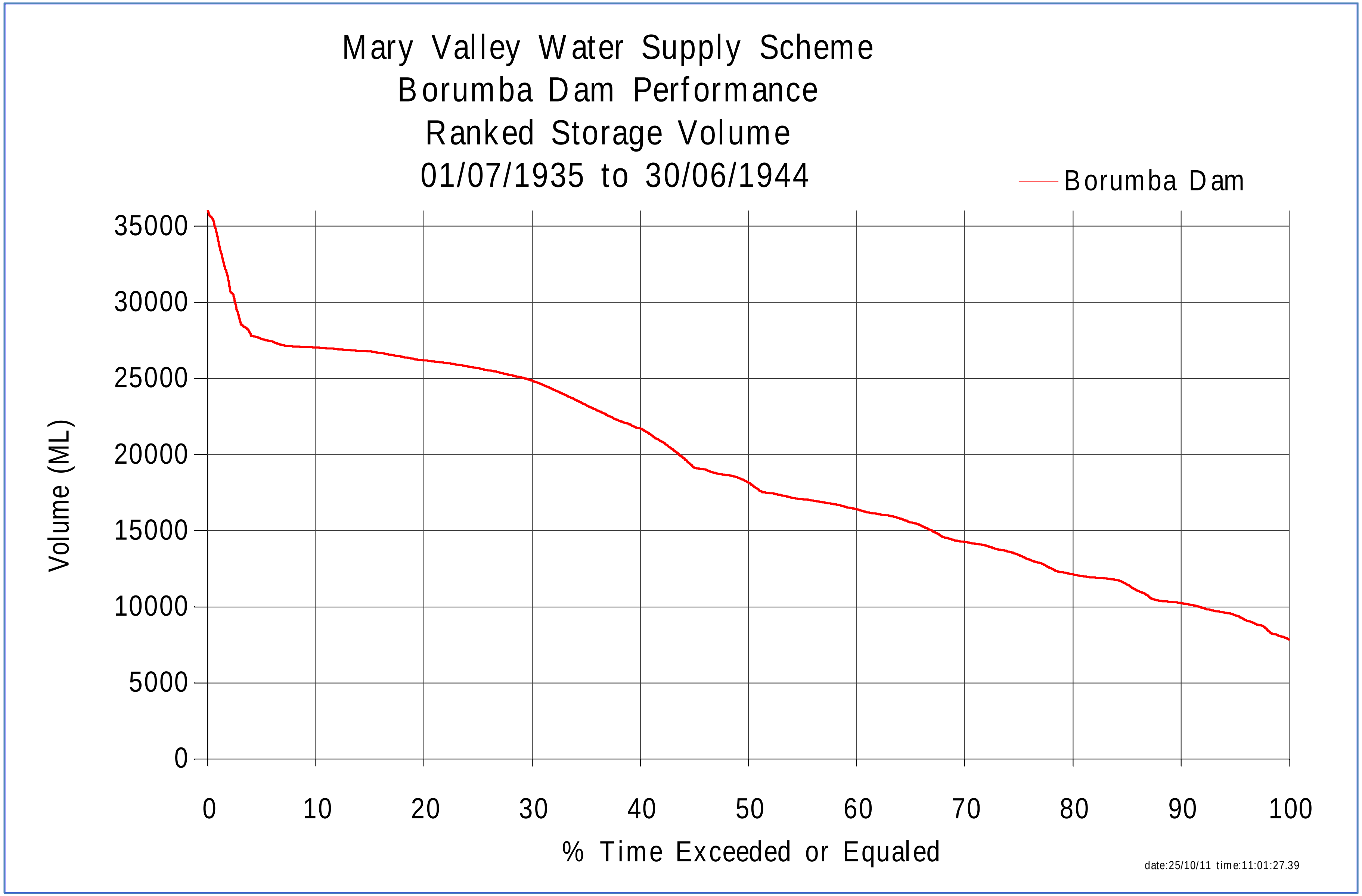


Figure D- 4. **Exceedance plot used for Mary Valley – 10 years drought (period 1935 – 1944**)

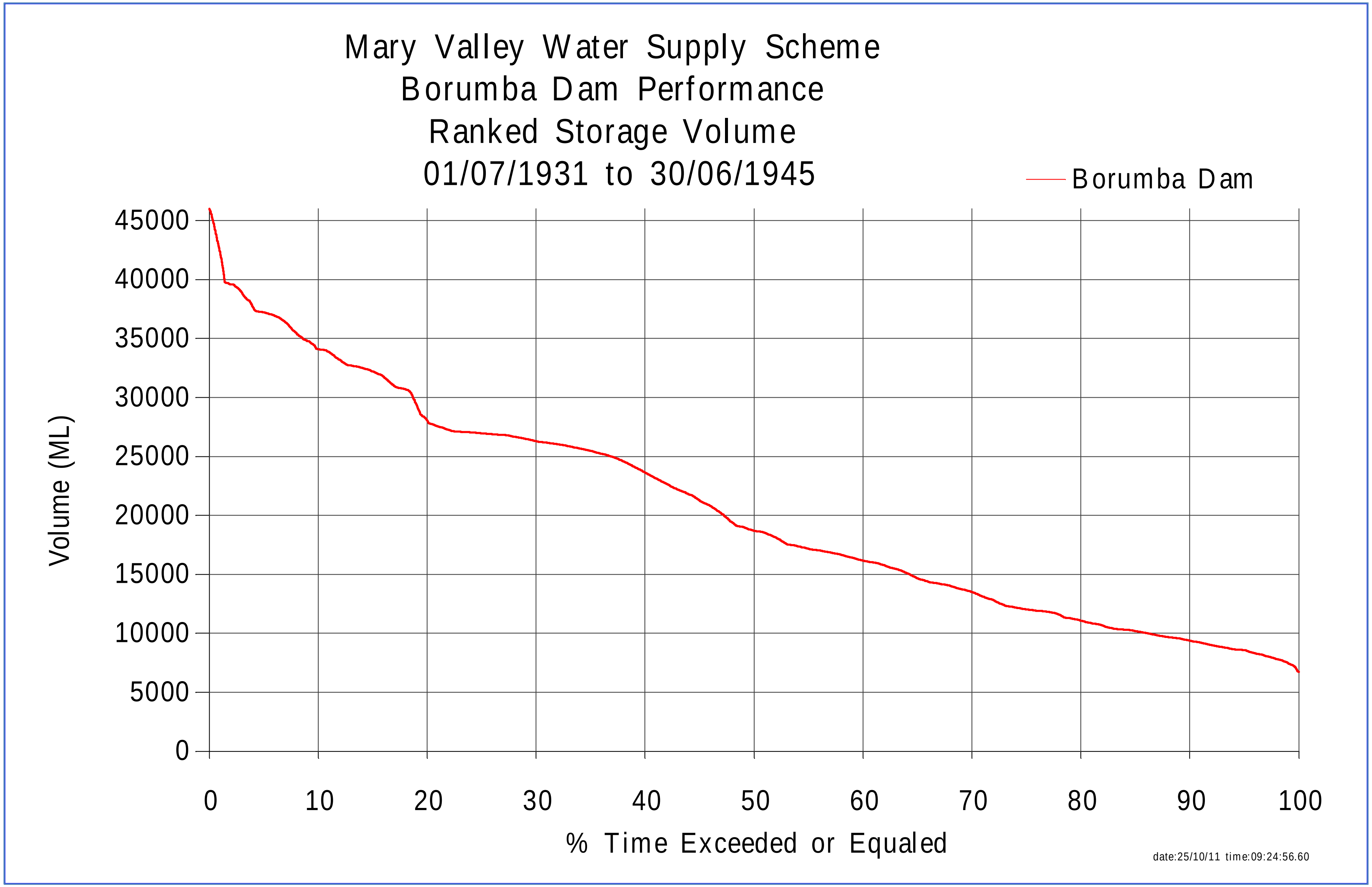


Figure D- 5. **Exceedance plot used for Mary Valley – 15 years drought (period 1931 – 1945**)

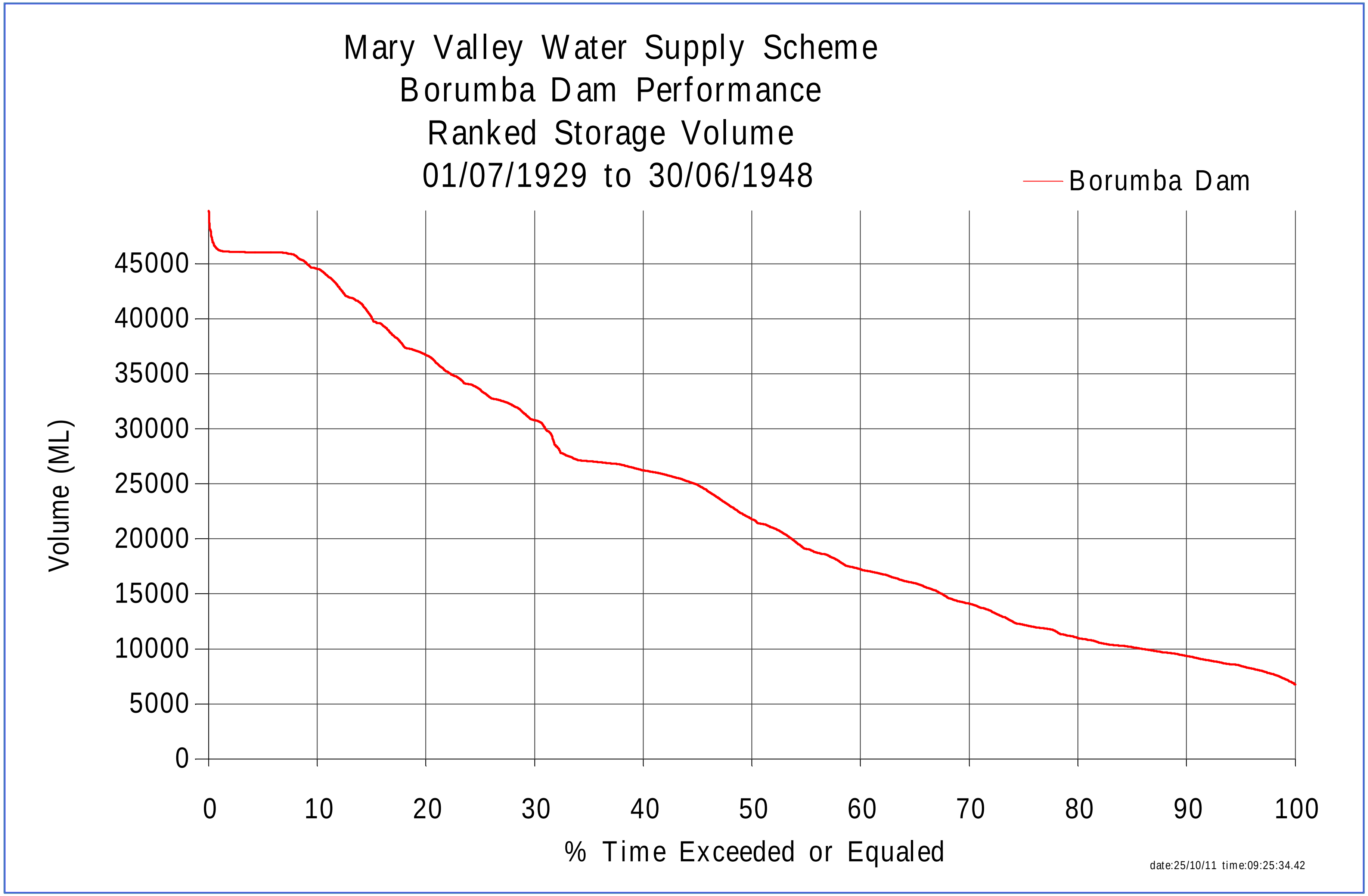


Figure D- 6. **Exceedance plot used for Mary Valley – 20 years drought (period 1929 – 1948**)

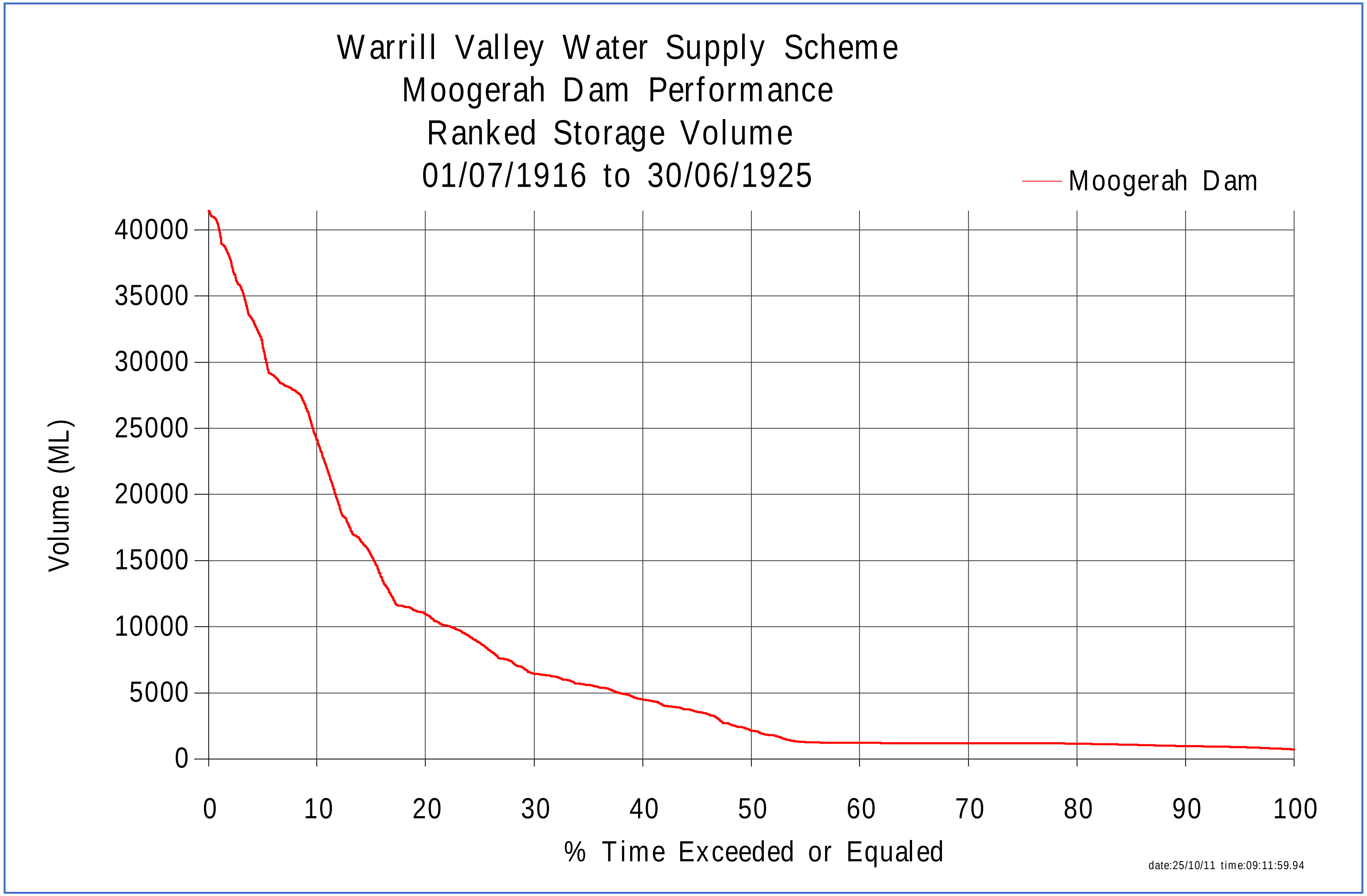


Figure D- 7. **Exceedance plot used for Warrill Valley – 10 years drought (period 1916 – 1925**)

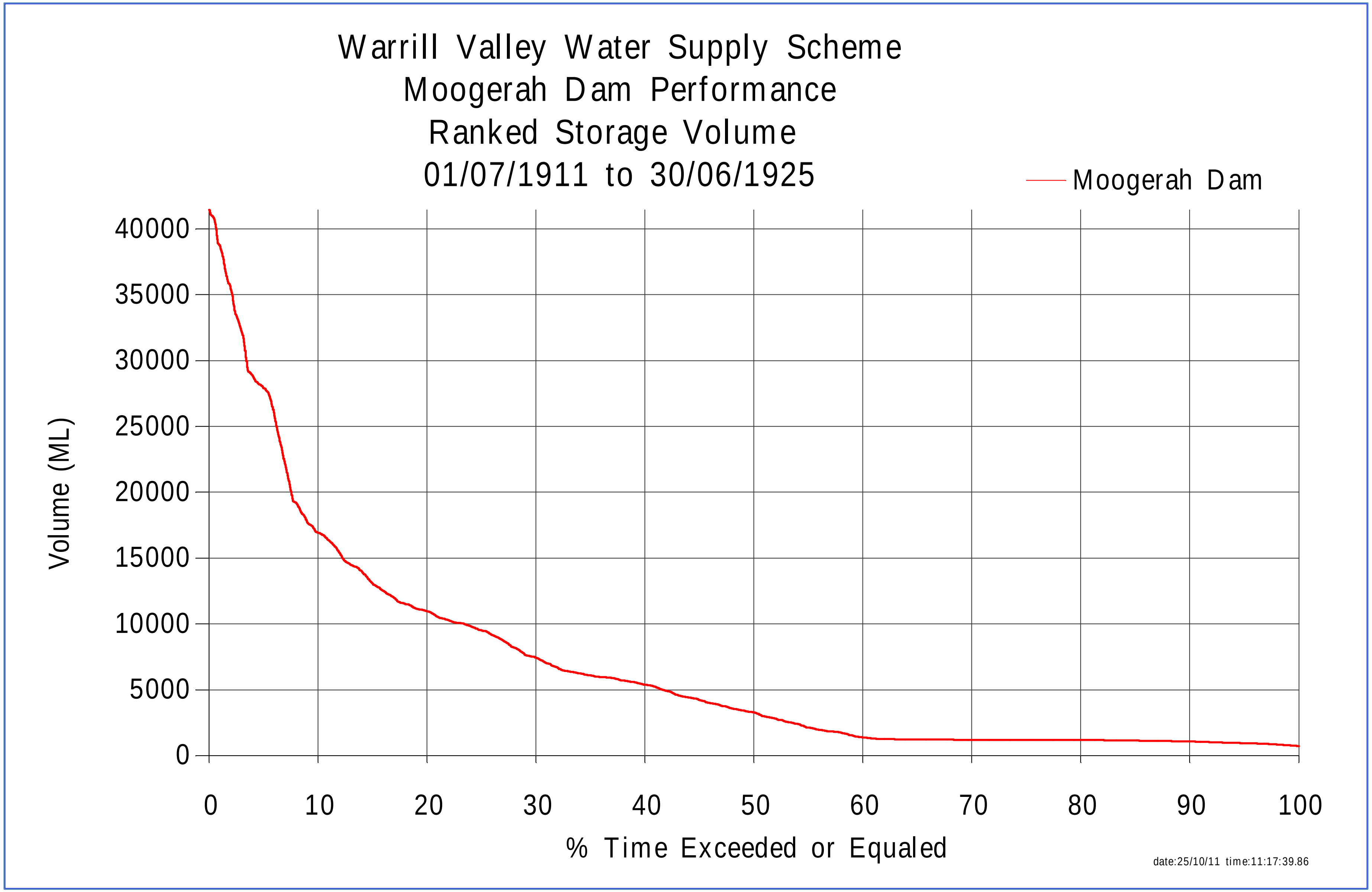


Figure D- 8. **Exceedance plot used for Warrill Valley – 15 years drought (period 1911 – 1925**)

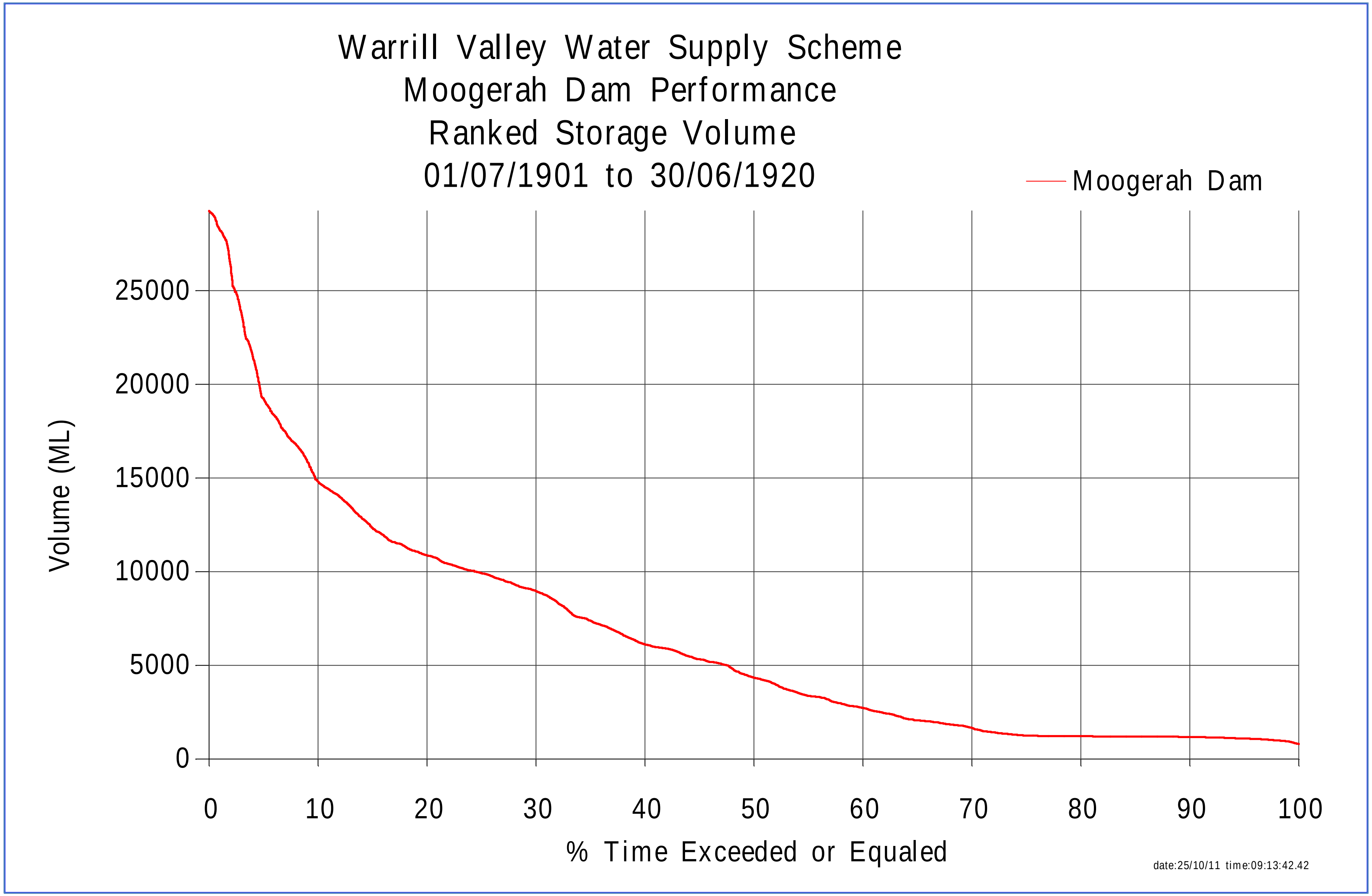


Figure D- 9. **Exceedance plot used for Warrill Valley – 20 years drought (period 1901 – 1920**)

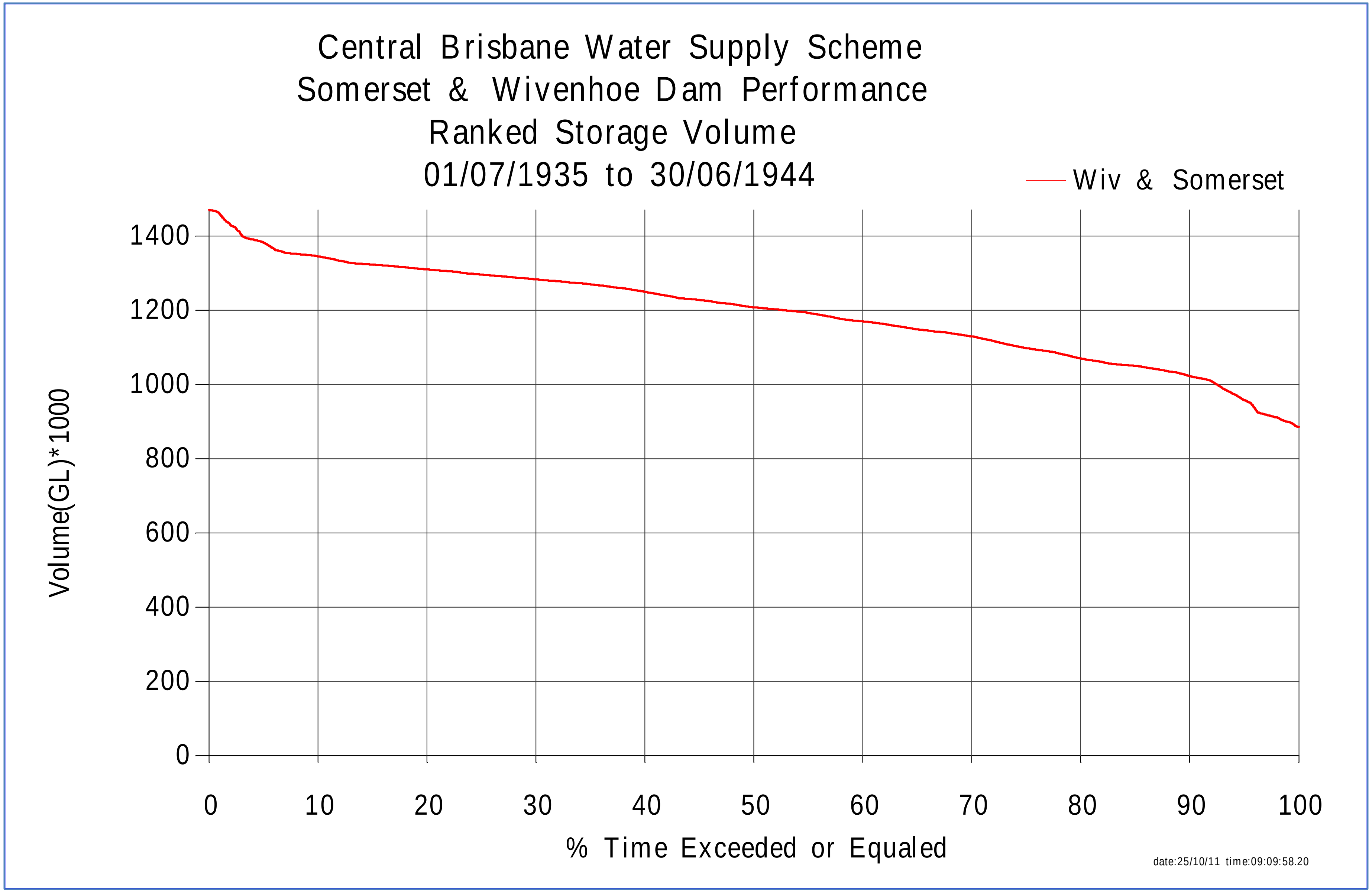


Figure D- 10. **Exceedance plot used for Central Brisbane – 10 years drought (period 1935 – 1944**)

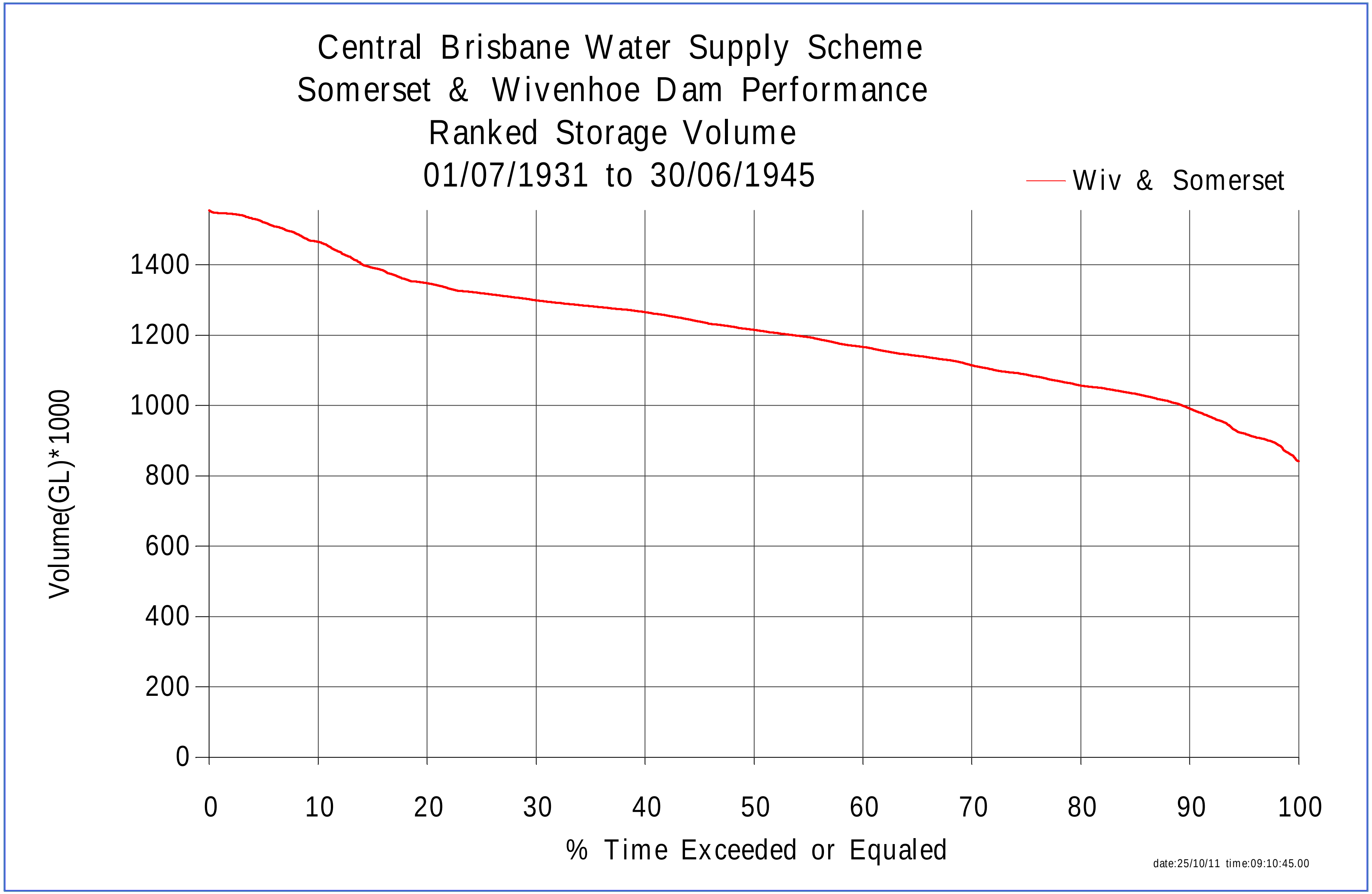


Figure D- 11. **Exceedance plot used for Central Brisbane – 15 years drought (period 1931 – 1945**)

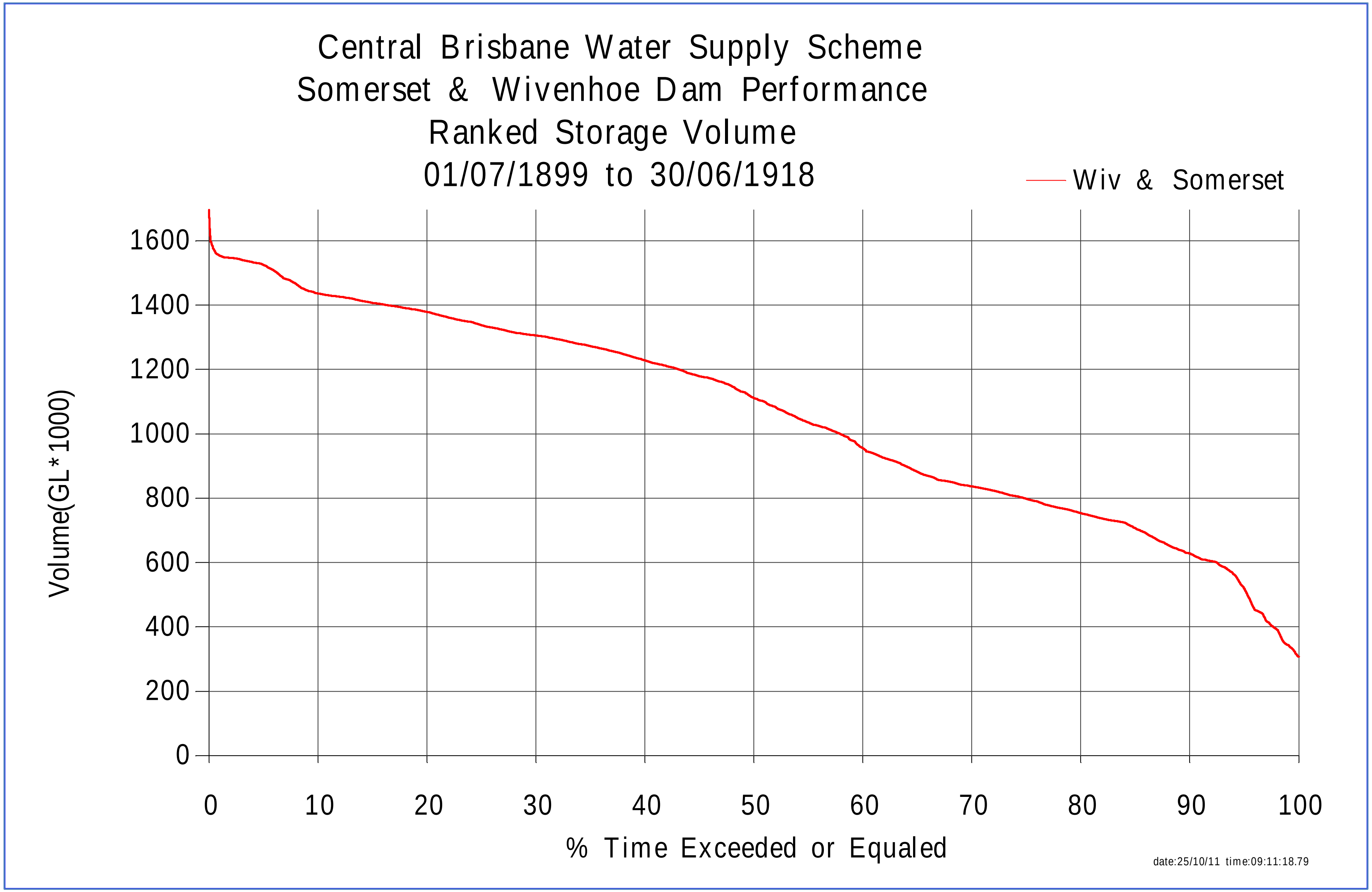


Figure D- 12. **Exceedance plot used for Central Brisbane – 20 years drought (period 1899 – 1918)**