REPUBLIC OF LEBANON

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

DESIGN OF BISRI DAM

UPDATED FEASIBILITY REPORT

JANUARY 2011

DAR AL HANDASAH NAZIH TALEB & PARTNERS

دار الهندسة نزيه طالب وشركاه

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

<table>
<tr><td rowspan="4">QC</td><td colspan="2">Ref: L1101D /664</td></tr>
<tr><td>Revision:</td><td>Date: January 2011</td></tr>
<tr><td>☑ Draft</td><td>☐ Final</td></tr>
<tr><td colspan="2">Signature:</td></tr>
</table>

CHAPTER 1 - INTRODUCTION AND RESULTS OF THE PREVIOUS FEASIBILITY REPORT

I.1 Overview

The principal purpose of the Bisri Project is to provide a reliable water supply for the City of Beirut, using the water resources of the Bisri River at a site approximately 30 kilometers south of Beirut. A secondary purpose includes water supply for generating hydroelectric energy.

The Bisri Dam Project is located on the Bisri River, approximately 17 kilometers inland from the City of Sidon. The City of Beirut lies approximately 30 kilometers to the north and west of the damsite.

Many prefeasibility studies and field investigation were performed in the 1954, 1974 and in early 1980's concerning the Bisri dam.

During the period from June, 1994 to April 1995, Dar Al Handasah Nazih Taleb and the American Consultant ECI, performed feasibility studies and investigations for the Bisri Dam Project. These investigations led to the siting of the dam and to the design of the dam and appurtenant structures at the feasibility level.

I.2 The Project as proposed in the Year 1995 Feasibility Study

The components recommended in the feasibility study for the Bisri Project of the year 1995 are presented briefly in this Section. The type and size of these project components have been selected through a series of analyses, which can be grouped into two basic procedures:

1. Selection of the best of the four alternatives, each alternative comprising a different combination of project components and facilities
2. Selection of the preferred dam height based on financial and natural resource issues

As part of the first procedure, four alternatives (A, B, C, and D) were evaluated to determine which combination of project components, facilities, and locations would result in the lowest capital cost, and which project components would be technically superior.

The second basic procedure involved the investigation of a range of dam heights for the composite dam to determine which dam crest elevation should be selected based primarily on three issues. These issues are:

- maximizing the release rate from the reservoir

- minimizing the unit cost of water (e.g. $US/m³) released from the reservoir
- minimizing water shortages which could occur

The recommended project has been selected through a series of comparative analyses, which can be grouped into two basic procedures.

I.2.1 Adopted alternative

Based on these evaluations, Alternative D was recommended for the Bisri Project. The basic components of the recommended project include the following:

- A composite dam, which is a zoned earthfill embankment with upstream and downstream berms, combined with a roller compacted concrete (RCC) spillway section
- Ungated RCC stepped, chute spillway in the dam
- Cut and cover diversion conduit
- Outlet works integrated with diversion conduit
- Hydroelectric power plant

The components of the recommended Alternative D are illustrated in Fig 1.1.

I.2.2 Dam site layout

The Bisri damsite is situated in a wide valley with moderately sloping abutment walls. The general site plan for the dam and reservoir is shown in Fig 1.2. The reservoir for the proposed Bisri Dam extends about 4 km upstream of Axis C on the Bisri River and then branches out along both the Nahr Barouk awards the north and the Ouadi Bhannine towards the south.

I.2.3 Site geology

The reservoir is wide through most of its length where the lacustrine clays have been deposited at the floor of the valley. Above the upper reaches of the reservoir, the valley narrows markedly where the Lake deposits feather out.

The stratigraphy in the reservoir is mainly friable sandstone with marl and argillaceous interbeds and some lignite layers. In the vicinity of the damsite, there is a sequence of interbedded limestones and marls that extends from Axis C upstream for about 1.7 km on the right abutment side. The left side of the reservoir is essentially composed, in its entirety, of the friable sandstone. Between the valley walls are the river terrace and floodplain deposits.

At the proposed dam location, the Bisri River is presently cutting through floodplain and terrace deposits. The present floodplain and active river deposits have a maximum thickness of 30 meters in the main channel section. These deposits are composed of silt, sand, gravel and cobbles. They overlie up to 90 meters of lake deposits which formed as a result of the large landslide at Anane (about three kilometers downstream from the axis) which blocked the Nahr Bisri Valley. These lacustrine deposits are nearly all highly plastic clayey soils with occasional sandy lenses of variable thicknesses.

The geology in the damsite area is shown on the cross sections in Fig 1.3.

I.2.4 Dam characteristics

- Type of Dam: zoned earth embankment dam with an RCC section which functions as the spillway.
- Maximum Dam Height: 74 meters.
- Streambed Elevation:. 395m.
- Dam Crest Elevation: 469m.
- Spillway Elevation: 461m.
- Dam Crest Length: 790 meters (RCC section forms approximately 70 meters)
- Crest width: 10 meters.
- Upstream and downstream dam slopes are 2.5H: 1V, including the RCC section.
- Freeboard: 8 meters.
- Storage Volume: 128 Mm^3.
- Dead Volume: 8 Mm^3.

I.2.5 Seismic loads

An in-depth evaluation of seismic design criteria has restated in a significant increase in the peak ground accelerations used at the damsite for the feasibility studies. Horizontal acceleration has been increased from 0.22 g to 0.70 g. This design criteria was the basis for the extensive additions in foundation treatment which were incorporated into the feasibility design of the dam. Design considerations, such as the potential for transverse cracking of the embankment during extreme earthquakes, have been based on these seismic design criteria.

I.2.6 Dam body materials

The earth embankment is comprised of seven zones, as shown in Fig 1.4. Shell and transition zones are provided on the upstream side of the dam followed by a core sloping upstream from the center of the dam. Immediately downstream of the core are a filter and chimney drain with transition and shell zones. Riprap is placed on the entire upstream face of the embankment. Construction materials for the dam are derived from the valley floor within the reservoir area. These materials include the sound and durable sand and gravel river channel deposits and the alluvial clay deposits. Shell and riprap material will come from a quarry site in the nearby limestone deposits.

Construction materials for the dam are derived from the valley floor within the reservoir area. These materials include the sound and durable sand and gravel river channel deposits and the alluvial clay deposits. Shell and riprap material will come from a quarry site in the nearby limestone deposits.

I.2.7 Spillway

The spillway will be an RCC, section located on the left side of the main embankment. Figure 6.5 shows the general arrangement for the composite dam with an RCC spillway. The spillway consists of an ungated crest structure, a sloping, stepped, discharge channel with energy dissipation by means of a stilling basin. The spillway was designed to pass the Probable Maximum Flood with an **inflow peak of 3,110 m^3/s.** The chute will have a rectangular cross-section with a constant width of 65.0 m from the crest structure through the stilling basin. A conventional stilling basin will be provided at the downstream end of the chute.

I.2.8 Temporary water diversion

During construction, diversion of the river through the damsite will be accomplished with a combination of cofferdam and conduit. The diversion facilities are designed to protect the embankment construction against a flood of 440m^3/s with a return interval of 25 years. The size of these facilities was determined from routing the 25-year good through the conduit in combination with an upstream cofferdam, resulting in a routed peak of 79 m^3/s.

The diversion releases will be through a cut and cover concrete conduit located on rock under the dam embankment and RCC section. The cofferdam will have a crest at El. 418. A conduit of 3.5-meter diameter will be required to accommodate a 2.0 meter diameter steel-lined outlet conduit associated with the outlet works, plus allow for access for maintenance from the downstream end.

I.2.9 Outlet works

The purposes of the outlet works are: 1) to provide municipal water to the City of Beirut; 2) to draw down the reservoir in case of emergency and 3) to provide for a connection to a penstock for power generation.

The outlet was sized to provide a constant release of up to 10 m^3/s for normal operation and a maximum discharge of $45m^3/s$ during reservoir evacuation. A constant discharge ($8m^3/s$) can be released as the reservoir drops in elevation as low as El. 424.

The conversion from diversion works to outlet works will require an intake structure, a gate chamber, two bifurcation, and an outlet dissipation structure added to, and connected by, the conduit. The intake structure will consist of a morning glory vertical intake structure, equipped with trashracks and a hemispherical bulkhead. The gate chamber will contain the emergency shutoff gate and house the transition from the 3-5 m diameter concrete conduit to the 2.0 m diameter steel pipe conduit. Emergency closure will he accomplished by a 4.0 x 2.8 m fixed wheel gate.

Emergency releases will be controlled by a Howell-Bunger valve, also known as a fixed-cone valve. A 0.8 diameter ring-jet valve controls the normal releases; through the 0.9 m diameter conduit, which will be used as a bypass when the hydropower plant is not in service.

I.2.10 Foundation treatment

An important aspect was the foundation treatment; this treatment includes plastic concrete slurry walls, 3-line grout curtains, consolidation grouting, wick drains, stabilizing berms, and vibro-compaction. These measures have been provided for defense against seepage and against large seismic loading, based on the potential for: liquefaction of foundation soils; fault rupture within the foundation; and embankment deformation.

I.3 Hydrology Of The Feasibility Study Of 1995

The streambed elevation of the damsite is about 395 meters above mean level. The 215 km^2 drainage basin, which provides water to the Bisri Reservoir, lies to the east of the damsite with elevations rising to 1,900 m.

According to the feasibility study of 1995, the precipitation in the Bisri watershed averages 1,300 millimeters per year, with virtually zero rainfall occurring from June through September. Streamflow from the watershed averages $4.5m^3/s$, equivalent to about 142 Mm^3 per year. Drought years with a 10 to 15 year frequency of occurrence, have historically provided as little as 60 Mm^3. The recommended project will be able to divert to the

City of Beirut approximately 75 percent of the total streamflow at the damsite.

The hydrological data of years extending from 1944-45 to 1973-74, showed that the water supply available to the project at the Bisri site averages approximately 142 Mm^3 per year, with recorded extremes ranging from in annual low of about 50 Mm^3 to a high of about 260 Mm^3.

The hydrologic study of the year 1995 concluded that with the Bisri Project, firm annual water supply is estimated to range from 79 Mm^3 to 110 Mm^3 depending upon the selected reservoir size, the pattern of release, and the shortage criteria.

I.3.1 Water release and yield as proposed in the year 1995

Bisri Dam is needed to store Bisri River water during the wet season and release this water downstream in the dry season. Several kilometers downstream of Bisri Dam, this water is diverted into the forebay of the Joun powerplant. From there it is conveyed to a bifurcation which is the intake to the Awali Conveyor Project. From there, the Awali Conveyor will transport this water to a treatment plant and then on to the City of Beirut for distribution.

The recommended constant release rate in the feasibility study of the year 1995 was 6.7 m^3/s for the six-month period from June through November, resulting in a monthly release of 17.6 Mm^3 each month. Water shortages were estimated to occur in about 6 out of 360 months over a 30-year period of operation, with total volumetric shortage equal to approximately 2.3 percent of the 30-year water supply delivered.

I.3.2 Hydroelectric power plant

A hydroelectric plant will be located at the foot of Bisri dam. A bifurcation at the downstream end of the outlet works diverts water to this plant. For releases at the recommended rate of 6.7m^3/s for 6 months release pattern, the installed capacity of the powerplant win be approximately 3.0 MW.

Final sizing of this hydropower plant will be determined when decisions are made regarding release patterns and release rates which will be utilized during the early years of operation. If the reservoir will be operated, during the initial years, at a constant release rate of 3.0m^3/s for 12 months, the smaller powerplant may be the best choice to maximize efficiencies. For purposes of the cost estimate in this report, a 1.4 MW plant was assumed to operate 12 months each year at a rate of 3.0m^3/s. This cost comprises less than, 2 percent of the construction cost for the project.

I.3.3 Financial analysis and construction cost of the year 1995

The estimated construction cost (in 1995 US dollars) for the recommended project was \$US 131.1 million. The unit cost of water (in 1995 \$US) was estimated as \$US 92 per 1000 cubic meters of water released.

The project costs presented here are for the recommended dam with a crest elevation at 469. The financial analysis is given in the table below, which includes the list of financial input data used in this analysis together with a summary of results. A summary of the key information presented in the table below.

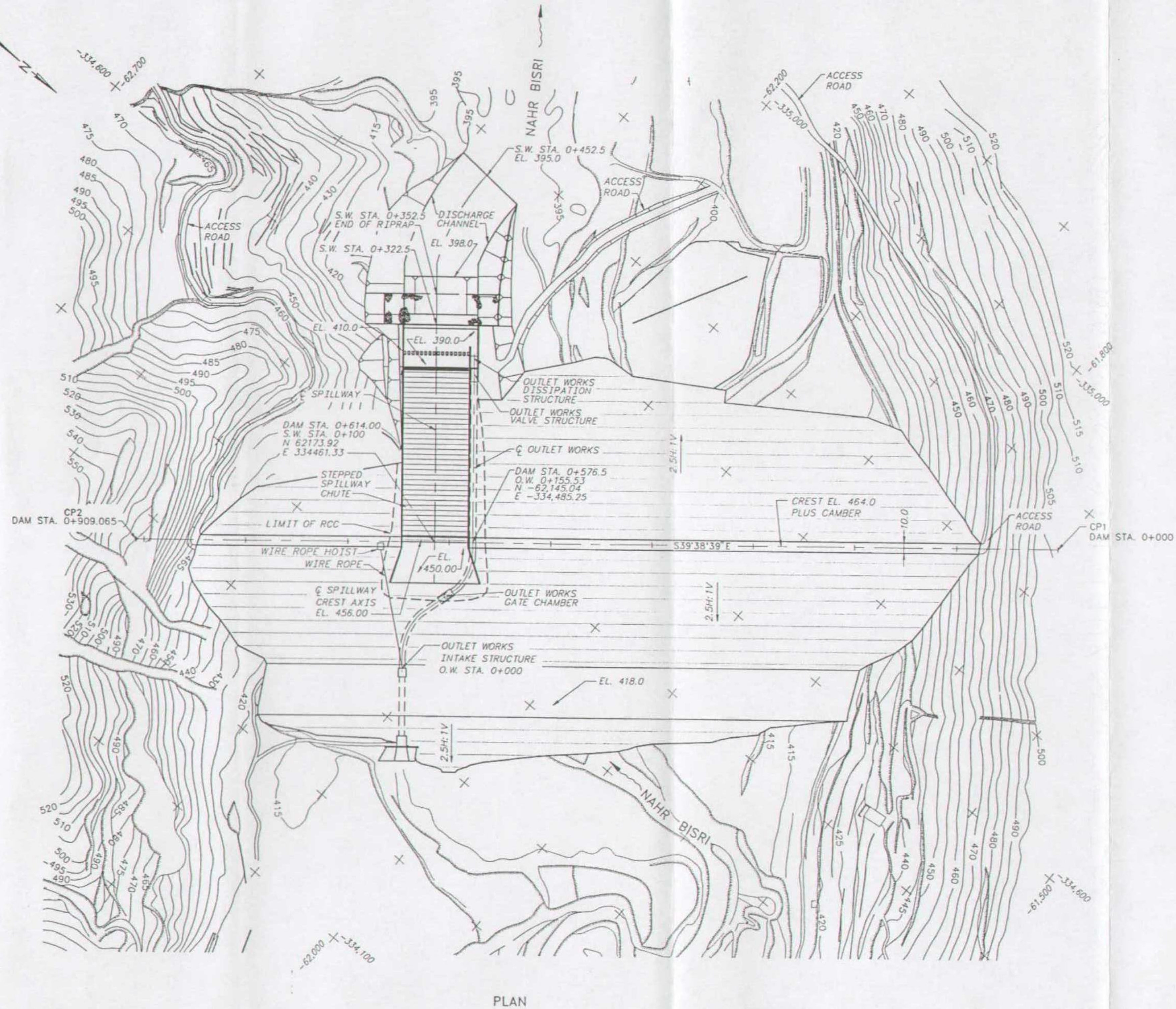
Dam Crest Elevation	469 m
Release Rate	6.7 m^3/s
Water Supply	105.6 Mm^3
Cost of Money	9%
Escalation Rate	4%
Period of Amortization	30 years (2000 to 2029)
Period of Construction	3 years (beginning in 1997)
Construction Cost (1995)	\$US 131.1 million
Interest During Construction	\$US 23.0 million
Escalated Capital Cost	\$US 172.5 million
Capital Cost (1995)	\$US 141.8 million
Average Unit Cost of Water (1995)	\$US 92.06/1,000 m^3
Annual Debt Service	\$US 16.8 million
O,M&R (First Year)	\$US 1.5 million
Annual Cost (First Year)	\$US 18.3 million

The costs which are incorporated above include the capital costs and annual O,M&R costs. There are two components of capital costs: 1) construction costs, and 2) interest during construction (TDC). Construction costs are comprised of the estimated contractor's cost plus expenditures for engineering and contract administration.

There are specific types of costs which are not incorporated to the present financial analyses. Most important of these are, the costs of conveying the water to the treatment plant; the cost of treating the water; and the cost of conveying the treated water to Beirut. A potentially large cost to the Bisri Project is the land acquisition. The area to be expropriated is up to 6 square kilometers of valley bottom with adjacent steep land slopes will be needed by the project.

Electricity can be generated from the water releases from the Bisri Dam. Based on the reservoir operation studies, an estimated 11 GWh ($11*10^6$ kWh) of energy can be generated from the reservoir releases.

For every $US 0,01 of value attributed to each kWh of energy approximately $US 110,000 could be generated in revenue each year.



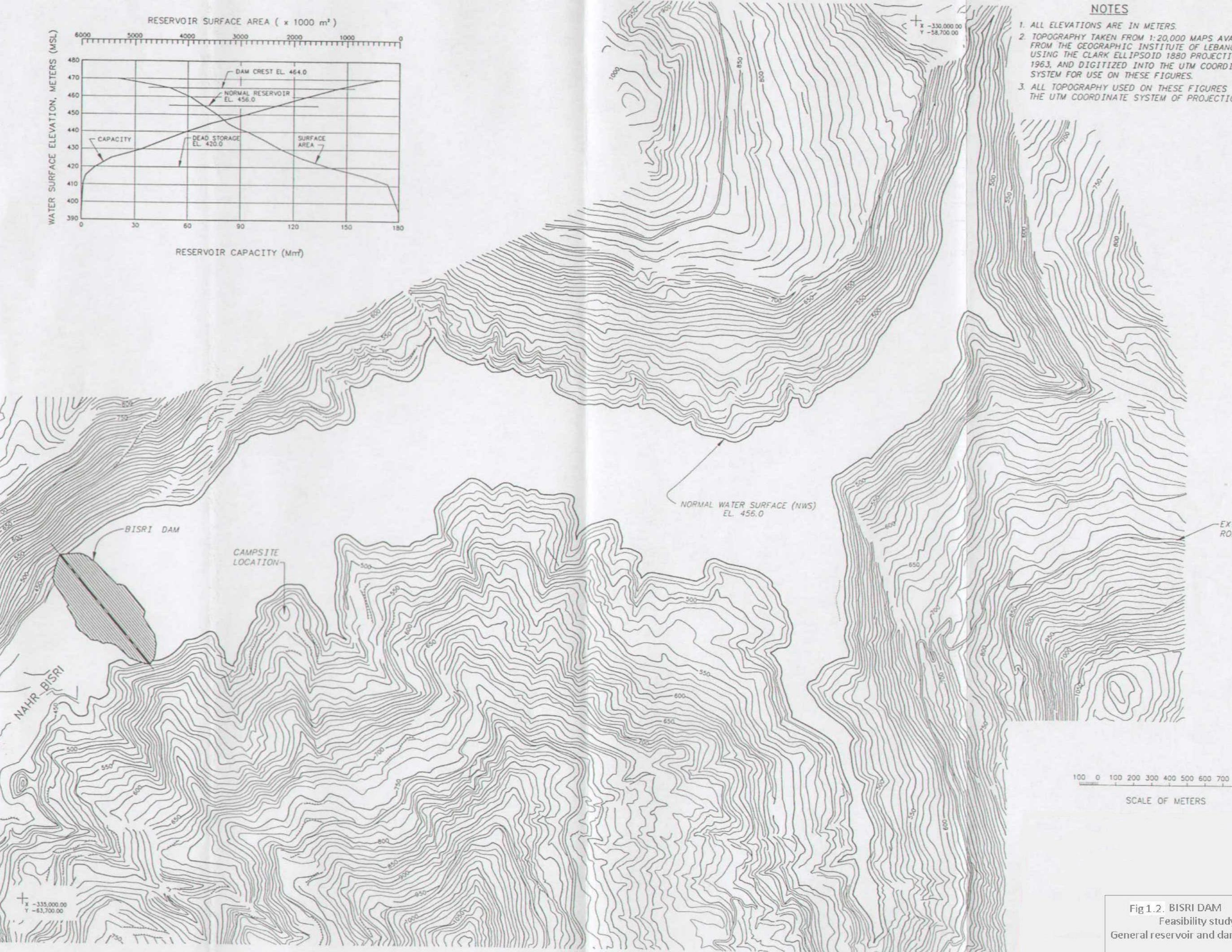
NOTES

1. ALL STATIONS, ELEVATIONS AND DIMENSI ARE IN METERS.
2. COORDINATES OF DAM CONTROL POINTS:

	N	E
CP1	-61,701.12	-334,853.07
CP2	-62,400.00	-334,274.00

3. FOR SPILLWAY DETAILS, SEE FIGURE D-9.
4. FOR OUTLET WORKS CONDUIT PROFILE, SEE FIGURE D-15.
5. FOR CURVE DETAILS FOR OUTLET WORKS SEE FIGURE D-3.
6. FOR DAM SECTION, SEE FIGURE D-10.
7. FOR DAM PROFILE AND SEEPAGE TREATMEN SEE FIGURE D-11.
8. FOR BERMS, WICKS DRAINS, AND FOUNDAT TREATMENT DETAILS, SEE APPENDIX A AND SECTION 5 OF THE FEASIBILITY REPORT.

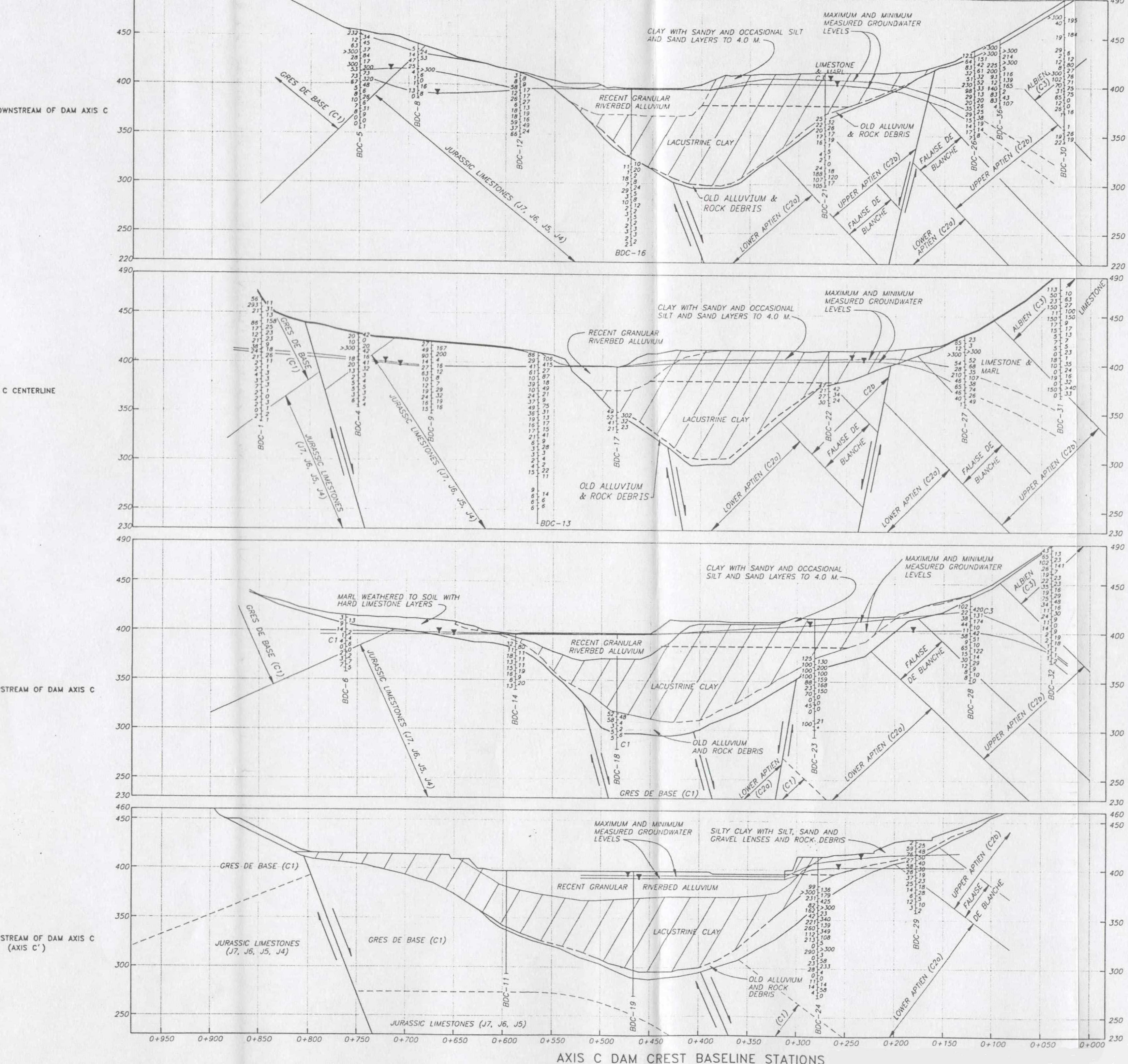
Fig 1.1. BISRI DAM
Feasibility stud
Alternative D
RCC spillway and outl



NOTES

1. ALL ELEVATIONS ARE IN METERS.
2. TOPOGRAPHY TAKEN FROM 1:20,000 MAPS AVA FROM THE GEOGRAPHIC INSTITUTE OF LEBANO USING THE CLARK ELLIPSOID 1880 PROJECTI 1963, AND DIGITIZED INTO THE UTM COORDI SYSTEM FOR USE ON THESE FIGURES.
3. ALL TOPOGRAPHY USED ON THESE FIGURES THE UTM COORDINATE SYSTEM OF PROJECTIO

Fig 1.2. BISRI DAM
Feasibility stud
General reservoir and dar



NOTES:

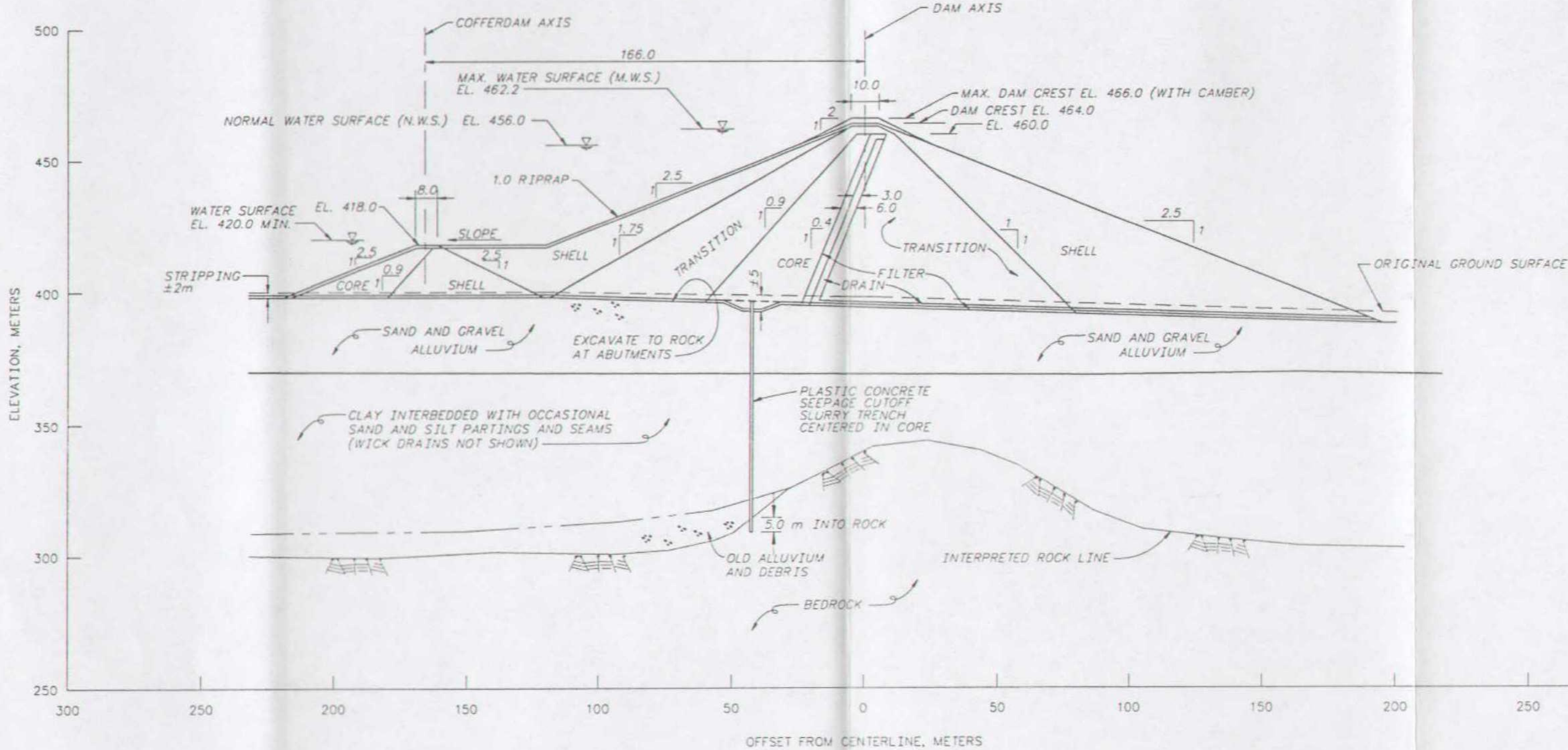
1. = PERMEABILITY IN LUGEONS

2. BASELINE STATIONS AND ELEVATIONS ARE IN

Fig 1.3. BISRI DAM
Feasibility study
Geologic sections parallel to

NOTES

1. ALL STATIONS, ELEVATIONS AND DIMENS ARE IN METERS.
2. FOR LAYOUT OF COFFERDAM AND EMBANK SEE FIGURES D-25 AND D-27.
3. DURING CONSTRUCTION MAXIMUM 25 YE POOL ELEVATION EL. 415.5
4. WICK DRAINS SHALL BE INSTALLED FR EXISTING GROUND SURFACE TO MAXIM PRACTICAL DEPTH (75 METERS).
5. FOR BERMS AND FOUNDATION TREATMEI DETAILS, SEE APPENDIX A.



TYPICAL EMBANKMENT SECTION

(STA 0+450)

10 0 10 20 30 40 50 60 70

SCALE OF METERS

Fig 1.4. BISRI DAM

Feasibility study

Maximum Embankment and Cofferdam; Cr

CHAPTER 2 - SUMMARY, CONCLUSION AND RECOMMENDATIONS OF THE UPDATED FEASIBILITY STUDY

II.1 Purpose Of The Updated Feasibility Study

Upon the request of the CDR and the representative of the Minister of Energy and Water, the current report was prepared. Its aim is to update the economical feasibility study of 1995 for Bisri Dam in light of the new available hydrologic data and taking the new market prices into account for the determination of the construction cost of the dam.

Noting that this update did not include the technical aspects concerning the dam, appurtenant structures, the reservoir, the hydropower plant,… where those aspects will be delt with during the detailes design phase when necessary modifications on the feasibility design will be included.

The Chapter 3 consists of an update of the data concerning climatology, hydrology and sedimentation. Its main objective is to determine the project flow at Bisri damsite.

The Chapter 4 consists of the yielding study based on the new flow data for several dam heights and release rates.

The Chapter 5 provides the new cost estimates for two dam heights based on the 2010 market prices.

The Chapter 6 consists of the Financial Analysis which aims to determine the price of the cubic meter of water and Internal Rate of Return of the project based on a sensitivity study involving several technical and economical data.

II.2 Climatology, Hydrology And Sedimentation

II.2.1 Rainfall

In the 1995 feasibility study, the data used for determining the basin precipitation was based on the following rainfall gauging stations:

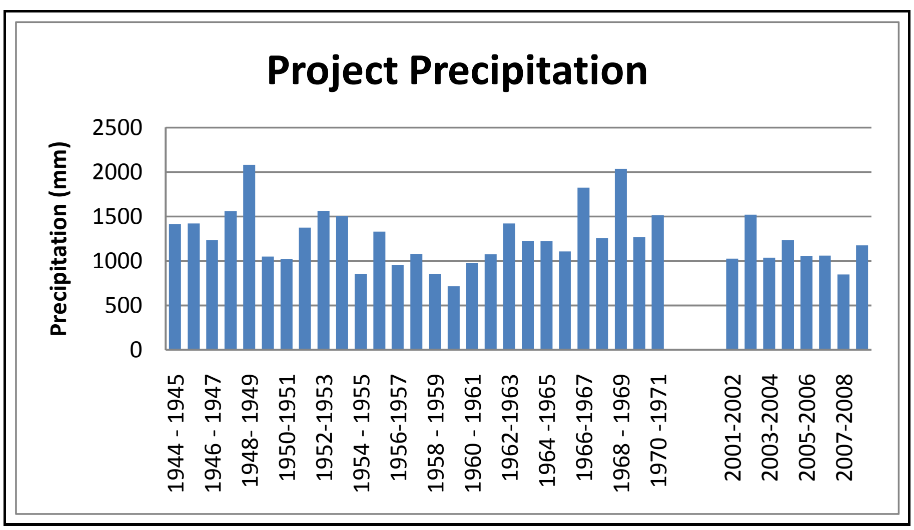
Name	Station No.	Percent Distribution	Mean Annual Precipitation	Station Elevation
Aain Zhalta	512	17.0	1,226 mm	1,080 m
Kfar-Nabrakh	514	12.8	1,300 mm	810 m
Jdeit-ech-Chouf	516	28.7	1,326 mm	770 m
Jezzine	519	41.5	1,299 mm	945 m

According to the climatological department at Beirut International Airport, data from these stations for the recent years are no longer available. The new established stations inside the Bisri watershed are the following:

Name	Station No.	Percent Distribution	Mean Annual Precipitation	Station Elevation
Jezzine	-	26.4	1,060 mm	1070 m
El Barouk Fraidis	-	28.4	998 mm	1114 m
Jbaa Ech Chouf	-	45.2	1,202 mm	1130 m

Based on the Thiessen Polygon method, the annual basin precipitation for the stations which data was used in the 1995 feasibility study is about 1,294 mm based on a 27 years period of record (1944-45 to 1970-71). As for the recently established stations, the annual basin precipitation is about 1,107 mm based on an 8 years period of record (2001-02 to 2008-09).

By comparing the two numbers, it can be concluded that a **15% reduction in the annual basin precipitation can be observed during the recent years.**



II.2.2 Streamflow

In the 1995 feasibility study, the streamflow data used for determining the project flow was extracted based on the Marj Bisri gauging station. This station is situated just downstream the damsite with a watershed area of 222 km^2. The damsite watershed area is 215 km^2.

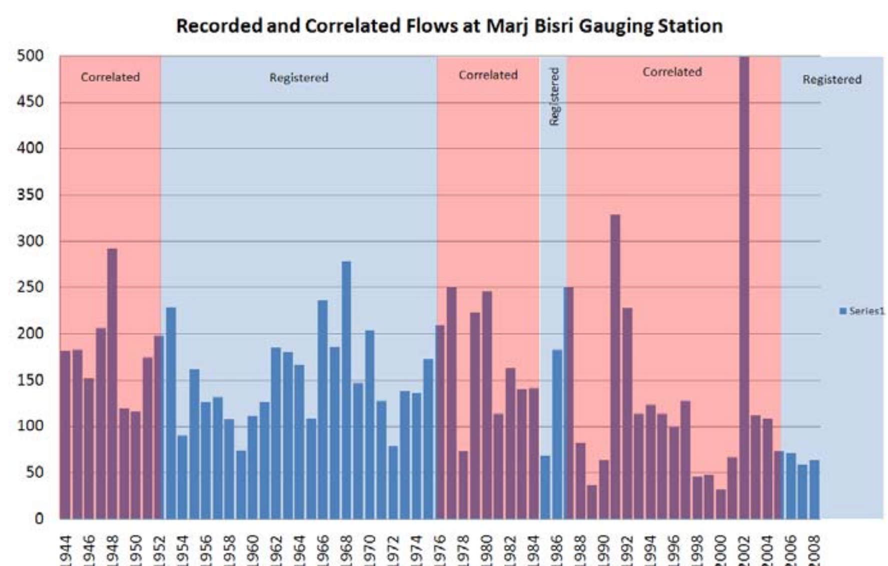
The available period of data used in the feasibility study extends from 1952-53 to 1973-74 for a period of 22 years. This data was extended by using a correlation with the basin precipitation for the period between 1944-45 and 1951-52.

In the current study, additional 10 years of data of Marj Bisri gauging station were collected from the Litani River basin authority extending from 1982-83 to 1983-84 and from 2001-02 to 2008-09. This data was extended by using a correlation with the data of annual available flow of the Litani River at Qaraoun lake for the period extending from 1974-75 to 1981-82 and from 1984-85 to 2000-01.

The project flows at Bisri damsite are illustrated in the following table. The table shows the average yearly flows for three periods.

Period of Data	Designation	Years	Average Yearly Project Flow
1944-45 to 1973-74	Old Data	30	142.4 Mm^3
1989-90 to 2008-09	New Data	20	111.5 Mm^3
1944-45 to 2008-09	All Data	65	134.9 Mm^3

By comparing the recent 20 years with the years of data used in the 1995 feasibility study, it can be concluded that a **22% reduction in the average yearly project flow can be observed during the recent years.**



II.2.3 Sedimentation

In the absence of any new measurements of sediment transport in the Bisri River, and after reviewing the information on catchment geology and soils, no demanding facts have been uncovered that would warrant changing the sediment yield from that estimated in the 1995 feasibility study. Therefore a sediment yield of 1,000 T/km^2/year is employed to estimate reservoir sedimentation. This value will result in a loss of approximately 15 percent of the reservoir volume during the first one hundred years of operation. Comparison to watersheds in a similar climate indicates that the values used for the Bisri Project are reasonable, and perhaps slightly conservative. Based on these analyses, it is concluded that reservoir sedimentation is not a significant concern for the Bisri Project.

II.3 Water Supply Yield

In the 1995 feasibility study, several options of reservoir capacity and release value / period were discussed in order to reach an acceptable level of reliability. A capacity of 110 Mm^3 with a release rate of 6 m^3/s during a period of 6 months was considered as an optimum choice based only on the water supply yield study (based on the Financial study, a capacity of 128 Mm^3 and a release rate of 6.7 m^3/s was selected).

The current study constitutes the update of the estimation of the capacity-yield relationship for Bisri Reservoir based on the new available hydrological data. Several options were computed:

- Reservoir capacities ranging between 90 Mm^3 and 150 Mm^3
- Release rates of 6 m^3/s and 7 m^3/s during a 6 months period each
- Three periods of project flows data in order to account for the decrease in project flows noted in the recent years:
  - Series of 30 years of data (1944-1945 to 1973-1974) referred to as “Old Data” (Same series used in the 1995 feasibility study).
  - Series of 20 years of data (1989-1990 to 2008-2009) referred to as “New Data”.
  - Series of 65 years of data (1944-1945 to 2008-2009) referred to as “All Data”.

The results of the water supply yield study in terms of volumetric shortage percentage are summarized in the following table. The series referred to as “Old Date” constitutes the results for the 1995 study.

Potable Water shortage (%)							
Reservoir Volume (Mm^3)	**90**	**100**	**110**	**120**	**130**	**140**	**150**
Old Data (6 m^3/s)	5.0%	2.6%	1.6%	0.8%	0.2%	0.0%	0.0%
Old Data (7 m^3/s)	15.4%	9.3%	5.9%	4.5%	3.3%	2.4%	1.8%
New Data (6 m^3/s)	19.0%	15.9%	14.2%	12.8%	11.7%	10.6%	9.5%
New Data (7 m^3/s)	27.6%	24.4%	21.6%	19.8%	18.3%	16.9%	15.6%
All Data (6 m^3/s)	9.7%	7.2%	5.9%	5.0%	4.3%	3.8%	3.5%
All Data (7 m^3/s)	19.3%	14.3%	11.2%	9.7%	8.4%	7.3%	6.4%

II.4 Cost Estimate

In the 1995 feasibility study, cost estimates for the four studied alternatives were made.

In the current study, since the alternative D was selected from a technical point of view, only cost estimates for Alternative D were updated.

Cost estimated for Alternative D - Axis C (Composite Earth, rock and RCC dam, integral spillway, conduit diversion) for two dam heights corresponding respectively to a reservoir storage capacity of 110 Mm^3 and 128 Mm^3 respectively are presented in the two tables below for the 1995 design and the 2010 design. These costs do not include land acquisition neither the downstream structures (conveying systems, treatment plants,…). All costs are expressed in U.S. dollars without escalation.

Cost estimate of 1995 design				
Crest elevation (m)	**Subtotal Contractor's Cost**	**Contingency**	**Engineering**	**Construction Cost**
464	88,358,000	17,700,000	15,900,000	121,958,000
469	95,000,000	19,000,000	17,100,000	131.080,000

Cost estimate of 2010 design				
Crest elevation (m)	**Subtotal Contractor's Cost**	**Contingency**	**Engineering**	**Construction Cost**
464	179,850,000	35,980,000	32,380,000	248,180,000
469	196,550,000	39,320,000	35,390,000	271,190,000

II.5 Financial Analysis

The initial financial analysis determined the size of dam which best meets the needs of the project owner based on the cost estimate and shortage criteria of the feasibility study conducted in 1995.

In the current study, an update of the initial financial analysis with the new cost estimates and the new shortage criteria for 6 and 7 m^3/s release rates and taking into consideration the long series of data (65 years) and the recent years series of data (20 years) for two cases of dam heights (Crest Level = 464 m and 469 m).

An additional sensitivity analyses was performed for all the options of base data in order to determine the Internal Rate of Return of the project. The results of the financial analysis in terms of cost of cubic meter of water are summarized in the Table below:

Reservoir Volume (Mm^3)	Release Rate (m^3/s)	Data Series	Unit Cost of Water $US Million (Year 2010) (Cost of Money Rate = 9%, Escalation Rate = 4%)
110	6	All	$0.22
	7	All	$0.20
	6	New	$0.24
	7	New	$0.21
128	6	All	$0.23
	7	All	$0.21
	6	New	$0.25
	7	New	$0.23

The results of the financial analysis in terms of IRR are summarized in the table below:

Reservoir Volume (Mm^3)	Release Rate (m^3/s)	Data Series	Unit Cost of Water $US Million (Year 2010) (Cost of Money Rate = 9%, Escalation Rate = 4%)
110	6	All	10.9%
	7	All	12.0%
	6	New	10.3%
	7	New	11.0%
128	6	All	10.0%
	7	All	11.3%
	6	New	9.5%
	7	New	10.4%

II.6 General Conclusion

The results obtained from the available water flows in the recent years (New Data) can not be taken alone into account as critical data because they represent a period of only 20 years including 12 years of extrapolated data. However, these results represent a trend that should be taken into consideration because they correlate with the rainfall data of the same period. As seen from the water yield study, they represent high shortages for the selected release rates. If this trend continues during the operation of the dam the release rate or the period of supply should be decreased.

Based on the long series of data (All Data), the table below illustrates the report results in terms of Construction Cost, Shortage, Water Unit Cost and IRR. From this table, it can be concluded that:

- The difference in construction cost is only about 9% between the two options of reservoir volume which can not be considered as a decisive factor especially in this stage of the study.
- The shortage for a release rate is significantly lower in the case of a release rate of 6m^3/s for the two reservoir capacities.
- The water unit cost ranges between 0.20$ and 0.23$ which are prices lower than the actual cost of water in Beirut.
- The IRR of the project ranges between 10% and 12% which represent a very good project feasibility.

Reservoir Volume (Mm^3)	Release Rate (m^3/s)	Construction Cost	Results		
			Shortage	Water Unit Cost	IRR
110	6	248 MUS $	5.9%	0.22 US$	10.9%
	7	248 MUS $	11.2%	0.20 US$	12.0%
128	6	271 MUS $	4.5%	0.23 US$	10.0%
	7	271 MUS $	8.7%	0.21 US$	11.3%

The above table shows that releases rate of 6m^3/s represents less shortage than 7m^3/s and a dam capacity of 128 Mm^3 will lead to less shortage. However, further discussions should be held with the Client and the Funding agency in order to decide the option of the dam to be adopted in the final design.

CHAPTER 3 - CLIMATOLOGY, HYDROLOGY AND SEDIMENTATION

III.1 Purpose

The purpose of this Chapter is to document the investigations that were performed for the hydrology and sediment studies for Bisri Dam. These studies are based in great part on the feasibility design performed by ECIDAH in the early 1995's. The following are the study objectives:

- Review the work that was performed for the 1995 feasibility study.
- Determine if additional data are available to further the investigation.

The data, assumptions, and procedures used in the 1995 feasibility study were reviewed and additional climatological and available hydrologic data have been added. In addition, greater clarification is presented regarding assumptions and procedures used for the analyses; and, additional types of analyses have been performed for purposes of verification and cross-checking results.

The methodology for the hydrology studies is presented in the following sections in this Chapter. In Section 2, a general description is given of the project watershed. Section 3 provides the precipitation and other climatic data used in these studies and describes methods used to check these data. In Section 4, a description is given of the methods for establishing a monthly streamflow record at the Bisri damsite. These studies included extending the basic data using rainfall and flow records.

Section 5 provides information on sedimentation and provides an estimate of long-term reservoir sedimentation.

III.2 Project Area

III.2.1 Introduction

The Bisri Dam Project is located in Southern Lebanon, east of the coastal city of Sidon. The proposed dam site is located on the Bisri River, at an elevation of 395 m, just east of the village of Bisri. The area of the project watershed is 215 km^2, mostly draining the western slope of the mountains named Jabal el Barouk and Jabal Niha. These mountains, rising to elevations higher than 1,900 m above mean sea level, are characterized by a continuous snow cover throughout most winter months.

The project watershed is located between latitude 33^o 30' and 33^o 45' North and longitude 35^o 32' and 35^o 46' East. Towns, villages and farms are scattered throughout the watershed primarily below 1,300 m in elevation. The town of Jezzine is the largest population center in the watershed.

Downstream of the Bisri damsite at elevation 230 m is the Aouali (Awali) hydropower plant which brings water from the Qaraaoun Reservoir on the Litani River. Up to 25 m^3/s can be diverted into the Bisri River through the power plant. The tailrace of the Aouali plant discharges into a 200,000 m^3 storage reservoir which forms the forebay of the Joun hydropower plant located at elevation 33 m, approximately 8 km downstream. Water from the Bisri River can also be diverted into this forebay to increase flow to the Joun powerplant. The Joun plant discharges into an afterbay and then back into the Aouali River, the name given to the Bisri river in its lower reach near the Mediterranean Sea. Thus the Aouali River, in the last 5 km before the sea, normally has a substantial flow even during the dry summer months.

III.2.2 Watershed description

The location of the project watershed is shown in Figure 3.1. The figure shows the general topography of the basin. The general shape of the basin is long and narrow. The northern two thirds of the watershed is drained by the El Barouk River which flows in a southerly direction to the Bisri River. The southern one third of the basin is drained by the Aariye River which flows in a northerly direction. Most of the flow entering each of these streams originates in the Niha and El Barouk Mountains which form the eastern boundary of the watershed. The slopes of the channels draining westerly from these mountains are extremely steep, dropping up to 1,200 m in a 5 km reach.

Soils are thin to nonexistent throughout much of the watershed, with large exposures of rock outcrop. Both clastic and carbonate geologic outcropping is found within the basin. The significant number of springs found throughout the Bisri watershed is characteristic of the karstic nature of the limestone in Lebanon.

Much of the land up to elevations as high as 1,200 m has been farmed during the last century. Because the land is generally quite steep, the farming has been done on terraces cut into the hillsides. Today, many of these terraces lie fallow. The effect of these terraces is to slow the velocity of runoff during storms and to maximize the amount of infiltration into the soil. Nevertheless during heavy storms, terraces being farmed can contribute significant amounts of sediment to the streams.

Crops grown on these terraces include a variety of vegetables in addition to grapes and olives. A mixture of hardwood and softwood trees is found in various locations throughout the watershed up to an elevation of about 1,000 m, but only where soil depths are adequate. Where soils are thinner, vegetation typical of desert climates can be found year round. This includes thorny bushes usually less than a meter high and succulents which reach up to a couple meters in height. This vegetation is the result of the long, very dry summer. During the wet winter season, a ground cover of grasses and weeds takes hold anywhere there is thin soil.

The report, Soils of Lebanon, by Sayegh et al. (no date) offers insight into soils derived from the predominate limestone deposits. In previous eras, the Cedars of Lebanon were prized throughout the Mediterranean. At that time, Mount Lebanon was described as densely wooded. The deforestation over a period of time resulted in the loss of the upper most beneficial layers of the soil. The present day cedar zone on Mount Lebanon lies above elevation 1,400 m. Below this elevation, the land is described as mainly waste and with a poor herbaceous stratum.

III.2.3 Watershed hydrology

The watershed hydrology is characterized by a rainy season of approximately seven months which begins in October or November of each year and lasts into April or May. Rainfall during the months of June through August is extremely rare. Streamflow is normally highest in February and March with an average discharge at the Bisri gaging station (222 km^2) 12.4 m^3/s. During September, the average is lowest at about 0.5 m^3/s.

III.3 Climate

III.3.1 Introduction

The Bisri Dam Project is located approximately 17 km inland from the coast of the Mediterranean Sea at an elevation of 395 meters above mean sea level. The elevation in the drainage basin ranges from 395 m at the damsite to over 1,900 m above mean sea level. The climate in the project area is moderately cold, windy and wet in the winter and warm and dry in the summer and fall.

Before any assessment of the water resources of a region can possibly be performed, current and past climate information pertaining to temperature, humidity, wind, and evaporation must be evaluated. An evaluation of the climate data was performed for the 1984 Prefeasibility Report (ECIDAH, 1984). No additional data have become available to reevaluate the consistency of these data. The procedures used for the 1984 Prefeasibility Report were evaluated and determined to be appropriate for this study.

III.3.2 Station location

The climatological information on the Bisri Basin was obtained from the following stations:

Weather Element	Name of Stations
Temperature	Bhamdoun and Kfar-Nabrakh
Relative Humidity	Bhamdoun and Kfar-Nabrakh
Wind	Ksara Observatory, A.U.B., and College of Machmouche
Evaporation	Kfar-Nabrakh and Bhamdoun

The stations from which precipitation data were collected and analyzed are listed in Section III.4. The weather elements, with the exception of precipitation, are discussed in the following section.

III.3.3 Climatology

The historical climatological records including temperature, relative humidity, evaporation, and precipitation indicate how the proposed system will respond in the future. The temperature and relative humidity are associated with the reservoir surface evaporation. Precipitation is directly related to runoff.

III.3.3.1 Temperature

Recorded temperatures at the stations of Bhamdoun and Kfar-Nabrakh were collected and analyzed. Both of these stations are close to the Bisri damsite as indicated in Figure 3.1. The monthly mean temperatures at both stations are presented in Tables 3.1 and 3.2. The monthly mean temperatures are also plotted in Figures 3.2 and 3.3.

The mean temperatures at Bhamdoun vary from a low of 7.2^{O}C in January to a high of 22.2^{O}C during the month of August. At Kfar-Nabrakh the mean temperatures vary from 8.3^{O}C in January to 23.1^{O}C in August.

III.3.3.2 Relative humidity

The relative humidity data for the Bisri Dam Project were available at the Bhamdoun and Kfar-Nabrakh stations. These data are presented in Tables 3.3 and 3.4 and are plotted in Figures 3.4 and 3.5. The mean of the monthly relative humidity at these two stations varies from a minimum of 55.6 percent in the month of May at Kfar-Nabrakh to a maximum of 72.1 percent in the month of January at Kfar-Nabrakh. The measured absolute monthly minimum was 30 percent in the month of

May at Kfar-Nabrakh, and the measured absolute monthly maximum was 88 percent in the month of January at Kfar-Nabrakh.

III.3.3.3 Wind

The wind records are available at KSARA observatory, A.U.B., and at a station located in the project watershed at the College of Machmouche near Jezzine. Maximum wind recorded at the College of Machmouche was a gust with a velocity of 47 m/s.

III.3.3.4 Evaporation

The available evaporation data measured at the stations of Bhamdoun and Kfar-Nabrakh were also collected for analysis. These data are presented in Tables 3.5 and 3.6 and are plotted in Figures 3.6 and 3.7. The evaporation measured at the station of Bhamdoun ranges between 19 mm and 196 mm per month, and the evaporation measured at Kfar-Nabrakh ranges between 15 mm and 175 mm per month. Of the two stations, Kfar-Nabrakh is closer to the damsite. The recorded evaporation at this station provides an indication of expected evaporation from the reservoir surface. The mean, the minimum, and the maximum of the measured monthly evaporation at the two stations are also presented in Tables 3.5 and 3.6.

III.3.4 Precipitation

III.3.4.1 Station network

The locations of the rainfall stations used in the feasibility study of 1995 for computing mean monthly and mean annual basin precipitation for Bisri Dam Project in addition to the new stations established in the recent years used to update the data in the current study are shown in Figure 3.1. The names of the stations, their identification numbers, and the period of available records are listed below:

Name of Station	Identification No.	Period of Available Record
Aain-Zhalta	512	1939-40 - 1970-71
Kfar-Nabrakh	514	1944-45 - 1970-71
Jdeit-ech-Chouf	516	1943-44 - 1970-71
Jezzine	519	1927-28 - 1936-37 and 1939-40 - 1970-71
Jezzine		2001-02 – 2008-09
El Barouk Fraidis		2001-02 – 2008-09
Deir El Kamar		2001-02 – 2008-09
Jbaa Ech Chouf		1964-65 – 1969-70 and 1991-92 – 2008-09
Meshref		2002-03 – 2008-09

III.3.4.2 Double mass analysis

The double mass analysis is a useful method of detecting an inconsistency in a data set. It is often used to check rainfall data by comparing each rain gage individually against the cumulative total of several nearby gages. If the rainfall record is consistent, a straight line is generally obtained. If, however, the rain gage has been moved or replaced, the double mass plot will often have a break in continuity. The double mass analyses that were performed for the 1984 Prefeasibility Report were reevaluated and were determined to be appropriate for this study.

A new double mass analysis was conducted on the stations recently established. The results of this analysis were inconsistent.

At each of the four stations of the feasibility study, the records from the years 1944-45 through 1970-71 were selected for analysis. For that period, precipitation records for the months of March, April and May in 1963 at station 514 were missing. Precipitation records for the months of September, October and November 1958, September and October 1959, and January 1960 at station 519 were also missing. The precipitation during the unrecorded months at station 514 was estimated from the records for those months at neighboring stations 513, 515 and 516. The precipitation for the unrecorded months at station 519 were estimated from the records at neighboring stations 514, 515 and 516. With missing data estimated, the four selected stations provided a continuous 27-years of record for testing the consistency of the data by double mass analyses. The precipitation data for each of the four selected stations during the years 1944-45 through 1970-71 are presented in Tables 3.10 through 3.13. The double mass analyses for annual precipitation for the four stations shows that the precipitation data are consistent and reasonably valid.

III.3.4.3 Basin precipitation

To compute the basin precipitation, the Thiessen method was used for the Bisri Basin with the four selected stations in the feasibility study of 1995 as a first approach and the most three representative recently established stations as a second approach. The two Thiessen polygon diagrams are shown in Figure 3.17. The Thiessen method assumes that at any point in the watershed the rainfall is the same as that at the nearest gage. Therefore, the depth recorded at a given gage is applied out to a distance halfway to the next station in any direction. The relative weights for each gage are computed from the corresponding polygon areas within the network. The Thiessen method does not directly account for orographic influences on rainfall but it is generally more accurate than using the arithmetic mean of the gages. The Thiessen method is the accepted procedure when the available data are limited.

The percentage of the total area assigned to each station was computed by planimetering each polygon. The following is the percent distribution of areas (area factors) for the four stations, showing also the mean annual precipitation at each of the recent stations and elevation of each.

Name	Station No.	Percent Distribution	Mean Annual Precipitation	Station Elevation
Stations used in the Feasibility Study of 1995				
Aain Zhalta	512	17.0	1,226 mm	1,080 m
Kfar-Nabrakh	514	12.8	1,300 mm	810 m
Jdeit-ech-Chouf	516	28.7	1,326 mm	770 m
Jezzine	519	41.5	1,299 mm	945 m
Recently Established Stations Used				
Jezzine	-	26.4	1,060 mm	1,070 m
El Barouk Fraidis	-	28.4	998 mm	1,114 m
Jbaa Ech Chouf	-	45.2	1,202 mm	1,130 m

The basin precipitation was computed by multiplying the precipitation at each of the stations by its respective area factor for the corresponding years of available data. The resulting monthly and annual precipitation for Bisri Basin is presented in Table 3.16. The monthly precipitation for Bisri Basin is plotted in Figure 3.18. The 35-year mean annual basin precipitation calculated by this method is 1,255 mm with an average of 1,294 mm for the old stations and 1,107 mm for the recently established stations. The average monthly precipitation varied from a minimum of zero in the month of July to a maximum of 283 mm in the month of January. Figure 3.19 compares the average annual precipitation data for all the available stations with the Bisri Basin computed data.

The mean annual precipitation for the basin was also planimetered from the national rainfall isohyetal map (F.A.O., 1973). The mean annual precipitation for the basin obtained by this procedure is 1,244 mm, which is about 1 percent lower than the mean annual basin precipitation obtained above. This indicates that basin precipitation calculated from the selected stations is representative of true basin precipitation. It also indicates that orographic influences of the mountain ranges are negligible in determining average precipitation for the Bisri Basin since orographic effects are reflected in the isohyetal map.

III.4 Water Availability

III.4.1 Introduction

The Bisri Dam Project is intended to store water for municipal and industrial uses within Beirut and surrounding areas. The source of water supply for the project is the Bisri River. The headwaters for the Bisri River are located in the Jabal el Barouk Mountains. Both rainfall and snowmelt contribute to the streamflow in the basin.

The following sections describe the development process used in determining water availability for this project. Figure 3.20 shows the development process used in deriving the daily and monthly virgin streamflows used in this study.

A monthly, 65-year project streamflow record was derived for this study using the procedures developed for the feasibility study of 1995. The record was used to study the water supply yield of the Bisri Dam Project. The yield analysis is presented in Chapter 4.

III.4.2 Streamflow data

There are two stream gaging stations within the project area; Marj Bisri station and Saida (Sidon) station. The Marj Bisri gaging station is located on the Bisri River and the Saida gaging station is located on the Aouali River. The contributing drainage area to the Bisri Station is 222°km^2. The station is located downstream of the Bisri damsite with a period of record of 32-years between 1952-53 through 1973-74 and 1982-83 through 1983-84 and 2001-02 through 2008-09. The Saida station is located near the mouth of the Aouali River as shown in Figure 3.1. The Marj Bisri station was selected for the study because the station is located on the Bisri River downstream of the Bisri damsite.

Monthly flow data are available for the Marj Bisri station. The monthly average recorded streamflows for the Marj Bisri station are listed in Table 3.17. The average flow for the 32 year period of record was 11.53 Mm^3/month (4.4 m^3/s) which is equal to an average annual yield of 138.27°Mm^3. The minimum average monthly flows of 1.41 Mm^3 (0.5 m^3/s) occurred during September. The maximum average monthly flows of 32.74 Mm^3 (16.6 m^3/s) occurred during Marsh. The minimum monthly discharge for the period of record was 0.14 Mm^3 (0.05 m^3/s) occurring in September 2001 and the maximum monthly flow for the period of record was 250.90°Mm^3 (96.79 m^3/s) occurring in Marsh 2003. Figure 3.21 shows the peak annual discharges for the period of record at the Marj Bisri station. Figure 3.22 shows the average monthly streamflows for the Marj Bisri station, respectively.

The monthly virgin flows at the Marj Bisri station were computed by adding historical upstream diversions to the recorded streamflows. The following were estimated to be upstream diversions in the basin.

Source	Type	Diverted Volume (Mm^3)			
		Average Flow Year		Dry Flow Year	
		Winter	Summer	Winter	Summer
Barouk	Domestic	3	3	3	3
Between Barouk and Moukhtara	Irrigation	1	6	1	4
Moukhtara	Irrigation	0	2	0	2
Total		**4**	**11**	**4**	**9**

The average year diversions for winter (December through April) and summer (May through November) equaled 4 Mm^3 and 11 Mm^3, respectively. The dry year diversions for winter and summer equaled 4 Mm^3 and 9 Mm^3, respectively. The Marj Bisri historical flows were increased by the average of the mean and dry year diversions which equaled 4 Mm^3 and 10 Mm^3 for the winter and summer months, respectively. To account for these diversions, the Marj Bisri station average monthly flows were increased by the following values to estimate monthly virgin flows:

Month	Historic Monthly Diversions (m^3/s)
September through November	0.54
December through April	0.31
May through August	0.54

The contributing drainage area at the Marj Bisri station is 222 km^2 while the contributing drainage area at the Bisri damsite is 215 km^2. The monthly virgin flows at the Marj Bisri station were multiplied by the ratio of 215/222 to compute the virgin flows at the Bisri Damsite. Due to the small difference in drainage areas, a more sophisticated transposition is not required. Table 3.19 lists the derived monthly virgin flows at the Bisri damsite.

The reliability assessment of the monthly streamflow data was made by plotting the annual virgin flows at the Bisri damsite versus the annual basin precipitation. The correlation resulted in a linear relationship with a coefficient of 0.92, indicating consistency between the streamflow and rainfall data.

III.4.3 Record extension

The 32-year period of record for the monthly virgin flows at the Bisri damsite were extended to 65-years. The monthly record was extended using the four precipitation stations in the vicinity of the Bisri basin and the Litani at Qaraoun Gauging Station. The following four precipitation stations were used for the record extension:

1. Aain-Zhalta Station Number 512 - Period of Record 1944-45 through 1970-71. The average monthly precipitation is equal to 102 mm. The minimum monthly average precipitation is zero which occurs during July. The maximum monthly average precipitation is equal to 290 mm which occurs during January.
2. Kfar-Nabrakh Station Number 514 - Period of Record 1944-45 through 1970-71. The average monthly precipitation is equal to 108 mm. The minimum monthly average precipitation is zero which occurs during July and August. The maximum monthly average precipitation is equal to 301 mm which occurs during January.
3. Jdeit-ech-Chouf Station Number 516 - Period of Record 1944-45 through 1970-71. The average monthly precipitation is equal to 110 mm. The minimum monthly average precipitation is equal to zero which occurs during July and August. The maximum monthly average precipitation is equal to 301 mm which occurs during January.
4. Jezzine Station Number 519 - Period of Record 1944-45 through 1970-71. The average monthly precipitation is equal to 108 mm. The minimum average monthly precipitation is equal to zero which occurs during July and August. The maximum average monthly precipitation is equal to 305 mm which occurs during the month of January.

Tables 3.7, 3.8, 3.9, and 3.10 list the monthly and annual precipitation records for Aain-Zhalta, Kfar-Nabrakh, Jdeit-ech-Chouf, and Jezzine stations, respectively. Figures 3.8, 3.9, 3.10, and 3.11 show the monthly precipitation records for Aain-Zhalta, Kfar-Nabrakh, Jdeit-ech-Chouf, and Jezzine stations, respectively. The basin monthly and annual precipitation data are shown in Table 3.16.

Using annual data of the rainfall stations, a linear regression analysis, between basin precipitation and basin runoff, was performed. The correlation coefficient of 0.92 was computed for the annual time horizon, indicating that the annual runoff and precipitation are well-correlated.

The annual correlation was used in synthesizing streamflow records at the Bisri damsite for the period 1944-45 through 1951-52. The correlation equation is as follows:

$$Y = 323.1 + 1.29(X)$$

Where:

Y = Annual basin precipitation for Bisri basin in mm

X = Annual virgin runoff at Bisri damsite in mm

The synthesized annual virgin runoff at the Bisri damsite was computed for the flows years of 1944-45 through 1951-52 using the correlation equation. The results are as follows:

Using annual data of the Litani at Qaraoun gauging station, a linear regression analysis, between Litani runoff and basin runoff, was performed. The correlation coefficient of 0.9 was computed for the annual time horizon, indicating that the annual runoffs of the basin and of the Litani are well-correlated.

The annual correlation was used in synthesizing streamflow records at the Bisri damsite for the period 1974-75 through 1981-82 and 1984-85 through 2000-01. The correlation equation is as follows:

$$Y = 0.456(X) + 0.18$$

Where:

Y = Annual virgin runoff at the Bisri damsite

X = Annual runoff of the Litani River at Qarqaoun damsite.

The synthesized annual virgin runoff at the Bisri damsite was computed using the correlation equation. The results are as follows:

Water Year	Annual Virgin Flow at Bisri Damsite (Mm^3)	Water Year	Annual Virgin Flow at Bisri Damsite (Mm^3)
1944-45	182.05	1985-86	68.58
1945-46	182.99	1986-87	182.58
1946-47	151.59	1987-88	250.98
1947-48	206.11	1988-89	82.26
1948-49	292.62	1989-90	36.66
1949-50	120.93	1990-91	64.02
1950-51	116.33	1991-92	328.5
1951-52	174.81	1992-93	228.18
1974-75	136.98	1993-94	114.18
1975-76	173.46	1994-95	123.3
1976-77	209.94	1995-96	114.18
1977-78	250.98	1996-97	100.5
1978-79	73.14	1997-98	127.86
1979-80	223.62	1998-99	45.78
1980-81	246.42	1999-00	48.06
1981-82	114.18	2000-01	32.1
1984-85	141.54		

The monthly virgin flows were synthesized by multiplying each annual monthly flow by the percentage of the average monthly flow computed from the derived virgin flows at Bisri Damsite. The following lists the percentages used to compute the monthly virgin flows.

Month	Bisri Damsite Average Monthly Flow Percentage
September	1.78
October	1.98
November	3.24
December	10.15
January	18.08
February	21.05
March	18.84
April	11.63
May	5.82
June	3.17
July	2.35
August	1.91
TOTAL	**100.00**

III.4.4 Project streamflow

Streamflow available for the Bisri Project were determined from the virgin streamflow data derived at the Bisri damsite. The historical diversions, noted earlier, were subtracted from the Bisri damsite virgin flows to establish the streamflow values available to the project. Project streamflow is presented in Table 3.21 in million cubic meters. Average annual flow available to the project at the Bisri damsite is estimated as 134.89 Mm3 (4.3 m^3/s), with annual values ranging from a high of 487.10 Mm^3 (15.4 m^3/s) to a low of 21.98 Mm^3 (0.7 m^3/s).

III.4.5 Flow duration analysis

One of the simplest and most informative means of showing the flow characteristics of a stream is the flow duration curve. This curve shows the percentage of the time during which specified discharges were equaled or exceeded during the period of record. The technique combines in one curve the flow characteristics of a stream throughout the range of discharge.

Flow duration values greater than 90 percent have been used as measures of a stream's low flow potential. The 90 percent value is used as a measure of ground water contribution to streamflow. The low flow portion of the curve is an index of the amount of ground water being contributed to streamflow from natural catchment storage. If the slope of the curve in the low flow portion is flat, ground water contributions are significant. On the other hand, a steep curve indicates poor base flows. Flow duration curves are a valuable tool for comparing drainage basic characteristics, particularly the effect of geology on low flows.

The monthly flow duration curve for the Marj Bisri gage were prepared for the recorded period of record between 1944-45 through 2008-09. Figure B4-4 shows the monthly duration curve. The monthly flow durations are listed below:

Time River Discharge Equaled or Exceeded (%)	Average Monthly (m^3/s)
0.9%	28.00
1.6%	25.00
4.3%	17.24
8.2%	12.01
16.1%	8.21
26.3%	5.69
37.9%	3.23
51.0%	1.81
69.7%	1.14
83.9%	0.79
90.1%	0.61
95.3%	0.44
98.3%	0.36
99.1%	0.24

The 90 percent value is approximately 0.6 m^3/s for the average monthly flows. The Bisri River base flow is approximately 0.6 m^3/s based on the monthly flow duration analysis.

The river flows are appreciable approximately 40 percent of the time of the year based on the flow duration curve. This corresponds to the length of the wet season as indicated by the precipitation data for the watershed.

III.5 Sedimentation

III.5.1 Introduction

Knowledge of the amount of sediment carried in Bisri River past the damsite is necessary to estimate the sediment storage requirement of the Bisri Reservoir. At the time of the feasibility study (ECIDAH, 1995), very limited sediment data from the Bisri streamgaging station were available to make a sediment load determination for the Bisri River. Additional sediment data have not become available since the feasibility study.

It is estimated that the sediment load that would be trapped in the Bisri Reservoir over the first fifty years of operations will be approximately 8 Mm^3. This is equivalent to a sediment load from the 215 km^2 watershed of 1,000 T/km^2/year or 755 m^3/km^2/year. In the absence of any recent measurements of sediment transport in the Bisri River, and after reviewing the information on catchment geology and soils, no change has been made in the sediment yield estimated in the prefeasibility study. Since the estimated 50-year reservoir sediment load of 8 Mm^3 is less than eight percent of the volume of the Bisri Reservoir, reservoir sedimentation is not considered a significant concern to project feasibility.

III.5.2 Previous studies

Between December 1952 and June 1953, the U.S. Bureau of Reclamation made 25 measurements of suspended sediment at the Bisri streamgaging station. From these values and the flow duration curve, the suspended sediment yield at the gage was estimated to be 800 T/km^2/year. The highest flow measured was 25 m^3/s for which the concentration was 1,060 mg/l. No size analysis was undertaken but it was observed that the sediment collected in the samples was sand.

Another 200 T/km^2/year was added to the suspended sediment to account for the bed load that was not measured, giving a sediment yield at the damsite of 1,000 t/km^2/year. The measuring site was slightly downstream from the dam axis near the end of the alluvial valley which will become the reservoir. The Bisri River is downcutting through previous deposits which resulted from ponding caused by ancient slides downstream from the gage site. The major portion of the deposits are lacustrian, clays and silts. These form the highest terraces. There are lower terraces of cobbles, gravel, and sand. At the floodplain and riverbed levels there are boulders along with cobbles, gravel, and sand.

The sediment samples collected at the gaging site contain some amount of sand eroded from the terraces and river banks. These terraces and riverbanks will become part of the reservoir floor after the completion of the dam. Thus, the sediment yield per square kilometer of watershed is less upstream of the reservoir than at the gaging station.

With a catchment area of 215 km^2 and an unit weight of 1.325 T/m^3, the 50-year deposit of sediment in the reservoir was estimated to be on the order of 8 Mm^3.

In later years, the yield of 1,000 T/km^2/year was considered high when compared to yields in rivers in Italy under similar cool Mediterranean climate regimes (reference).

The annual precipitation in the Bisri catchment is 1,300 mm, coming mostly in the winter months. The average annual temperature is approximately 17^{O}C. The Italian yields were from 28 to 1,580^{O}T/km^2/year for catchment precipitations between 550 and 2,660 mm/year. Nothing was said about the geology or land use in the Italian catchments.

III.5.3 Available information

The primary source of information on sediment loads in the Bisri/Aouali River system is Beydoun's study (Beydoun, 1976) and sediment measurements made by the U.S. Bureau of Reclamation in 1953 (USBR, 1953). Beydoun has indicated that sediments in Lebanon are derived primarily from regions with good exposure of clastics while little sediment contribution comes from carbonate terrain. As an indication of the erosion and sediment problems which can occur during a single large storm, Beydoun gives the following description:

Although rainfall is often torrential, large-scale flooding is only periodic. Sustained heavy downpours (even over low-lying areas) can result in very considerable amounts of soil and sediment being swept into fast-flowing channels and deposited over lowlying areas when streams overflow their banks. In December 1955, an area of over 500,000 m^2 in Tripoli was inundated as a result of flooding by the Abou Ali river after sustained downpour (especially over the foothills to the south), depositing some 200,000 m^3 of sediment; the thickness approximated 1.5 m in some places though much of the channel load was carried out to sea.

According to Beydoun,

The average figure for suspended sediment load in the Aouali and lower Litani basins is 685 m^3/km^2 of drainage basin area. The average figure for the Aouali River is 177,000 T/year passing the Bisri station ...

These figures are based on an analysis by the U.S. Bureau of Reclamation of 24 suspended sediment samples between December 1952 and June 1953. The results of these samples are listed in Table B6-1. Figure B6-1 shows that the maximum suspended sediment concentration measured was 1064 mg/l at a discharge of 25 m^3/s. The Bureau estimated 177,000 T/year of suspended sediment at the Bisri gage or 797 T/km^2/year.

Adding 203 T/km^2/year for unmeasured sediment load yields a total sediment load of 1,000 t/km^2/year.

Sediment volume can be estimated by assuming a density of 1.325 T/m^3. For the 215 km^2 watershed, mean annual sediment volume is thus calculated as 162,000 m^3. For a 50-year period, this means 8 Mm^3 of sediment would be trapped in the reservoir assuming a 100 percent trap efficiency. Trap efficiency of a reservoir can be defined as the percentage of the total inflowing sediment that is retained in the reservoir.

III.5.4 Present study

Since the time of the Bureau study, no new measurements of sediment transport have been made at the Bisri gage. In fact the gage had been destroyed three times in a 15-year period between 1967 and 1982. To appreciate better the sediment yield, a review was made of the geology of the catchment and the soils resulting from the weathering of the rocks exposed in the catchment.

Upstream from the reservoir, on the eastern flank of Mount Lebanon, the Bisri River is incised into sedimentary rocks of the Cretaceous and Jurassic Period. Most common is the Cenomanian formation consisting of well stratified, fractured, karstic, interbedded limestones, dolomites, and marls. In the canyons and escarpments, the calcareous rocks and argillaceous and marly sandstones of the Aptien formation are exposed. The higher rocks are the karstic calcareous cliff formers. Below are dolomites and alternating marls and limestones. The highest part of Mount Lebanon is composed of Jurassic Period marine shelf deposits - dolomite and limestones - with volcanic horizons, chert modules, and interbedded basalts. The highest point in the Bisri catchment is elevation 1948 m on the crest of Mount Lebanon. The river slopes steeply to the alluvial valley which will be the reservoir. The valley floor is near elevation 400 m.

Along the reservoir boundary and to the east is the Gres de Base formation. This is basal cretaceous sandstone - deltaic deposits - with some clays, shales, lignites, and occasional volcanics.

On the whole, the rocks in the upper Bisri catchment are not prolific sediment producers under such a climate regime. The marls are the most erosive, but these do not cover a significant area. The Gres de Base sandstones are so weakly cemented that the drilling cores crumble when removed. However, these deposits have been eroded in the past; so much of the surface is now C horizon soil.

The report, Soils of Lebanon, by Sayegh et al. (no date) offers insight into soils derived from the predominate limestone deposits. In prior eras, the Cedars of Lebanon were prized about the Mediterranean. At that time, Mount Lebanon was described as densely wooded. The deforestation over a period of time resulted in the loss of the upper most beneficial horizons of the soil. During this period the sediment yield was much higher than now. Dense forests have not returned. The degradation of the soil, started with these earlier civilizations, still carries on. Now the cedar zone on Mount Lebanon is above elevation 1400 m. Below, the land is described as mainly waste and with a poor herbaceous stratum.

On Mount Lebanon, the ferruginous sods of the mountains develop on limestone. At high levels, these are brown-red yellowish. At lower levels, they are brown-red or red. The depth is slight and the soil is saturated with calcium. The calcium carbonate has a major influence on the physical and chemical properties of the soil. Where there are calcareous soils with a high content of calcite and dolomite carbonates, there is a deficiency of potassium for plant growth.

In summary, most soils in the Bisri catchment are of slight depth, already degraded by the exploits of man and are not very productive, either for plant growth or for sediment yield.

There has been concern that upon filling, the Bisri reservoir will cause increased sliding in the Gres de Base sandstone valley walls along the reservoir. The volume of material expected to reach the reservoir, either by sliding under the influence of the reservoir, or moved as a safety measure before the reservoir is filled, must be added to the reservoir deposits estimated as coming from the catchment. Based on a recent evaluation of this concern, it is concluded that only very minor volumes of material will move into the active reservoir storage in this manner. Thus, additional reduction in reservoir volume is not considered necessary.

DISCHARGE	SUSPENDED SEDIMENT LOAD		CONCENTRATION
(cu. m/sec)	(t/day)	(kg/sec)	(mg/l)
1.1	1.1	0.013	11
1.1	4.0	0.046	42
2.1	1.0	0.012	5.5
2.6	4.0	0.046	18
2.9	11	0.127	44
4.5	19	0.220	49
4.8	16	0.185	39
5.2	31	0.359	70
5.7	21	0.243	43
6.3	55	0.637	101
7.8	320	3.704	475
8.0	101	1.169	146
8.1	88	1.018	126
9.2	72	0.833	91
14	590	6.829	488
15	750	8.681	579
16	740	8.565	535
18	700	8.102	450
24	2200	25.463	1061
25	2300	26.620	1064

Table 3.1: Monthly Mean Temperatures (°C) - Station Bhamdoun

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	MAY	AUG
1951 - 1952	19.9	15	12.3	6.4	7.4	7.9	8.5	13.4	16.6	19.4	20.9	22.8
1952-1953	23.1	18.1	12.2	10.9	7.4	8.1	5.8	12.8	16.2	20.4	23.5	22.3
1953-1954	19.7	17.9	9.5	6.5	5.5	7	11.5	11	17.7	21.2	24.1	24.1
1954-1955	20.3	17.6	12.9	9.1	9.5	10.9	10	13.4	17.5	22.6	22.2	20.6
1955 - 1956	20.2	19.5	12.6	8.8	7.1	8.7	6.8	13.3	14.8	20.3	23	24.4
1956-1957	19.7	16.4	13	7.3	4.8	7	9.4	12.9	16	20.4	22.3	23.7
1957 - 1958	19.3	15.6	12.2	8.5	7.1	8.8	11	14.6	16.6	19.7	21.3	23
1958-1959	18.7	15.6	13.2	10.3	7.6	1.4	8	14.5	17.6	21.7	19.7	20.4
1959 - 1960	17.9	14.9	12.3	10	7.8	9.3	10	13	19.8	19.7	21.8	22
1960 - 1961	19.8	20.1	13.7	11.8	6.6	6	7	13.5	18	20.6	22.1	22.1
1961 - 1962	17.2	16.4	12.1	8.8	7.7	6.4	12.5	11.5	17.3	21.3	22	23.2
1962 - 1963	20.9	17.5	16.7	9.7	9.1	9.1	7.9	13.4	15	20.3	21.6	22.7
1963 - 1964	19.9	17.6	13.3	9.2	4.2	5.6	10.2	11.4	14.8	20	21.9	20.9
1964 -1965	18.4	19.2	13.1	9.8	6.5	7.9	11.3	12	16.4	21.5	22	21.6
1965 - 1966	20	14.3	11.4	9.2	8.6	8.8	9.9	13.2	16	19.8	21.9	22.2
1966-1967	18.6	17.6	17.1	9.6	6.6	5.4	7	11.9	15.5	19	21.5	21.4
1967 - 1968	18.7	17.1	11.5	9	5.8	7.7	8.4	15.4	18.9	20	23.4	21.2
1968 - 1969	19.1	15.6	12.9	8.8	5.5	8.4	10.8	10.9	17.9	21.6	20.7	22.1
1969 -1970	22.1	16.8	13.4	9.9	8.1	8.1	11.9	15.3	16.4	19.8	20.7	21.8
1970 - 1971	20	16.7	14.4	7.7	1.3	6.4	10.3	11.4	18.8	----	20.1	----
AVERAGE	19.68	16.98	12.99	9.07	7.16	7.45	9.41	12.94	16.89	20.49	21.84	22.24
MEDIAN	19.75	16.95	12.9	9.15	7.25	7.9	9.95	13.1	16.6	20.3	21.9	22.1
MINIMUM	17.2	14.3	9.5	6.4	4.2	1.4	5.8	10.9	14.8	19	19.7	20.4
MAXIMUM	23.1	20.1	17.1	11.8	10.3	10.9	12.5	15.4	19.8	22.6	24.1	24.4
STD. DEV.	1.31	1.52	1.64	1.31	1.51	1.93	1.84	1.32	1.36	0.9	1.09	1.09
SKEWNESS	0.67	0.24	0.82	-0.3	0.06	-1.26	-0.25	0.19	0.27	0.57	0.11	0.26

Table 3.2: Monthly Mean Temperatures (ºC) - Station Kfar Nabrakh

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
1951 - 1952	22.3	16.6	13	7.6	7.4	8	9.6	14.5	17.1	20	23	25
1952-1953	24.5	20.2	13	11.6	8.5	8.7	8.2	13.3	16.8	19.5	24.6	22.1
1953-1954	22.3	19.2	----	7.5	6.5	8	12.3	13	19.2	22.3	23.8	24
1954-1955	20.3	18.8	14.6	9.9	10	11.3	11.7	13.8	18.2	22.7	22.5	21.9
1955 - 1956	----	20.1	13.3	10.3	8.8	10.4	7.8	13.9	16.9	21.1	24.2	25.4
1956-1957	21.3	17.1	14.1	9	6.6	----	11.1	14.4	17.1	20.9	----	----
1957 - 1958	----	----	----	----	----	----	13	15.9	17.7	20.8	22.3	24.3
1958-1959	19.7	16.2	14.3	10.9		----	----	----	19.1	21.2	21.3	21.9
1959 - 1960	19	15.6	14.3	11.6	10.8	----	10.2	13.5	----	----	----	22.8
1960 - 1961	19.6	19.7	14.5	12.9	---	----	9.7	14.2	18.5	21.6	22.8	21.5
1961 - 1962	18.3	17.4	---	---	9	6.6	13.2	12.1	----	---	22.7	23.5
1962 - 1963	21.8	18.4	16.5	10.1	9	9.4	----	----	----	22	22.3	23.3
1963 - 1964	20.3	18.1	13.7	8.3	----	6.2	10.4	11.1	14.9	19.8	21.4	21.9
1964 -1965	19	19.2	13.2	9.8	6.7	8.1	11.9	12.8	17.4	23.3	23.8	23.6
1965 - 1966	22.3	16.7	13.3	10.1	9.4	9.7	11	14.8	18	23.2	24.2	25
1966-1967	20.8	19.3	18.3	]0.5	7.4	6	7.4	13	17.3	21	23.5	23.9
1967 - 1968	21.1	19.2	12.9	10.4	6.8	8.7	8.9	16	20.7	21.7	24.8	22.8
1968 - 1969	21	17.2	13.7	9.8	6.5	9.1	11.6	11.8	19.1	22.4	21.1	22.5
1969 -1970	22.2	17.8	----	----	8.1	9.3	10.5	15.7	16.8	20.6	20.7	22.2
1970 - 1971	20.2	16.4	14.4	7.1	10.5	7.3	10.3	11.1	18.2	----	20.3	21.4
AVERAGE	20.89	18.06	14.19	9.85	8.25	8.45	10.49	13.61	17.82	21.42	22.74	23.11
MEDIAN	20.9	18.1	13.9	10.1	8.3	8.7	10.45	13.65	17.7	21.2	22.75	22.8
MINIMUM	18.3	15.6	12.9	7.1	6.5	6	7.4	11.1	14.9	19.5	20.3	21.4
MAXIMUM	24.5	20.2	18.3	12.9	10.8	11.3	13.2	16	20.7	23.3	24.8	25.4
STD. DEV.	1.49	1.38	1.37	1.51	1.42	1.46	1.64	1.46	1.27	1.1	1.33	1.21
SKEWNESS	0.39	-0.08	1.78	-0.14	0.28	0	-0.23	-0.06	0.06	0.05	-0.2	0.37

Table 3.3: Relative Humidity - Station Bhamdoun

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
1950 - 1951	68	64	70	62	65	68	54	58	51	67	62	60
1951 - 1952	68	76	70	81	71	no	59	59	52	56	60	56
1952-1953	54	65	72	68	73	69	77	63	62	60	53	60
1953-1954	62	56	74	76	82	79	62	71	50	60	52	56
1954-1955	64	60	72	79	71	64	71	----	62	50	59	69
1955 - 1956	64	54	76	80	76	67	79	60	62	56	51	47
1956-1957	56	56	58	76	70	76	70	----	64	64	60	68
1957 - 1958	----	71	----	----	82	74	63	52	67	67	61	61
1958-1959	73	74	62	74	77	76	75	58	56	56	68	65
1959 - 1960	69	72	68	65	----	65	65	62	----	----	56	53
1960 - 1961	----	----	----	----	----	----	----	56	49	47	53	58
1961 - 1962	66	59	61	68	----	68	53	62	54	48	55	56
1962 - 1963	55	60	44	66	----	----	67	58	----	----	----	57
1963 - 1964	---	----	59	59	68	73	64	61	57	58	58	----
1964 -1965	59	----	----	----	----	----	----	----	----	54	----	----
1965 - 1966	49	69	67	70	64	62		50	52	46	51	56
1966-1967	66	55	49	64	60	60	60	57	54	52	53	61
1967 - 1968	65	58	71	70	75	66	64	59	61	60	51	61
1968 - 1969	----	71	70	no	74	80	64	83	62	54	59	61
1969 -1970	----	78	52	67	71	69	58	57	54	64	73	64
1970 - 1971	62	67	----	----	----	----	----	----	----	----	----	----
AVERAGE	62.5	64.72	64.41	70.71	71.93	70.18	65	60.35	57	56.61	57.5	59.39
MEDIAN	64	64.5	68	70	71	69	64	59	56	56	57	60
MINIMUM	49	54	44	59	60	60	53	50	49	46	51	47
MAXIMUM	73	78	76	81	82	80	79	83	67	67	73	69
STD. DEV.	6.19	7.56	9.06	6.46	5.97	5.87	7.26	7.19	5.38	6.33	5.9	5.15
SKEWNESS	-0.51	0.18	-0.82	0.02	-0.1	0.09	0.31	1.74	0.19	0.01	1.02	-0.21

Table 3.4: Relative Humidity - Station Kfar Nabrakh

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
1955 - 1956	----	----	----	----	----	----	----	----	----	----	31	53
1956-1957	60	66	----	----	----	----	----	----	----	----	----	----
1957 - 1958	----	----	----	----	----	----	----	42	50	50	49	50
1958-1959	56	57	49	57	----	----	----	----	40	45	53	51
1959 - 1960	52	54	51	52	54	47	48	50	30	44	47	45
1960 - 1961	----	----	----	----	----	----	----	49	43	41	46	48
1961 - 1962	57	48	51	57	55	55	40	47	----	----	43	45
1962 - 1963	42	47	33	52	----	----	----	----	----	----	----	43
1963 - 1964	----	----	47	47	74	78	72	71	----	67	64	----
1964 -1965	65	----	----	----	----	----	----	----	----	----	----	----
1965 - 1966	----	----	----	----	----	----	----	----	----	----	----	----
1966-1967	----	----	----	----	78	82	80	---	80	73	77	78
1967 - 1968	80	82	84	84	88	85	85	76	82	84	81	84
1968 - 1969	83	87	86	74	76	66	65	81	57	59	66	63
1969 -1970	----	74	----	----	80	72	75	67	63	64	72	66
1970 - 1971	68	70	----	----	----	----	----	61	----	----	----	----
AVERAGE	62.56	65	57.29	60.43	72.14	69.29	66.43	60.44	55.63	58.56	57.18	56.91
MEDIAN	60	66	51	57	76	72	72	61	53.5	59	53	51
MINIMUM	42	47	33	47	54	47	40	42	30	41	31	43
MAXIMUM	83	87	86	84	88	85	85	81	82	84	81	84
STD. DEV.	12.35	13.65	18.44	12.45	11.89	13.11	15.46	13.25	17.46	13.88	15.09	13.32
SKEWNESS	0.22	0.17	0.6	0.88	-0.53	0.41	-0.58	0.12	0.24	0.36	0.04	0.88

Table 3.5: Monthly Evaporation - Station Bhamdoun

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
1950 - 1951	119	101	86	109	67	41	84	108	123	94	110	102
1951 - 1952	83	52	75	47	75	61	78	99	117	110	90	103
1952-1953	128	102	69	93	72	70	45	82	127	100	131	72
1953-1954	97	97	43	41	36	50	99	78	138	116	136	138
1954-1955	102	112	68	51	69	72	66	70	101	138	138	102
1955 - 1956	108	156	70	61	53	83	41	103	101	121	136	151
1956-1957	94	97	81	47	46	24	54	80	110	95	105	118
1957 - 1958	70	103	52	50	38	35	75	95	84	81	102	118
1958-1959	61	52	80	54	45	19	44	86	110	79	76	86
1959 - 1960	76	52	55	63	49	56	54	45	140	92	108	112
1960 - 1961	----	----	----	----	32.1	----	----	75	106.2	114.6	114.7	114.5
1961 - 1962	66	79	61	42	40	36	84	47	90	126	114	115
1962 - 1963	112	64	116	55	----	----	48	80	----	----	----	108
1963 - 1964	----	----	66	65	31	29	57	----	----	----	104	----
1964 -1965	74	150	115	61	36	46	87	----	98	132	124	104
1965 - 1966	90	66	63	57	57	40	----	113	70	135	125	132
1966-1967	89	114	143	62	52	35	60	96	96	153	163	175
1967 - 1968	109	102	72	62	44	70	80	99	176	160	196	140
1968 - 1969	75	64	67	46	36	69	60	87	155	165	132	150
1969 -1970	----	84	93	71	50	51	96	152	141	144	112	157
1970 - 1971	129	129	----	----	----	----	----	----	----	----	----	----
AVERAGE	93.44	93.47	77.63	59.84	48.85	49.28	67.33	88.61	115.73	119.76	121.93	120.92
MEDIAN	93	93.5	78	60	49	49	67	89	116	120	122	121
MINIMUM	61	52	43	41	31	19	41	45	70	79	76	72
MAXIMUM	129	150	143	109	72	83	99	152	176	165	196	175
STD. DEV.	21	31	24.5	17	14	18.5	18.4	24	26.7	26.4	26.6	26
SKEWNESS	0.19	0.38	1.2	1.61	0.58	0.15	0.19	0.49	0.5	0.11	1.01	0.27

Table 3.6: Monthly Evaporation - Station Kfar Nabrakh												
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
1955 - 1956	----	111	49	46	35	67	----	----	68	98	104	133
1956-1957	104	89	76	39	34	----	45	67	74	72	----	----
1957 - 1958	----	----	----	----	----	----	81	81	73	82	77	95
1958-1959	60	47	60	42	----	----	----	----	----	----	----	----
1959 - 1960	----	----	----	----	----	----	----	----	----	----	----	----
1960 - 1961	----	----	----	----	----	----	----	55	89.2	101.3	92	85
1961 - 1962	68	69	53	39	30	----	64	----	----	----	82	82
1962 - 1963	81	54	75	63	----	----	----	----	----	----	----	----
1963 - 1964	----	----	47	43	23	23	39	40	55	67	75	----
1964 -1965	58	106	45	40	20	30	60	----	74	100	99	66
1965 - 1966	74	41	39	34	40	29	----	59	71	96	85	73
1966-1967	44	46	63	28	27	15	26	42	40	76	77	80
1967 - 1968	54	50	31	25	24	28	33	52	67	68	77	90
1968 - 1969	58	36	35	40	25	48	175(?)	42	92	90	79	85
1969 -1970	----	54	53	----	37	34	63	84	78	87	71	87
1970 - 1971	71	57	----	----	----	----	----	----	----	----	----	----
AVERAGE	67.2	63.33	52.17	39.91	29.5	34.25	45.67	58	71.02	85.21	83.45	87.6
MEDIAN	67	63	52	40	29.5	34	65	58	71	85	83.5	87.6
MINIMUM	54	36	31	25	20	15	26	40	40	67	71	66
MAXIMUM	104	111	76	63	40	67	175	84	92	101	104	133
STD. DEV.	16.8	25.2	14.4	10	6.7	16.2	44.7	16.5	14.4	12.9	10.5	18
SKEWNESS	0.89	0.93	0.31	0.79	0.17	1.03	-0.43	0.48	-0.64	-0.16	0.86	1.62

Table 3.7: Monthly And Annual Precipitation 1944-45 Through 1970-71 – Aain-Zahlta - Station No. 512

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1944 - 1945	0	38	294	182	406	115	158	40	30	0	0	0	1263
1945-1946	4	0	56	266	104	387	225	21	161	0	0	0	1224
1946 - 1947	0	11	10	129	671	178	47	34	71	0	0	0	1151
1947 - 1948	4	10	103	89	270	468	284	124	112	0	0	0	1464
1948- 1949	4	12	292	242	305	227	208	141	0	0	0	0	1431
1949 - 1950	6	0	17	219	382	82	124	70	61	0	0	0	961
1950-1951	10	106	48	154	167	151	67	129	6	0	0	0	838
1951 -1952	0	95	92	435	113	333	285	9	0	0	0	0	1362
1952-1953	0	12	126	188	331	329	376	54	9	0	0	0	1425
1953 - 1954	0	40	228	94	424	401	108	160	0	0	0	0	1455
1954 - 1955	0	0	90	150	40	143	220	73	14	0	0	0	730
1955 - 1956	0	6	221	183	273	138	179	7	88	0	0	0	1095
1956-1957	0	15	80	112	279	103	134	82	34	1	0	0	840
1957 - 1958	0	26	62	270	316	34	105	46	25	0	0	0	884
1958 - 1959	14	30	13	180	240	157	103	55	48	6	0	0	846
1959 - 1960	72	32	87	73	200	84	239	95	11	0	0	0	893
1960 - 1961	0	10	159	101	264	221	188	20	19	0	0	0	982
1961 -1962	0	13	153	302	202	263	60	66	12	0	0	0	1071
1962-1963	0	86	0	335	258	302	243	166	54	0	0	0	1444
1963 -1964	0	82	51	156	143	370	255	56	55	0	0	0	1168
1964 -1965	0	0	341	58	263	292	150	150	14	15	0	0	1283
1965 - 1966	0	153	116	314	207	160	202	6	10	0	0	0	1168
1966-1967	4	36	17	456	270	363	381	90	140	0	0	0	1757
1967 - 1968	0	128	148	320	639	143	109	26	23	0	0	2	1538
1968 - 1969	0	46	161	607	675	136	325	94	26	0	0	0	2070
1969 -1970	0	73	104	182	252	168	317	78	11	0	0	0	1185
1970 -1971	0	51	99	254	145	401	168	452	0	0	0	0	1570
TOTAL	118	1111	3168	6051	7839	6149	5260	2344	1034	22	0	2	33098
AVERAGE	4.37	41.15	117.33	224.11	290.33	227.74	194.81	86.81	38.3	0.81	0	0.07	1225.85
MEDIAN	0	30	99	183	264	178	188	70	23	0	0	0	1185
MINIMUM	0	0	0	58	40	34	47	6	0	0	0	0	730
MAXIMUM	72	153	341	607	675	468	381	452	161	15	0	2	2070

STD. DEV.	13.7	41.49	89.74	126.42	158.01	117.69	91.48	85.49	42.37	3.01	0	0.38	308.77
SKEWNESS	4.45	1.12	0.9	1.16	1.14	0.36	0.34	2.81	1.5	4.06	0	4.9	0.59

Table 3.8: Monthly And Annual Precipitation 1944-45 Through 1970-71 – Kfar Nabrakh - Station No. 514													
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1944 - 1945	0	34	311	208	424	384	149	40	28	18	0	0	1596
1945-1946	4	3	80	305	119	436	256	16	214	0	0	0	1433
1946 - 1947	1	104	2	169	678	227	55	26	26	6	0	0	1294
1947 - 1948	10	9	137	83	294	586	340	103	61	0	0	0	1623
1948- 1949	7	18	248	267	347	367	246	200	2	0	0	0	1702
1949 - 1950	18	1	13	309	299	178	195	48	56	0	0	0	1117
1950-1951	11	98	75	222	260	148	110	142	9	0	0	0	1075
1951 -1952	4	118	116	489	144	327	231	52	4	0	0	0	1485
1952-1953	0	18	165	200	336	411	383	71	13	0	0	0	1597
1953 - 1954	2	0	306	149	449	429	106	190	17	0	0	0	1648
1954 - 1955	2	4	105	167	52	201	239	114	31	0	0	0	915
1955 - 1956	1	36	245	244	351	230	200	25	91	0	0	0	1423
1956-1957	0	14	100	221	311	121	233	79	72	6	0	0	1157
1957 - 1958	0	58	82	286	390	73	112	36	20	0	0	0	1057
1958 - 1959	18	59	15	182	328	202	115	45	36	0	0	0	1000
1959 - 1960	20	37	99	78	275	73	227	103	7	0	0	0	919
1960 - 1961	0	19	118	92	231	175	145	63	17	0	0	0	860
1961 -1962	0	14	138	314	190	342	53	43	7	1	0	0	1102
1962-1963	0	94	0	475	400	327	239	153	28	0	0	0	1716
1963 -1964	0	90	108	123	160	360	253	65	52	0	0	0	1211
1964 -1965	0	0	380	64	206	247	123	127	8	7	0	0	1162
1965 - 1966	0	113	117	329	245	131	141	7	6	0	0	0	1089
1966-1967	1	47	19	390	322	285	390	66	91	0	0	0	1611
1967 - 1968	3	89	139	257	365	103	72	18	15	0	0	0	1061
1968 - 1969	0	40	188	501	610	67	291	59	10	0	0	0	1766
1969 -1970	0	79	88	207	241	143	282	63	17	0	0	0	1120
1970 -1971	5	38	94	233	116	370	117	383	0	0	0	0	1356
TOTAL	107	1234	3488	6564	8143	6943	5303	2337	938	38	0	0	35095
AVERAGE	3.96	45.7	129.19	243.11	301.59	257.15	196.41	86.56	34.74	1.41	0	0	1299.81
MEDIAN	1	37	108	222	299	230	200	63	17	0	0	0	1211
MINIMUM	0	0	0	64	52	67	53	7	0	0	0	0	860
MAXIMUM	20	118	380	501	678	586	390	383	214	18	0	0	1766

STD. DEV.	6	38.12	95.27	118.17	137.82	132.03	92.42	76.84	43.49	3.81	0	0	276.27
SKEWNESS	1.62	0.49	0.93	0.62	0.74	0.41	0.35	2.2	2.67	3.26	0	0	0.19

Table 3.9: Monthly And Annual Precipitation 1944-45 Through 1970-71 – Jdeit-Ech-Chouf - Station No. 516													
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1944 - 1945	0	38	375	167	362	288	146	52	28	0	0	0	1456
1945-1946	0	10	102	235	112	474	217	18	254	0	0	0	1422
1946 - 1947	0	64	0	157	607	198	59	55	86	0	0	0	1226
1947 - 1948	6	3	122	91	240	508	273	110	94	0	0	0	1447
1948- 1949	0	19	415	463	548	742	516	306	0	0	0	0	3009
1949 - 1950	6	0	19	293	296	163	192	70	55	0	0	0	1094
1950-1951	5	63	85	181	235	165	121	140	12	0	0	0	1007
1951 -1952	0	153	87	476	137	293	241	48	0	0	0	0	1435
1952-1953	0	20	171	157	324	392	351	53	12	0	0	0	1480
1953 - 1954	0	0	265	152	476	374	102	155	16	0	0	0	1540
1954 - 1955	0	0	108	174	53	194	220	128	35	0	0	0	912
1955 - 1956	0	26	231	270	272	201	199	18	87	0	0	0	1304
1956-1957	0	0	111	240	282	166	179	47	78	5	0	0	1108
1957 - 1958	0	51	70	300	378	52	114	39	12	0	0	0	1016
1958 - 1959	0	43	10	197	294	217	118	19	36	10	0	0	944
1959 - 1960	11	44	70	80	186	74	200	99	4	0	0	0	768
1960 - 1961	0	21	170	92	237	228	209	69	22	0	0	0	1048
1961 -1962	10	24	127	300	169	300	37	24	8	0	0	0	999
1962-1963	0	95	1	355	395	238	251	125	16	0	0	0	1476
1963 -1964	2	73	90	152	181	386	239	41	59	0	0	0	1223
1964 -1965	1	1	358	55	236	263	116	132	2	7	0	0	1171
1965 - 1966	0	61	138	292	219	137	173	9	7	0	0	0	1036
1966-1967	2	46	21	463	335	315	423	89	81	0	0	0	1775
1967 - 1968	1	90	111	302	470	116	78	28	25	0	0	0	1221
1968 - 1969	0	54	188	507	703	104	341	83	16	0	0	0	1996
1969 -1970	0	77	109	182	260	161	369	83	13	0	0	0	1254
1970 -1971	0	50	79	215	134	391	170	402	1	0	0	0	1442
TOTAL	44	1126	3633	6548	8141	7140	5654	2442	1059	22	0	0	35809
AVERAGE	1.63	41.7	134.56	242.52	301.52	264.44	209.41	90.44	39.22	0.81	0	0	1326.26
MEDIAN	0	43	109	215	272	228	199	69	16	0	0	0	1226
MINIMUM	0	0	0	55	53	52	37	9	0	0	0	0	768
MAXIMUM	11	153	415	507	703	742	516	402	254	10	0	0	3009

STD. DEV.	3.08	35.77	108.48	123.1	151.38	148.97	111.18	85.94	51.59	2.4	0	0	425.95
SKEWNESS	1.95	1.02	1.15	0.66	0.87	1.22	0.88	2.22	2.69	2.86	0	0	2.26

Table 3.10: Monthly And Annual Precipitation 1944-45 Through 1970-71 – Jezzine- Station No. 519													
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1944 - 1945	0	18	371	166	391	260	107	57	28	0	0	0	1398
1945-1946	0	2	96	312	55	514	244	16	262	0	0	0	1501
1946 - 1947	0	75	0	121	756	174	37	45	47	0	0	0	1255
1947 - 1948	6	11	216	95	278	517	309	139	91	0	0	0	1662
1948- 1949	0	15	218	316	404	386	295	189	0	0	0	0	1823
1949 - 1950	6	0	15	280	286	160	180	52	56	0	0	0	1035
1950-1951	5	148	66	181	251	174	106	161	0	0	0	0	1092
1951 -1952	0	125	116	448	129	321	120	42	0	0	0	0	1301
1952-1953	0	24	145	219	283	422	526	48	0	0	0	0	1667
1953 - 1954	0	0	184	129	494	300	123	223	12	0	0	0	1465
1954 - 1955	0	0	84	200	59	110	225	137	30	0	0	0	845
1955 - 1956	0	24	233	231	371	197	255	16	92	0	0	0	1419
1956-1957	0	0	64	95	262	150	130	69	60	5	0	0	835
1957 - 1958	0	30	135	437	496	29	50	20	12	0	0	0	1209
1958 - 1959	11	57	14	185	210	120	100	21	15	9	0	0	742
1959 - 1960	16	47	43	18	248	10.3	98	57	7.3	0	0	0	544.6
1960 - 1961	0	10	110	63	281	241	176	74	10	0	0	0	965
1961 -1962	0	30	96	397	175	320	33	33	33	0	0	0	1117
1962-1963	0	39	0	388	264	324	149	102	16	0	0	0	1282
1963 -1964	0	63	85	140	194	418	258	39	58	0	0	0	1255
1964 -1965	0	0	349	62	264	306	137	133	0	5	0	0	1256
1965 - 1966	0	150	86	345	201	184	169	8	0	0	0	0	1143
1966-1967	25	45	16	414	403	392	518	89	53	0	0	0	1955
1967 - 1968	7	75	131	314	476	79	72	36	35	0	0	0	1225
1968 - 1969	0	60	193	623	687	95	407	64	10	0	0	0	2139
1969 -1970	0	130	190	192	199	148	393	83	17	0	0	0	1352
1970 -1971	0	37	80	228	141	429	187	483	0	0	0	0	1585
TOTAL	76	1215	3336	6599	8258	6780.3	5404	2436	944.3	19	0	0	35067.6
AVERAGE	2.81	45	123.56	244.41	305.85	251.12	200.15	90.22	34.97	0.7	0	0	1298.8
MEDIAN	0	30	96	219	264	241	169	57	16	0	0	0	1256
MINIMUM	0	0	0	18	55	10.3	33	8	0	0	0	0	544.6
MAXIMUM	25	150	371	623	756	517	526	483	262	9	0	0	2139

STD. DEV.	5.88	45.2	94.75	141.62	165.17	140.63	132.57	94.44	51.92	2.09	0	0	357.81
SKEWNESS	2.45	1.1	0.94	0.62	0.98	0.21	1.04	2.71	3.1	2.94	0	0	0.23

Table 3.11: Monthly And Annual Precipitation 2001-2002 Through 2008-2009 – Jezzine

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
2001-2002	0.4	77.8	101.5	210.5	225.1	104.8	75.5	36.4	18.5	3.5	1.5	0.6	856.1
2002-2003	4.5	35.6	124.2	245.5	204.5	310.3	177.5	45.5	16.4	4.8	3.6	4.8	1177.2
2003-2004	3.7	12	88.6	135.5	348.2	186.8	133.5	66.4	23.4	3.2	1.5	6.8	1009.6
2004-2005	0	20.1	189.8	75.1	227.3	170.5	49.2	1.2	42.7	0.2	0	1.4	777.5
2005-2006	1.4	54.1	217.2	203.1	236.8	133.6	19.2	218	3.2	0	1	0.8	1088.4
2006-2007	11.9	165.5	125.1	67	248.7	425.6	153.2	24.6	24.8	1.4	0.8	1.6	1250.2
2007-2008	2.2	8.2	204.8	232.8	226.6	202.8	71.2	2	0	3.8	0	0.4	954.8
2008-2009	69	63.6	71.4	224.3	113.8	331.2	122.8	8.6	11.2	0.2	10	1.2	1027.3
TOTAL	93.1	436.9	1122.6	1393.8	1831	1865.6	802.1	402.7	140.2	17.1	18.4	17.6	8141.1
AVERAGE	11.64	54.61	140.33	174.23	228.88	233.2	100.2	50.34	17.53	2.14	2.3	2.2	1017.64
MEDIAN	2.95	44.85	124.65	206.8	226.95	194.8	99.15	30.5	17.45	2.3	1.25	1.3	1018.45
MINIMUM	0	8.2	71.4	67	113.8	104.8	19.2	1.2	0	0	0	0.4	777.5
MAXIMUM	69	165.5	217.2	245.5	348.2	425.6	177.5	218	42.7	4.8	10	6.8	1250.2
STD. DEV.	23.48	51.32	55.98	71.7	63.87	110.83	54.79	71.46	13.5	1.91	3.31	2.32	156.94
SKEWNESS	2.69	1.62	0.34	-0.78	0.12	0.71	-0.06	2.29	0.62	0.07	2.24	1.53	-0.06

Table 3.12: Monthly And Annual Precipitation 2001-2002 Through 2008-2009 – EL-Barouk_Fraidis													
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
2001-2002	2.6	88.5	10.5	203	222.5	197.5	133.5	75.4	33.5	0.8	0	0	967.8
2002-2003	3.5	27.5	99.7	187.5	185.7	311.2	177.5	33.5	5.3	1.2	2.5	0	1035.1
2003-2004	7.5	19.5	66.4	132.5	188.4	113.4	45.5	22.4	8.5	3.2	0	5.4	612.7
2004-2005	17.8	65.4	222.5	198.5	311.6	244.4	88.5	55.4	18.4	3.2	4.4	0	1230.1
2005-2006	3.3	77.5	135.5	156.5	234.7	155.5	123.4	165.4	11.4	2.5	0	3.6	1069.3
2006-2007	13.5	175.5	165.5	153.7	173.4	244.6	150.4	45.5	17.5	0.5	0	0.4	1140.5
2007-2008	2.8	6.8	164.6	174.5	176	150.5	81.3	5.2	11.5	0	0	0.2	773.4
2008-2009	99.5	95.5	70.4	204.3	103.5	144.6	256.6	63.3	18.4	5.8	0.6	2.4	1001.6
TOTAL	150.5	556.2	935.1	1410.5	1595.8	1561.7	1056.7	402.8	124.5	17.2	7.5	12	7830.5
AVERAGE	18.81	69.53	116.89	176.31	199.48	195.21	132.09	57.54	15.56	2.15	0.94	1.5	978.81
MEDIAN	5.5	71.45	117.6	181	187.05	176.5	128.45	45.5	14.5	1.85	0	0.3	1018.35
MINIMUM	2.6	6.8	10.5	132.5	103.5	113.4	45.5	5.2	5.3	0	0	0	612.7
MAXIMUM	99.5	175.5	222.5	204.3	311.6	311.2	256.6	165.4	33.5	5.8	4.4	5.4	1230.1
STD. DEV.	33.08	54.18	68.1	26.56	59.88	66.71	65.42	52.69	8.71	1.92	1.64	2.07	199.11
SKEWNESS	2.67	0.92	-0.02	-0.51	0.49	0.62	0.79	1.69	1.23	0.9	1.76	1.19	-0.89

Table 3.13: Monthly And Annual Precipitation 2001-2002 Through 2008-2009 – Deir El_kamar													
YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
2001-2002	0.4	113.5	94	189	244	186	146	57.3	45.6	1	0	0.6	1077.4
2002-2003	3	33	115	223	192	298	167.5	29.5	2.2	0	0.4	0	1063.6
2003-2004	13.3	23.5	56.4	128.4	190.5	133	12.5	12.4	1.5	1	0	6.8	579.3
2004-2005	13.5	48.7	298.6	230	358.5	238.9	65.6	44.9	28.6	0.6	2.4	1.4	1331.7
2005-2006	0.4	89.3	164.7	151.1	240.8	149.8	117.7	153.1	7.4	0.8	0.4	1	1076.5
2006-2007	1.8	214.9	156.8	147	180.6	283.2	139.6	20.7	24.7	1	0.2	1.2	1171.7
2007-2008	3.2	4.4	190.9	186.8	213.5	183	65.4	3	8.2	0.6	1.6	32.5	893.1
2008-2009	81.4	104.8	71.8	237.3	64.2	362.8	216.4	18.6	8.45	0	4.4	0	1170.15
TOTAL	117	632.1	1148.2	1492.6	1684.1	1834.7	930.7	339.5	126.65	5	9.4	43.5	8363.45
AVERAGE	14.63	79.01	143.53	186.58	210.51	229.34	116.34	42.44	15.83	0.63	1.18	5.44	1045.43
MEDIAN	3.1	69	135.9	187.9	202.75	212.45	128.65	25.1	8.33	0.7	0.4	1.1	1076.95
MINIMUM	0.4	4.4	56.4	128.4	64.2	133	12.5	3	1.5	0	0	0	579.3
MAXIMUM	81.4	214.9	298.6	237.3	358.5	362.8	216.4	153.1	45.6	1	4.4	32.5	1331.7
STD. DEV.	27.51	67.73	78.3	41.4	81.93	80.31	65.47	48.02	15.6	0.42	1.56	11.15	225.59
SKEWNESS	2.62	1.14	1.06	-0.11	0.05	0.47	-0.14	2.14	1.12	-0.83	1.53	2.63	-1.28

Table 3.14: Monthly And Annual Precipitation 1964-1965 Through 1969-1970 and 1991-1992 Trough 2008-2009 – Jbaa-Ech-Chouf

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1964-1965	0.5	66.5	347.6	57.9	194.8	196	116.3	134	0	0	0	0	1113.6
1965-1966	0	102	145	234.5	198.4	122.6	113	10.5	0	0	0	0	926
1966-1967	0	21	19.2	318	302.8	265.7	297	65	85	0	0	0	1373.7
1967-1968	0	90.5	84.7	347.5	526.6	36	53.9	9.3	25	0	0	0	1173.5
1968-1969	0	14.4	145.8	611.5	637.8	73.7	311.8	105.4	0	0	0	0	1900.4
1969-1970	0	119	136.5	182.4	312.5	176.5	128.4	84.4	20.08	0	0	0	1159.78
1991-1992	4.5	94.5	232	436.9	368.9	603	122	25	84.5	0	0	0	1971.3
1992-1993	4	62	183.7	404	179	161	139.5	12.5	67.7	0	0	0	1213.4
1993-1994	0	2	205	81	289	283.5	125	62.5	21.5	0	0	0	1069.5
1994-1995	3	66.5	310.5	389	140	135	114	41.5	9	0	0	0	1208.5
1995-1996	0	10.5	270.5	64.5	365.5	166	352.5	90.5	19.5	0	0	0	1339.5
1996-1997	13	154	9.5	189	101	117	204.5	107.5	37.5	0	0	0	933
1997-1998	0	51.5	153.5	250	173	137	333.5	30.5	35	0	0	0	1164
1998-1999	0	16	37.5	220	161	111	153.5	33	0	0	0	0	732
1999-2000	0	22	30.5	81	441	135	78.5	29.5	0	0	0	0	817.5
2000-2001	34	100	7	246.5	91.5	238.5	151	65	13	0	0	0	946.5
2001-2002	0	70	125.5	191.5	354.5	142	140.5	140.5	0	0	0	0	1164.5
2002-2003	0	28.5	152.5	416.5	241	603.5	458.5	126.5	0	0	0	0	2027
2003-2004	13	56.46	143.14	247.49	287.5	311.5	207.5	56.5	0	0	0	0	1323.09
2004-2005	0	32	312.5	49	279	396	307.5	113.4	7.5	1.3	0	0	1498.2
2005-2006	3.4	24.5	165.5	222.4	198.7	132	71	212	0	0	0	0	1029.5
2006-2007	1.5	13.8	115.4	145.5	175.5	234.5	177.5	34.5	4.5	0	0	0	902.7
2007-2008	3.5	22.4	158.4	164.5	186.7	175.5	93.4	11.5	14.5	0	0	0	830.4
2008-2009	112.5	105.4	75.4	222.4	138	357.5	231.5	119	10	0	0	0	1371.7
TOTAL	192.9	1345.46	3566.8	5773	6343.7	5310	4481.8	1720	454.28	1.3	0	0	29189.28
AVERAGE	8.04	56.06	148.62	240.54	264.32	221.25	186.74	71.67	18.93	0.05	0	0	1216.22
MEDIAN	0	53.98	145.4	222.4	219.85	170.75	145.75	63.75	9.5	0	0	0	1164.25
MINIMUM	0	2	7	49	91.5	36	53.9	9.3	0	0	0	0	732
MAXIMUM	112.5	154	347.6	611.5	637.8	603.5	458.5	212	85	1.3	0	0	2027
STD. DEV.	23.47	41.25	96.24	139.85	134.51	146.24	104.96	52.27	25.95	0.27	0	0	349.28
SKEWNESS	4.22	0.64	0.41	0.78	1.18	1.57	1.02	0.83	1.71	4.9	0	0	1.08

Table 3.15: Monthly And Annual Precipitation 2002-2003 Through 2008-2009 – Meshref

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
2002-2003	14.4	28.2	128.2	241	211.5	317.2	187.8	49.3	2.2	0	0.4	0	1180.2
2003-2004	33.2	25	70.4	148.5	210.7	152.2	16.4	11.2	2	0.2	0	23.8	693.6
2004-2005	12.4	20.2	205	90.6	228.5	2.6	27.1	12.8	9.3	0.4	0.2	0	609.1
2005-2006	0.4	135.7	170.7	123.2	258.6	117.9	117.6	133.7	5	2	1.8	1.2	1067.8
2006-2007	6.8	163.5	104.5	83.1	175.7	230.7	83	12.2	15	1.2	0.8	0	876.5
2007-2008	3.2	64.4	112.2	189.2	233.5	210.5	75.4	11.5	10.4	2.2	0.4	22.4	935.3
2008-2009	61.4	88.5	81.4	217.4	168.4	204.2	146.5	28.8	7.2	0.6	2	1.4	1007.8
TOTAL	131.8	525.5	872.4	1093	1486.9	1235.3	653.8	259.5	51.1	6.6	5.6	48.8	6370.3
AVERAGE	18.83	75.07	124.63	156.14	212.41	176.47	93.4	37.07	7.3	0.94	0.8	6.97	910.04
MEDIAN	12.4	64.4	112.2	148.5	211.5	204.2	83	12.8	7.2	0.6	0.4	1.2	935.3
MINIMUM	0.4	20.2	70.4	83.1	168.4	2.6	16.4	11.2	2	0	0	0	609.1
MAXIMUM	61.4	163.5	205	241	258.6	317.2	187.8	133.7	15	2.2	2	23.8	1180.2
STD. DEV.	21.63	57.02	48.24	61.67	31.95	99.1	62.01	44.88	4.7	0.88	0.79	11.04	202.73
SKEWNESS	1.57	0.66	0.76	0.17	-0.16	-0.59	0.24	2.17	0.45	0.6	0.88	1.22	-0.36

Table 3.16: Bisri Basin Precipitation

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL
1944 - 1945	0	29	351	174	389	259	132	50	28	2	0	0	1417
1945-1946	1	4	89	281	88	471	235	17	236	0	0	0	1423
1946 - 1947	0	65	2	139	689	188	47	44	60	1	0	0	1234
1947 - 1948	6	8	160	91	268	515	298	124	92	0	0	0	1562
1948- 1949	2	16	291	339	421	459	337	216	0	0	0	0	2081
1949 - 1950	8	0	16	277	307	150	176	60	57	0	0	0	1050
1950 - 1951	7	110	70	182	233	164	104	147	6	0	0	0	1022
1951 - 1952	1	127	104	459	130	316	197	39	1	0	0	0	1373
1952 - 1953	0	20	152	194	310	396	432	53	7	0	0	0	1563
1953 - 1954	0	7	230	132	471	355	112	189	12	0	0	0	1508
1954 - 1955	0	1	95	180	53	151	225	121	29	0	0	0	854
1955 - 1956	0	23	232	236	323	192	219	16	90	0	0	0	1331
1956-1957	0	4	85	156	277	143	158	66	62	4	0	0	955
1957 - 1958	0	39	97	350	418	42	86	32	15	0	0	0	1079
1958 - 1959	9	49	13	187	254	165	108	29	29	8	0	0	851
1959 - 1960	25	42	65	53	226	49	168	81	7	0	0	0	716
1960 - 1961	0	14	137	81	259	225	184	62	16	0	0	0	978
1961 -1962	3	23	120	342	180	307	41	37	19	0	0	0	1073
1962-1963	0	70	0	381	318	296	206	126	24	0	0	0	1421
1963 -1964	1	73	84	144	177	393	251	46	57	0	0	0	1225
1964 -1965	0	0	354	60	248	284	131	135	4	8	0	0	1224
1965 - 1966	0	120	110	322	213	160	172	8	4	0	0	0	1110
1966-1967	12	44	18	432	351	351	451	86	81	0	0	0	1826
1967 - 1968	4	90	129	304	488	104	80	30	28	0	0	0	1256
1968 - 1969	0	53	185	571	680	101	359	74	14	0	0	0	2038
1969 -1970	0	99	139	189	231	154	359	80	15	0	0	0	1266
1970 -1971	1	43	85	229	136	406	170	442	0	0	0	0	1512
2001-2002	1	77	87	200	283	148	121	95	14	1	0	0	1027
2002-2003	2	30	130	306	216	443	305	79	6	2	2	1	1521
2003-2004	9	34	107	185	275	222	142	49	9	2	0	3	1039
2004-2005	5	38	255	98	275	293	177	67	20	2	1	0	1232
2005-2006	3	47	171	199	219	139	72	200	4	1	0	1	1056

2006-2007	8	100	132	127	194	288	163	35	14	1	0	1	1062
2007-2008	3	14	172	185	194	176	84	7	10	1	0	0	847
2008-2009	97	92	73	218	122	290	210	74	13	2	3	1	1194
TOTAL	205.77	1607.09	4538.32	8005.27	9916.19	8796.41	6712.90	3015.98	1080.53	32.79	6.99	8.39	43926.63
AVERAGE	5.88	45.92	129.67	228.72	283.32	251.33	191.80	86.17	30.87	0.94	0.20	0.24	1255.05
MINIMUM	0.00	0.13	0.29	52.82	53.15	42.08	41.30	7.20	0.26	0.00	0.00	0.00	715.87
MAXIMUM	97.32	127.04	354.19	571.37	688.80	514.92	451.06	441.68	236.39	7.63	2.81	3.33	2081.25
STD. DEV.	16.67	37.06	88.55	118.26	141.52	124.88	103.86	81.38	44.03	1.91	0.58	0.64	317.40
SKEWNESS	5.18	0.66	0.94	0.91	1.27	0.38	0.89	2.74	3.31	2.76	3.58	3.82	0.86

Table 3.17: Recorded Flows at Station Marj Bisri

Water Year	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	May	Aug	Annual
1952-1953	2.06	1.97	2.42	5.93	29.07	44.5	58.46	21.2	8.89	4.89	3.17	2.18	184.74
1953 - 1954	1.74	1.78	9.53	10.78	58	53.66	27.99	32.08	9.99	5.18	3.27	2.33	216.33
1954 - 1955	1.96	1.93	2.72	4.77	5.73	12.62	21.15	10.62	6.39	2.17	1.57	1.23	72.86
1955 - 1956	1.15	1.27	7.59	18.58	31.05	31.11	28.93	10.25	9	3.76	2.58	1.56	146.83
1956-1957	1.37	1.54	2.26	8.11	18.69	27.77	23.92	13.4	6.72	3.34	2	1.29	110.41
1957 - 1958	1.14	1.7	2.27	21.13	38.92	20.18	13.89	7.98	3.95	1.98	1.53	1.33	116
1958 - 1959	1.4	1.61	1.58	4.8	13.33	20.37	31.4	8.01	4.33	2.1	1.53	1.18	91.64
1959 - 1960	1.17	1.4	1.79	1.88	9.27	7.56	14.22	11.77	3.71	1.58	1.15	1.07	56.57
1960 - 1961	0.89	0.96	3.11	3.31	15.78	28.2	16	17.57	4.78	1.81	1.16	1.07	94.64
1961 -1962	1.03	1.2	2.78	25.39	18.44	36.84	10.42	5.12	4.15	2.25	1.77	1.43	110.82
1962-1963	0.71	1.33	1.67	21.18	25.27	49.46	32.94	16.68	12.44	4.36	3.02	1.93	170.99
1963 -1964	1.72	2.36	2.46	8.44	16.51	53.37	51.8	12.89	8.27	3.95	2.7	1.92	166.39
1964 -1965	1.58	1.64	15.56	7.1	24.33	49.15	16.87	23.29	6.32	2.98	1.79	1.21	151.82
1965 - 1966	0.89	1.58	2	18.28	18.16	20.9	15.64	8.14	3.63	1.82	1.07	0.58	92.69
1966-1967	0.79	1.21	1.07	24.29	29.38	41.61	73.22	25.46	13.8	6.34	4.03	2.65	223.85
1967 - 1968	1.85	2.58	3.17	20.38	67.04	32.16	19.67	9.85	6.92	3.87	2.44	1.69	171.62
1968 - 1969	1.22	1.75	3.37	68.86	76.6	43.1	32.08	18.81	11.33	5.24	3.09	1.97	267.42
1969 -1970	1.54	2.58	4.06	8.39	36.23	14.56	41.81	10.59	6.18	2.86	1.71	1.03	131.54
1970 -1971	0.8	1.23	1.69	11.72	9.11	45.55	29.85	63.45	15.34	6.1	3.71	1.91	190.46
1971-1972	1.43	1.45	2.2	23.33	21.36	27.19	9.52	11.03	7.26	3.61	1.95	1.61	111.94
1972-1973	1.61	1.22	2.15	2.13	5.52	9.01	22.15	9.8	3.72	1.97	1	0.82	61.1
1973 -1974	0	1.02	2.41	5.97	24.02	23.32	25.62	26.71	7.56	3.27	1.73	1.08	122.71
1982-1983	2.46	2.35	3.72	4.28	22.10	21.16	58.18	20.02	12.63	7.29	4.59	4.34	163.12
1983-1984	3.76	4.69	11.46	7.16	23.97	22.09	25.84	24.50	9.60	3.65	1.86	1.77	140.33
2001-2002	0.14	0.17	1.72	3.73	15.44	4.98	9.72	14.45	6.08	4.67	4.22	1.65	66.97
2002-2003	0.97	0.46	1.54	46.34	18.57	120.69	250.90	25.44	15.36	5.07	10.33	7.77	503.44
2003-2004	1.78	1.35	2.73	2.70	32.36	34.61	19.27	6.94	4.45	2.72	2.32	1.43	112.65
2004-2005	0.38	0.58	6.26	3.50	17.18	40.19	17.44	10.52	8.35	2.06	1.50	1.12	109.09
2005-2006	1.12	1.72	4.99	2.81	9.44	11.70	10.70	18.05	5.96	2.45	2.14	2.39	73.47
2006-2007	1.06	1.10	6.86	3.23	9.37	17.12	13.07	11.15	4.82	1.62	1.08	1.15	71.64
2007-2008	2.43	1.95	1.55	2.60	2.18	15.36	9.41	10.68	6.13	3.27	2.10	1.32	59.00
2008-2009	1.43	1.54	1.25	2.68	3.67	16.82	15.68	10.66	4.01	2.21	2.04	1.42	63.42

TOTAL	43.57	51.23	119.95	403.78	746.09	996.91	1047.76	527.12	242.06	110.46	80.16	57.42	4426.50
AVERAGE	1.36	1.60	3.75	12.62	23.32	31.15	32.74	16.47	7.56	3.45	2.50	1.79	138.33
MEDIAN	1.30	1.54	2.44	7.13	18.63	27.48	21.65	12.33	6.56	3.27	2.02	1.43	114.32
MINIMUM	0.00	0.17	1.07	1.88	2.18	4.98	9.41	5.12	3.63	1.58	1.00	0.58	56.57
MAXIMUM	3.76	4.69	15.56	68.86	76.60	120.69	250.90	63.45	15.36	7.29	10.33	7.77	503.44
STD. DEV.	0.72	0.79	3.27	14.31	17.25	21.58	42.82	10.94	3.45	1.51	1.72	1.29	85.26
SKEWNESS	0.99	1.81	2.25	2.48	1.62	2.35	4.55	2.75	0.91	0.79	3.25	3.62	2.71

Table 3.18: Derived Virgin Flows at Station Marj Bisri

Water Year	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	May	Aug	Annual
1952-1953	3.48	3.39	3.84	6.74	29.88	45.31	59.27	22.01	10.31	6.31	4.59	3.60	198.75
1953 - 1954	3.16	3.20	10.95	11.59	58.81	54.47	28.80	32.89	11.41	6.60	4.69	3.75	230.34
1954 - 1955	3.38	3.35	4.14	5.58	6.54	13.43	21.96	11.43	7.81	3.59	2.99	2.65	86.87
1955 - 1956	2.57	2.69	9.01	19.39	31.86	31.92	29.74	11.06	10.42	5.18	4.00	2.98	160.84
1956-1957	2.79	2.96	3.68	8.92	19.50	28.58	24.73	14.21	8.14	4.76	3.42	2.71	124.42
1957 - 1958	2.56	3.12	3.69	21.94	39.73	20.99	14.70	8.79	5.37	3.40	2.95	2.75	130.01
1958 - 1959	2.82	3.03	3.00	5.61	14.14	21.18	32.21	8.82	5.75	3.52	2.95	2.60	105.65
1959 - 1960	2.59	2.82	3.21	2.69	10.08	8.37	15.03	12.58	5.13	3.00	2.57	2.49	70.58
1960 - 1961	2.31	2.38	4.53	4.12	16.59	29.01	16.81	18.38	6.20	3.23	2.58	2.49	108.65
1961 -1962	2.45	2.62	4.20	26.20	19.25	37.65	11.23	5.93	5.57	3.67	3.19	2.85	124.83
1962-1963	2.13	2.75	3.09	21.99	26.08	50.27	33.75	17.49	13.86	5.78	4.44	3.35	185.00
1963 -1964	3.14	3.78	3.88	9.25	17.32	54.18	52.61	13.70	9.69	5.37	4.12	3.34	180.40
1964 -1965	3.00	3.06	16.98	7.91	25.14	49.96	17.68	24.10	7.74	4.40	3.21	2.63	165.83
1965 - 1966	2.31	3.00	3.42	19.09	18.97	21.71	16.45	8.95	5.05	3.24	2.49	2.00	106.70
1966-1967	2.21	2.63	2.49	25.10	30.19	42.42	74.03	26.27	15.22	7.76	5.45	4.07	237.86
1967 - 1968	3.27	4.00	4.59	21.19	67.85	32.97	20.48	10.66	8.34	5.29	3.86	3.11	185.63
1968 - 1969	2.64	3.17	4.79	69.67	77.41	43.91	32.89	19.62	12.75	6.66	4.51	3.39	281.43
1969 -1970	2.96	4.00	5.48	9.20	37.04	15.37	42.62	11.40	7.60	4.28	3.13	2.45	145.55
1970 -1971	2.22	2.65	3.11	12.53	9.92	46.36	30.66	64.26	16.76	7.52	5.13	3.33	204.47
1971-1972	2.85	2.87	3.62	24.14	22.17	28.00	10.33	11.84	8.68	5.03	3.37	3.03	125.95
1972-1973	3.03	2.64	3.57	2.94	6.33	9.82	22.96	10.61	5.14	3.39	2.42	2.24	75.11
1973 -1974	1.42	2.44	3.83	6.78	24.83	24.13	26.43	27.52	8.98	4.69	3.15	2.50	136.72
1982-1983	3.88	3.77	5.14	5.09	22.92	21.97	59.00	20.83	14.05	8.71	6.01	5.76	177.13
1983-1984	5.18	6.11	12.88	7.98	24.78	22.90	26.65	25.31	11.02	5.07	3.28	3.19	154.34
2001-2002	1.56	1.59	3.14	4.55	16.25	5.80	10.53	15.26	7.49	6.09	5.64	3.07	80.98
2002-2003	2.39	1.88	2.96	47.15	19.39	121.50	251.72	26.25	16.78	6.49	11.74	9.19	517.45
2003-2004	3.20	2.77	4.15	3.51	33.17	35.42	20.08	7.75	5.87	4.14	3.74	2.84	126.65
2004-2005	1.80	2.00	7.68	4.31	18.00	41.01	18.25	11.34	9.77	3.48	2.92	2.54	123.09
2005-2006	2.54	3.14	6.41	3.62	10.25	12.51	11.51	18.87	7.38	3.87	3.56	3.80	87.47
2006-2007	2.48	2.52	8.27	4.05	10.19	17.94	13.88	11.97	6.24	3.04	2.50	2.57	85.65
2007-2008	3.85	3.37	2.97	3.42	3.00	16.18	10.22	11.50	7.55	4.69	3.52	2.74	73.01
2008-2009	2.85	2.96	2.67	3.50	4.48	17.64	16.50	11.48	5.42	3.63	3.46	2.84	77.43

TOTAL	88.99	96.64	165.36	429.85	772.16	1022.98	1073.83	553.19	287.47	155.87	125.57	102.83	4874.74
AVERAGE	2.78	3.02	5.17	13.43	24.13	31.97	33.56	17.29	8.98	4.87	3.92	3.21	152.34
MEDIAN	2.71	2.96	3.86	7.95	19.45	28.29	22.46	13.14	7.97	4.69	3.44	2.85	128.33
MINIMUM	1.42	1.59	2.49	2.69	3.00	5.80	10.22	5.93	5.05	3.00	2.42	2.00	70.58
MAXIMUM	5.18	6.11	16.98	69.67	77.41	121.50	251.72	64.26	16.78	8.71	11.74	9.19	517.45
STD. DEV.	0.72	0.79	3.27	14.31	17.25	21.58	42.82	10.94	3.45	1.51	1.72	1.29	85.26
SKEWNESS	0.99	1.81	2.25	2.48	1.62	2.35	4.55	2.75	0.91	0.79	3.25	3.62	2.71

Table 3.19: Derived Virgin Flows at Bisri Damsite

Water Year	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	May	Aug	Annual
1952-53	3.37	3.28	3.72	6.53	28.94	43.89	57.41	21.32	9.98	6.11	4.44	3.49	192.48
1953-54	3.06	3.10	10.60	11.23	56.96	52.76	27.90	31.86	11.05	6.39	4.54	3.63	223.07
1954-55	3.27	3.24	4.01	5.41	6.34	13.01	21.27	11.07	7.56	3.48	2.89	2.57	84.13
1955-56	2.49	2.60	8.73	18.78	30.86	30.92	28.81	10.72	10.09	5.02	3.87	2.89	155.77
1956-57	2.70	2.87	3.56	8.64	18.89	27.68	23.95	13.77	7.88	4.61	3.31	2.62	120.49
1957-58	2.48	3.02	3.57	21.25	38.48	20.33	14.24	8.52	5.20	3.29	2.86	2.66	125.91
1958-59	2.73	2.93	2.90	5.44	13.70	20.52	31.20	8.55	5.57	3.41	2.86	2.52	102.32
1959-60	2.51	2.73	3.11	2.61	9.77	8.11	14.56	12.19	4.97	2.90	2.49	2.41	68.35
1960-61	2.24	2.30	4.39	3.99	16.07	28.10	16.28	17.80	6.00	3.13	2.50	2.41	105.22
1961-62	2.37	2.54	4.07	25.38	18.65	36.47	10.88	5.75	5.39	3.55	3.09	2.76	120.89
1962-63	2.06	2.66	2.99	21.30	25.26	48.69	32.69	16.94	13.42	5.60	4.30	3.24	179.16
1963-64	3.04	3.66	3.76	8.96	16.78	52.48	50.96	13.27	9.38	5.20	3.99	3.23	174.71
1964-65	2.90	2.96	16.44	7.67	24.35	48.39	17.13	23.34	7.50	4.26	3.11	2.55	160.60
1965-66	2.24	2.90	3.31	18.49	18.38	21.03	15.94	8.67	4.89	3.14	2.41	1.94	103.33
1966-67	2.14	2.55	2.41	24.31	29.24	41.09	71.70	25.45	14.74	7.51	5.28	3.94	230.36
1967-68	3.17	3.87	4.44	20.53	65.72	31.93	19.84	10.33	8.08	5.12	3.74	3.01	179.77
1968-69	2.56	3.07	4.64	67.48	74.97	42.53	31.86	19.01	12.35	6.45	4.37	3.28	272.55
1969-70	2.87	3.87	5.31	8.91	35.88	14.89	41.28	11.05	7.36	4.14	3.03	2.37	140.96
1970-71	2.15	2.57	3.01	12.14	9.61	44.90	29.70	62.24	16.23	7.28	4.97	3.22	198.02
1971-72	2.76	2.78	3.51	23.38	21.48	27.12	10.01	11.47	8.41	4.87	3.26	2.93	121.98
1972-73	2.93	2.56	3.46	2.85	6.13	9.51	22.24	10.28	4.98	3.28	2.34	2.17	72.74
1973-74	1.37	2.36	3.71	6.57	24.05	23.37	25.60	26.66	8.70	4.54	3.05	2.42	132.41
1982-83	3.76	3.65	4.98	4.93	22.19	21.28	57.14	20.18	13.61	8.44	5.82	5.58	171.55
1983-84	5.01	5.91	12.47	7.73	24.00	22.18	25.81	24.51	10.67	4.91	3.18	3.08	149.48
2001-02	1.51	1.54	3.04	4.41	15.74	5.62	10.20	14.78	7.26	5.90	5.46	2.97	78.43
2002-03	2.32	1.82	2.87	45.67	18.78	117.67	243.78	25.42	16.25	6.29	11.37	8.90	501.13
2003-04	3.10	2.69	4.02	3.40	32.13	34.31	19.45	7.51	5.68	4.01	3.62	2.76	122.66
2004-05	1.74	1.94	7.44	4.17	17.43	39.72	17.68	10.98	9.46	3.37	2.82	2.46	119.21
2005-06	2.46	3.04	6.21	3.51	9.93	12.12	11.15	18.27	7.15	3.75	3.45	3.68	84.72
2006-07	2.40	2.44	8.01	3.92	9.86	17.37	13.45	11.59	6.04	2.95	2.42	2.49	82.95
2007-08	3.73	3.27	2.88	3.31	2.90	15.67	9.90	11.14	7.31	4.54	3.41	2.66	70.71
2008-09	2.76	2.87	2.59	3.39	4.34	17.08	15.98	11.12	5.25	3.51	3.35	2.75	74.99

TOTAL	86.18	93.59	160.15	416.30	747.81	990.72	1039.97	535.75	278.40	150.95	121.61	99.59	4721.03
AVERAGE	2.69	2.92	5.00	13.01	23.37	30.96	32.50	16.74	8.70	4.72	3.80	3.11	147.53
MEDIAN	2.63	2.87	3.74	7.70	18.83	27.40	21.76	12.73	7.72	4.54	3.33	2.76	124.28
MINIMUM	1.37	1.54	2.41	2.61	2.90	5.62	9.90	5.75	4.89	2.90	2.34	1.94	68.35
MAXIMUM	5.01	5.91	16.44	67.48	74.97	117.67	243.78	62.24	16.25	8.44	11.37	8.90	501.13
STD. DEV.	0.70	0.76	3.16	13.86	16.71	20.90	41.47	10.59	3.34	1.47	1.66	1.25	82.58
SKEWNESS	0.99	1.81	2.25	2.48	1.62	2.35	4.55	2.75	0.91	0.79	3.25	3.62	2.71

Table 3.20: Synthesized Virgin Flows at Bisri Damsite

Water Year	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	May	Aug	Annual
1944-45	3.24	3.60	5.90	18.48	32.91	38.32	34.30	21.17	10.60	5.77	4.28	3.48	182.05
1945-46	3.26	3.62	5.93	18.57	33.08	38.52	34.48	21.28	10.65	5.80	4.30	3.50	182.99
1946-47	2.70	3.00	4.91	15.39	27.41	31.91	28.56	17.63	8.82	4.81	3.56	2.90	151.59
1947-48	3.67	4.08	6.68	20.92	37.26	43.39	38.83	23.97	12.00	6.53	4.84	3.94	206.11
1948-49	5.21	5.79	9.48	29.70	52.91	61.60	55.13	34.03	17.03	9.28	6.88	5.59	292.62
1949-50	2.15	2.39	3.92	12.27	21.86	25.46	22.78	14.06	7.04	3.83	2.84	2.31	120.93
1950-51	2.07	2.30	3.77	11.81	21.03	24.49	21.92	13.53	6.77	3.69	2.73	2.22	116.33
1951-52	3.11	3.46	5.66	17.74	31.61	36.80	32.93	20.33	10.17	5.54	4.11	3.34	174.81
1974-75	2.44	2.71	4.44	13.90	24.77	28.83	25.81	15.93	7.97	4.34	3.22	2.62	136.98
1975-76	3.09	3.43	5.62	17.61	31.36	36.51	32.68	20.17	10.10	5.50	4.08	3.31	173.46
1976-77	3.74	4.16	6.80	21.31	37.96	44.19	39.55	24.42	12.22	6.66	4.93	4.01	209.94
1977-78	4.47	4.97	8.13	25.47	45.38	52.83	47.28	29.19	14.61	7.96	5.90	4.79	250.98
1978-79	1.30	1.45	2.37	7.42	13.22	15.40	13.78	8.51	4.26	2.32	1.72	1.40	73.14
1979-80	3.98	4.43	7.25	22.70	40.43	47.07	42.13	26.01	13.01	7.09	5.26	4.27	223.62
1980-81	4.39	4.88	7.98	25.01	44.55	51.87	46.43	28.66	14.34	7.81	5.79	4.71	246.42
1981-82	2.03	2.26	3.70	11.59	20.64	24.03	21.51	13.28	6.65	3.62	2.68	2.18	114.18
1984-85	2.52	2.80	4.59	14.37	25.59	29.79	26.67	16.46	8.24	4.49	3.33	2.70	141.54
1985-86	1.22	1.36	2.22	6.96	12.40	14.44	12.92	7.98	3.99	2.17	1.61	1.31	68.58
1986-87	3.25	3.62	5.92	18.53	33.01	38.43	34.40	21.23	10.63	5.79	4.29	3.49	182.58
1987-88	4.47	4.97	8.13	25.47	45.38	52.83	47.28	29.19	14.61	7.96	5.90	4.79	250.98
1988-89	1.46	1.63	2.67	8.35	14.87	17.32	15.50	9.57	4.79	2.61	1.93	1.57	82.26
1989-90	0.65	0.73	1.19	3.72	6.63	7.72	6.91	4.26	2.13	1.16	0.86	0.70	36.66
1990-91	1.14	1.27	2.07	6.50	11.57	13.48	12.06	7.45	3.73	2.03	1.50	1.22	64.02
1991-92	5.85	6.50	10.64	33.34	59.39	69.15	61.89	38.20	19.12	10.41	7.72	6.27	328.50
1992-93	4.06	4.52	7.39	23.16	41.25	48.03	42.99	26.54	13.28	7.23	5.36	4.36	228.18
1993-94	2.03	2.26	3.70	11.59	20.64	24.03	21.51	13.28	6.65	3.62	2.68	2.18	114.18
1994-95	2.19	2.44	3.99	12.51	22.29	25.95	23.23	14.34	7.18	3.91	2.90	2.36	123.30
1995-96	2.03	2.26	3.70	11.59	20.64	24.03	21.51	13.28	6.65	3.62	2.68	2.18	114.18
1996-97	1.79	1.99	3.26	10.20	18.17	21.16	18.93	11.69	5.85	3.19	2.36	1.92	100.50
1997-98	2.28	2.53	4.14	12.98	23.12	26.91	24.09	14.87	7.44	4.05	3.00	2.44	127.86
1998-99	0.81	0.91	1.48	4.65	8.28	9.64	8.62	5.32	2.66	1.45	1.08	0.87	45.78
1999-00	0.86	0.95	1.56	4.88	8.69	10.12	9.05	5.59	2.80	1.52	1.13	0.92	48.06

2000-01	0.57	0.64	1.04	3.26	5.80	6.76	6.05	3.73	1.87	1.02	0.75	0.61	32.10
TOTAL	88.03	97.92	160.23	501.96	894.13	1041.01	931.72	575.15	287.82	156.77	116.22	94.46	4945.41
AVERAGE	2.67	2.97	4.86	15.21	27.09	31.55	28.23	17.43	8.72	4.75	3.52	2.86	149.86
MEDIAN	2.44	2.71	4.44	13.90	24.77	28.83	25.81	15.93	7.97	4.34	3.22	2.62	136.98
MINIMUM	0.57	0.64	1.04	3.26	5.80	6.76	6.05	3.73	1.87	1.02	0.75	0.61	32.10
MAXIMUM	5.85	6.50	10.64	33.34	59.39	69.15	61.89	38.20	19.12	10.41	7.72	6.27	328.50
STD. DEV.	1.36	1.51	2.48	7.75	13.81	16.08	14.39	8.88	4.45	2.42	1.80	1.46	76.39
SKEWNESS	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41

Table 3.21: Monthly 65-Year Project Flows Bisri Damsite

Water Year	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	May	Aug	Annual
1944-45	1.82	2.19	4.48	17.66	32.10	37.51	33.48	20.36	9.18	4.35	2.86	2.06	168.04
1945-46	1.84	2.20	4.51	17.76	32.27	37.70	33.66	20.47	9.23	4.38	2.88	2.08	168.98
1946-47	1.28	1.58	3.49	14.57	26.59	31.10	27.74	16.82	7.40	3.39	2.14	1.48	137.58
1947-48	2.25	2.66	5.26	20.11	36.45	42.57	38.02	23.16	10.58	5.11	3.42	2.52	192.10
1948-49	3.79	4.37	8.06	28.89	52.09	60.78	54.31	33.22	15.61	7.86	5.46	4.17	278.61
1949-50	0.73	0.98	2.50	11.46	21.05	24.64	21.97	13.25	5.62	2.41	1.42	0.89	106.92
1950-51	0.65	0.88	2.35	10.99	20.22	23.67	21.10	12.71	5.35	2.27	1.31	0.80	102.32
1951-52	1.69	2.04	4.24	16.93	30.79	35.98	32.12	19.52	8.75	4.12	2.69	1.92	160.80
1952-53	1.95	1.86	2.30	5.72	28.13	43.07	56.59	20.51	8.56	4.69	3.03	2.07	178.47
1953-54	1.64	1.68	9.18	10.41	56.15	51.94	27.08	31.04	9.63	4.97	3.12	2.21	209.07
1954-55	1.85	1.82	2.59	4.59	5.52	12.20	20.46	10.26	6.14	2.06	1.48	1.15	70.12
1955-56	1.07	1.19	7.31	17.97	30.05	30.10	27.99	9.90	8.67	3.60	2.45	1.47	141.76
1956-57	1.28	1.45	2.14	7.83	18.07	26.87	23.14	12.95	6.46	3.19	1.89	1.20	106.49
1957-58	1.06	1.60	2.15	20.44	37.67	19.52	13.43	7.70	3.78	1.87	1.44	1.24	111.90
1958-59	1.31	1.51	1.49	4.62	12.88	19.70	30.38	7.73	4.15	1.99	1.44	1.10	88.31
1959-60	1.09	1.31	1.69	1.80	8.95	7.30	13.75	11.37	3.55	1.49	1.07	0.99	54.34
1960-61	0.82	0.88	2.97	3.18	15.26	27.29	15.47	16.99	4.58	1.71	1.08	0.99	91.21
1961-62	0.95	1.12	2.65	24.56	17.83	35.65	10.07	4.93	3.97	2.13	1.67	1.34	106.88
1962-63	0.64	1.24	1.57	20.49	24.45	47.87	31.88	16.13	12.00	4.18	2.88	1.82	165.16
1963-64	1.62	2.24	2.34	8.15	15.96	51.66	50.14	12.46	7.96	3.78	2.57	1.81	160.70
1964-65	1.49	1.54	15.02	6.85	23.54	47.57	16.31	22.53	6.08	2.84	1.69	1.13	146.59
1965-66	0.82	1.49	1.89	17.68	17.56	20.22	15.12	7.86	3.47	1.72	0.99	0.52	89.33
1966-67	0.72	1.13	0.99	23.50	28.43	40.27	70.89	24.63	13.32	6.10	3.86	2.52	216.35
1967-68	1.75	2.45	3.03	19.71	64.90	31.12	19.02	9.51	6.66	3.70	2.32	1.59	165.77
1968-69	1.14	1.65	3.22	66.66	74.16	41.72	31.04	18.19	10.93	5.03	2.95	1.86	258.55
1969-70	1.45	2.45	3.89	8.10	35.06	14.08	40.47	10.23	5.94	2.73	1.61	0.95	126.95
1970-71	0.73	1.15	1.59	11.32	8.80	44.09	28.88	61.42	14.81	5.86	3.55	1.81	184.01
1971-72	1.34	1.36	2.09	22.57	20.66	26.31	9.19	10.66	6.99	3.45	1.84	1.51	107.97
1972-73	1.51	1.14	2.04	2.04	5.32	8.70	21.43	9.47	3.56	1.86	0.92	0.75	58.73
1973-74	0.00	0.94	2.29	5.76	23.24	22.56	24.79	25.84	7.28	3.12	1.63	1.00	118.44
1974-75	1.02	1.29	3.02	13.09	23.95	28.02	24.99	15.12	6.55	2.92	1.80	1.20	122.97
1975-76	1.67	2.02	4.20	16.79	30.55	35.70	31.87	19.36	8.68	4.08	2.66	1.89	159.45

1976-77	2.32	2.74	5.38	20.49	37.14	43.38	38.74	23.60	10.80	5.24	3.51	2.59	195.93
1977-78	3.05	3.55	6.71	24.66	44.56	52.02	46.47	28.37	13.19	6.54	4.48	3.37	236.97
1978-79	0.00	0.03	0.95	6.61	12.41	14.58	12.96	7.69	2.84	0.90	0.30	0.00	59.27
1979-80	2.56	3.01	5.83	21.88	39.62	46.26	41.32	25.19	11.60	5.67	3.84	2.85	209.61
1980-81	2.97	3.46	6.56	24.20	43.74	51.06	45.61	27.84	12.92	6.39	4.37	3.29	232.41
1981-82	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76	100.17
1982-83	2.34	2.23	3.56	4.12	21.38	20.47	56.32	19.36	12.19	7.02	4.40	4.16	157.54
1983-84	3.60	4.49	11.05	6.91	23.19	21.36	25.00	23.70	9.25	3.49	1.76	1.67	135.47
1984-85	1.10	1.38	3.17	13.55	24.78	28.98	25.85	15.65	6.82	3.07	1.91	1.28	127.53
1985-86	0.00	0.00	0.80	6.15	11.58	13.62	12.11	7.16	2.57	0.75	0.19	0.00	54.94
1986-87	1.83	2.20	4.50	17.72	32.20	37.62	33.58	20.42	9.21	4.37	2.87	2.07	168.57
1987-88	3.05	3.55	6.71	24.66	44.56	52.02	46.47	28.37	13.19	6.54	4.48	3.37	236.97
1988-89	0.05	0.21	1.25	7.53	14.06	16.50	14.68	8.75	3.37	1.19	0.51	0.15	68.25
1989-90	0.00	0.00	0.00	2.91	5.81	6.90	6.09	3.45	0.71	0.00	0.00	0.00	25.88
1990-91	0.00	0.00	0.66	5.68	10.76	12.66	11.25	6.63	2.31	0.61	0.09	0.00	50.64
1991-92	4.43	5.09	9.22	32.53	58.58	68.33	61.07	37.39	17.70	8.99	6.30	4.86	314.49
1992-93	2.64	3.10	5.97	22.35	40.44	47.22	42.17	25.72	11.86	5.81	3.94	2.94	214.17
1993-94	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76	100.17
1994-95	0.78	1.02	2.58	11.70	21.48	25.14	22.42	13.53	5.76	2.49	1.48	0.94	109.29
1995-96	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76	100.17
1996-97	0.37	0.57	1.84	9.39	17.36	20.34	18.12	10.87	4.43	1.77	0.94	0.50	86.49
1997-98	0.86	1.11	2.72	12.16	22.30	26.10	23.27	14.06	6.02	2.63	1.59	1.02	113.85
1998-99	0.00	0.00	0.06	3.83	7.46	8.82	7.81	4.51	1.25	0.03	0.00	0.00	33.78
1999-00	0.00	0.00	0.14	4.06	7.87	9.30	8.24	4.77	1.38	0.10	0.00	0.00	35.87
2000-01	0.00	0.00	0.00	2.44	4.99	5.94	5.23	2.92	0.45	0.00	0.00	0.00	21.98
2001-02	0.09	0.12	1.62	3.59	14.92	4.80	9.39	13.97	5.84	4.48	4.04	1.55	64.42
2002-03	0.90	0.40	1.45	44.85	17.96	116.85	242.97	24.61	14.83	4.87	9.96	7.48	487.12
2003-04	1.68	1.27	2.60	2.58	31.31	33.49	18.63	6.70	4.26	2.59	2.20	1.34	108.65
2004-05	0.32	0.52	6.02	3.36	16.62	38.90	16.86	10.17	8.04	1.95	1.41	1.04	105.21
2005-06	1.04	1.63	4.79	2.69	9.12	11.30	10.33	17.46	5.73	2.33	2.03	2.27	70.71
2006-07	0.98	1.02	6.59	3.11	9.05	16.56	12.63	10.78	4.62	1.53	1.00	1.07	68.94
2007-08	2.31	1.85	1.46	2.50	2.09	14.85	9.09	10.32	5.89	3.12	1.99	1.24	56.70
2008-09	1.34	1.45	1.17	2.57	3.53	16.27	15.16	10.30	3.83	2.09	1.93	1.33	60.98
TOTAL	85.39	101.94	228.75	865.30	1588.99	1978.78	1918.73	1057.94	473.98	216.14	147.44	104.70	8768.08

AVERAGE	1.31	1.57	3.52	13.31	24.45	30.44	29.52	16.28	7.29	3.33	2.27	1.61	134.89
MEDIAN	1.10	1.38	2.59	10.77	21.38	26.87	23.14	13.53	6.46	3.07	1.89	1.33	113.85
MINIMUM	0.00	0.00	0.00	1.80	2.09	4.80	5.23	2.92	0.45	0.00	0.00	0.00	21.98
MAXIMUM	4.43	5.09	15.02	66.66	74.16	116.85	242.97	61.42	17.70	8.99	9.96	7.48	487.12
STD. DEV.	1.00	1.13	2.80	11.15	15.30	18.47	30.68	9.69	3.91	1.98	1.68	1.29	78.63
SKEWNESS	0.89	0.97	1.68	2.14	1.06	1.71	5.45	1.81	0.56	0.56	1.76	1.89	1.65

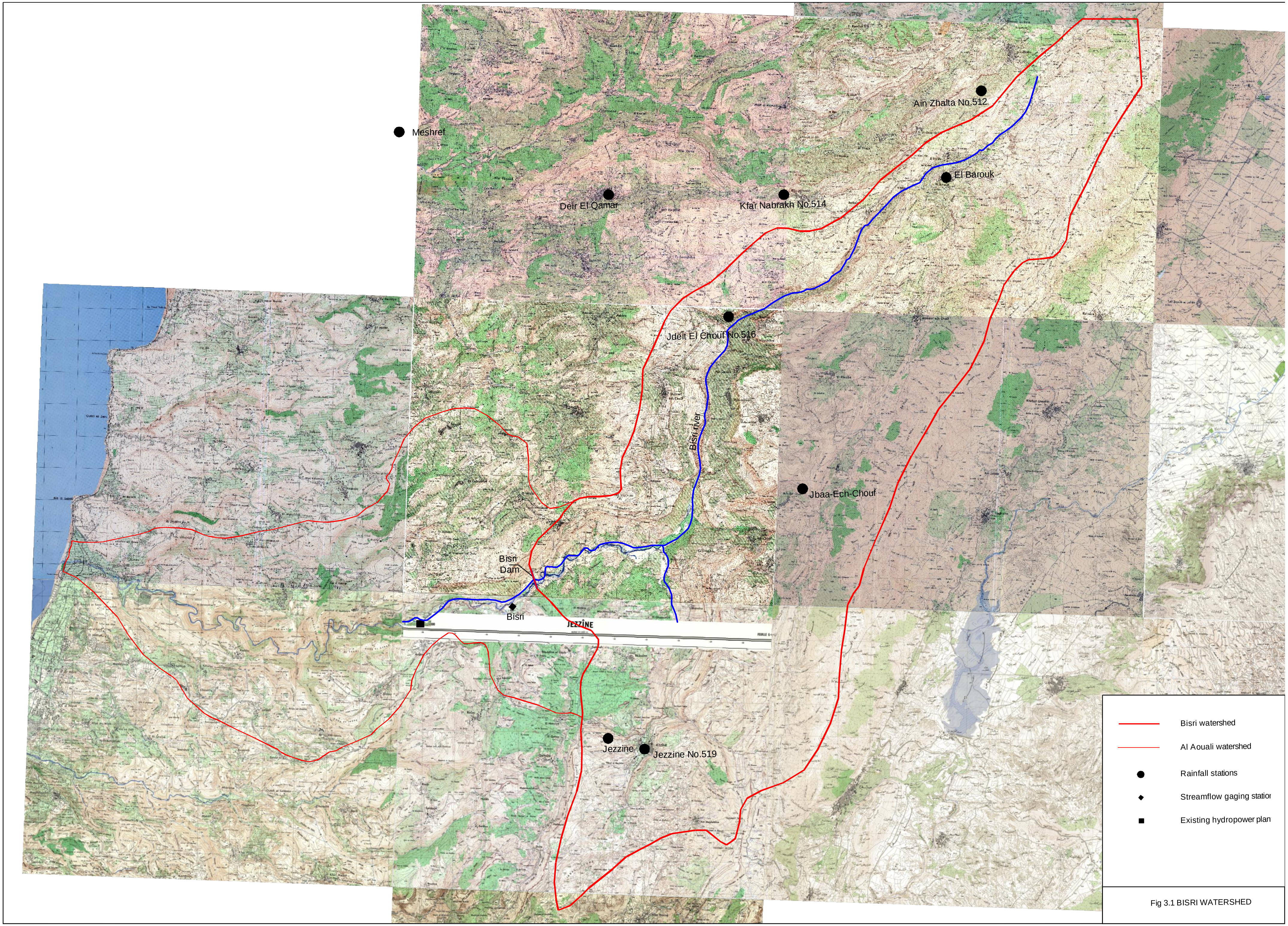
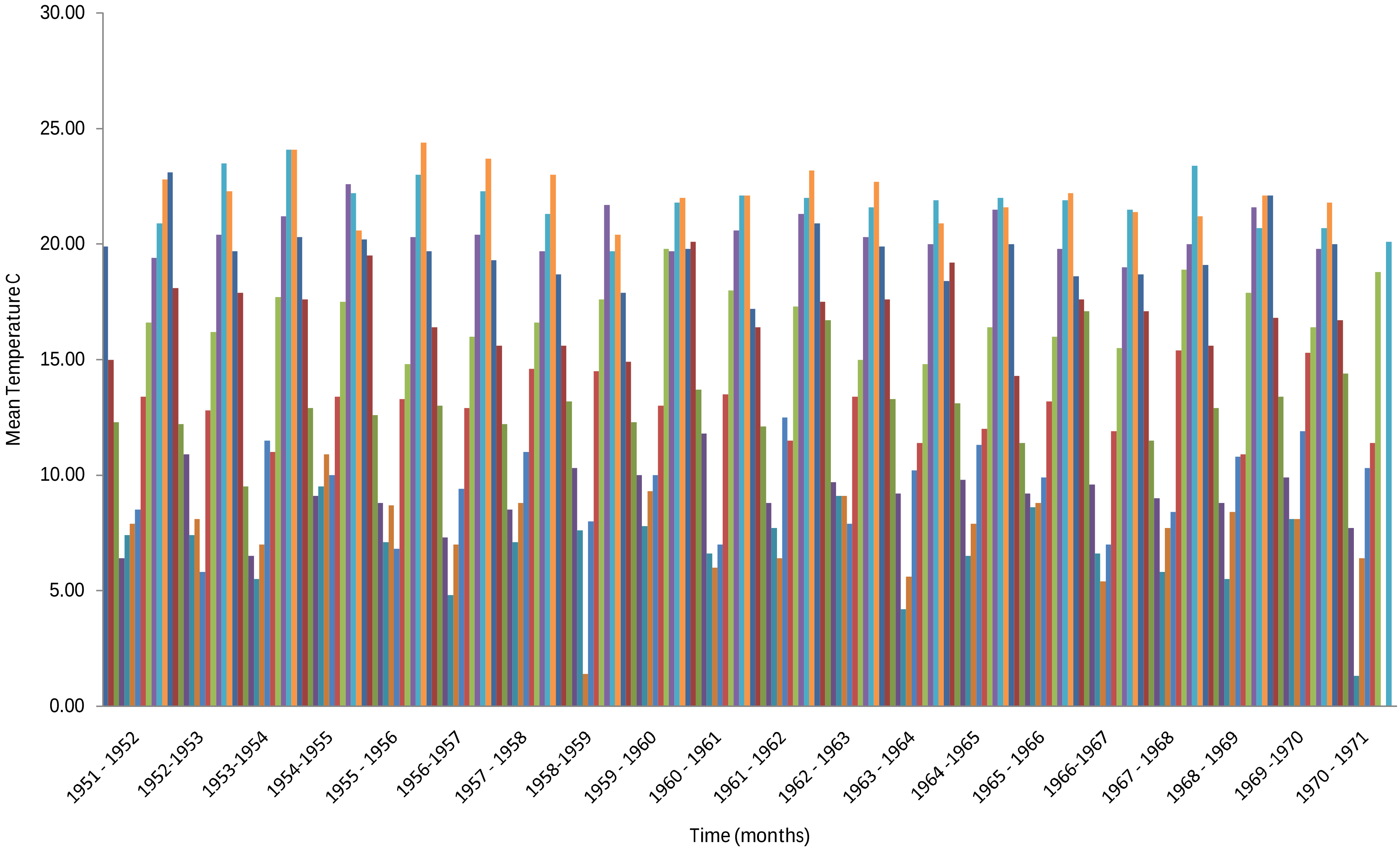


Fig 3.1 BISRI WATERSHED

Figure 3.2: Monthly Mean Temperatures (°C) at Bhamdoun



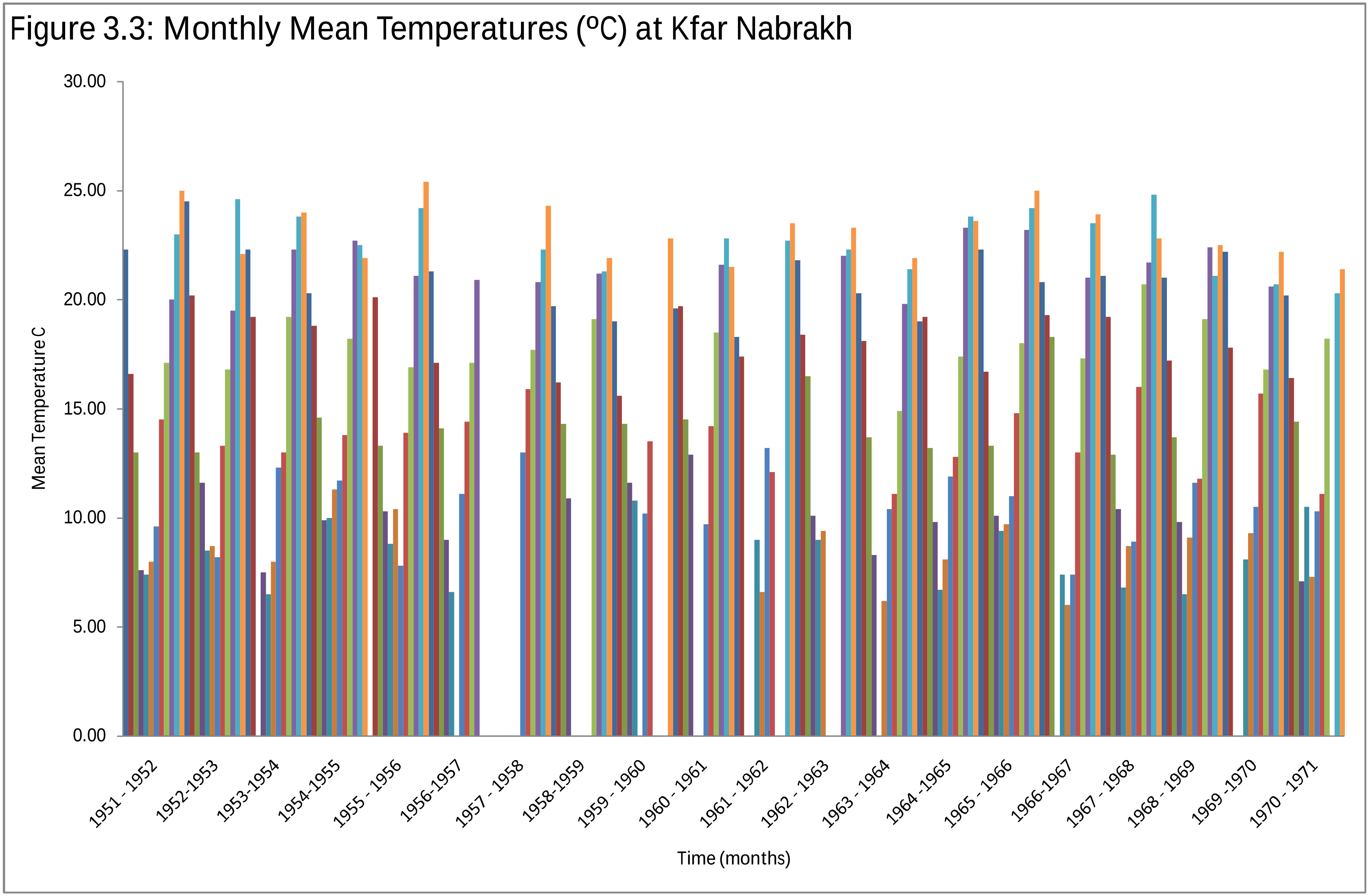


Figure 3.3: Monthly Mean Temperatures (ºC) at Kfar Nabrakh
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Mean Temperature C
1951 - 1952
1952-1953
1953-1954
1954-1955
1955 - 1956
1956-1957
1957 - 1958
1958-1959
1959 - 1960
1960 - 1961
1961 - 1962
1962 - 1963
1963 - 1964
1964 -1965
1965 - 1966
1966-1967
1967 - 1968
1968 - 1969
1969 -1970
1970 - 1971
Time (months)

Figure 3.4: Relative Humidity at Bhamdoun

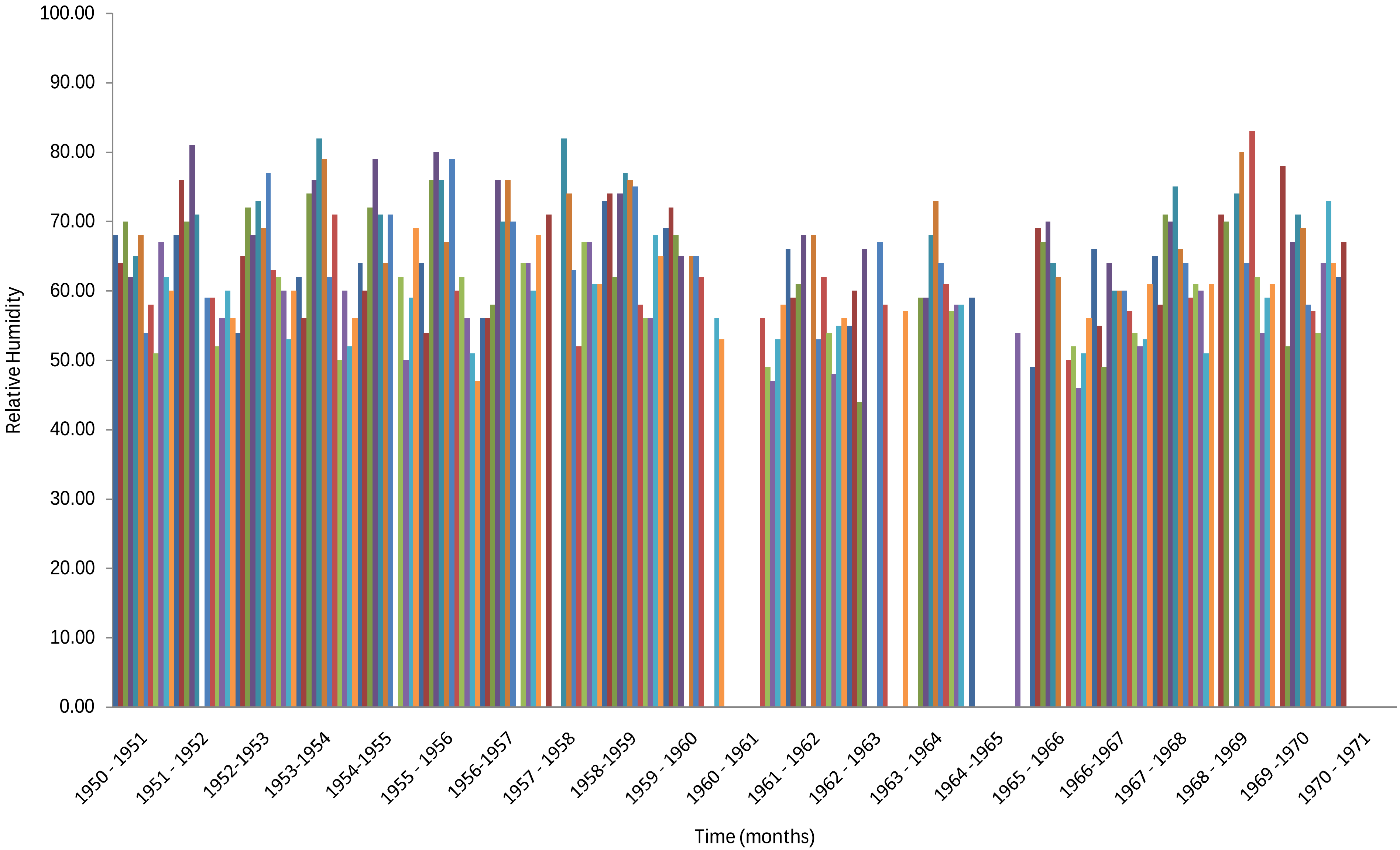


Figure 3.5: Relative Humidity at Kfar Nabrakh

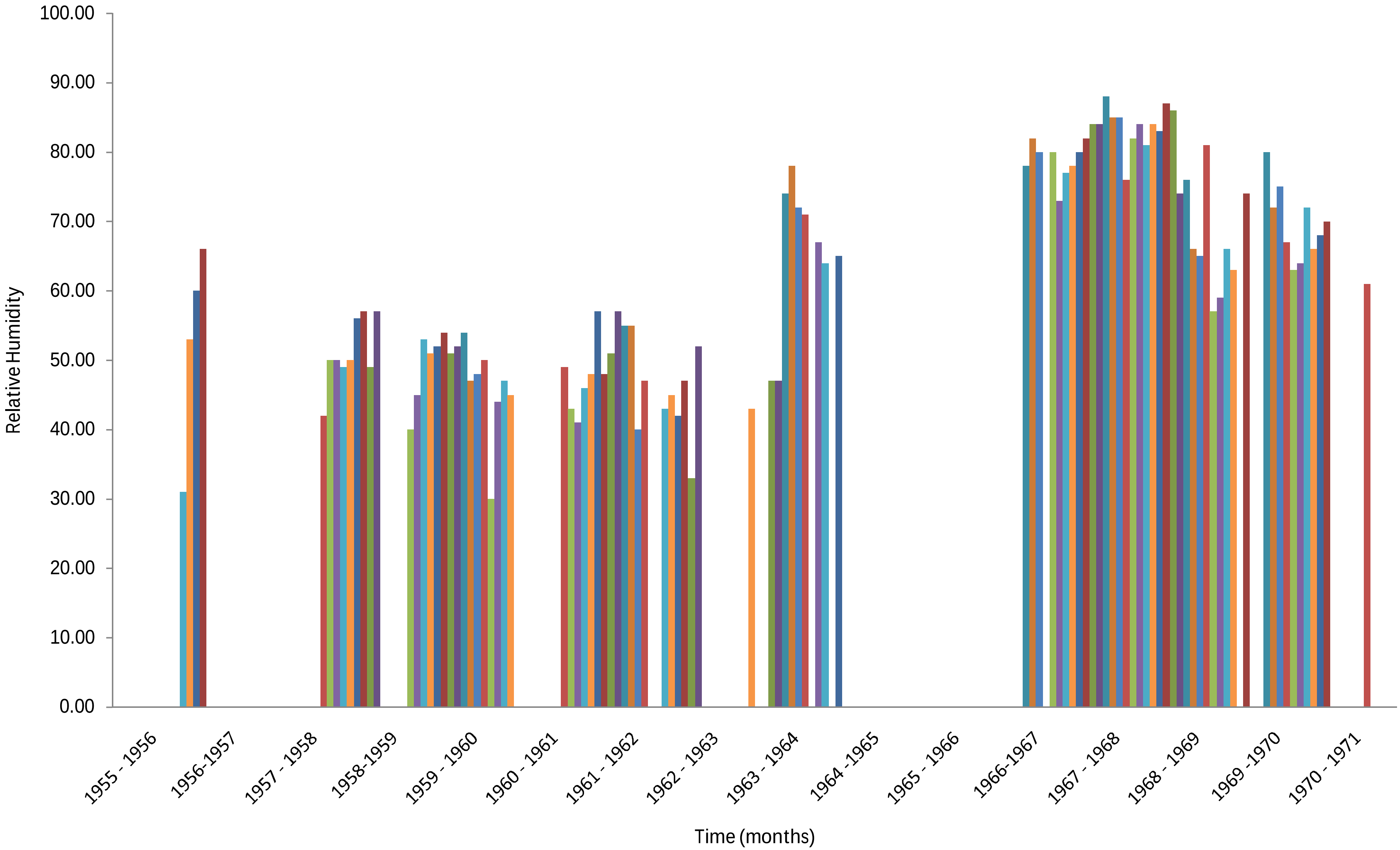


Figure 3.6: Monthly Evaporation at Bhamdoun

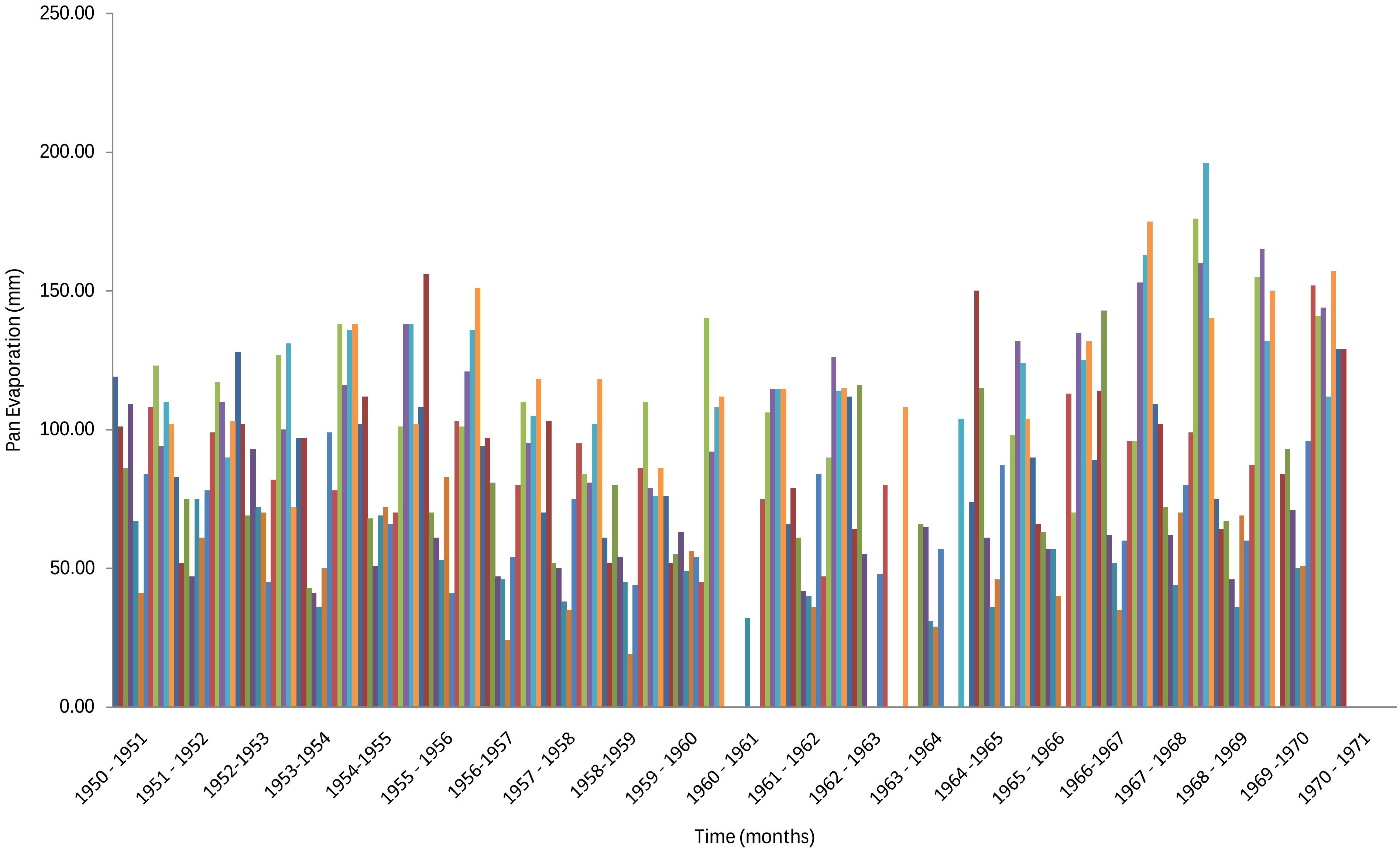


Figure 3.7: Monthly Evaporation at Kfar Nabrakh

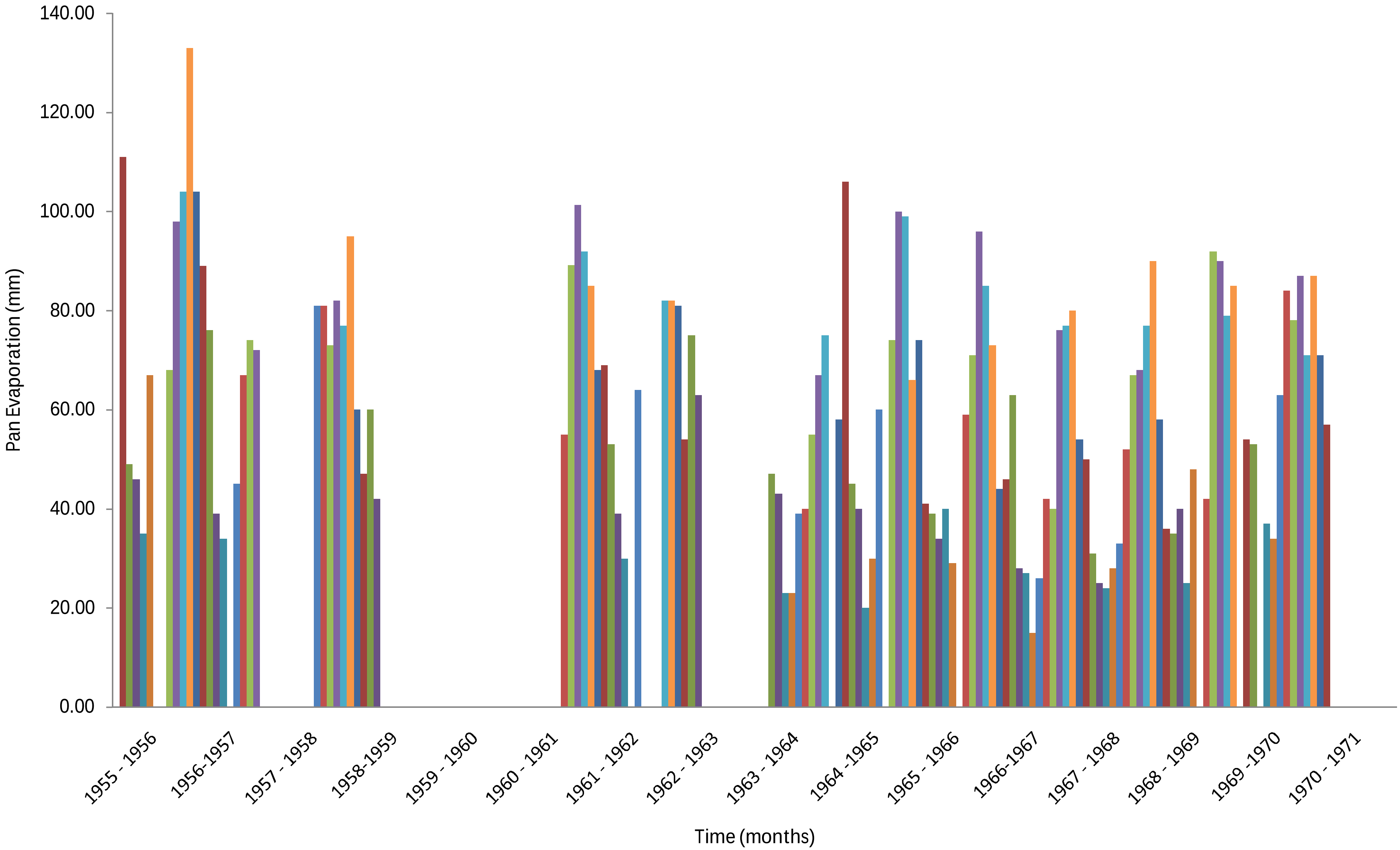


Figure 3.8: Monthly And Annual Precipitation at Aain-Zahlta

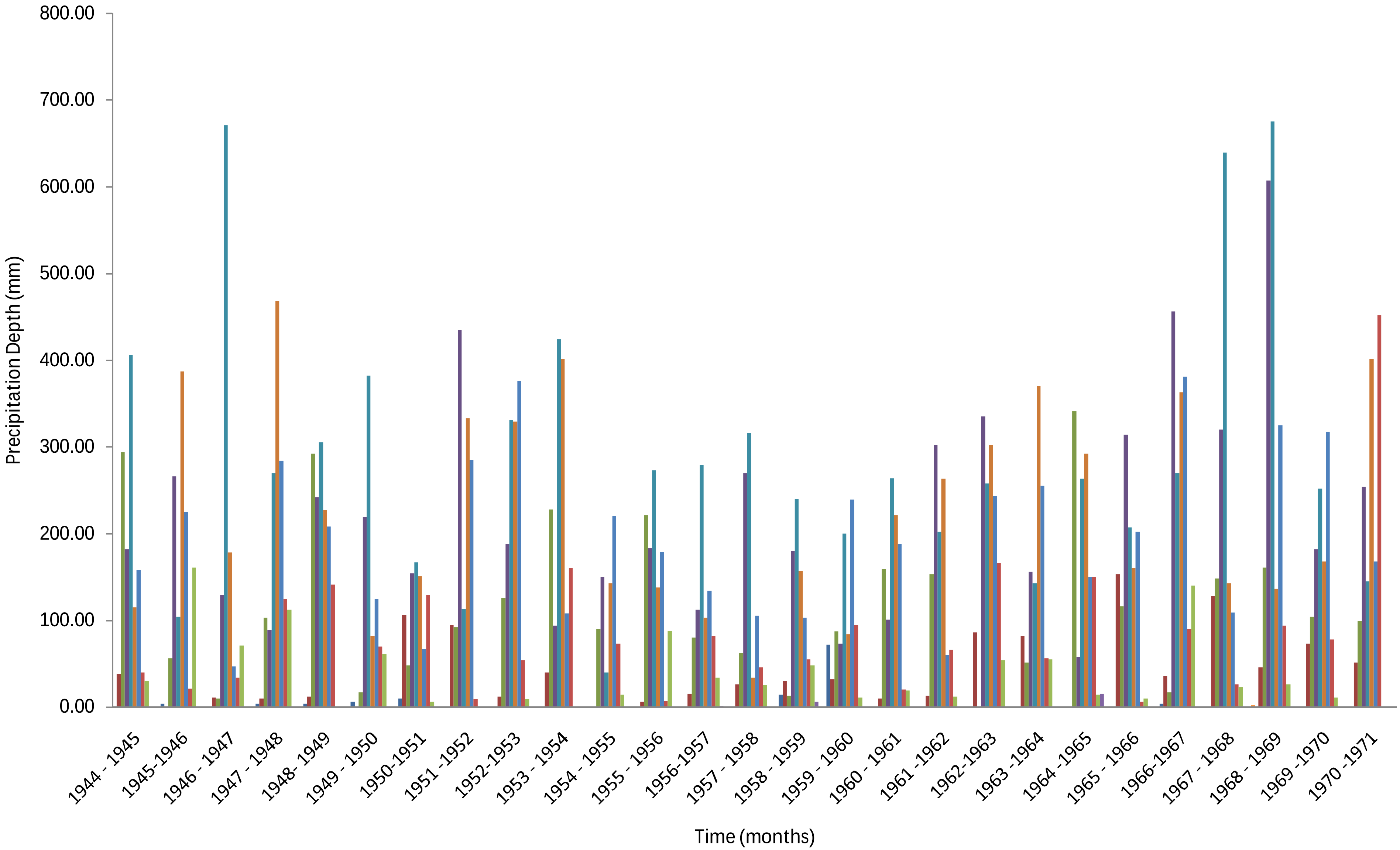


Figure 3.9: Monthly And Annual Precipitation at Kfar Nabrakh

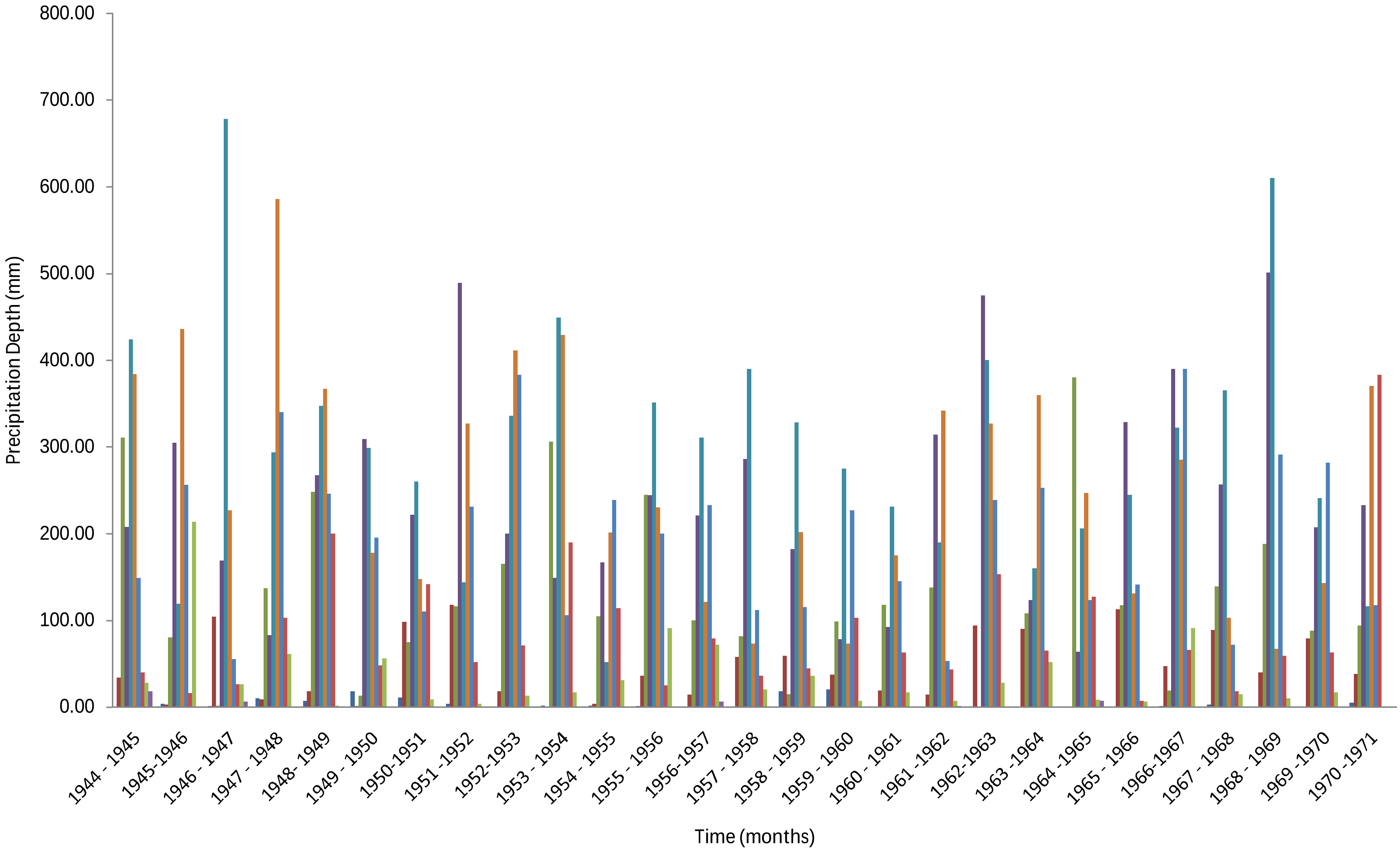


Figure 3.10: Monthly And Annual Precipitation at Jdeit-Ech-Chouf

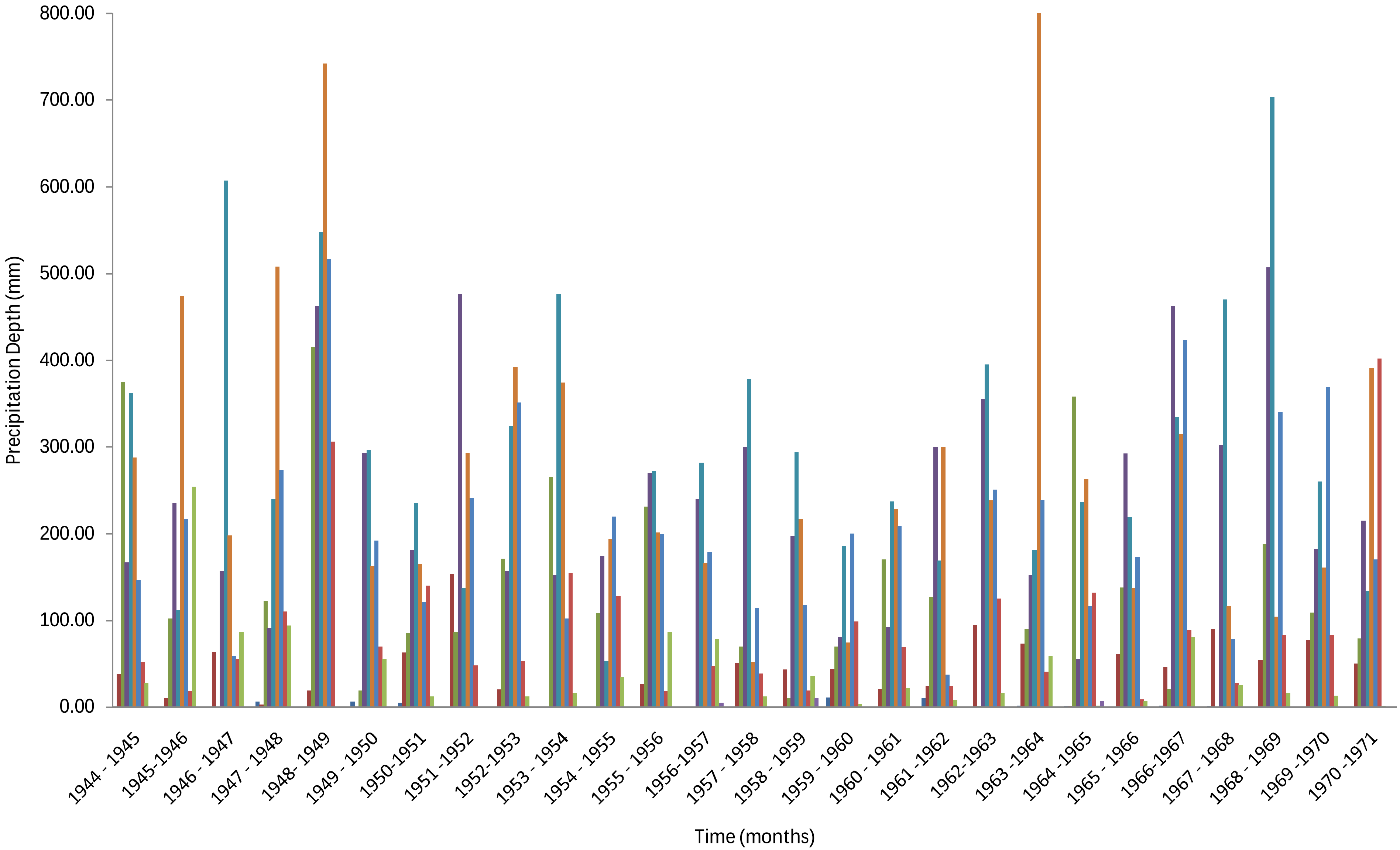


Figure 3.11: Monthly And Annual Precipitation at Jezzine

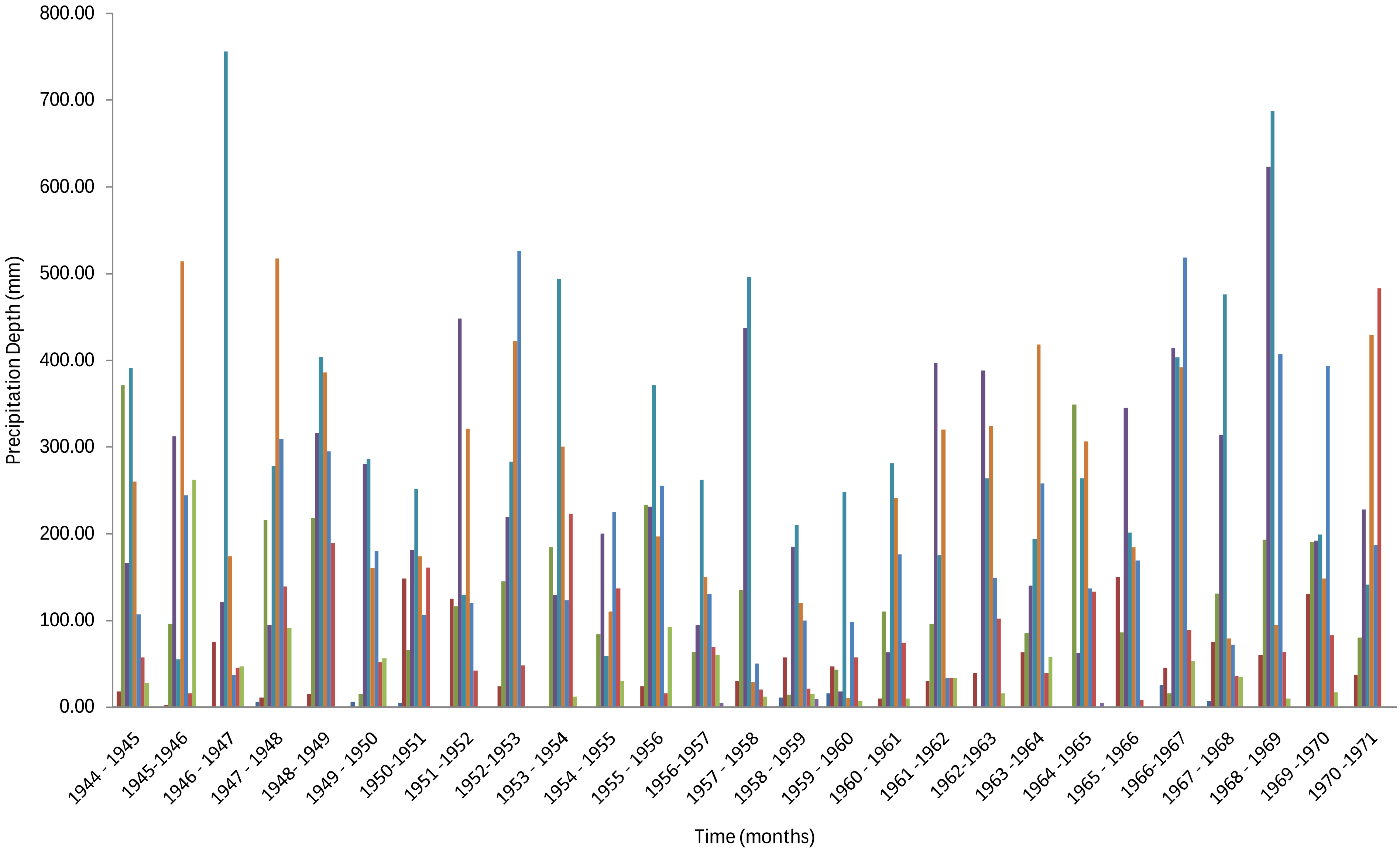


Figure 3.12: Monthly And Annual Precipitation at Jezzine

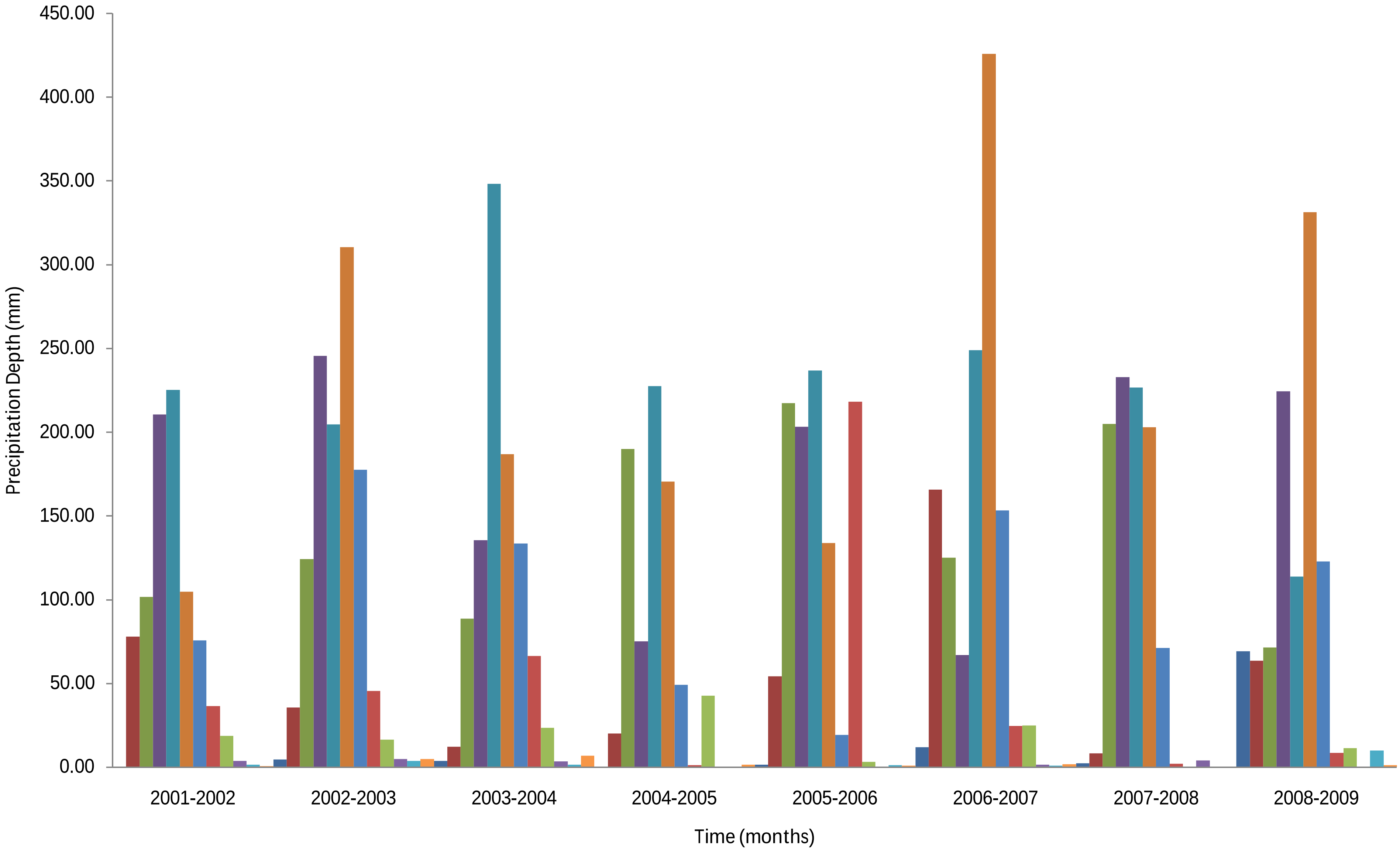


Figure 3.13: Monthly And Annual Precipitation at El-Barouk_Fraidis

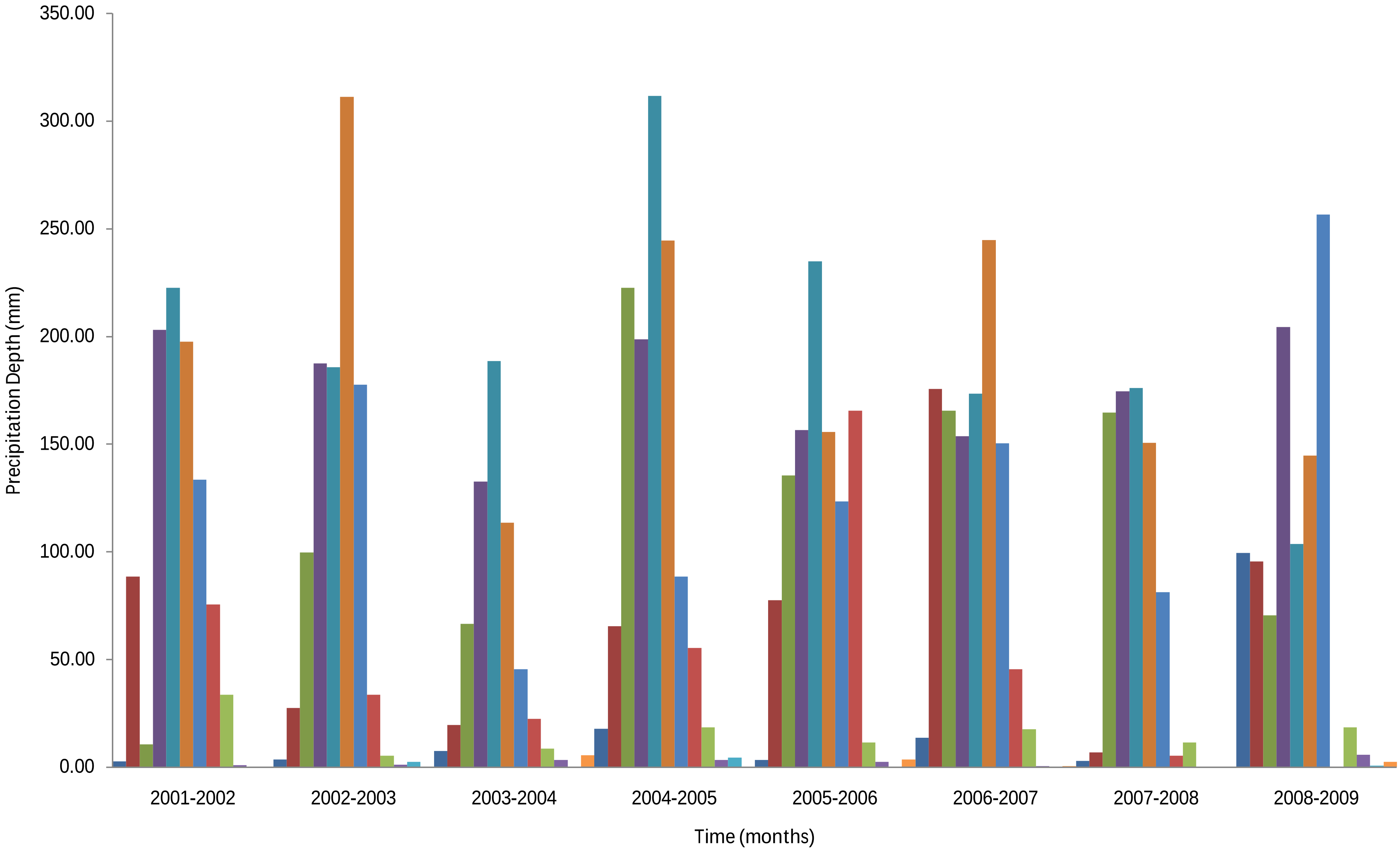


Figure 3.14: Monthly And Annual Precipitation at Deir El-kamar

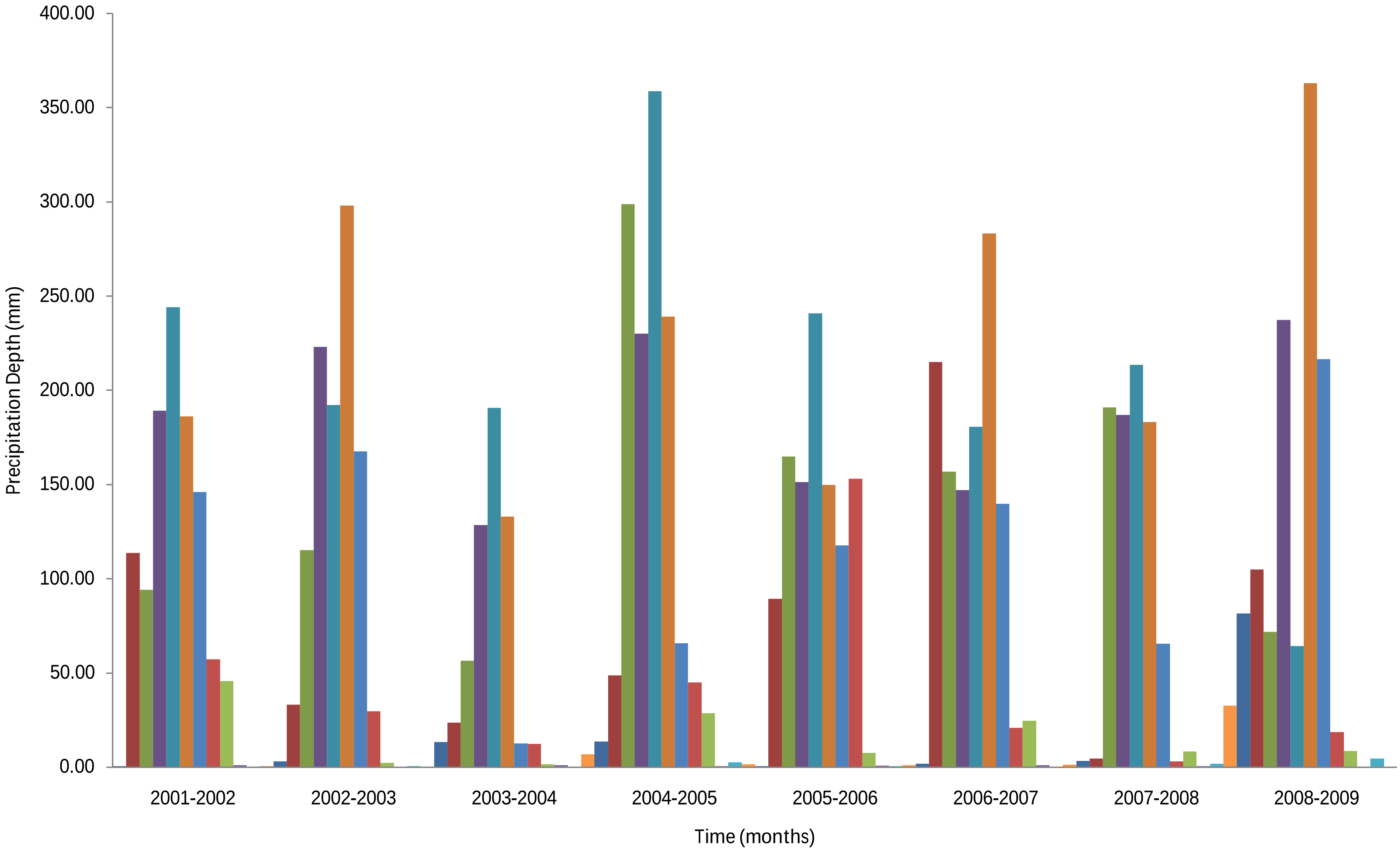


Figure 3.15: Monthly And Annual Precipitation at Jbaa-Ech-Chouf

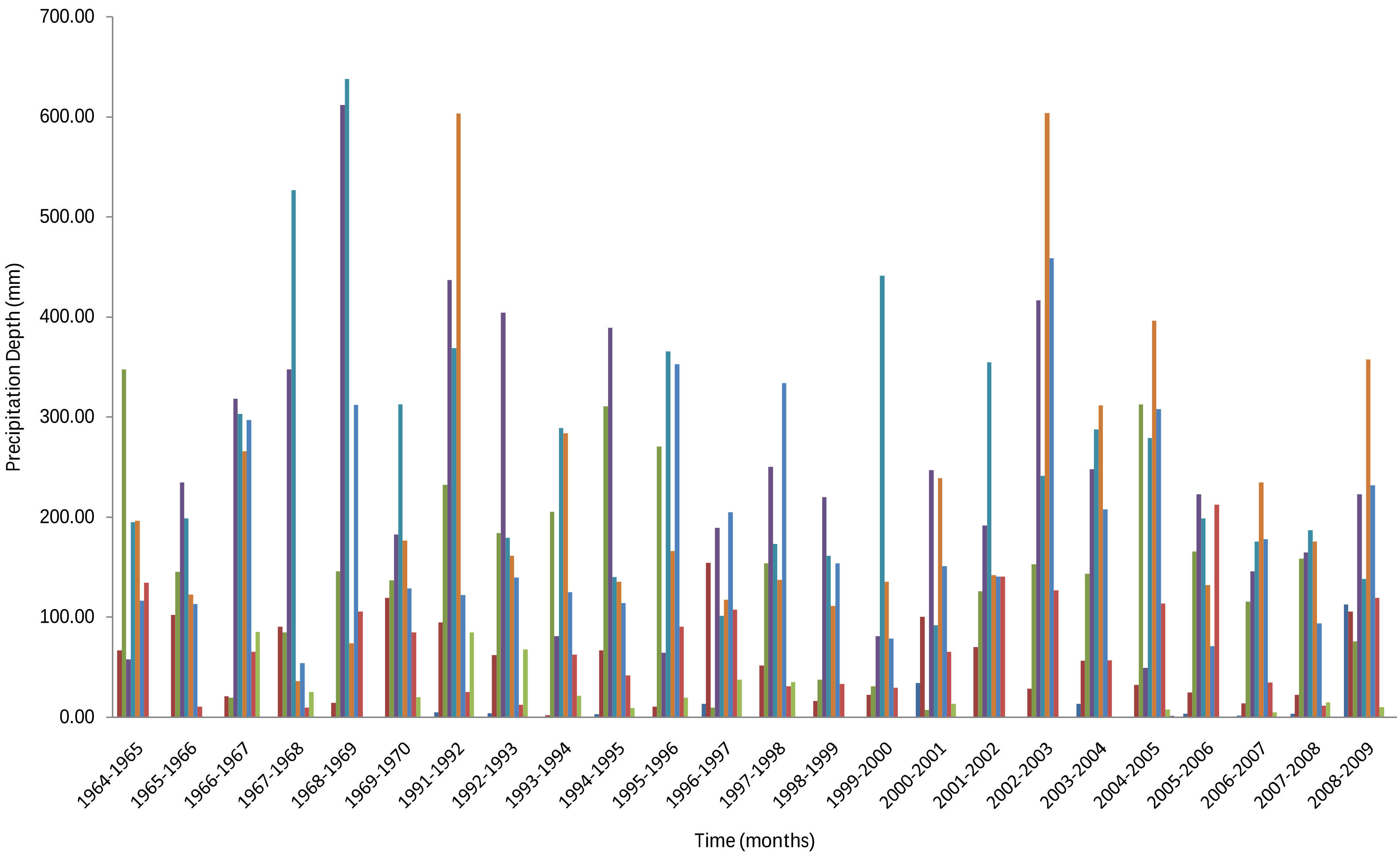
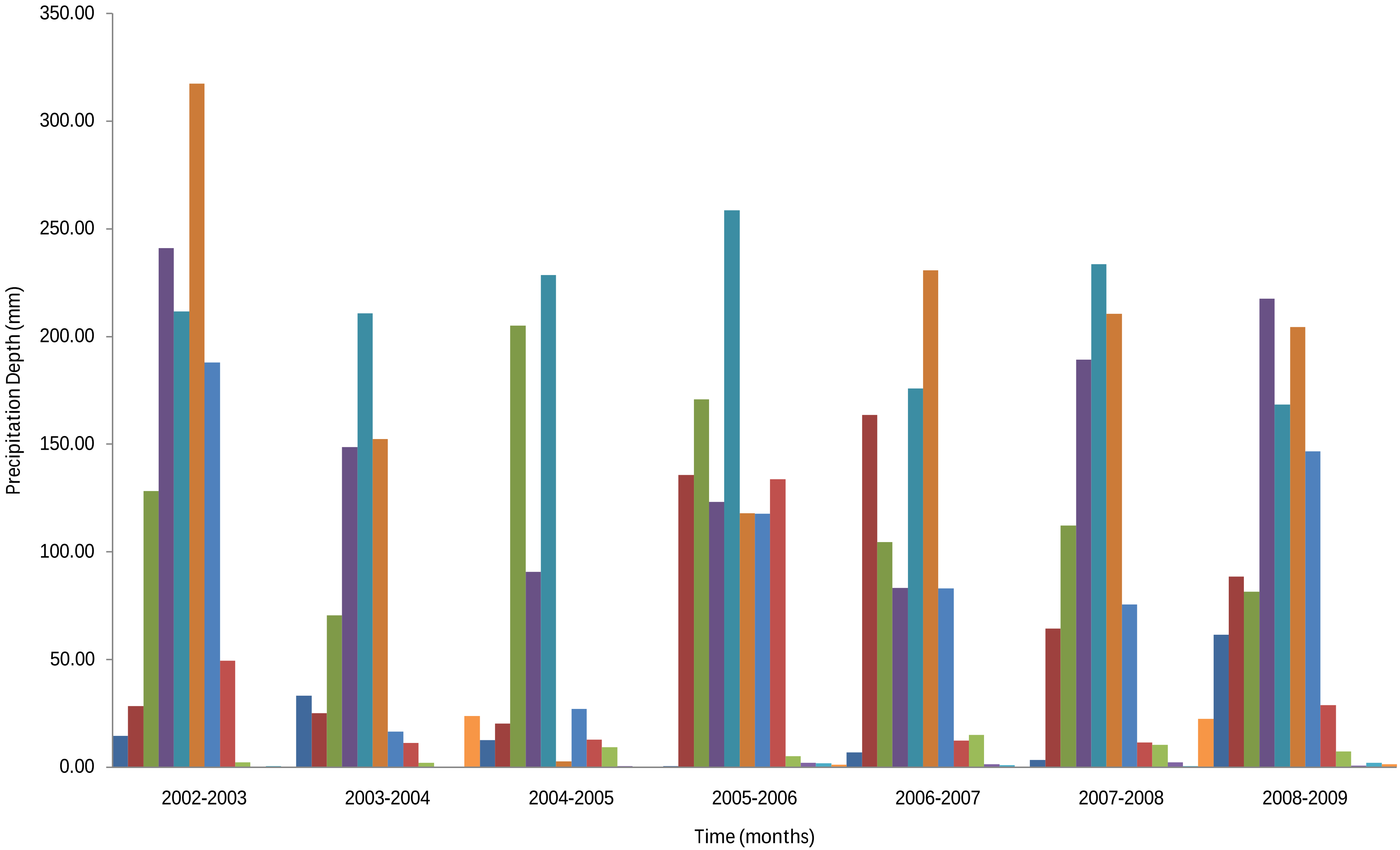


Figure 3.16: Monthly And Annual Precipitation at Meshref



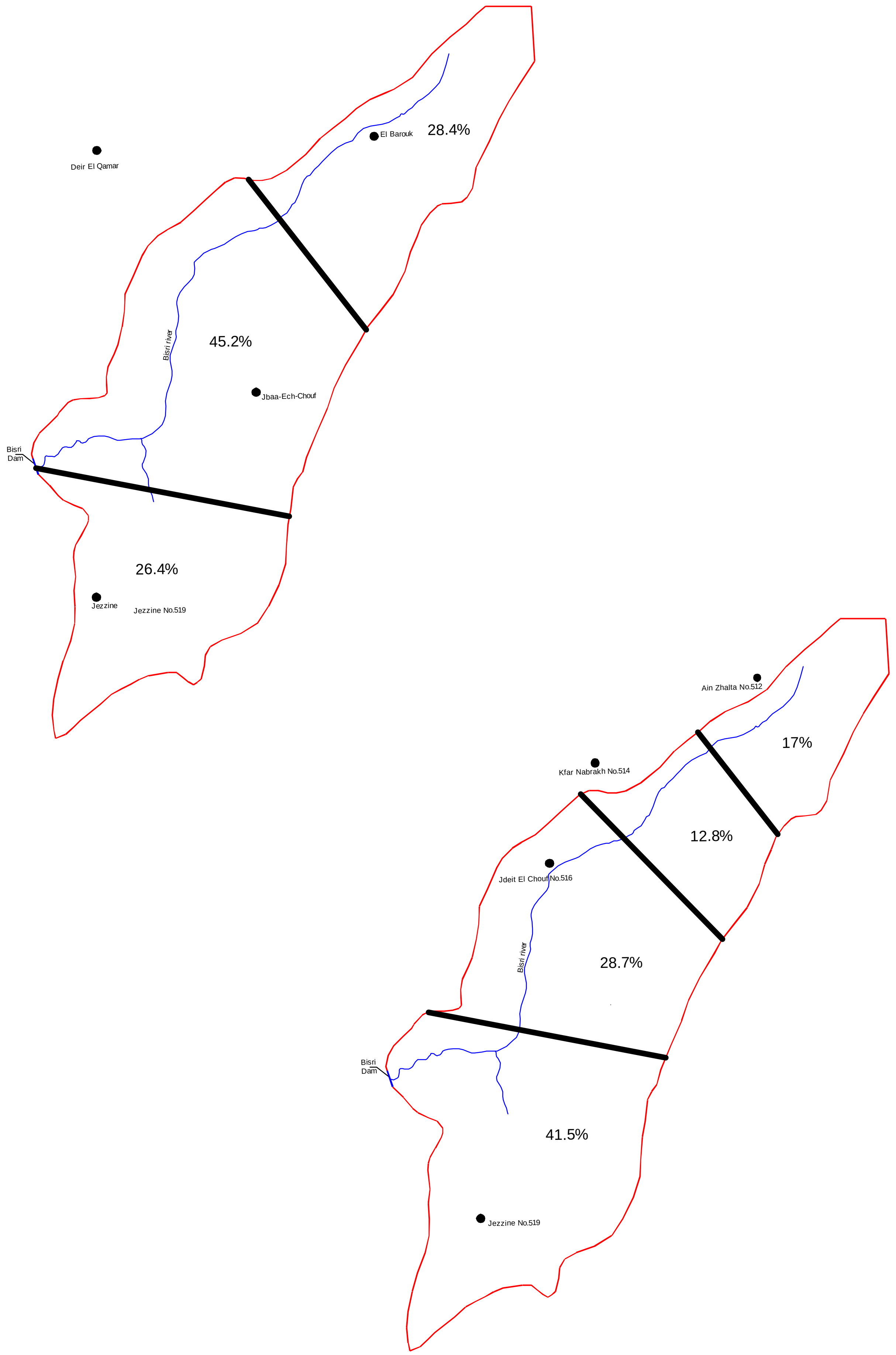
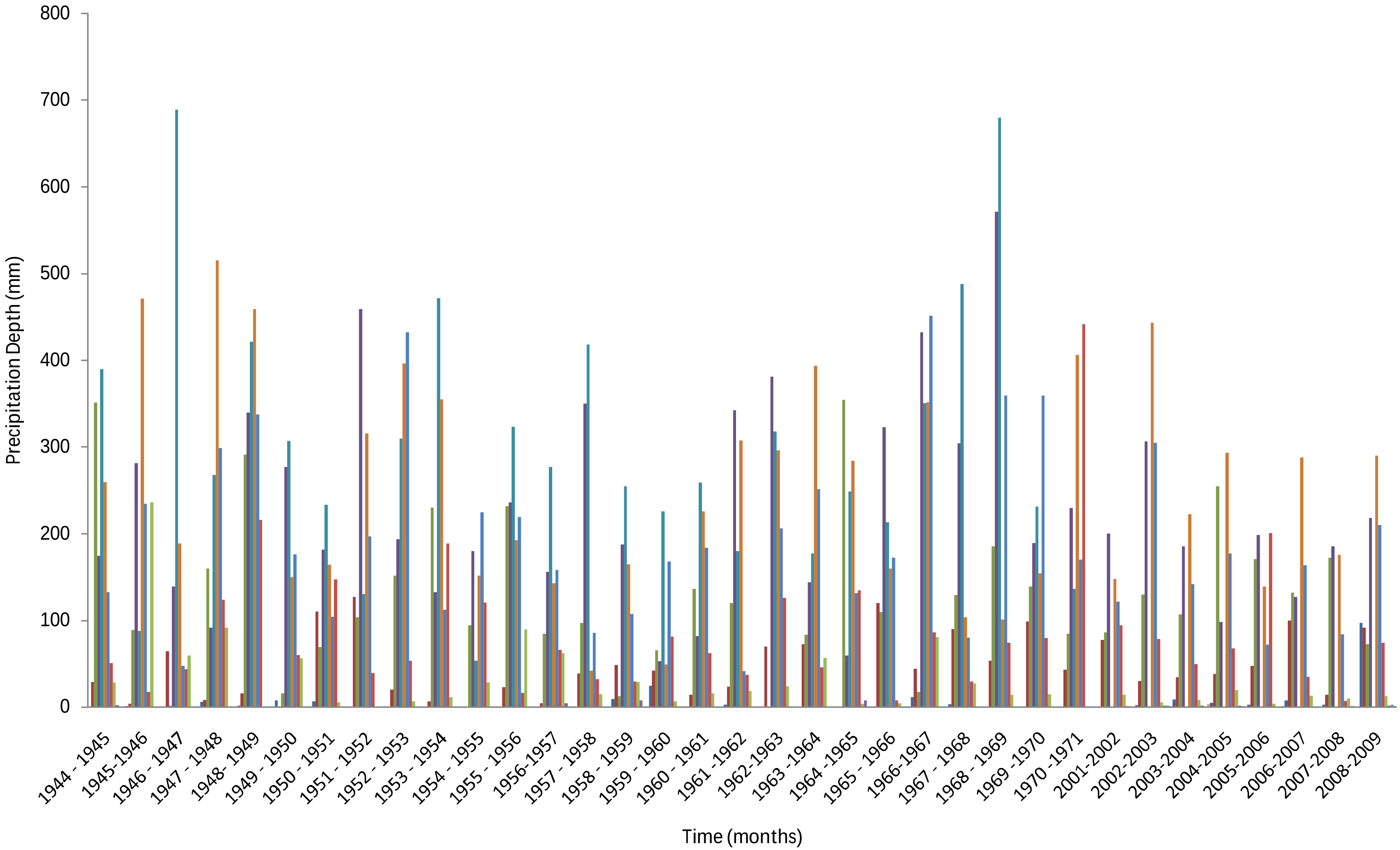


Fig 3.17 Bisri Basin; Theissen Polygon Networ

Figure 3.18: Bisri Basin Precipitation



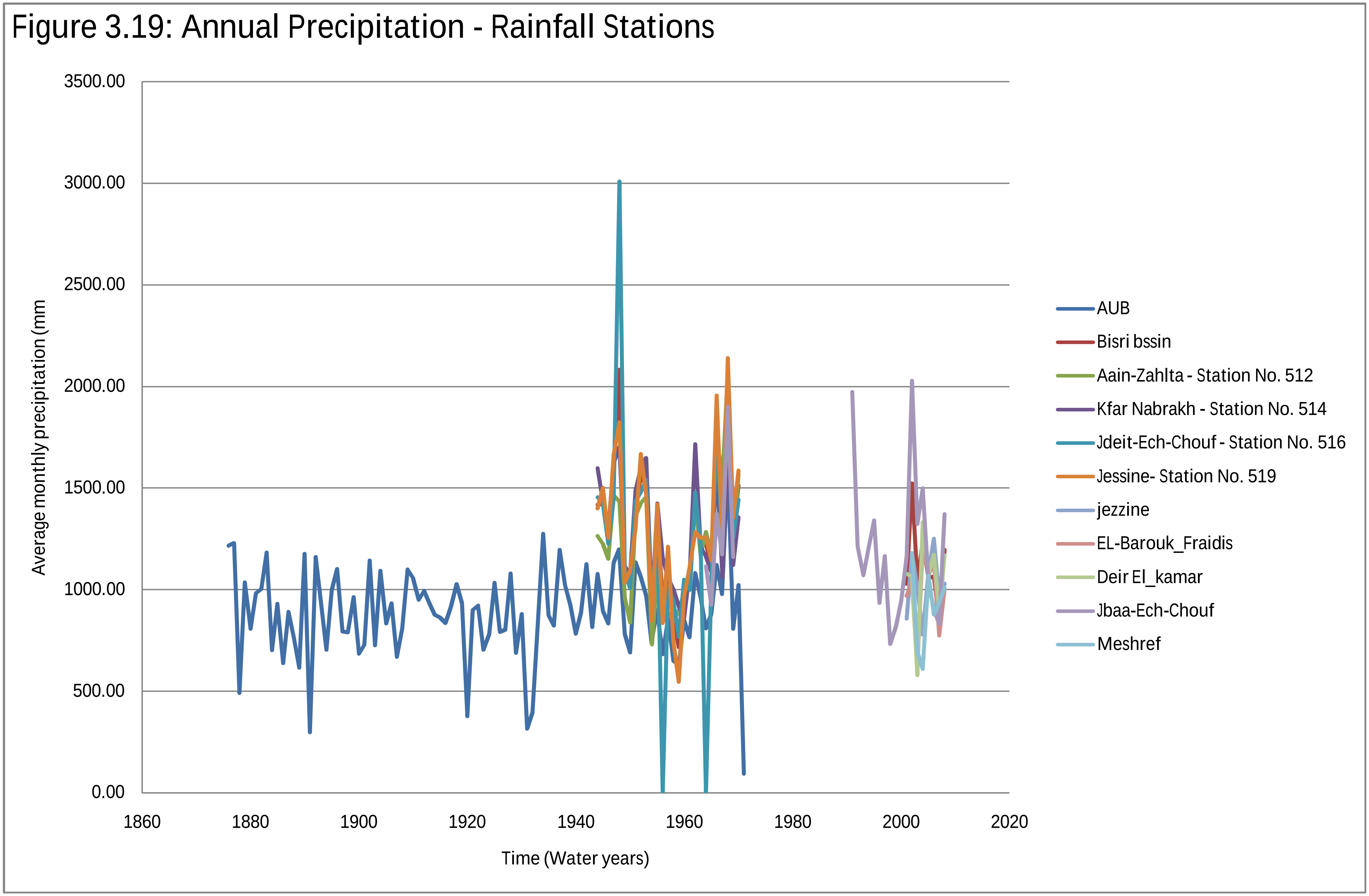


Figure 3.19: Annual Precipitation - Rainfall Stations
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Average monthly precipitation (mm
1860
1880
1900
1920
1940
1960
1980
2000
2020
Time (Water years)
AUB
Bisri bssin
Aain-Zahlta - Station No. 512
Kfar Nabrakh - Station No. 514
Jdeit-Ech-Chouf - Station No. 516
Jessine- Station No. 519
jezzine
EL-Barouk_Fraidis
Deir El_kamar
Jbaa-Ech-Chouf
Meshref

Figure 3.20: Streamflow Developpment

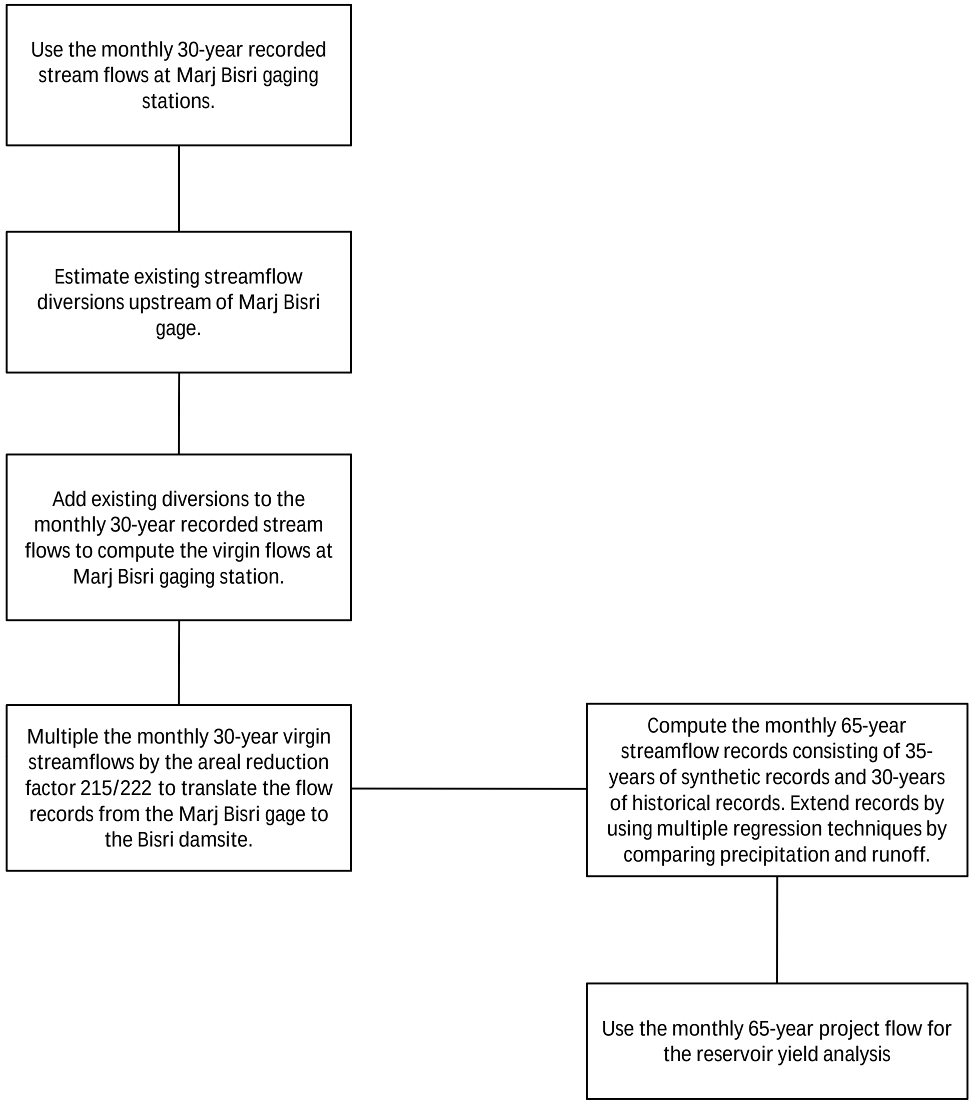


Figure 3.21: Peak annual discharge; Marj Bisri

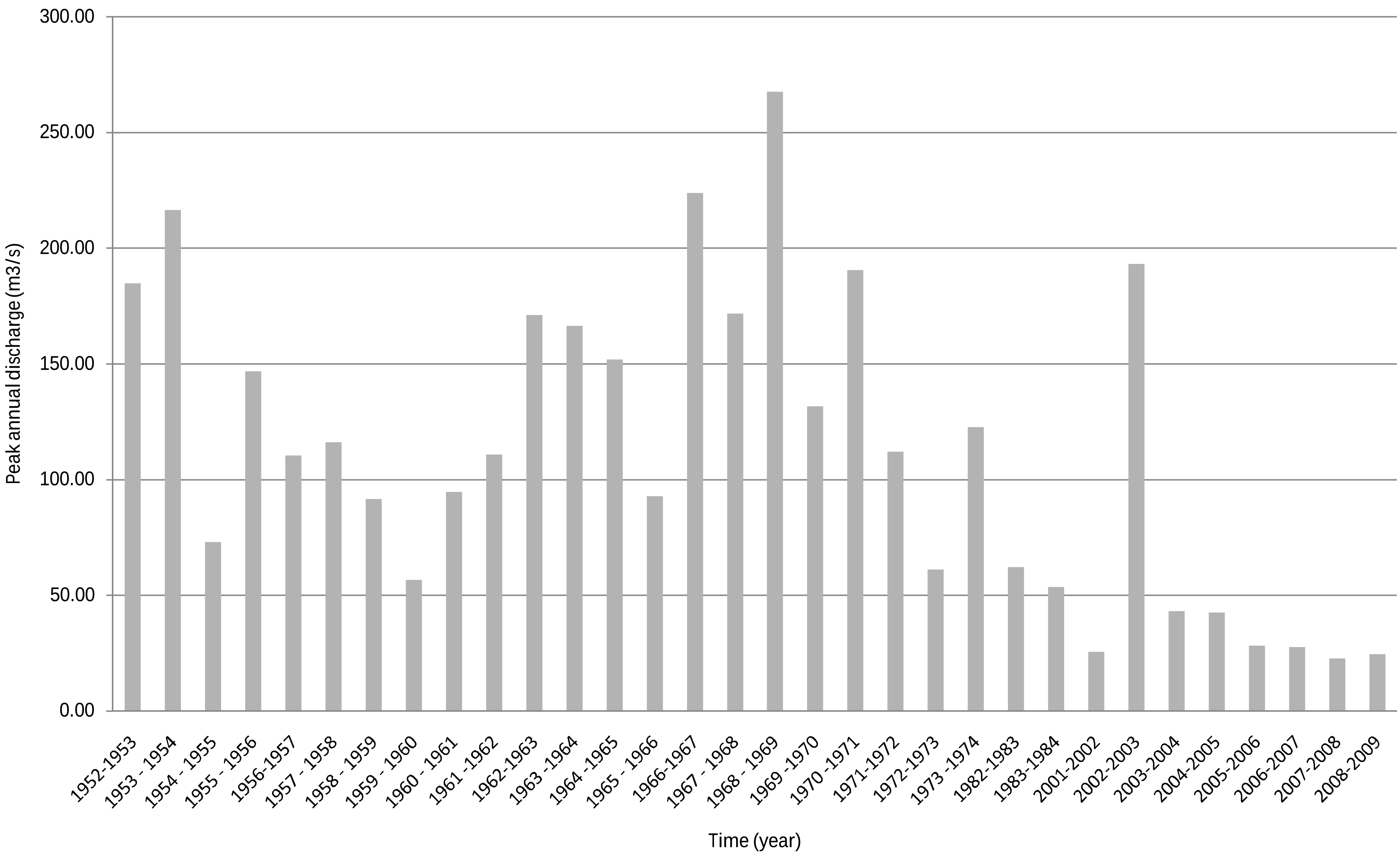


Figure 3.22: Average Monthly Streamflow; Marj Bisri Gage

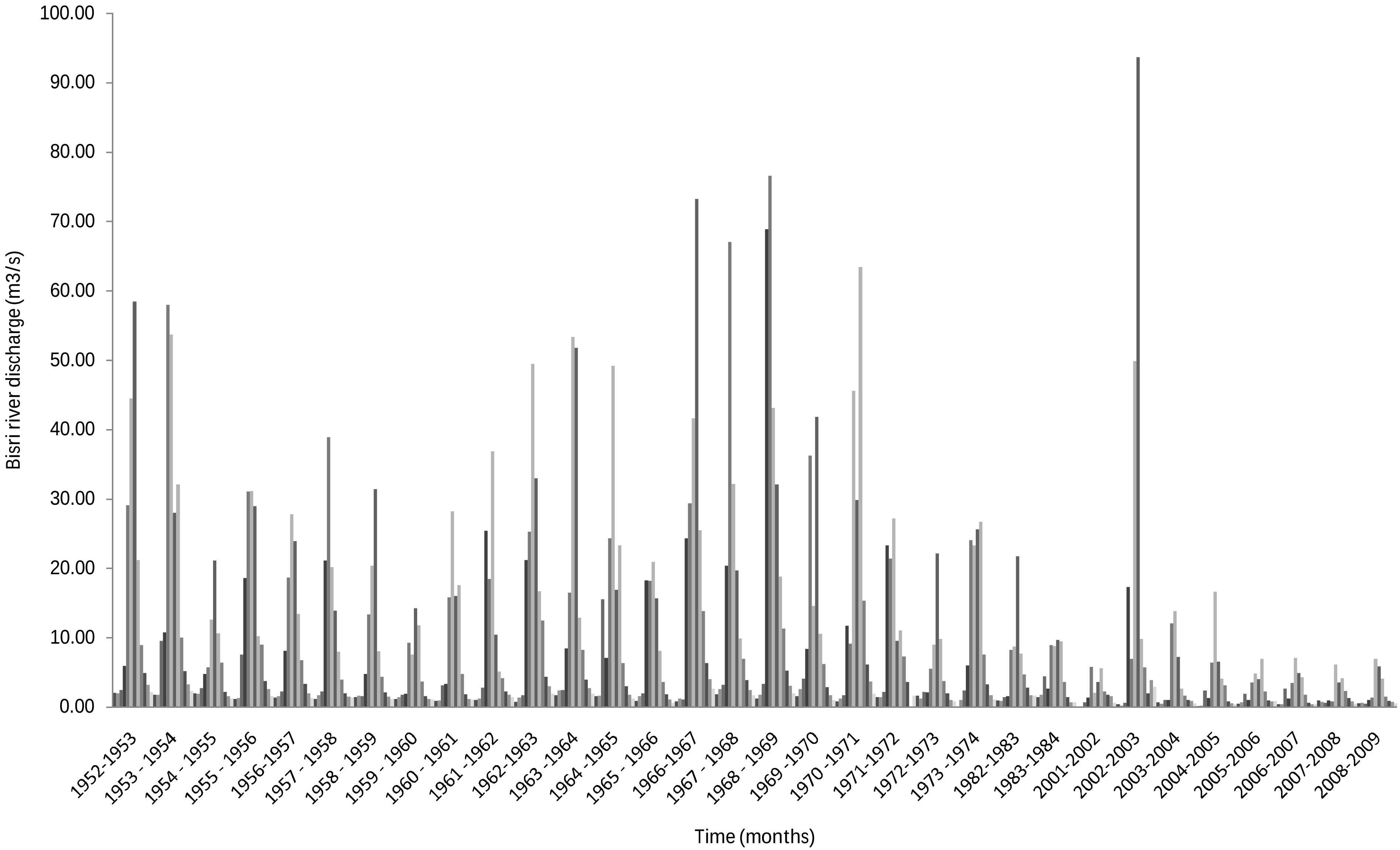


Figure 3.23: Monthly flow duration curve

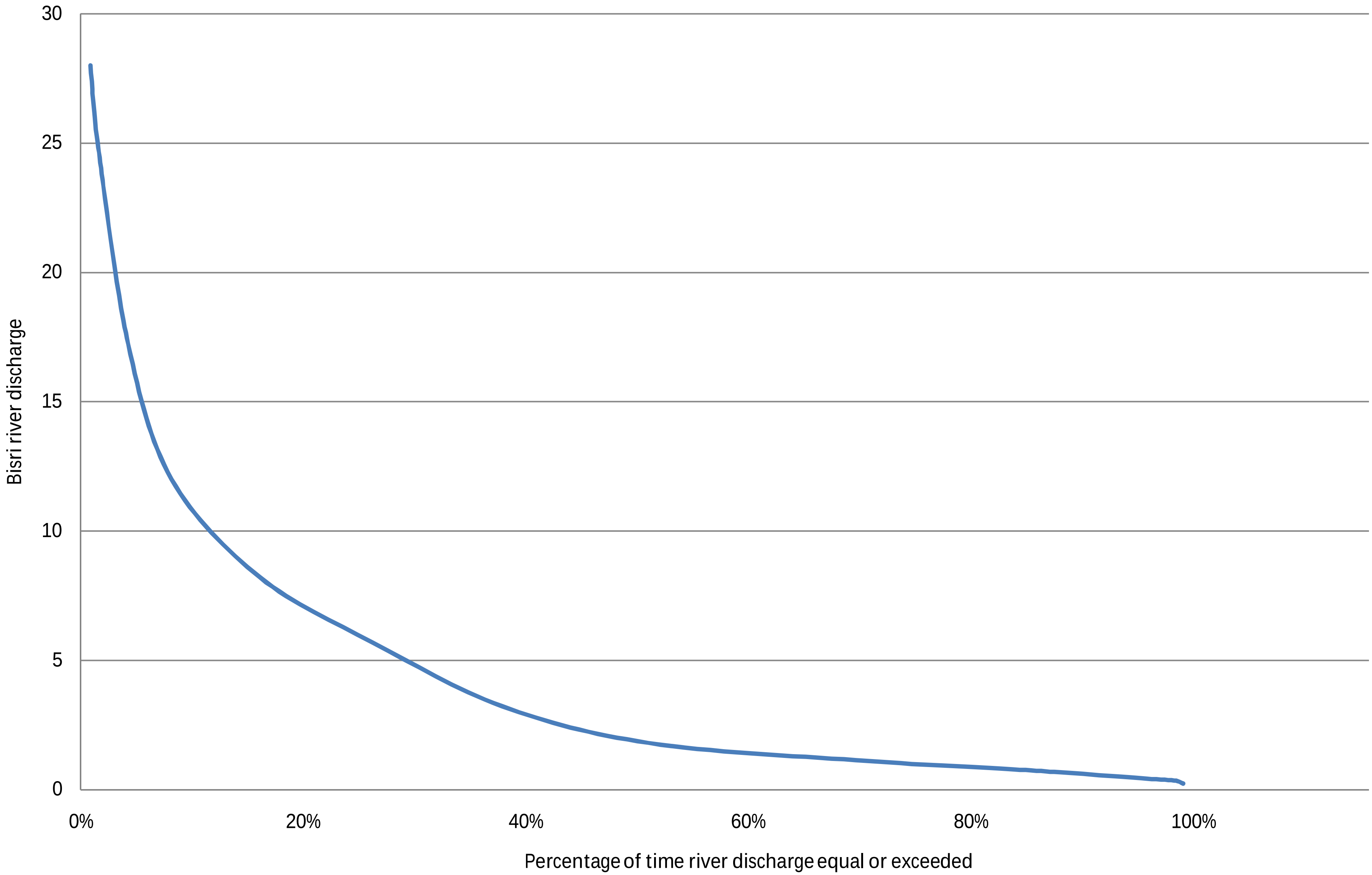
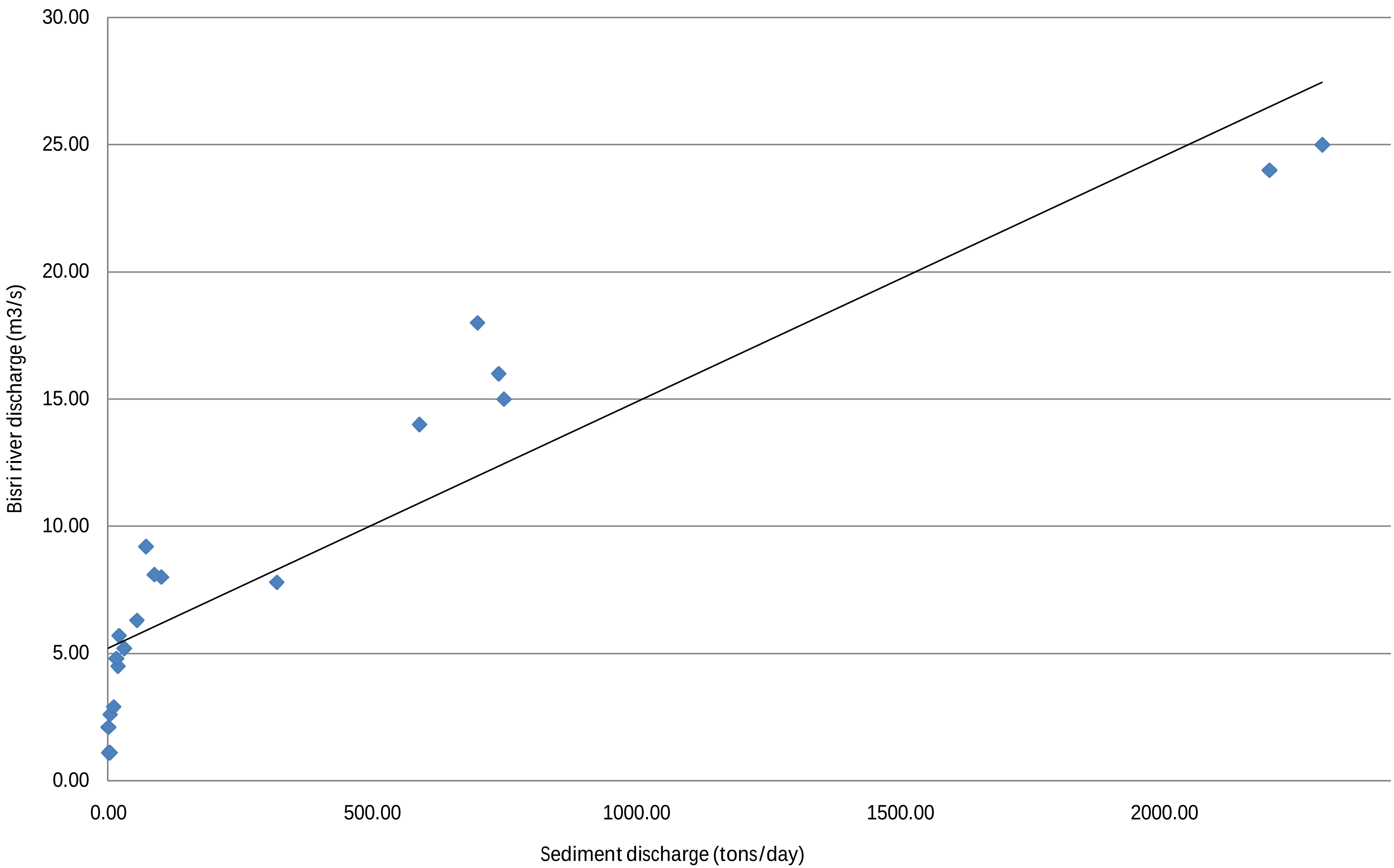


Figure 3.24: Sediment discharge curve



CHAPTER 4 - WATER SUPPLY YIELD

IV.1 Introduction

This chapter presents the update of the estimation of the capacity-yield relationship for Bisri Reservoir based on the new available hydrological data. The question "How large does the reservoir capacity need to be to provide for a given controlled release with an acceptable level of reliability" needs to be answered. This section is divided into six main parts: (1) Definition of Terms; (2) Methodology; (3) Shortage Criteria; (4) System Characteristics; (5) Reservoir Capacity-Yield Analyses; and (6) Conclusions based on the analyses.

IV.2 Definition Of Terms

Active Storage: The active storage of a reservoir is the water stored above the level of the lowest offtake. It is equal to the total volume of stored water less the volume of "dead" storage (the volume below the level of the offtake).

Carryover Storage: The volume of active storage in Bisri Reservoir at the beginning of the wet season.

Critical Period: The period during which a reservoir goes from full condition to an empty condition without spilling in the intervening period. The start of a critical period is a full reservoir; the end of the critical period is when the active storage is zero.

Demand: Demand is the water supply required by a water user.

Normal Water Surface Elevation: The maximum reservoir operating level during normal operating conditions.

Operating Rule: Usually the volume of water released from a reservoir is equal to the volume of water required by the consumers. However, there may be periods when either the reservoir level is so low that the water required cannot be supplied, or when prudence dictates that only part of the water demanded should be released from storage. The way in which releases are controlled is called the operating rule or rule curve.

Release: Release is the volume of controlled water released from a reservoir during a given time interval.

Storage: The storage of a reservoir is total storage which includes dead and active storages.

Volumetric Shortage: The percentage of the volume of water which is required for release to Beirut but cannot be supplied due to lack of water available in the reservoir over the 30-year study period.

IV.3 Methodology

Three series of simulations were performed for the Bisri Reservoir:

- Simulation or Behavior Analyses using the series of 30 years of data (1944-1945 to 1973-1974) referred to as “Old Data”.
- Simulation or Behavior Analyses using the series of 20 years of data (1989-1990 to 2008-2009) referred to as “New Data”.
- Simulation or Behavior Analyses using the series of 65 years of data (1944-1945 to 2008-2009) referred to as “All Data”.

The simulation analysis method requires an unbroken sequence of streamflow data and an assumed starting condition for the storage; the result is often sensitive to both the initial reservoir storage value chosen and the particular period of streamflow data available. The method is flexible and includes such factors as evaporation, seasonal demand, and reservoir restrictions in the computations.

In a simulation analysis, the changes in storage volume of a finite reservoir are calculated using a mass storage equation balancing inflow and outflow from the system. Two assumptions were made: the reservoir is initially full; and the historical data sequence is representative of future river flows.

The three series of simulation analyses were performed for reservoirs with total storage volumes ranging from 90 to 150 Mm^3 in 10 Mm^3 increments for a 6 month constant demand from 6 to 7 m^3/sec. The active storage used for these analyses included 25 years of reservoir sedimentation. The preliminary analyses were performed for the monthly records at the Bisri damsite which included reservoir evaporation losses.

IV.4 Shortage Criteria

Water stored in Bisri Reservoir will be used for municipal and industrial purposes for the City of Beirut. If any excess water is available in the early years of the project, the excess amount could probably be used for irrigation. Water shortage is calculated (as a percentage) by dividing the total water shortage (in Mm^3) by total demand for water during the 30-year study period. No criteria were established for determining yield for an irrigation purpose since it is not known how much water will be needed for municipal and industrial uses.

IV.5 System Characteristics

To estimate the water yield of a reservoir project, the reservoir characteristics need to be determined as accurately as available data will allow. Following is a description of the reservoir characteristics determined for the Bisri Reservoir.

IV.5.1 Reservoir area-capacity curves

The area-capacity curves for Bisri Reservoir were prepared from a topographic map on a scale of 1:20,000 and having a contour interval of 10 meters. Areas were planimetered from the topographic map enlarged to a scale of 1:5,000. The original area-capacity curves are presented in Figure 4.1. For the purposes of reservoir operation studies, the 25-year sediment deposition of 4 Mm^3 was used to modify the area-capacity curves. In revising the original area-capacity curves of Bisri Reservoir, the empirical area reduction method, outlined in the "Design of Small Dams," Second Edition, a publication of the United States Bureau of Reclamation (USBR, 1973), was used. The revised area-capacity curves are also presented in Figure 4.1. Values for the original and revised curves are provided in Table 4.1.

IV.5.2 Hydropower development

Hydropower development is a secondary priority for the Bisri Project. The first priority is to deliver domestic and industrial water supply to the City of Beirut. The energy produced from the powerplant is a by-product of the reservoir releases required for water supply. The system flow constraints are based on the normal operating range of the reservoir. Except when the reservoir is spilling, the maximum reservoir elevation is the normal water surface (NWS) elevation 456 m. The minimum operating elevation is 424 m. This allows for a 4-meter depth of water above the invert of the outlet works.

IV.6 System Losses

System losses are the water losses from the reservoir due to evaporation, seepage, and transmission losses from the release point (at the dam) to the delivery point. The largest impact on the Bisri Project is the reservoir evaporation. Seepage losses are considered equal to 5% of the volume due to the cutoffs to be provided at the dam and in the reservoir. Transmission losses are estimated to be minor. Following is a discussion of the system losses included in this analysis.

IV.6.1 Net reservoir evaporation

Net reservoir evaporation is the difference in evapotranspiration from the reservoir area before and after the reservoir is in place. Evapotranspiration, prior to the reservoir, can be approximated as the difference between rainfall and runoff which occurs in the reservoir area. Evapotranspiration after the reservoir is in place can be estimated from the recorded pan-evaporation data. For this study, reservoir evaporation equals 0.8 times the mean monthly pan evaporation.

The available evaporation data are discussed in Chapter 3. Of the two stations having evaporation data, the Kfar-Nabrakh is closer to the proposed Bisri Reservoir. The mean monthly evaporation data from this station were assumed to represent evaporation from the Bisri Reservoir. Of the four rainfall stations which were selected for determining basin precipitation, Jdeidet-ech-chouf is closest to the Bisri Reservoir. The mean monthly precipitation at this station was, therefore, considered most representative of precipitation on the surface of Bisri Reservoir. The reservoir evaporation for Bisri Reservoir is shown in Figure 4.2.

IV.6.2 Reservoir seepage potential

It was assumed that the seepage loss is equal to 5% of the volume in the reservoir operation study.

IV.6.3 Downstream transmission losses

The downstream transmission losses include the riverbank losses between the reservoir and the user, in this case the intake to the water treatment plant at the Awali powerplant. The required releases from the reservoir must be adjusted to ensure that the requested amount reaches the diversion point. For the present study, it was assumed that any transmission losses are compensated by local inflow between Bisri Dam and the diversion point.

IV.7 Reservoir Capacity-Yield Analysis

The following section discusses the results of the yield-capacity analyses performed for the Bisri Reservoir. The results are presented in graphical form showing the shortage versus demand for finite reservoir volumes ranging from 90 Mm^3 to 150 Mm^3 by increments of 10 Mm^3. The results are presented for the simulation analysis and then the Gould's Probability Matrix Method for a specific reservoir volume. The relationship between reservoir volume and the normal water surface elevation is:

Reservoir Volume Mm^3	90	100	110	120	130	140	150
NWS Elevation	450.8	453.5	456.2	459.0	461.5	463.9	466.1

IV.7.1 Simulation analyses

Simulation analyses for the 30-year monthly streamflow data (1944-1945 to 1973-1974), for the 20-year monthly streamflow data (1989-1990 to 2008-2009) and for the 65-year monthly streamflow data (1944-1945 to 2008-2009) were performed for reservoirs with storage volumes from 90 to

150 Mm^3 in 10 Mm^3 increments for a 6-month constant demand of 6 and 7 m^3/sec.

Figures 4.3 and 4.4 and Tables 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7 show the results of the analyses.

Appendix A shows the monthly reservoir operations for the 42 simulations.

Appendix B shows the detailed calculation steps for reservoir storage of 110 Mm^3 and a delivery of 6 m^3/s for six months between June through November based on the 65-year monthly flow data.

Table 4.1: Reservoir Area-Capacity Relationship

	ORIGINAL		REVISED FOR 25-YEARS OF SEDIMENT	
ELEVATION	AREA	CAPACITY	AREA	CAPACITY
(m)	(x 1000 sq.m)	(x 1000 cu.m)	(x 1000 sq.m)	(x 1000 cu.m)
395	0	0	0	0
411	210	970	0	0
415	650	2690	460	920
420	1320	7620	1160	4970
425	1850	15500	1740	12220
430	2228	34069	2178	30339
435	2530	45975	2490	42065
440	2889	59509	2889	54509
442	3055	65404	3055	61404
445	3216	74648	3216	70648
450	3410	91064	3410	87064
460	3957	127850	3957	123850
465	4375	148385	4375	144385
470	5327	170589	5327	166589

Table 4.2: Simulations results for 65 years of data (Release Rate = 6 m^3/s)							
Simulation	1.1	1.2	1.3	1.4	1.5	1.6	1.7
Demand (m^3/s)	6	6	6	6	6	6	6
Reservoir Storage (Mm^3)	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	9.7%	7.2%	5.9%	5.0%	4.3%	3.8%	3.5%
Yearly Maximum	74%	74%	74%	74%	74%	74%	74%
Monthly Maximum	100%	100%	100%	100%	100%	100%	100%
Percentage of years of % shortage							
0%	38%	72%	77%	80%	83%	89%	89%
< 5%	60%	77%	83%	83%	88%	91%	91%
Annual overflow (Mm^3)							
Average	55.3	53.0	52.1	51.3	50.6	50.2	49.8
Maximum	387.2	377.1	366.9	356.8	346.7	336.6	326.6

Table 4.3: Simulations results for 65 years of data (Release Rate = 7 m^3/s)							
Simulation	1.8	1.9	1.10	1.11	1.12	1.13	1.14
Demand	7	7	7	7	7	7	7
Reservoir Storage	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	19.3%	14.3%	11.2%	9.7%	8.4%	7.3%	6.4%
Yearly Maximum	77%	77%	77%	77%	77%	77%	77%
Monthly Maximum	100%	100%	100%	100%	100%	100%	100%
Percentage of years of % shortage							
0%	5%	17%	52%	66%	69%	74%	77%
< 5%	18%	42%	69%	71%	74%	80%	82%
Annual overflow (Mm^3)							
Average	52.9	46.7	43.0	41.6	40.4	39.3	38.5
Maximum	387.2	377.1	366.9	356.8	346.7	336.6	326.6
Percentage of years with the Reservoir reaching Full Capacity							
Percentage	75%	69%	63%	62%	60%	58%	58%

Table 4.4: Simulations results for the 30 years of data used in the Feasibility Study of 1995 (Release Rate = 6 m^3/s)							
Simulation	2.1	2.2	2.3	2.4	2.5	2.6	2.7
Demand	7	7	7	7	7	7	7
Reservoir Storage	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	5.0%	2.6%	1.6%	0.8%	0.2%	0.0%	0.0%
Yearly Maximum	39%	39%	27%	16%	5%	0%	0%
Monthly Maximum	94%	94%	85%	81%	30%	0%	0%
Percentage of years of % shortage							
0%	47%	87%	90%	90%	93%	100%	100%
< 5%	70%	90%	93%	93%	97%	100%	100%
Annual overflow (Mm^3)							
Average	58.2	55.7	54.9	54.3	53.8	53.5	53.5
Maximum	183.3	183.2	183.0	182.9	182.8	182.8	182.9
Percentage of years with the Reservoir reaching Full Capacity							
Percentage	90%	83%	83%	80%	77%	77%	77%

Table 4.5: Simulations results for the 30 years of data used in the Feasibility Study of 1995 (Release Rate = 7 m^3/s)

Simulation	2.8	2.9	2.10	2.11	2.12	2.13	2.14
Demand	7	7	7	7	7	7	7
Reservoir Storage	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	15.4%	9.3%	5.9%	4.5%	3.3%	2.4%	1.8%
Yearly Maximum	46%	46%	46%	46%	46%	39%	30%
Monthly Maximum	96%	96%	96%	96%	96%	95%	94%
Percentage of years of % shortage							
0%	3%	17%	60%	77%	80%	87%	87%
< 5%	17%	50%	80%	80%	87%	90%	90%
Annual overflow (Mm^3)							
Average	55.9	48.3	43.9	42.5	41.5	40.9	40.5
Maximum	170.4	167.3	167.2	167.1	167.1	167.0	167.1
Percentage of years with the Reservoir reaching Full Capacity							
Percentage	90%	80%	73%	73%	70%	70%	70%

Table 4.6: Simulations results for the last 20 years of data (Release Rate = 6 m^3/s)							
Simulation	3.1	3.2	3.3	3.4	3.5	3.6	3.7
Demand	7	7	7	7	7	7	7
Reservoir Storage	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	19.0%	15.9%	14.2%	12.8%	11.7%	10.6%	9.5%
Yearly Maximum	74%	74%	74%	74%	74%	74%	74%
Monthly Maximum	100%	100%	100%	100%	100%	100%	100%
Percentage of years of % shortage							
0%	20%	50%	60%	70%	70%	75%	75%
< 5%	35%	55%	65%	70%	70%	75%	75%
Annual overflow (Mm^3)							
Average	48.9	46.6	45.6	44.8	44.3	43.8	43.2
Maximum	387.2	377.1	366.9	356.8	346.7	336.6	326.6
Percentage of years with the Reservoir reaching Full Capacity							
Percentage	55%	50%	50%	50%	50%	50%	50%

Table 4.7: Simulations results for the last 20 years of data (Release Rate = 7 m^3/s)							
Simulation	3.8	3.9	3.10	3.11	3.12	3.13	3.14
Demand	7	7	7	7	7	7	7
Reservoir Storage	90	100	110	120	130	140	150
Potable Water shortage (%)							
Average	27.6%	24.4%	21.6%	19.8%	18.3%	16.9%	15.6%
Yearly Maximum	77%	77%	77%	77%	77%	77%	77%
Monthly Maximum	100%	100%	100%	100%	100%	100%	100%
Percentage of years of % shortage							
0%	10%	15%	25%	45%	50%	55%	65%
< 5%	20%	20%	45%	50%	50%	60%	70%
Annual overflow (Mm^3)							
Average	46.9	43.1	40.3	38.8	37.8	36.8	35.9
Maximum	387.2	377.1	366.9	356.8	346.7	336.6	326.6
Percentage of years with the Reservoir reaching Full Capacity							
Percentage	55%	50%	40%	35%	35%	35%	35%

Figure 4.1: Elevation - Area - Capacity Curve

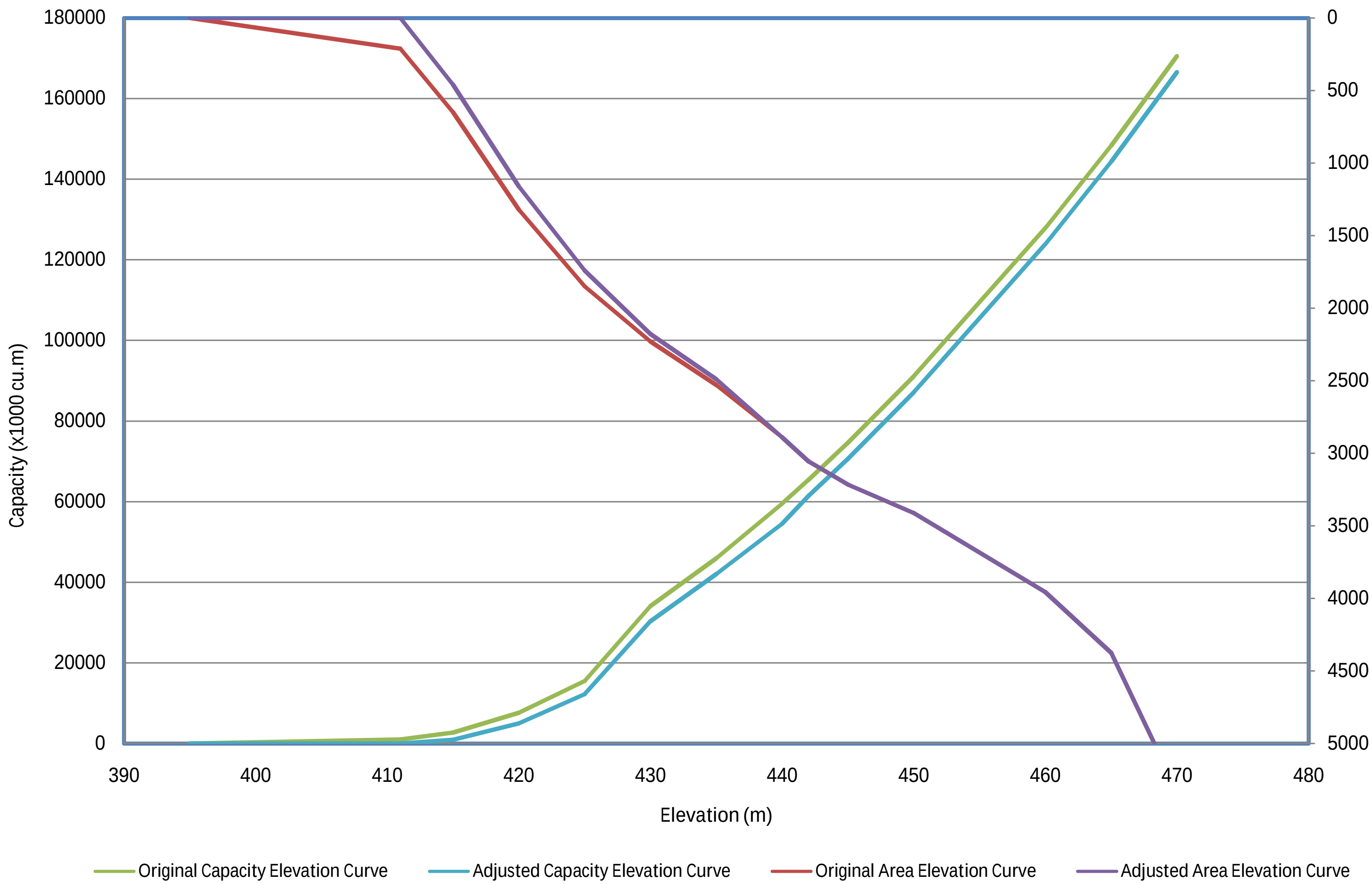


Figure 4.2: Monthly Reservoir Evaporation

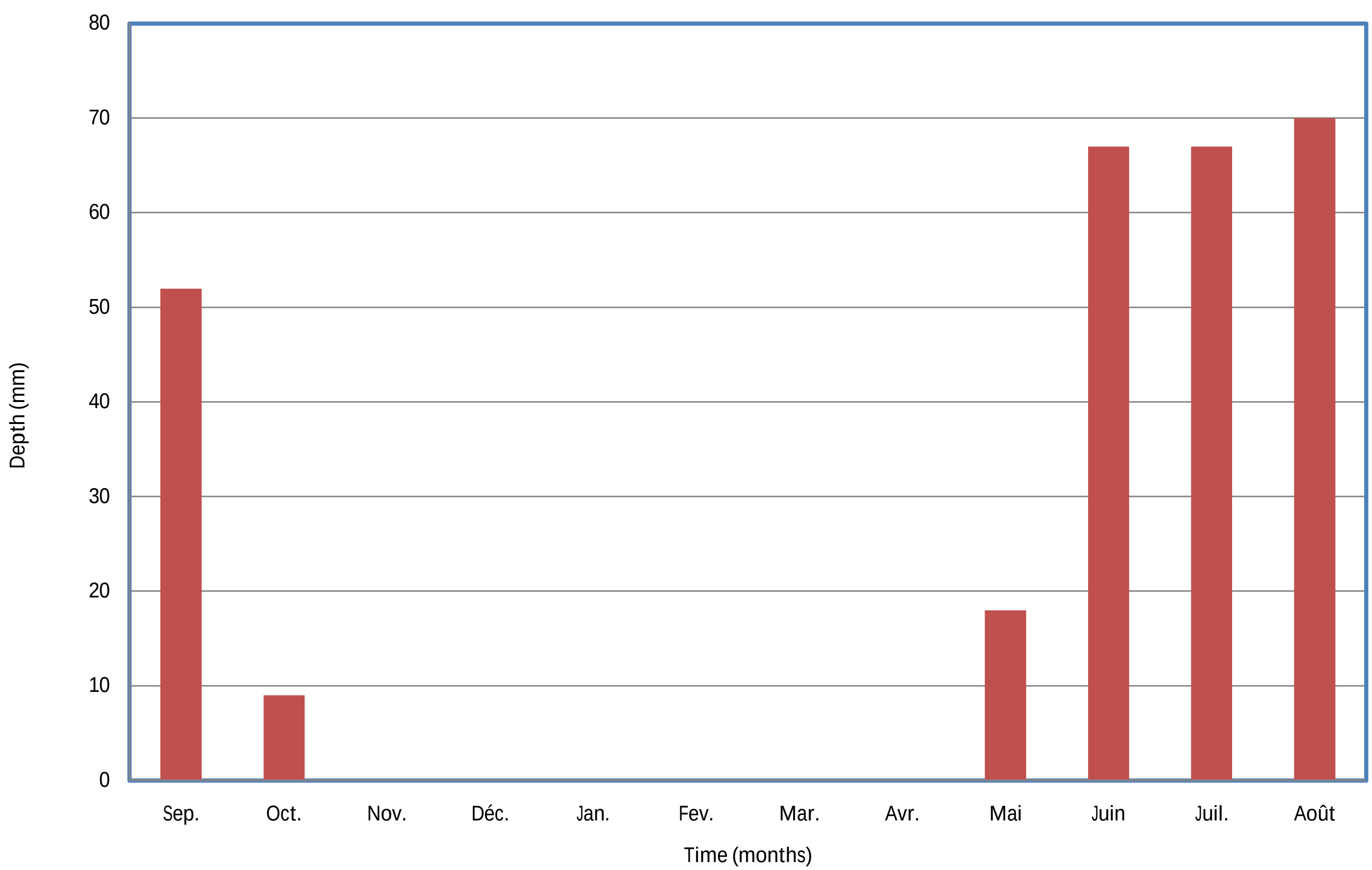


Figure 4.3: Results of the Simulations in term of Average Shortage Percentage

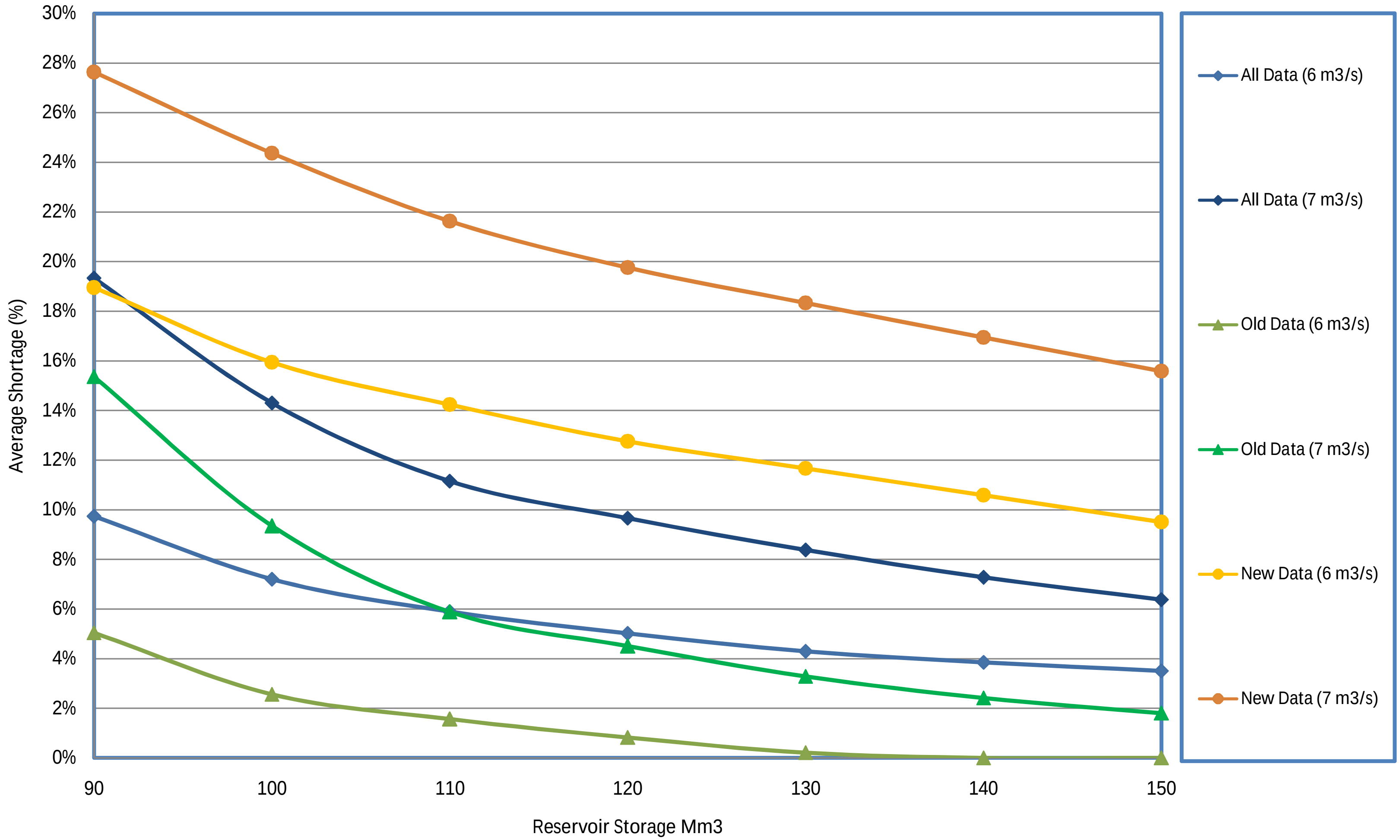
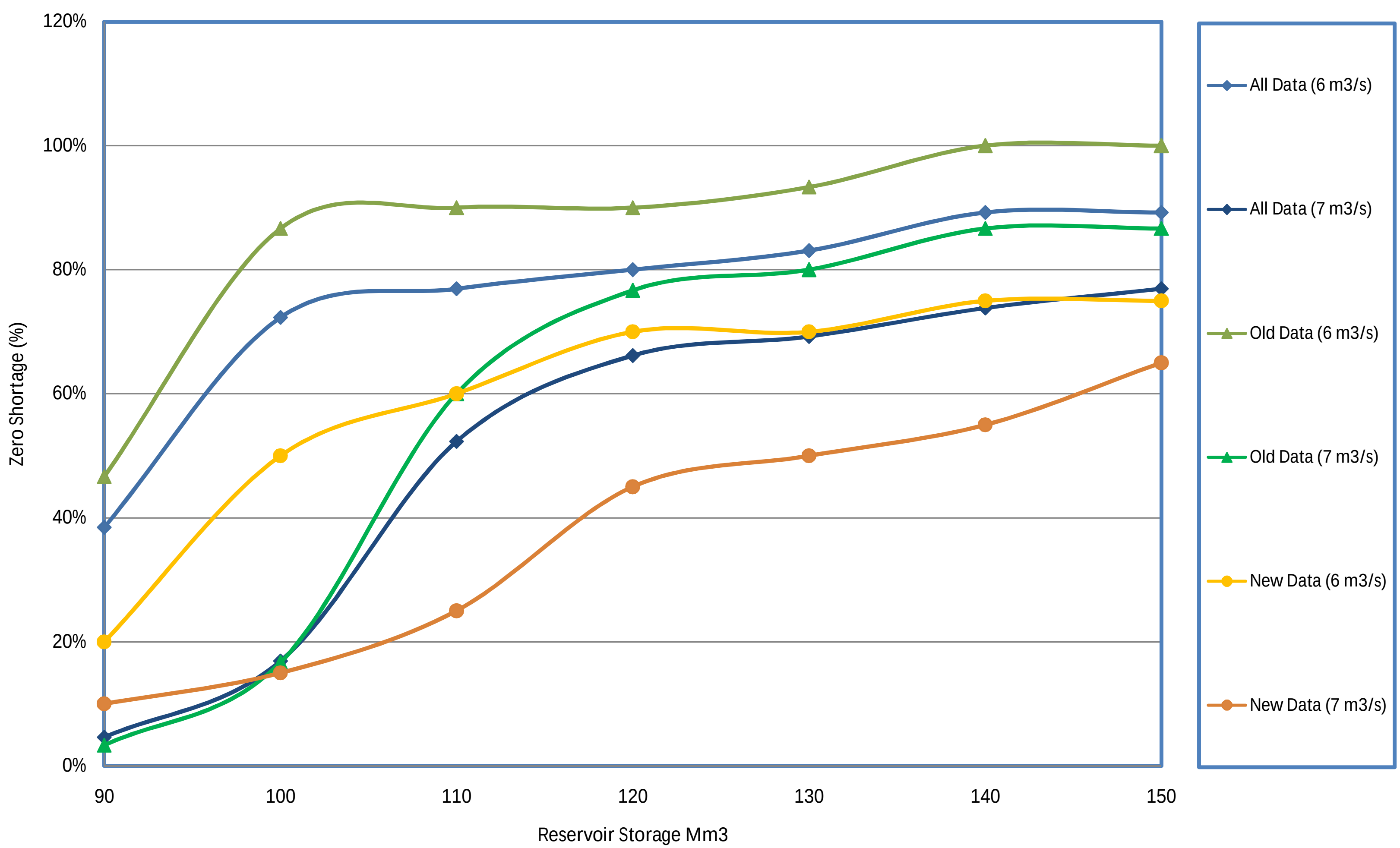


Figure 4.4: Results of the Simulations in term of Zero Shortage Percentage



CHAPTER 5 - COST ESTIMATE FOR DIFFERENT DAM HEIGHTS

V.1 Purpose

Uncertainties exist in the preparation of this cost estimate. The additional field exploration and analyses to be completed have been specified to clarify each of these uncertainties. Accordingly, assumptions have been made at the feasibility level as to the characteristics of the borrow pit materials. Reevaluation of those assumptions will be performed based on the results of the field testing program.

Cost estimates for Alternative D / Axis C (Composite Earth, rock and RCC dam, integral spillway, conduit diversion) for two dam heights are presented in the two tables below for the 1995 design and the 2010 design. These costs do not include land acquisition. All costs are expressed in U.S. dollars without escalation. The detailed cost estimate for the two dam heights is illustrated respectively.

Cost estimate of 1995 design				
Crest Elevation (m)	**Subtotal Contractor's Cost**	**Contingency**	**Engineering**	**Construction Cost**
464	88,358,000	17,700,000	15,900,000	121,958,000
469	95,000,000	19,000,000	17,100,000	131.080,000

Cost estimate of 2010 design				
Crest Elevation (m)	**Subtotal Contractor's Cost**	**Contingency**	**Engineering**	**Construction Cost**
464	179,850,000	35,980,000	32,380,000	248,180,000
469	196,550,000	39,320,000	35,390,000	271,190,000

V.2 General

Large, heavy construction equipment will be mobilized for the excavation and fill placement operations to take advantage of the economies associated with size and relatively high production which can be expected with the large volumes of materials to be moved.

In preparing the cost estimates, a "contractor-type" approach was used, as opposed to escalating previously derived costs or referring to published cost guides. Crews and equipment fleets were sized based on actual experience from similar operations and reasonable production rates were assigned recognizing the type of work and location of the project. Local prices were obtained for construction materials and supplies and prevailing wage rates were determined for each of the construction trades to be employed. It was assumed that no royalties would be charged for excavated materials and no fee would be paid for the use of water.

Specialized equipment for certain activities will be required and, where possible, specialized work will be subcontracted. Activities which fall into this category include slurry wall construction, vibro-compaction, wick drain installation and foundation grouting.

Acquisition of approximately 5.5 million m^2 of land will be required for the Bisri Project. A determination as to ownership of the land which will be required for access roads, temporary and permanent features and reservoir inundation has not been initiated. Only very limited investigation has been carried out to date to determine the land values in the project area. Under existing security conditions, consensus as to land values has not been possible. Therefore, costs for the acquisition of property for construction of the project are not included in this estimate.

V.3 Quantities

Using the preliminary layout drawings which were prepared in the feasibility study of 1995, quantities for the work activities were calculated. In general, excavation and embankment quantities were derived through average-end-area method calculations using the contour elevations from the prefeasibility report drawings. Volumes of concrete were calculated from the details shown on the layout drawings. The unit costs for structural concrete in the estimates include an allowance for the supply and installation of rebar. Foundation treatment quantities were established through analysis of the available geologic and geotechnical data, based on experience and site information gathered over the period of our involvement with the project. As discussed above, when additional information is produced from the latest field exploration program, these analyses will be reviewed and adjustments made as appropriate.

V.4 Wage Rates

It has been assumed that the contractor's supervisory personnel will be foreign nationals and compensated in line with typical positions abroad. A total of 6 positions for management and supervision by expatriate personnel has been anticipated.

The expatriate management staff will be supplemented with local support personnel, compensated in line with prevailing wages.

V.5 Equipment Rates

Hourly ownership and operating rates for construction equipment were derived using historical cost records. The rates include capital cost depreciation, financing and insurance under ownership; fuel, oil and grease; service and maintenance labor; major and minor repair parts costs; tires/tracks; and ground engaging tools under operating rates. Cost of the operating labor is a separate charge.

V.6 Materials Cost

Representative costs for construction materials were obtained after several investigations. Quotations for supply and installation of permanent materials and equipment for the project were obtained in part, by checking with major suppliers of hydraulic equipment. The unit prices for supplies and permanent materials (complete sets with controls and accessories as required), were incorporated into the cost estimates as appropriate.

For the feasibility level studies, cost estimates for the powerplant building and the generating, switching and transmission equipment were prepared using curves produced by EPRI, and escalated using USBR cost indexes. Powerplant costs represent less than three percent of total project costs.

V.7 Production Rates

Average production rates for the various work activities were established based on the experiences of our personnel with work of a similar nature using the same type of equipment. The rates have been averaged to account for productions which will be achieved during "learning curve", confined space, and "peak" periods. For certain of the work activities which will involve specialty applications, the rates were established after discussions with experienced subcontractors.

V.8 Contingencies

Because of the present status of the detailed design and the incomplete exploration program, a contingent amount of twenty percent (20%) has been added to the total estimated construction cost for each alternative. As the final design is developed and the details from the subsurface investigations are revealed, this amount may be reduced. Of course, the additional investigation could reveal conditions which have not been anticipated to date and the overall cost may increase. We believe such an event to be unlikely, but possible.

V.9 Engineering And Administration

Fifteen percent (15%) has been added to the total estimated construction cost (including contingency) to cover the costs for preparation of final design drawings and bid documents, for assistance during the bidding and award phases, for monitoring, inspection, materials testing and administration of the construction contractor, for reviewing submittals from the permanent equipment suppliers, and for providing operation and maintenance training to the permanent staff. This rate generally covers costs of the Owner's project staff during construction.

Table 5.1 Project cost estimate; Alternatine D crest at 464m

ITEM	QUANT	UNIT	-March - 1995' UNIT PRICE (U.S.$ 1995)	COST (U.S.$)	-March - 2010' UNIT PRICE	COST (U.S.$)
COFFERDAM						
Excavation-earth	70,500	m³	3.10	218,550.00	3.5	246,750
Wick drains	138,550	m	4.35	602,692.50	7.0	969,850
Vibro-compaction	174,290	m³	1.85	322,436.50	3.0	522,870
Placing and compacting shell	200,880	m³	5.90	1,185,192.00	8.0	1,607,040
Placing and compacting core	128,340	m³	2.05	263,097.00	10.0	1,283,400
Placing rip rap	23,940	m³	8.85	211,869.00	17.0	406,980
Backfill	2,870	m³	11.90	34,153.00	6.0	17,220
subtotal - Cofferdam				**2,837,990.00**		**5,054,110**
MAIN DAM						
Excavation-earth	651,200	m³	2.40	1,562,880.00	3.5	2,279,200
Wick drains	1,246,950	m	4.35	5,424,232.50	7.0	8,728,650
Vibro-compaction	1,568,610	m³	2.50	3,921,525.00	4.0	6,274,440
Construct slurry cutoff-full valley depth	24,970	m²	301.05	7,517,218.50	450.0	11,236,500
Left abutment cutoff-rock	8,921	m²	400.55	3,573,306.55	650.0	5,798,650
Drilling holes for foundation grouting	21,400	m	28.95	619,530.00	100.0	2,140,000
Hookups to grout holes	762	hookups	14.45	11,010.90	25.0	19,050
Pressure grouting foundations	7,550	m³	451.50	3,408,825.00	800.0	6,040,000
Placing and compacting shell	3,158,330	m³	4.30	13,580,819.00	8.0	25,266,640
Placing and compacting core	599,990	m³	1.90	1,139,981.00	10.0	5,999,900
Placing and compacting transition	2,165,180	m³	2.20	4,763,396.00	10.0	21,651,800
Placing and compacting drain	182,530	m³	4.95	903,523.50	15.0	2,737,950
Placing and compacting filter	224,030	m³	6.21	1,391,226.30	15.0	3,360,450
Placing and compacting rip rap	86,650	m³	8.20	710,530.00	17.0	1,473,050
Placing and compacting RCC	356,000	m³	5.80	2,064,800.00	70.0	24,920,000
Cutoff/blanket for reservoir	310,000	m²	11.60	3,596,000.00	20.0	6,200,000
Left abutment drain holes	2,800	m	17.35	48,580.00	35.0	98,000
RCC drain holes	850	m	17.35	14,747.50	35.0	29,750
Piezometers	1,650	m	231.55	382,057.50	300.0	495,000
Settlement casings	1,010	m	156.90	158,469.00	250.0	252,500
Inclinometers	490	m	254.70	124,803.00	350.0	171,500
Seismographs	4	each	57,900.00	231,600.00	25,000.0	100,000
Seepage weirs	3	each	5,790.00	17,370.00	7,000.0	21,000
Survey monuments	50	each	173.65	8,682.50	200.0	10,000
subtotal - Main Dam				**55,175,113.75**		**135,304,030**
DIVERSION CONDUIT						
Earth excavation	247,500	m³	2.55	631,125.00	3.5	866,250
Rock excavation	27,000	m³	6.05	163,350.00	7.0	189,000
Lean concrete	16,000	m³	198.50	3,176,000.00	150.0	2,400,000
Structural concrete	10,025	m³	268.15	2,688,203.75	270.0	2,706,750
Earth backfill	260,000	m³	0.45	117,000.00	4.0	1,040,000
Tunnel stoplogs	1		58,900.00	58,900.00	100,000.0	100,000
subtotal - Diversion Conduit				**6,834,578.75**		**7,302,000**
LOW LEVEL OUTLET - INTAKE STRUCTURE						
Structural concrete	500	m³	278.50	139,250.00	270.0	135,000
Hemispherical bulkhead	1	set	203,200.00	203,200.00	350,000.0	350,000
Furnish & install 3.5m x 3.5m fixed wheel gate	1	each	281,300.00	281,300.00	400,000.0	400,000

subtotal - Low Level Outlet - Intake structure				**623,750.00**		**885,000**
LOW LEVEL OUTLET - OUTLET STRUCTURE						
Steel Pipe	167,000	Kg	6.05	1,010,350.00	7.0	1,169,000
Furnish & install 1 butterfly valve, 0.9m dia..	1	each	125,000.00	125,000.00	200,000.0	200,000
Furnish & install 1 ring jet valve. 0.8m dia.	1	each	156,300.00	156,300.00	250,000.0	250,000
Furnish & install outlet guard valve. 2.0m dia.	1	each	468,900.00	468,900.00	700,000.0	700,000
Furnish & install 1 Howell Bunger valve, 1.8m di	1	each	625,200.00	625,200.00	950,000.0	950,000
subtotal - Low Level Outlet - Outlet structure				**2,385,750.00**		**3,269,000**
SPILLWAY - OVERFLOW						
Structural concrete for stepped spillway	46,240	m³	254.50	11,768,080.00	270.0	12,484,800
Concrete paving in stilling basin	13,590	m³	249.75	3,394,102.50	200.0	2,718,000
subtotal - Spillway				**15,162,182.50**		**15,202,800**
MOBILIZATION/OVERHEAD						
Mobilization	1	lump sum	1,102,300.00	1,102,300.00	3,000,000.0	3,000,000
Overhead	1	lump sum	1,966,100.00	1,966,100.00	6,000,000.0	6,000,000
subtotal - Mobilization				**3,068,400.00**		**9,000,000**
HYDROPOWER(1.4MW)						
Penstock	1	lump sum	24,300.00	24,300.00	50,000.0	50,000
Powerplant-structure	1	lump sum	607,700.00	607,700.00	1,250,000.0	1,250,000
Powerplant-equipment	1	lump sum	923,700.00	923,700.00	1,500,000.0	1,500,000
Switchyard	1	lump sum	316,000.00	316,000.00	500,000.0	500,000
Switchyard equipment	1	lump sum	194,500.00	194,500.00	300,000.0	300,000
Transmission line	1	lump sum	121,500.00	121,500.00	200,000.0	200,000
Subtotal - Hydropower				**2,187,700.00**		**3,800,000**
Subtotal Contractors' Costs,				**88,275,465.00**		**179,816,940**
Contingency. 20%				**17,655,093.00**		**35,963,388**
Total Contractors' Costs				**105,930,558.00**		**215,780,328**
Engineering & Administration. 15%				**15,889,583.70**		**32,367,049**
Construction Cost.				**121,820,141.70**		**248,147,377**

Table 5.2 Project cost estimate; Alternatine D crest at 469m

ITEM	QUANT	UNIT	-March - 1995' UNIT PRICE (U.S.$ 1995)	COST (U.S.$)	-March - 2010' UNIT PRICE	COST (U.S.$)
COFFERDAM						
Excavation-earth	80,860	m³	3.10	250,666.00	3.5	283,010
Wick drains	158,900	m	4.35	691,215.00	7.0	1,112,300
Vibro-compaction	199,900	m³	1.85	369,815.00	3.0	599,700
Placing and compacting shell	230,400	m³	5.90	1,359,360.00	8.0	1,843,200
Placing and compacting core	147,200	m³	2.05	301,760.00	10.0	1,472,000
Placing rip rap	27,460	m³	8.85	243,021.00	17.0	466,820
Backfill	2,870	m³	11.90	34,153.00	6.0	17,220
subtotal - Cofferdam				**3,249,990.00**		**5,794,250**
MAIN DAM						
Excavation-earth	746,900	m³	2.40	1,792,560.00	3.5	2,614,150
Wick drains	1,430,300	m	4.35	6,221,805.00	7.0	10,012,100
Vibro-compaction	1,799,200	m³	2.50	4,498,000.00	4.0	7,196,800
Construct slurry cutoff-full valley depth	24,970	m²	301.05	7,517,218.50	450.0	11,236,500
Left abutment cutoff-rock	8,921	m²	400.55	3,573,306.55	650.0	5,798,650
Drilling holes for foundation grouting	21,400	m	28.95	619,530.00	100.0	2,140,000
Hookups to grout holes	762	hookups	14.45	11,010.90	25.0	19,050
Pressure grouting foundations	7,550	m³	451.50	3,408,825.00	800.0	6,040,000
Placing and compacting shell	3,536,420	m³	4.30	15,206,606.00	8.0	28,291,360
Placing and compacting core	686,250	m³	1.90	1,303,875.00	10.0	6,862,500
Placing and compacting transition	2,473,980	m³	2.20	5,442,756.00	10.0	24,739,800
Placing and compacting drain	208,540	m³	4.95	1,032,273.00	15.0	3,128,100
Placing and compacting filter	256,140	m³	6.21	1,590,629.40	15.0	3,842,100
Placing and compacting rip rap	110,900	m³	8.20	909,380.00	17.0	1,885,300
Placing and compacting RCC	408,332	m³	5.80	2,368,325.60	70.0	28,583,240
Cutoff/blanket for reservoir	310,000	m²	11.60	3,596,000.00	20.0	6,200,000
Left abutment drain holes	2,800	m	17.35	48,580.00	35.0	98,000
RCC drain holes	850	m	17.35	14,747.50	35.0	29,750
Piezometers	1,650	m	231.55	382,057.50	300.0	495,000
Settlement casings	1,010	m	156.90	158,469.00	250.0	252,500
Inclinometers	490	m	254.70	124,803.00	350.0	171,500
Seismographs	4	each	57,900.00	231,600.00	25,000.0	100,000
Seepage weirs	3	each	5,790.00	17,370.00	7,000.0	21,000
Survey monuments	50	each	173.65	8,682.50	200.0	10,000
subtotal - Main Dam				**60,078,410.45**		**149,767,400**
DIVERSION CONDUIT						
Earth excavation	265,800	m³	2.55	677,790.00	3.5	930,300
Rock excavation	29,000	m³	6.05	175,450.00	7.0	203,000
Lean concrete	17,200	m³	198.50	3,414,200.00	150.0	2,580,000
Structural concrete	10,800	m³	268.15	2,896,020.00	270.0	2,916,000
Earth backfill	280,000	m³	0.45	126,000.00	4.0	1,120,000
Tunnel stoplogs	1		58,900.00	58,900.00	100,000.0	100,000
subtotal - Diversion Conduit				**7,348,360.00**		**7,849,300**
LOW LEVEL OUTLET - INTAKE STRUCTURE						
Structural concrete	500	m³	278.50	139,250.00	270.0	135,000
Hemispherical bulkhead	1	set	203,200.00	203,200.00	350,000.0	350,000
Furnish & install 3.5m x 3.5m fixed wheel gate	1	each	281,300.00	281,300.00	400,000.0	400,000
subtotal - Low Level Outlet - Intake structure				**623,750.00**		**885,000**

LOW LEVEL OUTLET - OUTLET STRUCTURE						
Steel Pipe	167,000	Kg	6.05	1,010,350.00	7.0	1,169,000
Furnish & install 1 butterfly valve, 0.9m dia..	1	each	125,000.00	125,000.00	200,000.0	200,000
Furnish & install 1 ring jet valve. 0.8m dia.	1	each	156,300.00	156,300.00	250,000.0	250,000
Furnish & install outlet guard valve. 2.0m dia.	1	each	468,900.00	468,900.00	700,000.0	700,000
Furnish & install 1 Howell Bunger valve, 1.8m di	1	each	625,200.00	625,200.00	950,000.0	950,000
subtotal - Low Level Outlet - Outlet structure				**2,385,750.00**		**3,269,000**
SPILLWAY - OVERFLOW						
Structural concrete for stepped spillway	49,700	m³	254.50	12,648,650.00	270.0	13,419,000
Concrete paving in stilling basin	13,590	m³	249.75	3,394,102.50	200.0	2,718,000
subtotal - Spillway				**16,042,752.50**		**16,137,000**
MOBILIZATION/OVERHEAD						
Mobilization	1	lump sum	1,102,300.00	1,102,300.00	3,000,000.0	3,000,000
Overhead	1	lump sum	1,966,100.00	1,966,100.00	6,000,000.0	6,000,000
subtotal - Mobilization				**3,068,400.00**		**9,000,000**
HYDROPOWER(1.4MW)						
Penstock	1	lump sum	24,300.00	24,300.00	50,000.0	50,000
Powerplant-structure	1	lump sum	607,700.00	607,700.00	1,250,000.0	1,250,000
Powerplant-equipment	1	lump sum	923,700.00	923,700.00	1,500,000.0	1,500,000
Switchyard	1	lump sum	316,000.00	316,000.00	500,000.0	500,000
Switchyard equipment	1	lump sum	194,500.00	194,500.00	300,000.0	300,000
Transmission line	1	lump sum	121,500.00	121,500.00	200,000.0	200,000
Subtotal - Hydropower				**2,187,700.00**		**3,800,000**
Subtotal Contractors' Costs,				**94,985,112.95**		**196,501,950**
Contingency. 20%				**18,997,022.59**		**39,300,390**
Total Contractors' Costs				**113,982,135.54**		**235,802,340**
Engineering & Administration. 15%				**17,097,320.33**		**35,370,351**
Construction Cost.				**131,079,455.87**		**271,172,691**

CHAPTER 6 - FINANCIAL ANALYSIS

VI.1 Initial Financial Analysis

The initial financial analysis determined the size of dam which best meets the needs of the project owner based on the cost estimate and shortage criteria of the feasibility study conducted in 1995.

In order to make this selection from a range of possible dam heights, 4 parameters were considered:

- the range of capital costs for the dams being considered
- the volume of water which can be supplied each year
- the unit cost of water which can be supplied from the reservoir
- shortage of water occurring when the reservoir is drawn down to its minimum level due to climatic conditions

The determination of dam size was made by carefully balancing the importance (to the project owner) of each of these 4 parameters. The objective of this process was to minimize:

- Minimize the capital costs of the project,
- Minimize the unit costs of the water which can be released from the dam, and
- Minimize the shortages of water during severe droughts.
- Maximize the available water supply.

By subjective weighting of these 4 parameters, the selection of the dam height which best meets the needs of the project owner was made.

VI.2 Purpose Of The Current Study

The purpose of the actual financial analysis is to update the initial financial analysis conducted during the year 1995 taking into consideration the new cost estimates and the new shortage criteria for 6 and 7 m3/s release rates, taking into consideration the long series of data (65 years) and the recent years series of data (20 years) for two cases of dam heights (Crest Level = 464 m and 469 m).

VI.3 Procedures

The financial comparisons described in this report are based on true, out-of-pocket costs to the owner. That is, only those costs which must be paid out by the owner of the project, to an individual or an entity (i.e.

accounts payable), are incorporated into this analysis. These payments are of two types: 1) annual debt service to amortize the capital costs of the project, and 2) annual operation, maintenance, and replacement costs (O, M&R costs).

Investment decisions by a water supply and distribution authority are normally based on the ability of that agency to collect adequate revenues to amortize the original investment and also operate the facilities. Thus, potential revenues from a consumer, rather than economic benefits, are central to the decision-making process. Therefore, those additional costs and benefits which are commonly dealt with only in an economic analysis are not the focus of this report.

All costs are presented in United States dollars ($US) since it is anticipated that a specialized project of this size will be bid internationally. The basic financial analyses are based on the following parameters:

- Cost of borrowing money is 9 percent.
- The period for borrowing money is 30 years.
- The escalation rate (rate of inflation) is assumed to be 4 percent from 2010 through the end of amortization in year 2044.
- No salvage value is incorporated into the analyses.
- Construction costs are escalated to the actual year in which they are expended.
- Financing is provided for 100 percent of the escalated capital costs.
- O, M&R costs are assumed constant for the 30-year period of debt service however; these costs are escalated to the actual year in which they are expended.
- Debt service payments begin 1 year after the completion of construction.
- Water deliveries to Beirut begin in the month of June 2016, 45 months after construction startup.
- Construction costs in year 1 = 10%, year 2 = 46%, year 3 = 44%.
- Real Cost of one cubic meter of water in 2010 = 0.41 US$.
- Yearly raise of the cost of one cubic meter of water = 1%.

In addition to the basic financial analysis performed using the parameters listed above, Unit Cost sensitivity analyses and IRR sensitivity analyses were performed.

The sensitivity analyses were performed for two values of dam crest level (i.e. 464 m and 469 m) and two release rates (i.e. 6 m^3/s and 7 m^3/s) by repeating the basic financial analysis, but using a combination of optimistic and a combination of pessimistic values for selected financial parameters. For example, the cost of borrowing is varied from 6 to 13 percent and escalation rates are varied from 3 to 5 percent.

VI.4 Project Costs

The project costs incorporated into these analyses are comprised of those costs related to the structural components of the Bisri Project. These components include: 1) the composite dam, 2) each of the dam's appurtenant structures, and 3) the hydroelectric power plant.

These costs were updated from the initial study conducted in 1995 and are illustrated in Chapter 5.

The costs which are defined for these structures are the capital costs and annual O, M & R costs. There are two components of capital costs: 1) construction costs and 2) interest during construction (IDC). Construction costs are comprised of the estimated contractor's cost plus expenditures for engineering and contract administration. As part of each financial analysis, construction costs were escalated to the actual year of expenditure. Interest during construction is calculated for the 3 years of construction. Total escalated construction costs and total IDC is summarized in each financial analysis.

There are specific types of costs which are not incorporated into the present financial analyses. Most important of these are: the costs of conveying the water to the treatment plant; the cost of treating the water; and the cost of conveying the treated water to Beirut in addition to a potentially large cost to the Bisri Project which is the land acquisition.

There is the potential for some additional project-related costs. These costs might include: mitigation costs for either environmental or socioeconomic issues which may later be identified; and the cost for developing an alternative method for providing a portion of the water supply during severe drought years when the full demand for water cannot be supplied from the Bisri reservoir alone. If any environmental mitigation costs are identified, these will be essentially the same, within the range of the selected dam height. Supply of full water requirements during drought years will require the conjunctive operation and management of Bisri Reservoir together with other existing and potential water supplies available to the City of Beirut. These supplies could include sources such as surface water and groundwater in the vicinity of Beirut, and/or Litani River water which is diverted to the Awali Powerplant.

VI.5 Objectives Of The Financial Analyses

The first objective of the unit cost sensitivity financial analyses is to determine the unit cost of the water supply which can be developed at the Bisri damsite for a range of reservoir sizes and a range of water supply yields. Unit cost of water supply is the cost of water released from the reservoir, reported in dollars per cubic meters of water ($\$US/m^3$). Using the resulting information on unit costs, it is possible to achieve the second objective of the sensitivity analyses, which is to identify a range of dam crest elevations versus reservoir release rates which result in acceptable rates of water supply shortage.

Having accomplished these two objectives, it is possible to achieve the goal of these financial analyses, which is to select the dam and reservoir size that best meets the needs of the project owner. This is done by simultaneously comparing the following four financial parameters: 1) unit cost of water 2) water supply yield 3) water shortage 4) capital cost of the project.

The objective of the IRR sensitivity analyses is to determine the Internal Rate of Return for each of the cases based on the Net Present Value Method.

VI.6 Potential Revenues From Hydropower

Electricity can be generated from the water releases from the Bisri Dam. The construction cost for a 1.4 MW hydropower plant is included in the project cost estimate. Based on the reservoir operation studies, an estimated 11 GWh (11*106 kWh) of energy can be generated from the reservoir releases.

For every $US 0.01 of value attributed to each kWh of energy, approximately $US 110,000 could be generated in revenue each year. Thus, if energy is valued at $US 0.10 per kWh, approximately $US 1,100,000 in revenue could be generated by the hydropower plant. If these revenues belong to the owner, approximately 5 percent of the annual project costs (amortized cost plus O, M & R) could be paid by hydropower generation.

The 1.4 MW size of the hydropower plant is based on the assumption of releasing water at 3.0m³/s for 12 months of the year. If the Bisri Reservoir is to be operated in this manner in the early years, energy would be generated throughout the year. However, if water is to be released for only 6 months from the first year of operation, a power plant approximately double in size would be required for a release of 6.0m³/s. However, the same approximate energy would be generated in 6 rather than 12 months. No energy would be generated in the remaining 6 months when there are no releases.

VI.7 The Basic Financial Analyses

The financial analyses have been performed using the least cost alternative of the feasibility study of 1995.

The basic financial analyses have been performed using costs for 2 dam heights for the least cost alternative. The base case is for the dam crest at elevation 464, with a normal water surface elevation of 456, and a reservoir capacity of 110 Mm³. The other case is for a dam 5 meters higher (El. 469). Basic cost data for these 2 dam heights are as follows:

Dam Crest Elevation	464	469
Construction Cost (2010 $US Millions)	248.2	271.2
Capital Cost (2015 $US Millions)	326.6	356.8

Costs for the dam with a crest elevation of 464 and 469 were obtained by means of the detailed cost estimate described in previous sections of this report. Construction Costs and Capital costs are plotted in Figures 6.1 and 6.2.

Analyses were performed for 2 constant water release rates for a 6-month period. The 2 rates of release are 6.0 and 7.0 m³/s. The monthly and annual volumes of water released from Bisri reservoir for each of these 2 rates are:

Release Rate (m³/s)	**Monthly Volume (Mm³)**	**Annual Volume (Mm³)**
6.0	15.8	94.6
7.0	18.4	110.4

For each of the 2 dam heights versus each of the 2 release rates for the long series of registered data (65 years), a financial analysis was performed using the above defined parameters. The results of these analyses are shown in Table 6.1, 6.2, 6.3 and 6.4. As part of each of these tables, the financial parameters used as input, and the financial results of each analysis, are presented. From these 4 spreadsheet analyses, the following unit costs per cubic meters of released water are presented in the following table:

Cost (2010 US $) per Cubic Meters of Water Released from Bisri Dam		
Release Rate	Dam Crest Elevation	
	464	469
6.0 m³/s	0.20$	0.22$
7.0 m³/s	0.23$	0.25$

From this table it can be seen that the lowest unit cost of water occurs for the lowest dam height (El. 464) combined with the highest water release rate (7.0 m³/s). However, each of these values of unit cost must also take into account that there will be water supply shortages, in some years, related to each of these project combinations. Thus, the lower the dam height and the higher the release rate, the greater win be the expected shortage.

VI.8 Unit Cost Sensitivity Analyses

Unit Cost sensitivity analyses were performed, with release rates of 6.0 and 7.0m³/s, dam crest elevations of 464 and 469 and for shortages resulting from the long series of data (65 years) and the series of data for the recent years (20 years).

Two sets of analyses were performed, one with an optimistic outlook and one with a pessimistic view. Two financial parameters were varied for these analyses.

For the pessimistic case, cost of money was increased from 9 to 13 percent and escalation rates were increased from 4 to 5 percent. For the optimistic case, the cost of money was decreased from 9 to 6 percent and escalation rates were decreased from 4 to 3 percent.

The results of these analyses are summarized in the figure 6.3 through figure 6.10 for the Average unit cost of water (Year 2010) and in figure 6.11 through 6.18 for the average unit cost of water (Actual).

The appendix C illustrates the spreadsheets used for the sensitivity analysis for the case of dam height 464, release rate 6 m^3/s and the shortage resulting from the long series of data. As part of each of these spreadsheets/tables, the financial parameters used as input, and the financial results of each analysis, are presented.

The same 24 spreadsheets were used to conduct the other 7 analyses; the following unit costs per cubic meter of released water are plotted versus dam crest elevation in Figure 6.19.

VI.9 IRR Sensitivity Analyses

IRR Sensitivity analyses were performed, with release rates of 6.0 and 7.0m³/s, dam crest elevations of 464 and 469 and for shortages resulting from the long series of data (65 years) and the series of data for the recent years (20 years).

Two sets of analyses were performed, one with an optimistic outlook and one with a pessimistic view. Two financial parameters were varied for these analyses.

For the pessimistic case, cost of money was increased from 9 to 13 percent and escalation rates were increased from 4 to 5 percent. For the optimistic case, the cost of money was decreased from 9 to 6 percent and escalation rates were decreased from 4 to 3 percent.

The results of these analyses are summarized in the figure 6.20 through figure 6.27.

The appendix D illustrates the spreadsheets used for the sensitivity analysis for the case of dam height 464, release rate 6 m^3/s and the shortage resulting from the long series of data. As part of each of these spreadsheets / tables, the financial parameters used as input, and the financial results of each analysis, are presented.

The same 24 spreadsheets were used to conduct the other 7 analyses, the following average IRR are plotted versus dam crest elevation in Figure 6.28.

TABLE 6.1: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$43.57	million
Escalated Capital Cost (yr 2015)	$326.58	million
Capital Cost (yr 2010)	$268.43	million
Average unit Cost of Water (actual)	$0.42	/ m^3
Average Unit Cost of Water (yr 2010)	$0.21	/ m^3
Debt Service Cost (sum for 30 years)	$969.66	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.42						
2013	114.16	128.42	14.19						
2014	109.20	127.75	26.97						
2015				326.58	32.32	2.83	35.15	0.39	0.32
2016					32.32	2.94	35.27	0.40	0.31
2017					32.32	3.06	35.38	0.40	0.30
2018					32.32	3.18	35.51	0.40	0.29
2019					32.32	3.31	35.63	0.40	0.28
2020					32.32	3.44	35.77	0.40	0.27
2021					32.32	3.58	35.90	0.40	0.26
2022					32.32	3.72	36.05	0.40	0.25
2023					32.32	3.87	36.20	0.41	0.24
2024					32.32	4.03	36.35	0.41	0.24
2025					32.32	4.19	36.51	0.41	0.23
2026					32.32	4.36	36.68	0.41	0.22
2027					32.32	4.53	36.85	0.41	0.21
2028					32.32	4.71	37.03	0.42	0.21
2029					32.32	4.90	37.22	0.42	0.20
2030					32.32	5.10	37.42	0.42	0.19
2031					32.32	5.30	37.62	0.42	0.19
2032					32.32	5.51	37.83	0.42	0.18
2033					32.32	5.73	38.06	0.43	0.17
2034					32.32	5.96	38.28	0.43	0.17
2035					32.32	6.20	38.52	0.43	0.16
2036					32.32	6.45	38.77	0.44	0.16
2037					32.32	6.71	39.03	0.44	0.15
2038					32.32	6.98	39.30	0.44	0.15
2039					32.32	7.25	39.58	0.44	0.14
2040					32.32	7.54	39.87	0.45	0.14
2041					32.32	7.85	40.17	0.45	0.13
2042					32.32	8.16	40.48	0.45	0.13
2043					32.32	8.49	40.81	0.46	0.13
2044					32.32	8.83	41.15	0.46	0.12

Notes :

1. All costs are in US dollars
2. Constrcution Cost means the amount of money required in 2010 to construct the dam project
3. O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cost
4. IDC means interest during construction
5. Escalated Capital Cost means the summation of each year's escalated and IDC costs
6. Water Supply means the yearly water supply prior to accounting for any shortages
7. Shortage means the percentage of the average water supply not provided over a long-term period
8. Annual Costs means the summation of the annual dept service and O,M,&R costs.
9. Unit Costs are based in water supply minus shortage

TABLE 6.2: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 110.4 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	469.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	110.4	million m^3/yr
Release Rate	7	m3/sec
Shortage	11.2%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$43.57	million
Escalated Capital Cost (yr 2015)	$326.58	million
Capital Cost (yr 2010)	$268.43	million
Average unit Cost of Water (actual)	$0.38	/ m^3
Average Unit Cost of Water (yr 2010)	$0.19	/ m^3
Debt Service Cost (sum for 30 years)	$969.66	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.42						
2013	114.16	128.42	14.19						
2014	109.20	127.75	26.97						
2015				326.58	32.32	2.83	35.15	0.36	0.29
2016					32.32	2.94	35.27	0.36	0.28
2017					32.32	3.06	35.38	0.36	0.27
2018					32.32	3.18	35.51	0.36	0.26
2019					32.32	3.31	35.63	0.36	0.26
2020					32.32	3.44	35.77	0.36	0.25
2021					32.32	3.58	35.90	0.37	0.24
2022					32.32	3.72	36.05	0.37	0.23
2023					32.32	3.87	36.20	0.37	0.22
2024					32.32	4.03	36.35	0.37	0.21
2025					32.32	4.19	36.51	0.37	0.21
2026					32.32	4.36	36.68	0.37	0.20
2027					32.32	4.53	36.85	0.38	0.19
2028					32.32	4.71	37.03	0.38	0.19
2029					32.32	4.90	37.22	0.38	0.18
2030					32.32	5.10	37.42	0.38	0.17
2031					32.32	5.30	37.62	0.38	0.17
2032					32.32	5.51	37.83	0.39	0.16
2033					32.32	5.73	38.06	0.39	0.16
2034					32.32	5.96	38.28	0.39	0.15
2035					32.32	6.20	38.52	0.39	0.15
2036					32.32	6.45	38.77	0.40	0.14
2037					32.32	6.71	39.03	0.40	0.14
2038					32.32	6.98	39.30	0.40	0.13
2039					32.32	7.25	39.58	0.40	0.13
2040					32.32	7.54	39.87	0.41	0.13
2041					32.32	7.85	40.17	0.41	0.12
2042					32.32	8.16	40.48	0.41	0.12
2043					32.32	8.49	40.81	0.42	0.11
2044					32.32	8.83	41.15	0.42	0.11

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam project
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cost
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term period
8 Annual Costs means the summation of the annual dept service and O,M,&R costs.
9 Unit Costs are based in water supply minus shortage

TABLE 6.3: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 4%)

Construction Cost: $271.17 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	469.0	m
Construction Cost (yr 2010)	$271.17	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	4.4%	

Financial Results		
Escalated Construction Cost	$309.22	million
Interest During Construction IDC (yr 2015)	$47.61	million
Escalated Capital Cost (yr 2015)	$356.83	million
Capital Cost (yr 2010)	$293.29	million
Average unit Cost of Water (actual)	$0.45	/ m^3
Average Unit Cost of Water (yr 2010)	$0.22	/ m^3
Debt Service Cost (sum for 30 years)	$1,041.99	million
O,M, & R Cost (sum for 30 years)	$173.43	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	27.12	29.33	2.64						
2013	124.74	140.31	15.51						
2014	119.31	139.58	29.46						
2015				356.83	34.73	3.09	37.83	0.42	0.34
2016					34.73	3.22	37.95	0.42	0.33
2017					34.73	3.34	38.08	0.42	0.32
2018					34.73	3.48	38.21	0.42	0.31
2019					34.73	3.62	38.35	0.42	0.30
2020					34.73	3.76	38.50	0.43	0.29
2021					34.73	3.91	38.65	0.43	0.28
2022					34.73	4.07	38.80	0.43	0.27
2023					34.73	4.23	38.96	0.43	0.26
2024					34.73	4.40	39.13	0.43	0.25
2025					34.73	4.58	39.31	0.43	0.24
2026					34.73	4.76	39.49	0.44	0.23
2027					34.73	4.95	39.68	0.44	0.23
2028					34.73	5.15	39.88	0.44	0.22
2029					34.73	5.35	40.09	0.44	0.21
2030					34.73	5.57	40.30	0.45	0.20
2031					34.73	5.79	40.52	0.45	0.20
2032					34.73	6.02	40.76	0.45	0.19
2033					34.73	6.26	41.00	0.45	0.18
2034					34.73	6.51	41.25	0.46	0.18
2035					34.73	6.78	41.51	0.46	0.17
2036					34.73	7.05	41.78	0.46	0.17
2037					34.73	7.33	42.06	0.47	0.16
2038					34.73	7.62	42.35	0.47	0.16
2039					34.73	7.93	42.66	0.47	0.15
2040					34.73	8.24	42.98	0.48	0.15
2041					34.73	8.57	43.31	0.48	0.14
2042					34.73	8.92	43.65	0.48	0.14
2043					34.73	9.27	44.01	0.49	0.13
2044					34.73	9.64	44.38	0.49	0.13

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam project
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cost
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term period
8 Annual Costs means the summation of the annual dept service and O,M,&R costs.
9 Unit Costs are based in water supply minus shortage

TABLE 6.4: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 4%)

Construction Cost: $271.17 million Water Supply: 110.4 Mm3/yr

Financial Parameters

Current Year	2010	
Dam Crest Elevation	469.0	m
Construction Cost (yr 2010)	$271.17	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	110.4	million m^3/yr
Release Rate	7	m3/sec
Shortage	8.6%	

Financial Results

Escalated Construction Cost	$309.22	million
Interest During Construction IDC (yr 2015)	$47.61	million
Escalated Capital Cost (yr 2015)	$356.83	million
Capital Cost (yr 2010)	$293.29	million
Average unit Cost of Water (actual)	$0.40	/ m^3
Average Unit Cost of Water (yr 2010)	$0.19	/ m^3
Debt Service Cost (sum for 30 years)	$1,041.99	million
O,M, & R Cost (sum for 30 years)	$173.43	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	27.12	29.33	2.64						
2013	124.74	140.31	15.51						
2014	119.31	139.58	29.46						
2015				356.83	34.73	3.09	37.83	0.37	0.31
2016					34.73	3.22	37.95	0.38	0.30
2017					34.73	3.34	38.08	0.38	0.29
2018					34.73	3.48	38.21	0.38	0.28
2019					34.73	3.62	38.35	0.38	0.27
2020					34.73	3.76	38.50	0.38	0.26
2021					34.73	3.91	38.65	0.38	0.25
2022					34.73	4.07	38.80	0.38	0.24
2023					34.73	4.23	38.96	0.39	0.23
2024					34.73	4.40	39.13	0.39	0.22
2025					34.73	4.58	39.31	0.39	0.22
2026					34.73	4.76	39.49	0.39	0.21
2027					34.73	4.95	39.68	0.39	0.20
2028					34.73	5.15	39.88	0.40	0.20
2029					34.73	5.35	40.09	0.40	0.19
2030					34.73	5.57	40.30	0.40	0.18
2031					34.73	5.79	40.52	0.40	0.18
2032					34.73	6.02	40.76	0.40	0.17
2033					34.73	6.26	41.00	0.41	0.16
2034					34.73	6.51	41.25	0.41	0.16
2035					34.73	6.78	41.51	0.41	0.15
2036					34.73	7.05	41.78	0.41	0.15
2037					34.73	7.33	42.06	0.42	0.14
2038					34.73	7.62	42.35	0.42	0.14
2039					34.73	7.93	42.66	0.42	0.14
2040					34.73	8.24	42.98	0.43	0.13
2041					34.73	8.57	43.31	0.43	0.13
2042					34.73	8.92	43.65	0.43	0.12
2043					34.73	9.27	44.01	0.44	0.12
2044					34.73	9.64	44.38	0.44	0.12

Notes :

1. All costs are in US dollars
2. Constrcution Cost means the amount of money required in 2010 to construct the dam project
3. O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cost
4. IDC means interest during construction
5. Escalated Capital Cost means the summation of each year's escalated and IDC costs
6. Water Supply means the yearly water supply prior to accounting for any shortages
7. Shortage means the percentage of the average water supply not provided over a long-term period
8. Annual Costs means the summation of the annual dept service and O,M,&R costs.
9. Unit Costs are based in water supply minus shortage

Figure 6.1: Construction Cost Curve Based on Year 2010 US DOLLARS

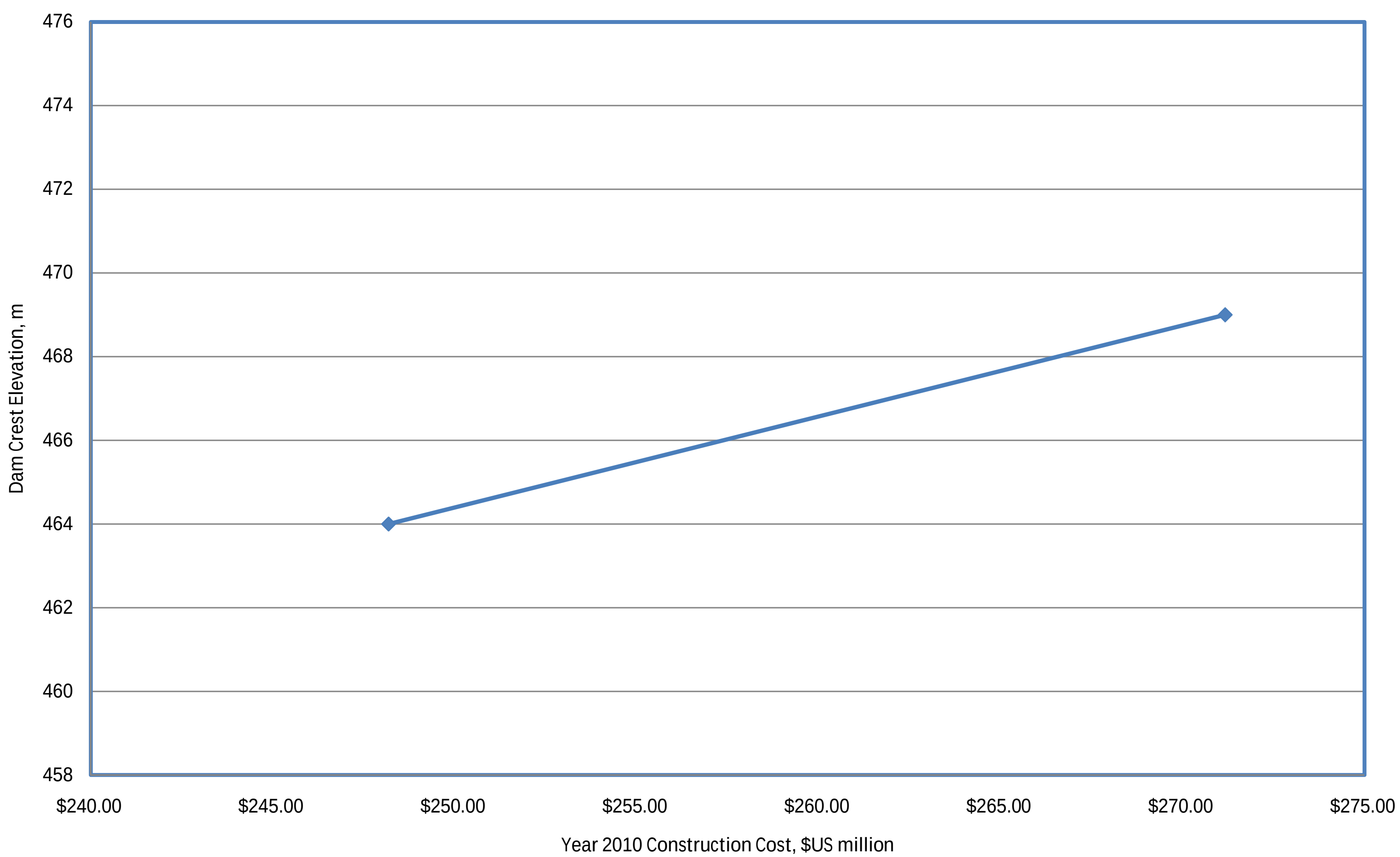


Figure 6.2: Capital Cost Curve Based on Year 2015 US DOLLARS

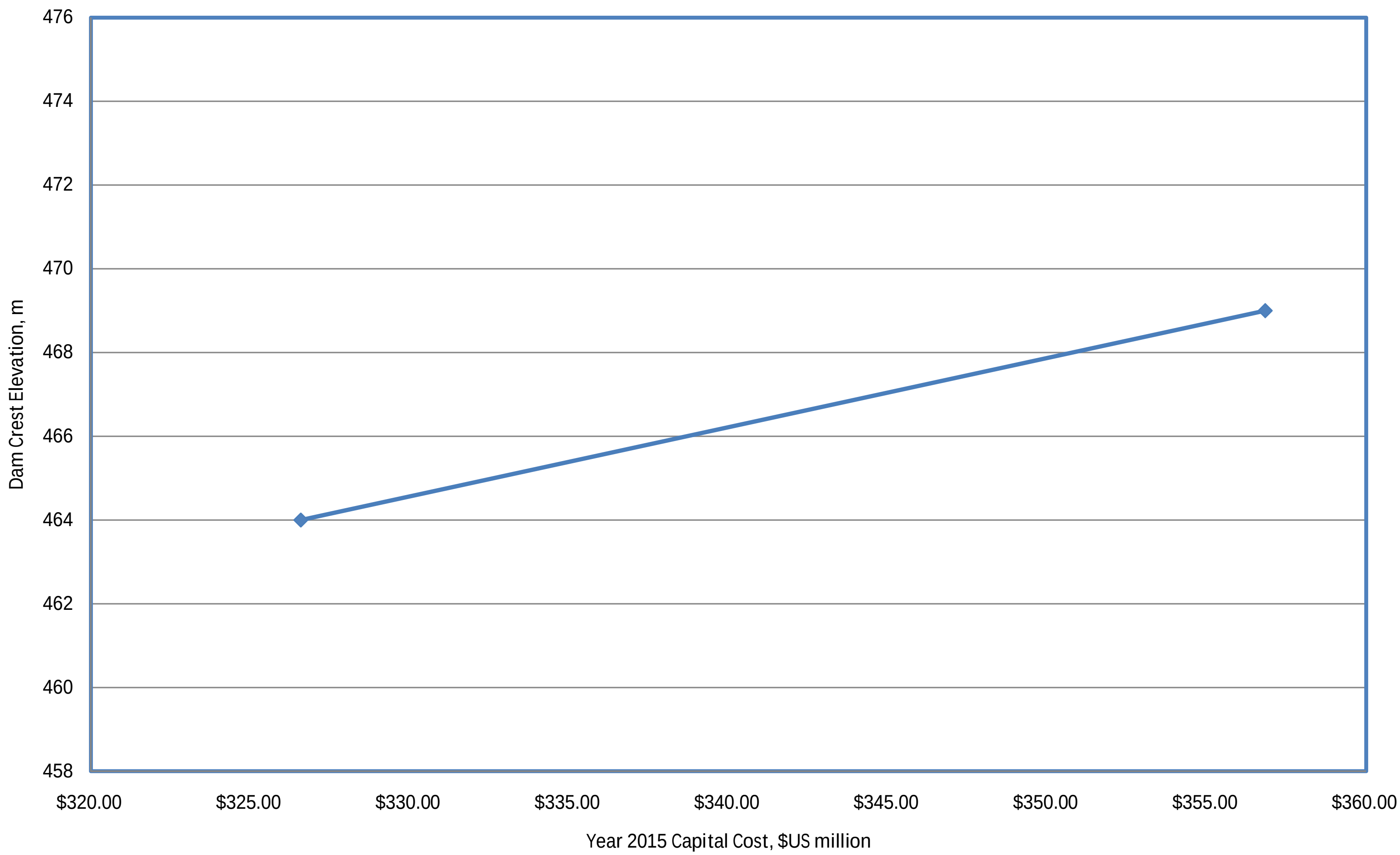
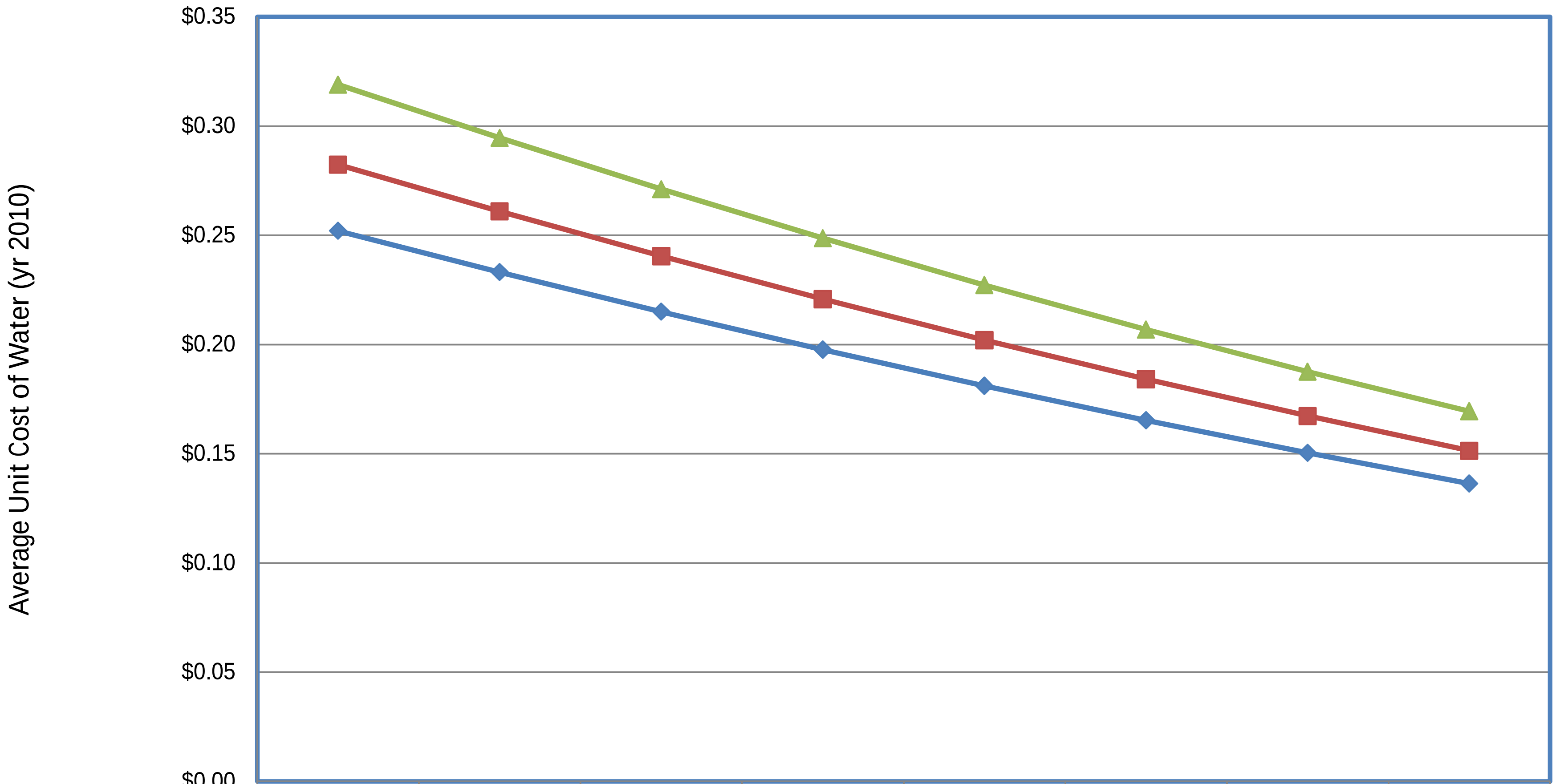
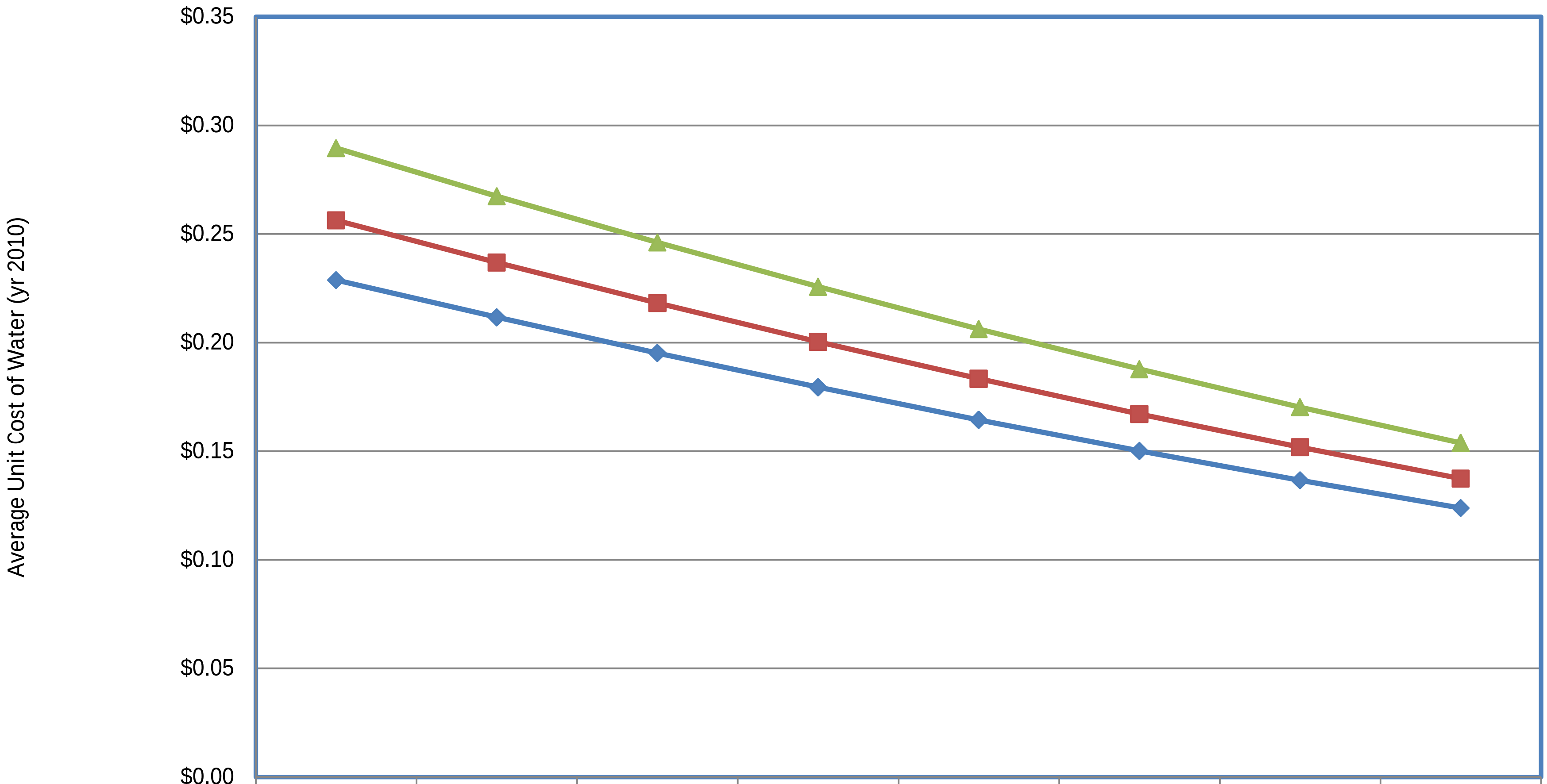


Figure 6.3: Average Unit Cost of Water (2010)
(El. = 464m, Release = 6m^3/s, Data Series = 65 Years)



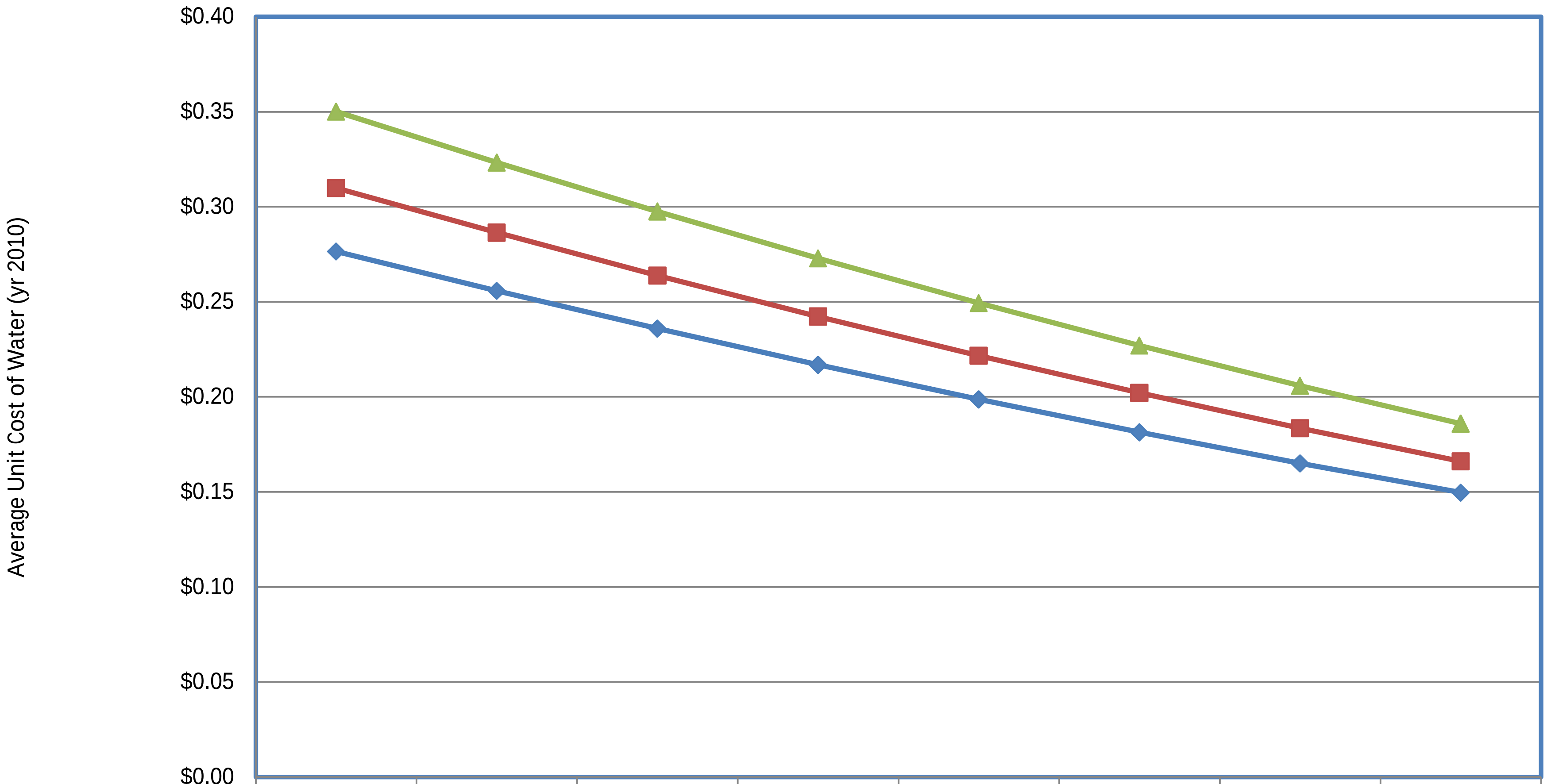
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.252012638	0.233154985	0.215033808	0.197673874	0.181102364	0.165348265	0.150441484	0.136411637
Escalation Rate 4%	0.282372453	0.261010087	0.240483143	0.220819584	0.2020501	0.184207424	0.167325317	0.151437213
Escalation Rate 3%	0.318963488	0.294575532	0.271142621	0.248696569	0.227272298	0.206907052	0.187639244	0.169506903

Figure 6.4: Average Unit Cost of Water (2010)
(El. = 464m, Release = 7m3/s, Data Series = 65 Years)



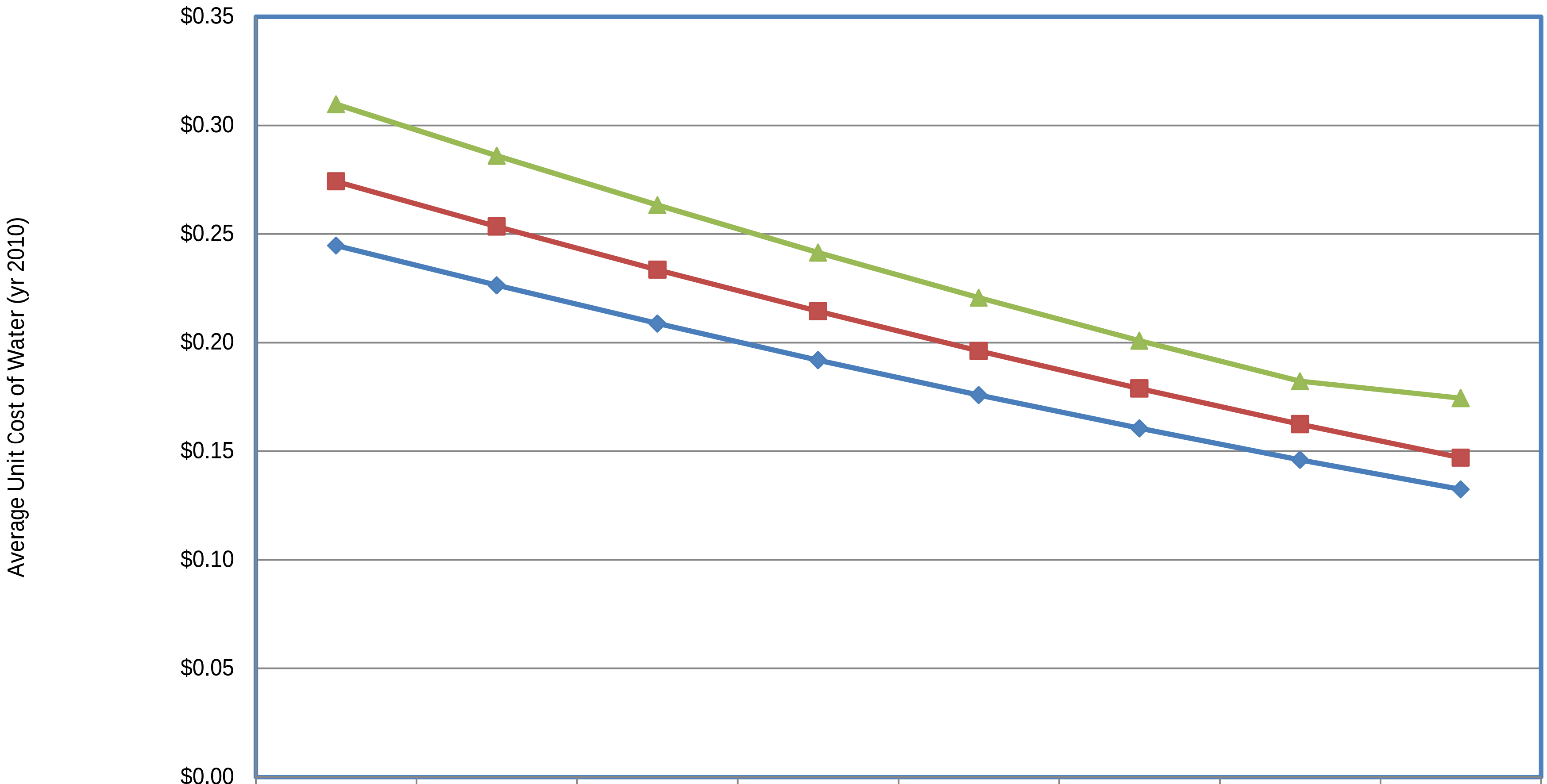
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.22874852	0.211631679	0.195183328	0.179425947	0.164384207	0.150084421	0.136553734	0.123819029
Escalation Rate 4%	0.25630572	0.236915385	0.218283351	0.200435	0.183398189	0.167202629	0.151878965	0.137457544
Escalation Rate 3%	0.289518916	0.267382293	0.246112551	0.225738568	0.206292042	0.187806779	0.170317646	0.153859161

Figure 6.5: Average Unit Cost of Water (2010)
(El. = 464m, Release = 6m3/s, Data Series = 20 Years)



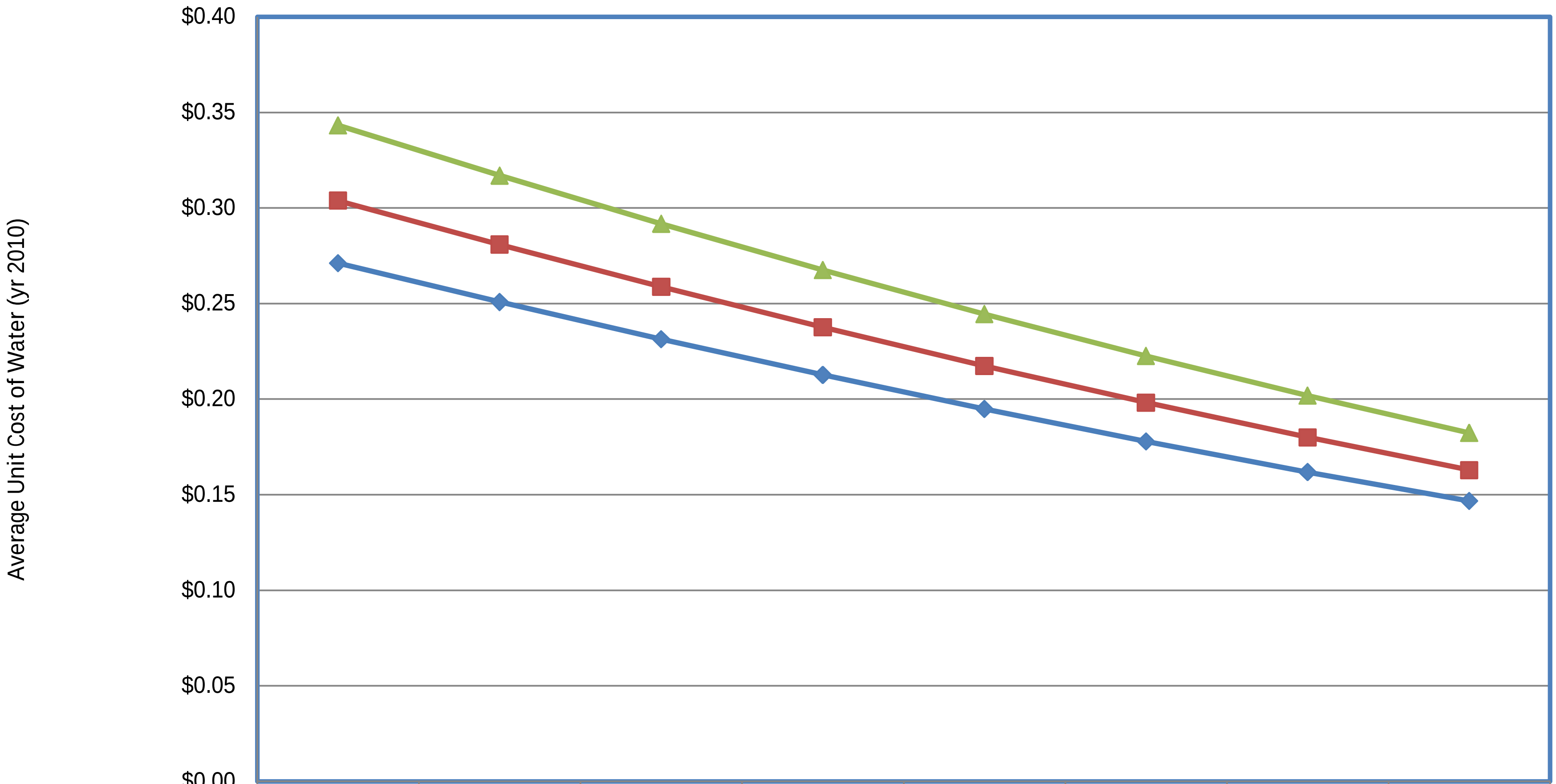
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.276536678	0.255843935	0.235959337	0.21691006	0.198725931	0.181438758	0.165081357	0.149686227
Escalation Rate 4%	0.30985089	0.286409693	0.263885217	0.242308143	0.221712149	0.202133153	0.183608202	0.166173982
Escalation Rate 3%	0.350002699	0.323241484	0.297528252	0.272897913	0.249388787	0.227041743	0.205898933	0.186002083

Figure 6.6: Average Unit Cost of Water (2010)
(El. = 464m, Release = 7m3/s, Data Series = 20 Years)



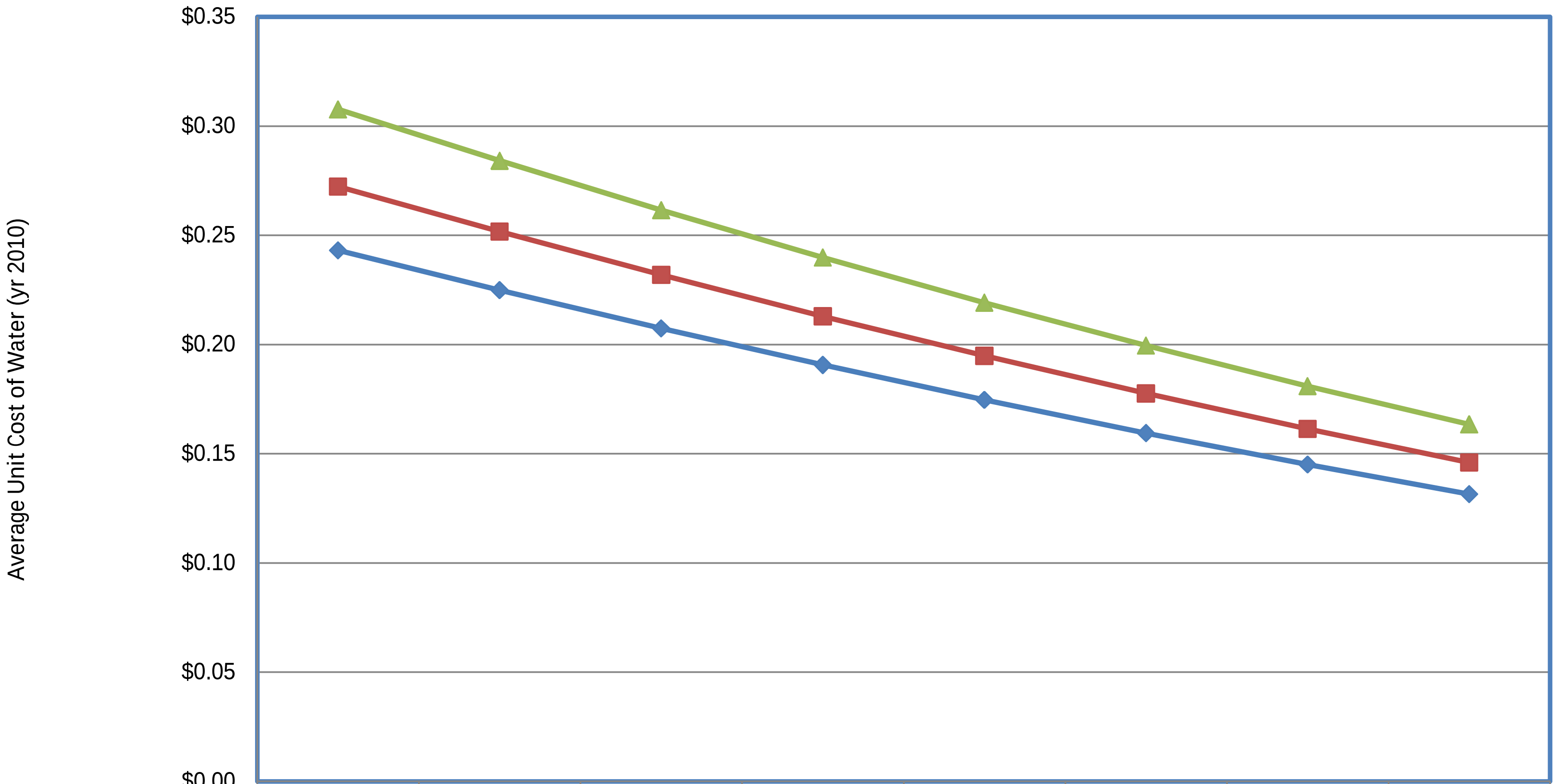
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.244691122	0.226381325	0.208786608	0.191931018	0.175840945	0.160544538	0.146070831	0.132448582
Escalation Rate 4%	0.274168918	0.253427175	0.233496584	0.214404294	0.196180105	0.178855797	0.162464152	0.147037631
Escalation Rate 3%	0.309696904	0.286017471	0.263265337	0.241471392	0.220669542	0.200895951	0.182187915	0.174423902

Figure 6.7: Average Unit Cost of Water (2010)
(El. = 469m, Release = 6m3/s, Data Series = 65 Years)



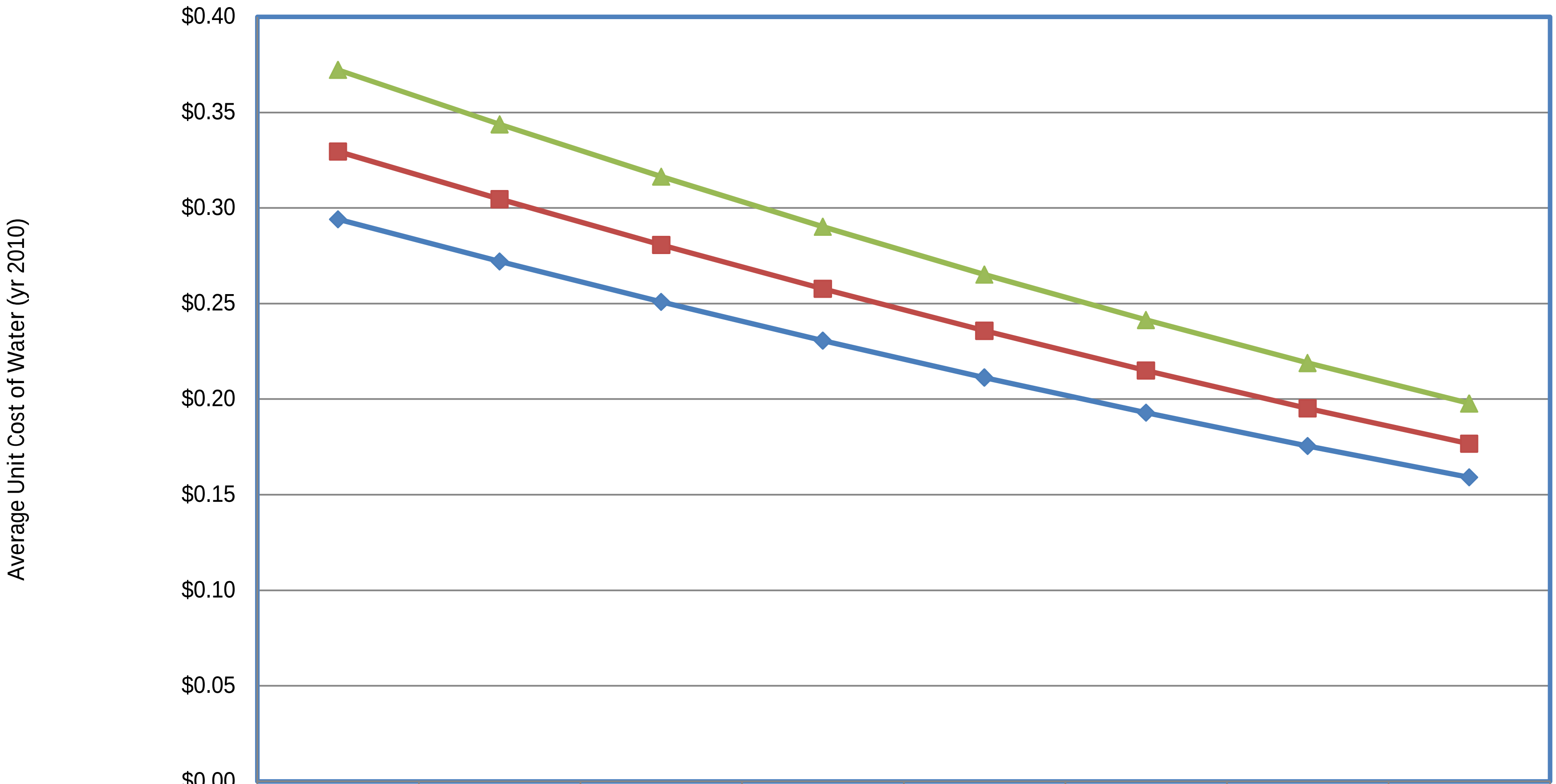
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.271151039	0.250861293	0.231363954	0.212685668	0.19485568	0.177905181	0.161866345	0.14677104
Escalation Rate 4%	0.303816445	0.280831774	0.258745968	0.237589115	0.217394234	0.198196545	0.180032374	0.162937691
Escalation Rate 3%	0.343186285	0.316946253	0.291733795	0.267583139	0.244531861	0.222620033	0.201888986	0.182379634

Figure 6.8: Average Unit Cost of Water (2010)
(El. = 469m, Release = 7m3/s, Data Series = 65 Years)



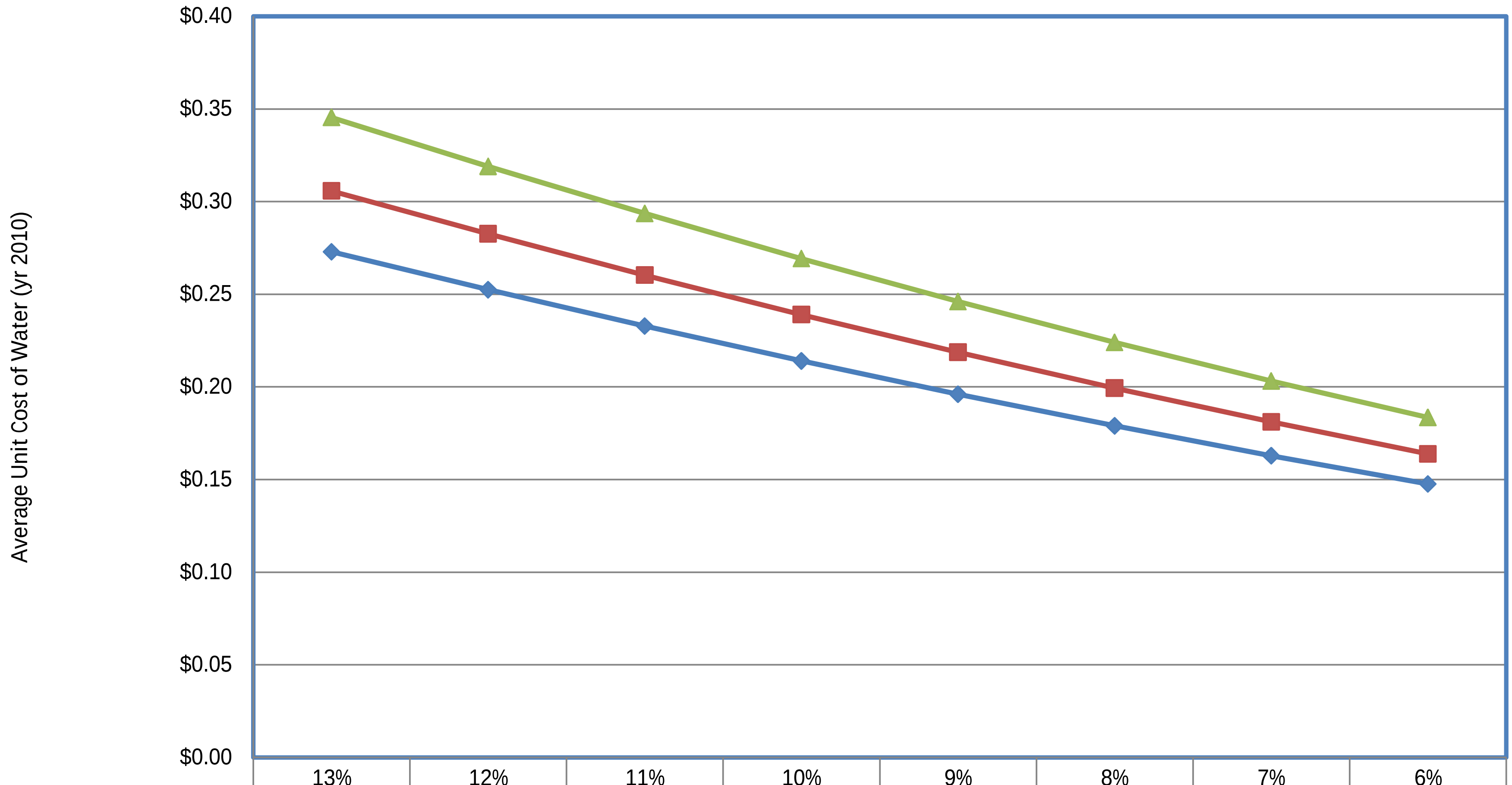
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.243042309	0.224855889	0.207379731	0.19063772	0.174656068	0.159462733	0.145086555	0.131556097
Escalation Rate 4%	0.272321473	0.251719495	0.231923203	0.212959564	0.194858175	0.177650604	0.161369413	0.146046841
Escalation Rate 3%	0.307610059	0.284090187	0.261491364	0.239844274	0.219182594	0.199542245	0.18096027	0.163473345

Figure 6.9: Average Unit Cost of Water (2010)
(El. = 469m, Release = 6m3/s, Data Series = 20 Years)



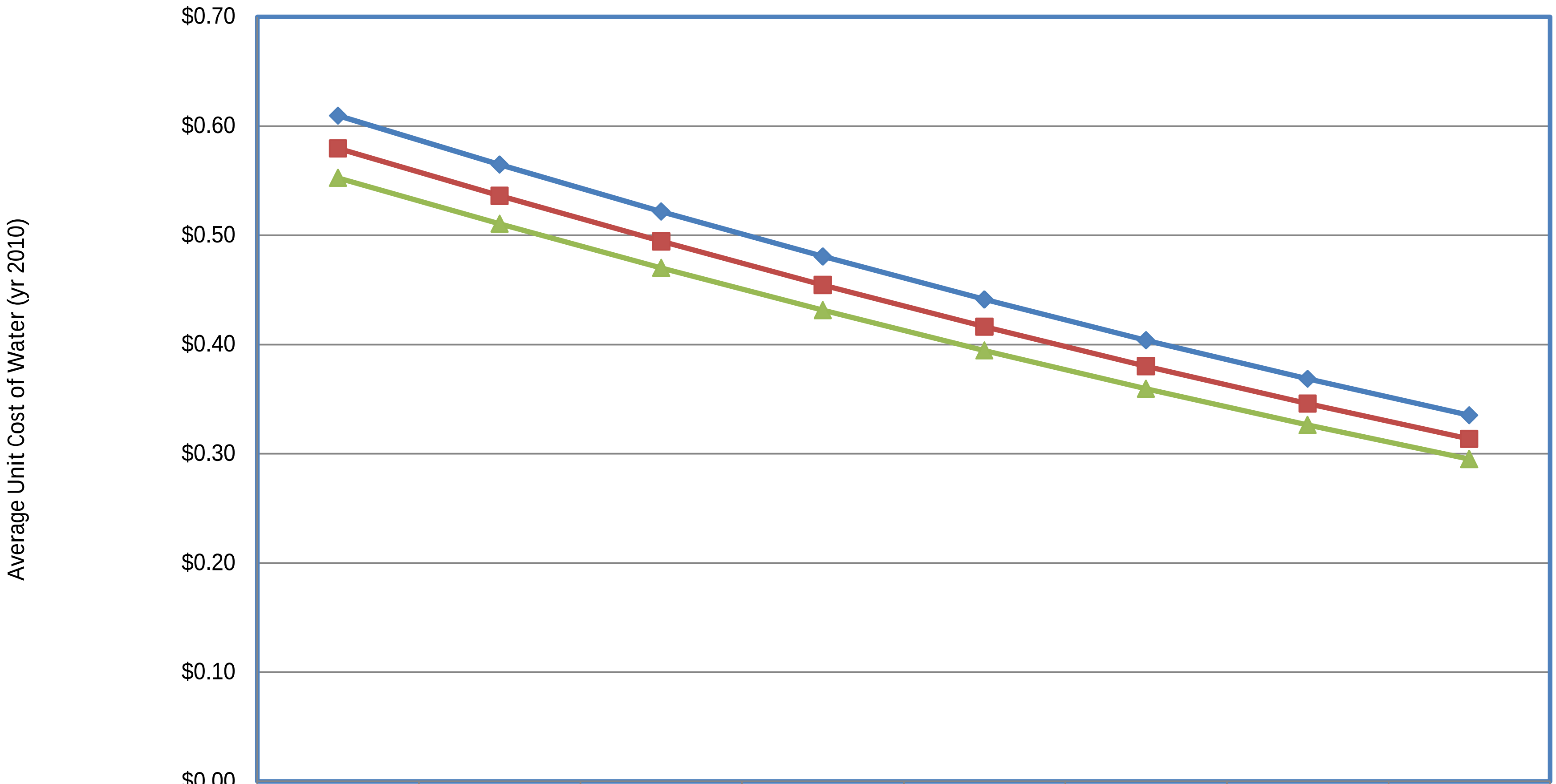
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.294065314	0.272060934	0.250915925	0.230659186	0.211322431	0.192939489	0.175545252	0.159174282
Escalation Rate 4%	0.32949119	0.304564143	0.280611923	0.257667158	0.235765661	0.214945624	0.195246446	0.176707135
Escalation Rate 3%	0.372188073	0.343730564	0.316387466	0.290195901	0.265196619	0.241433078	0.218950103	0.197792066

Figure 6.10: Average Unit Cost of Water (2010)
(El. = 469m, Release = 7m3/s, Data Series = 20 Years)



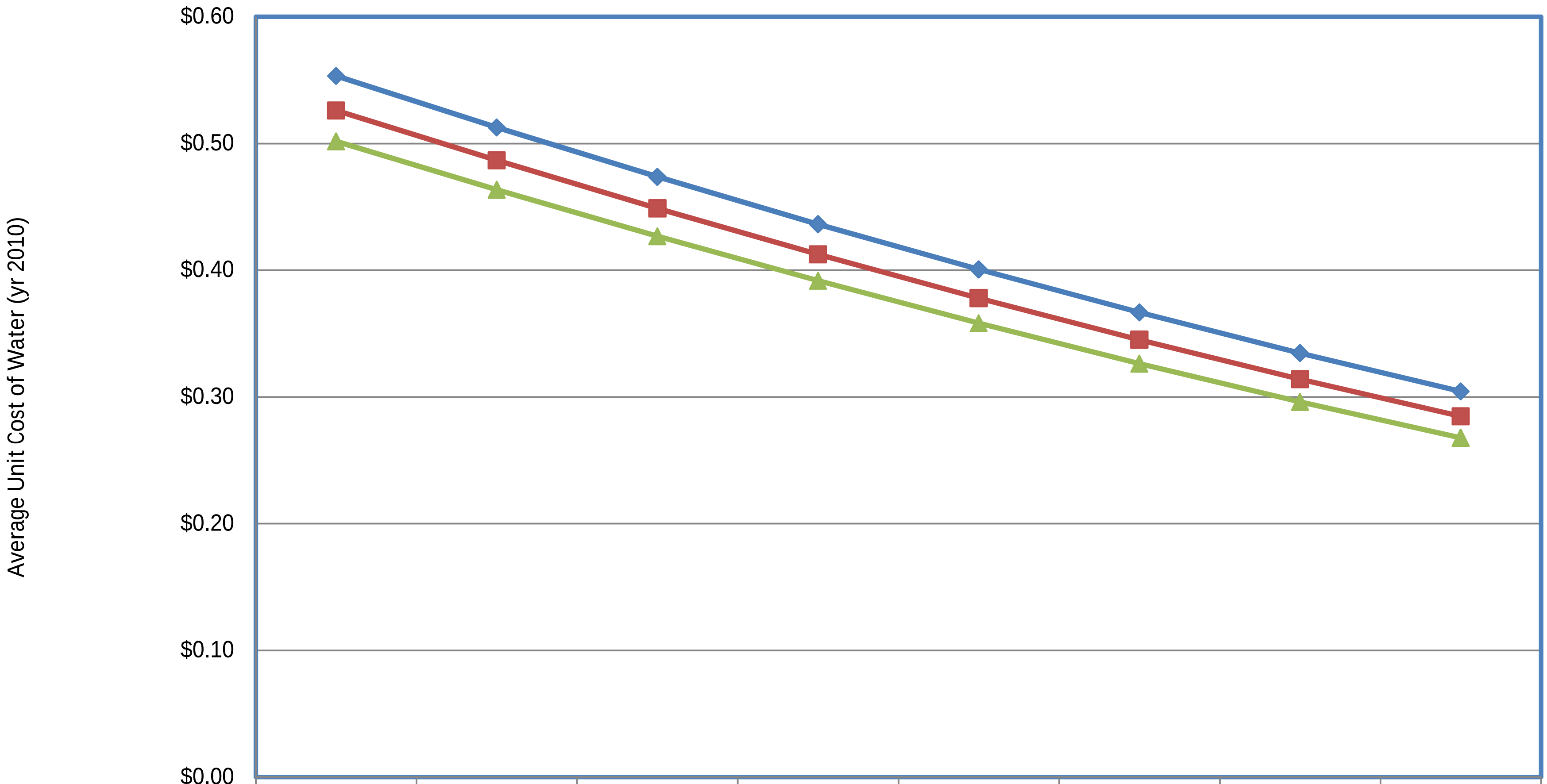
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.272865134	0.252447126	0.232826533	0.214030172	0.196087471	0.179029817	0.162889591	0.147698861
Escalation Rate 4%	0.305737037	0.282607066	0.260381644	0.239091047	0.218768503	0.199449455	0.181170458	0.16396771
Escalation Rate 3%	0.345355755	0.318949846	0.293578005	0.26927468	0.246077682	0.224027338	0.203165237	0.183532556

Figure 6.11: Average Unit Cost of Water (Actual)
(El. = 464m, Release = 6m3/s, Data Series = 65 Years)



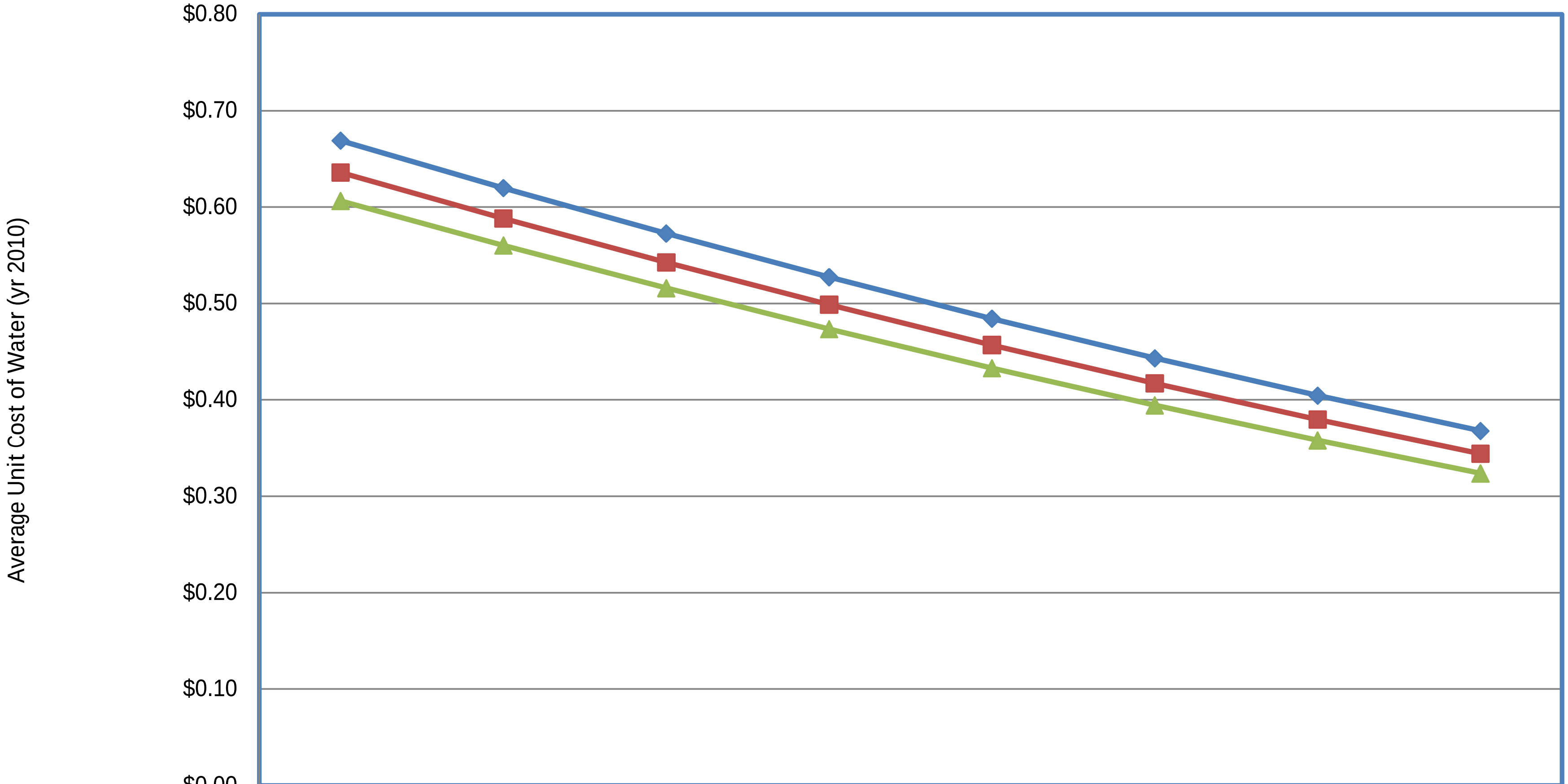
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.609489088	0.564756607	0.521771133	0.480591412	0.44128192	0.403911422	0.368550855	0.335270475
Escalation Rate 4%	0.579500254	0.536143386	0.494482084	0.4545731	0.416478722	0.380265385	0.346001612	0.313755256
Escalation Rate 3%	0.552544426	0.510531811	0.470164433	0.431497095	0.394589958	0.359507181	0.326314937	0.295078738

Figure 6.12: Average Unit Cost of Water (Actual)
(El. = 464m, Release = 7m3/s, Data Series = 65 Years)



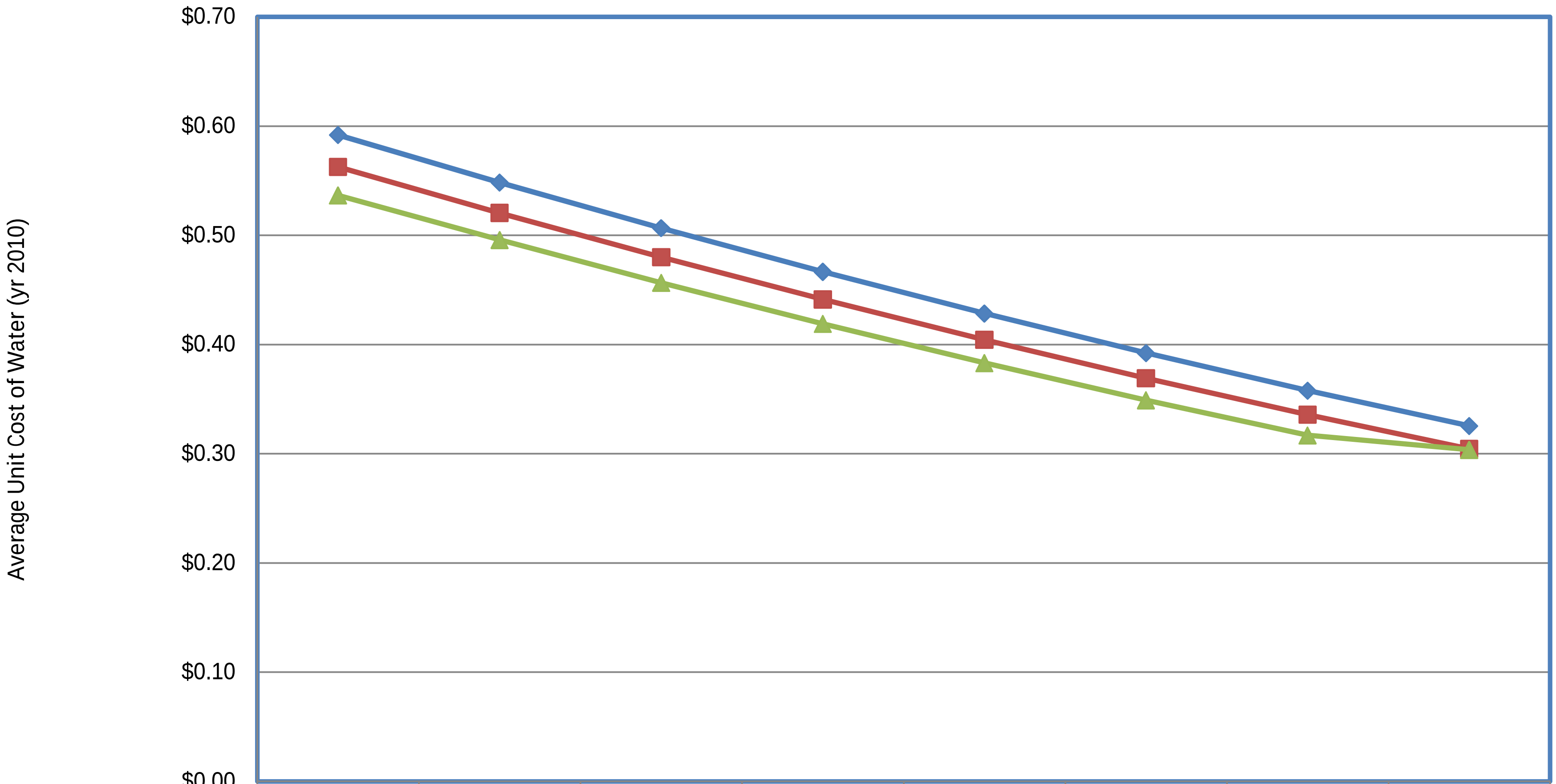
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.553225139	0.512622061	0.473604718	0.436226433	0.400545729	0.366625026	0.334528709	0.304320551
Escalation Rate 4%	0.526004674	0.486650221	0.448834811	0.412609957	0.378032197	0.345161832	0.314061061	0.284791473
Escalation Rate 3%	0.501537226	0.463402935	0.426762002	0.391664174	0.358164057	0.326319887	0.296191729	0.267839046

Figure 6.13: Average Unit Cost of Water (Actual)
(El. = 464m, Release = 6m3/s, Data Series = 20 Years)



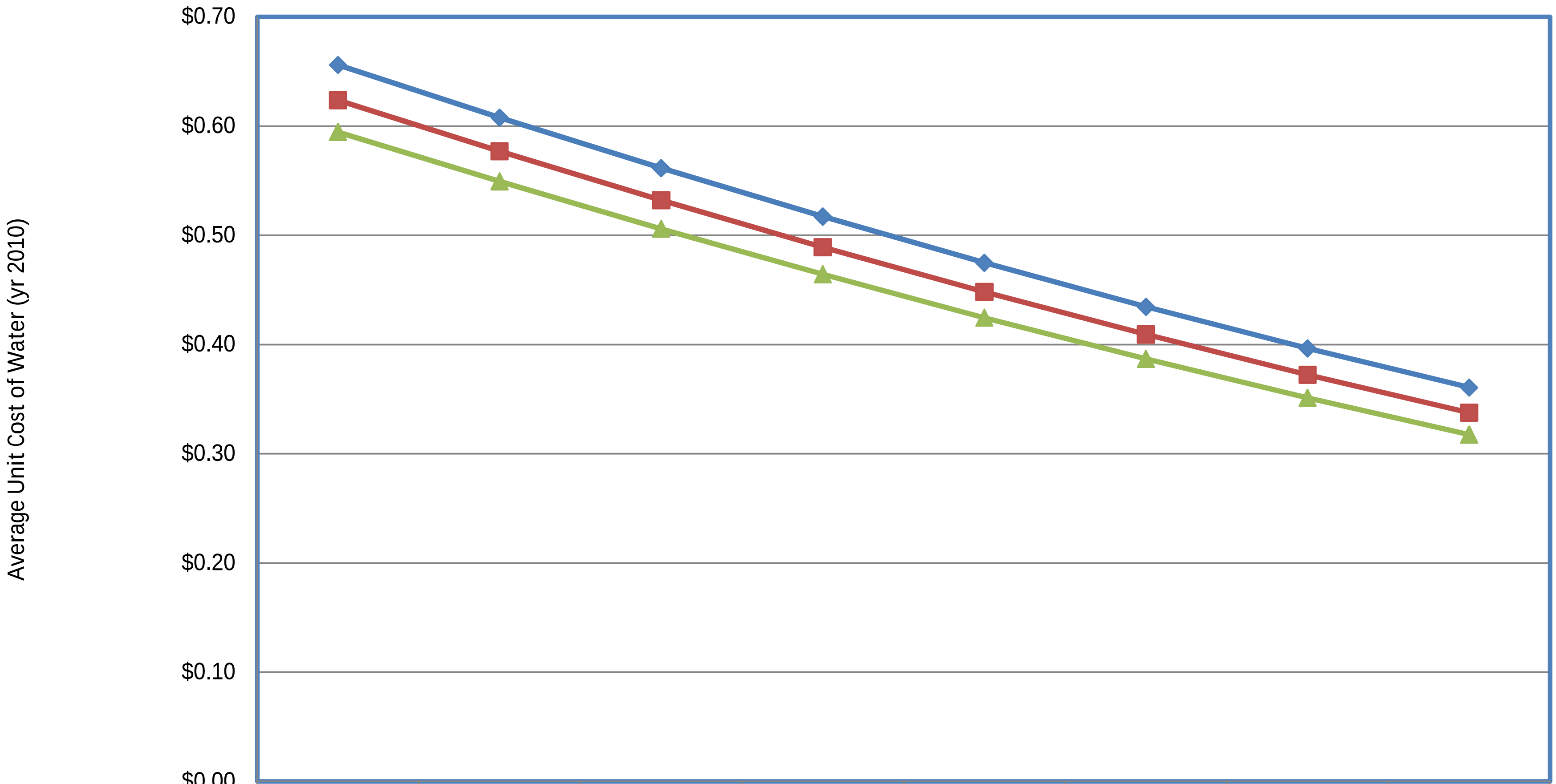
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.66880014	0.619714619	0.57254611	0.527359078	0.484224271	0.443217148	0.404415547	0.367896563
Escalation Rate 4%	0.635893011	0.588316967	0.54260149	0.498808853	0.457007407	0.417270051	0.379671976	0.344287639
Escalation Rate 3%	0.606314037	0.56021306	0.515917421	0.473487259	0.432988587	0.394491809	0.358069537	0.323793658

Figure 6.14: Average Unit Cost of Water (Actual)
(El. = 464m, Release = 7m3/s, Data Series = 20 Years)



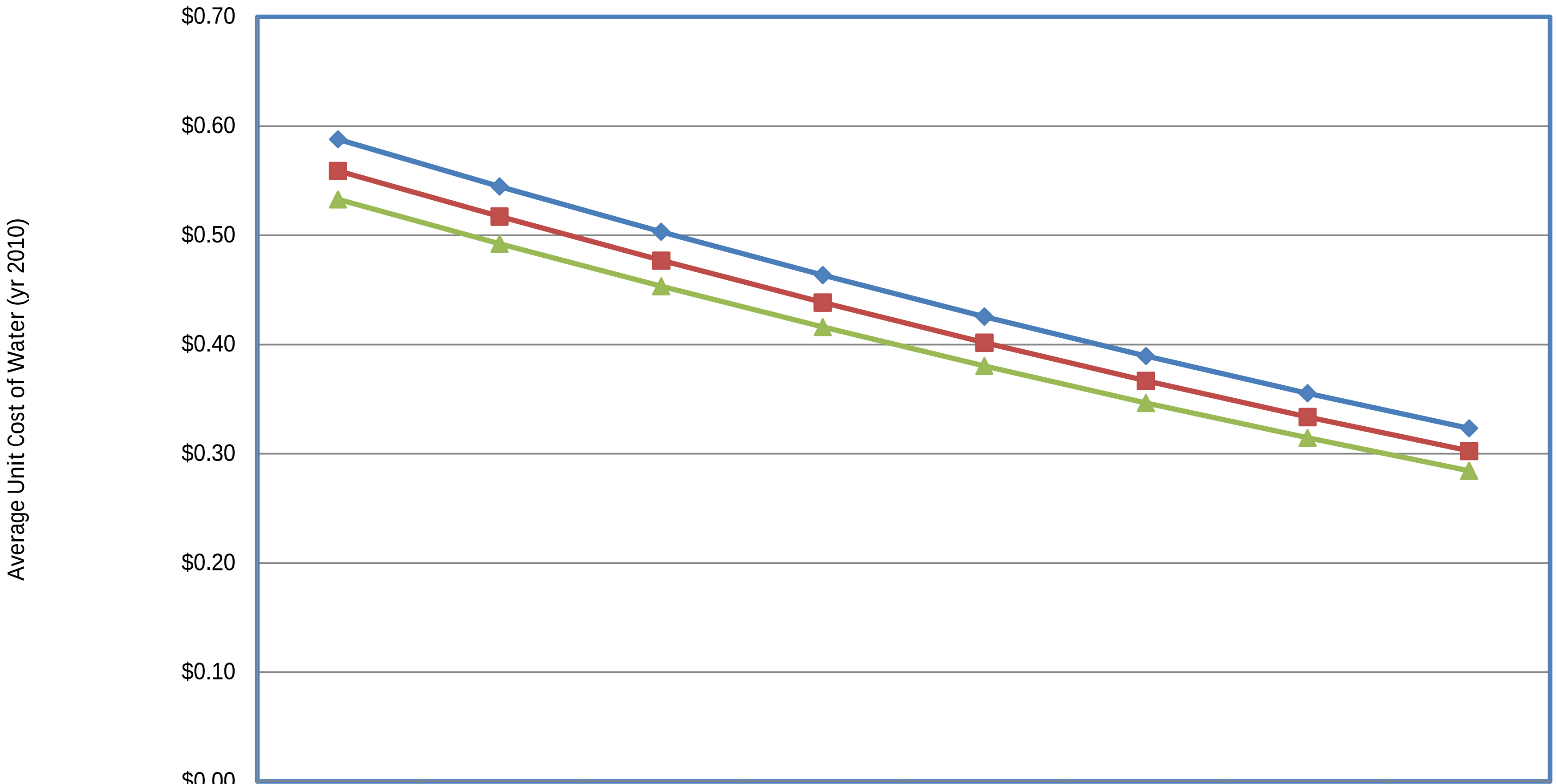
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.591782102	0.548349197	0.506612544	0.466629184	0.428461718	0.392176915	0.357843649	0.325530137
Escalation Rate 4%	0.562664509	0.520567252	0.480116302	0.441366761	0.404379108	0.369217847	0.335949511	0.304639982
Escalation Rate 3%	0.536491806	0.49569975	0.456505131	0.418961164	0.383126259	0.349062714	0.316834777	0.303638283

Figure 6.15: Average Unit Cost of Water (Actual)
(El. = 469m, Release = 6m3/s, Data Series = 65 Years)



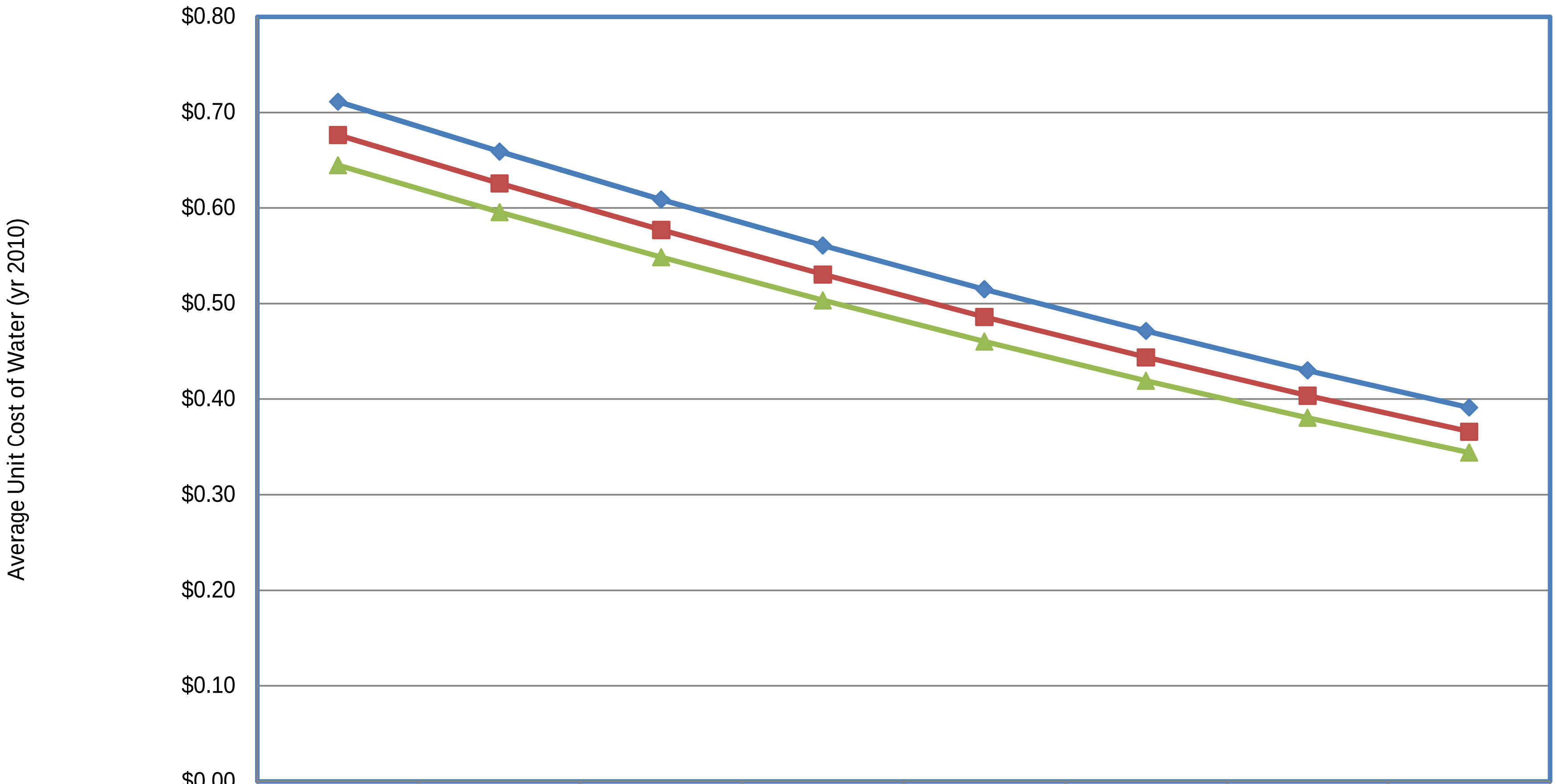
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.655775045	0.60764548	0.561395593	0.517088592	0.47479385	0.434585353	0.396539426	0.360731661
Escalation Rate 4%	0.623508792	0.576859307	0.532034153	0.489094392	0.448107043	0.409143584	0.372277744	0.337582528
Escalation Rate 3%	0.594505878	0.549302733	0.505869765	0.464265944	0.424555997	0.386808956	0.35109602	0.317487673

Figure 6.16: Average Unit Cost of Water (Actual)
(El. = 469m, Release = 7m3/s, Data Series = 65 Years)



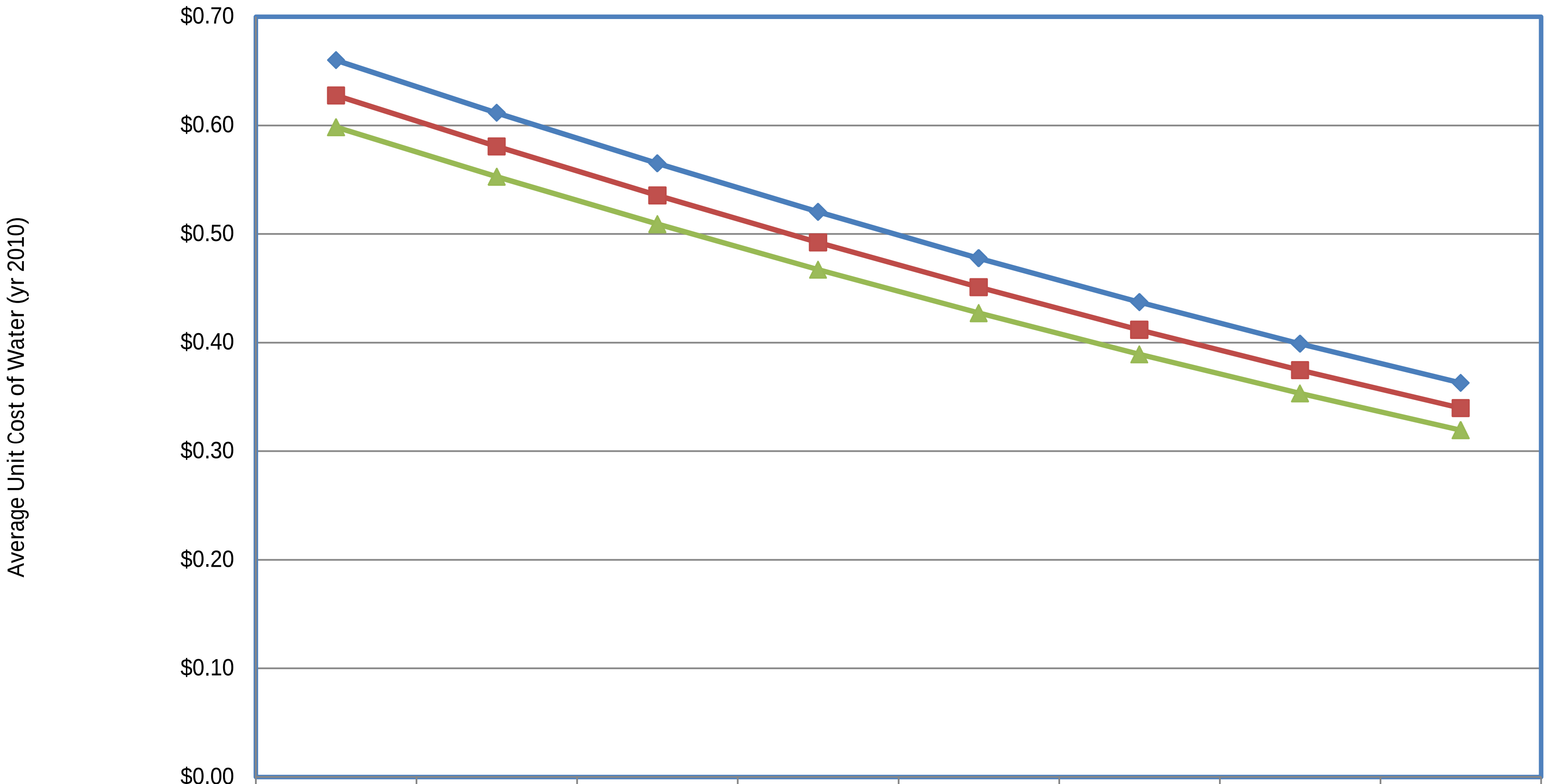
	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.587794469	0.544654231	0.503198814	0.463484875	0.425574595	0.389534291	0.355432375	0.323336603
Escalation Rate 4%	0.558873081	0.51705949	0.476881112	0.438392679	0.401654261	0.366729929	0.333685767	0.302587212
Escalation Rate 3%	0.532876739	0.492359553	0.453429042	0.416138059	0.380544622	0.346710608	0.314699835	0.28457548

Figure 6.17: Average Unit Cost of Water (Actual)
(El. = 469m, Release = 6m3/s, Data Series = 20 Years)



	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.711192903	0.658996033	0.608837687	0.560786416	0.514917454	0.471311041	0.430049951	0.391216163
Escalation Rate 4%	0.676199913	0.6256082	0.576994988	0.530426498	0.485975414	0.443719253	0.403737976	0.366110757
Escalation Rate 3%	0.644746037	0.595722891	0.548619515	0.503499862	0.460434129	0.419497183	0.380766239	0.344317738

Figure 6.18: Average Unit Cost of Water (Actual)
(El. = 469m, Release = 7m3/s, Data Series = 20 Years)



	13%	12%	11%	10%	9%	8%	7%	6%
Escalation Rate 5%	0.659920562	0.611486743	0.564944485	0.520357395	0.477795284	0.437332608	0.399046171	0.363012045
Escalation Rate 4%	0.627450336	0.580505954	0.535397435	0.492186228	0.450939775	0.411730007	0.374631117	0.339716573
Escalation Rate 3%	0.598264078	0.552775179	0.509067648	0.467200826	0.42723985	0.389254189	0.353315492	0.319494688

Figure 6.19: 2010 Unit Cost of Water Curves

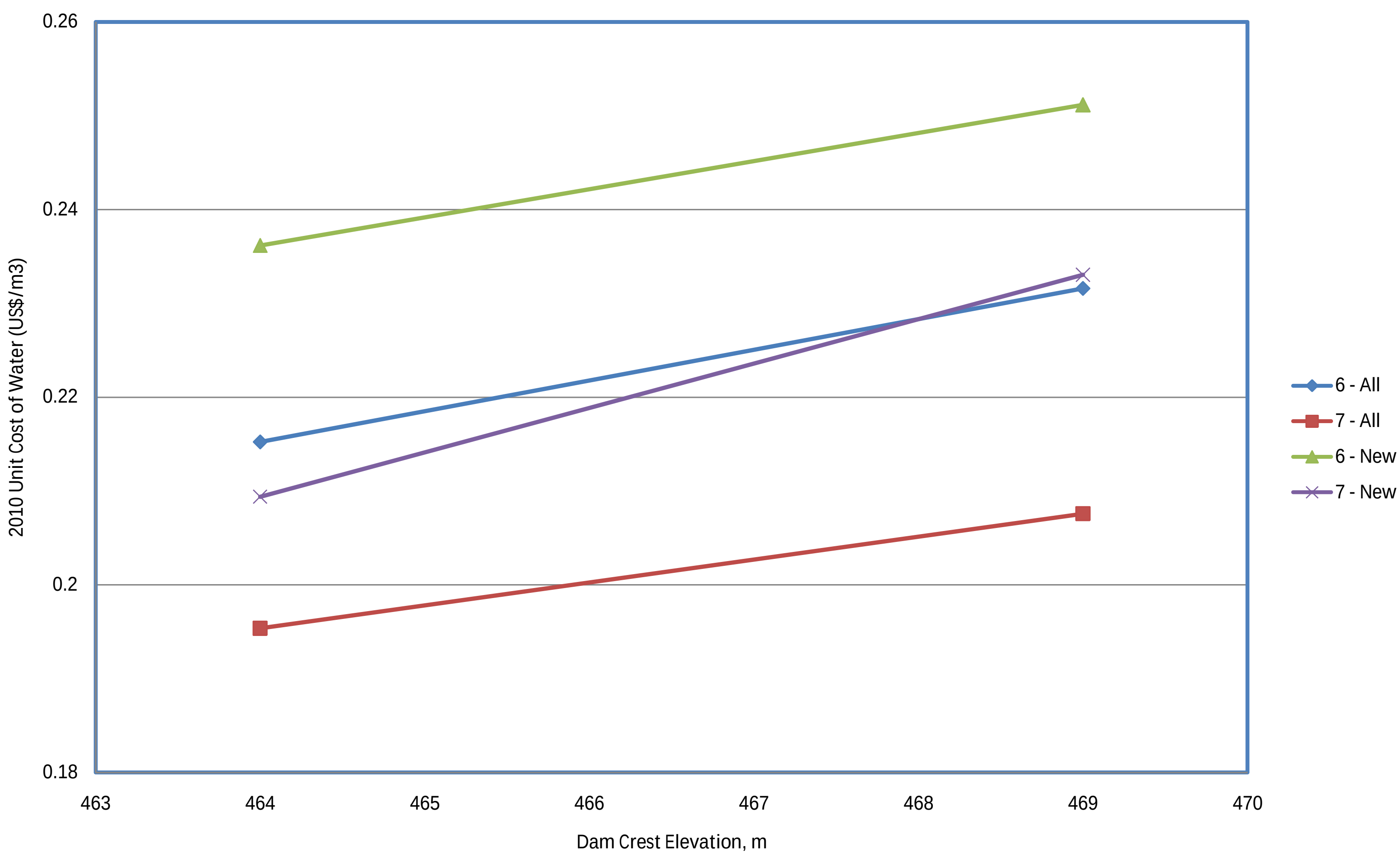
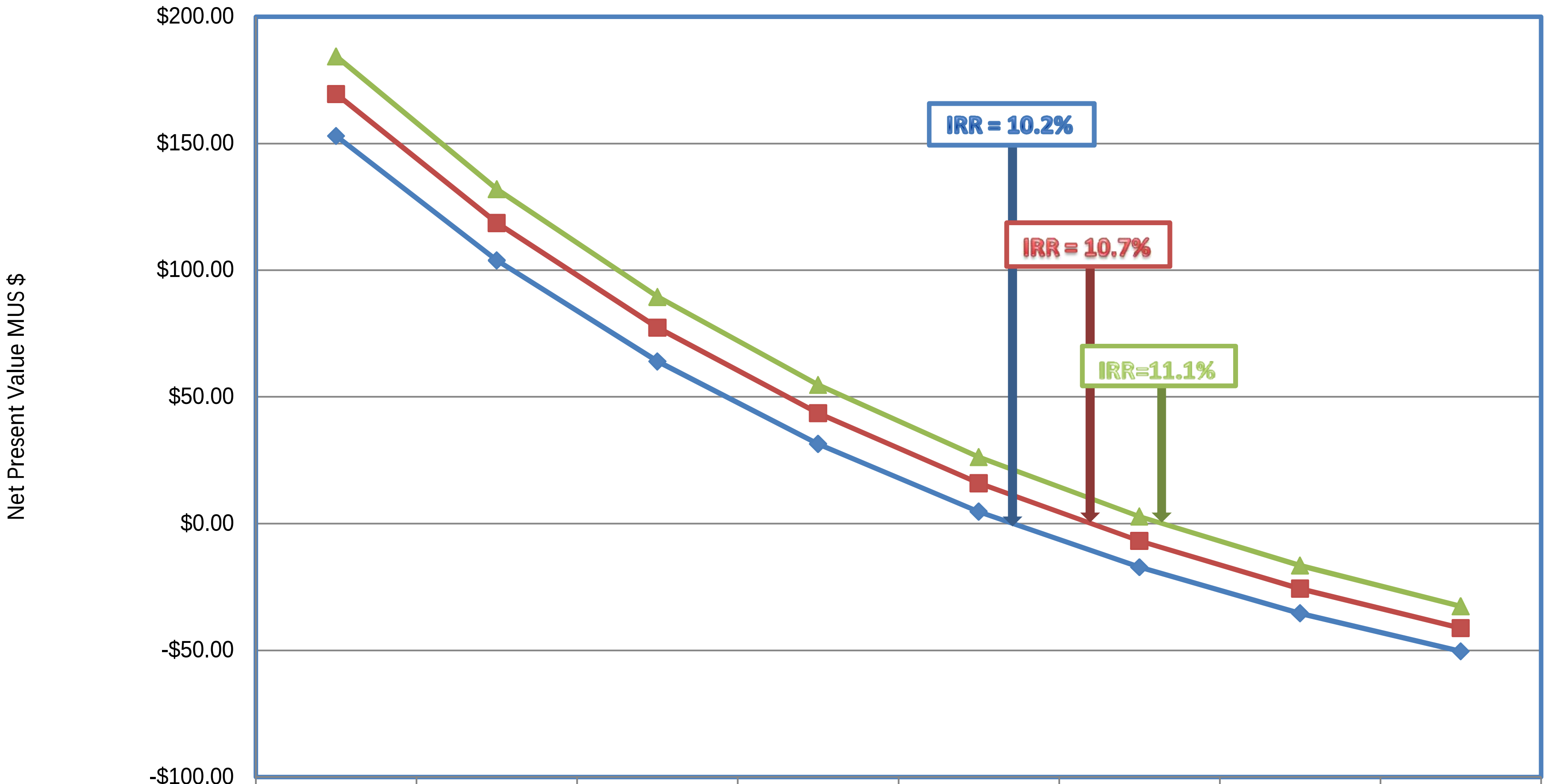
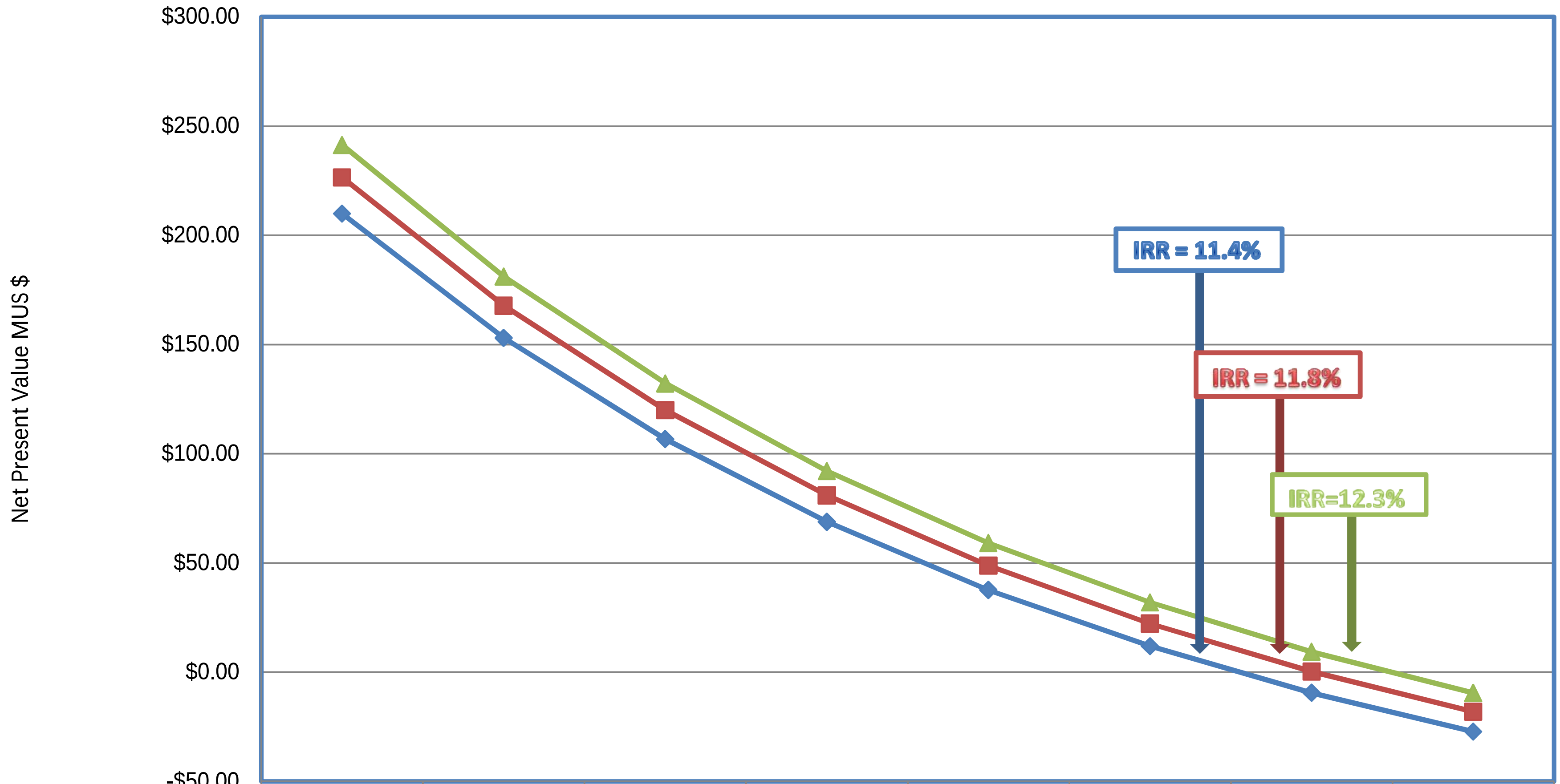


Figure 6.20: Internal Rate of Return Determination
(El. = 464m, Release = 6m3/s, Data Series = 65 Years)



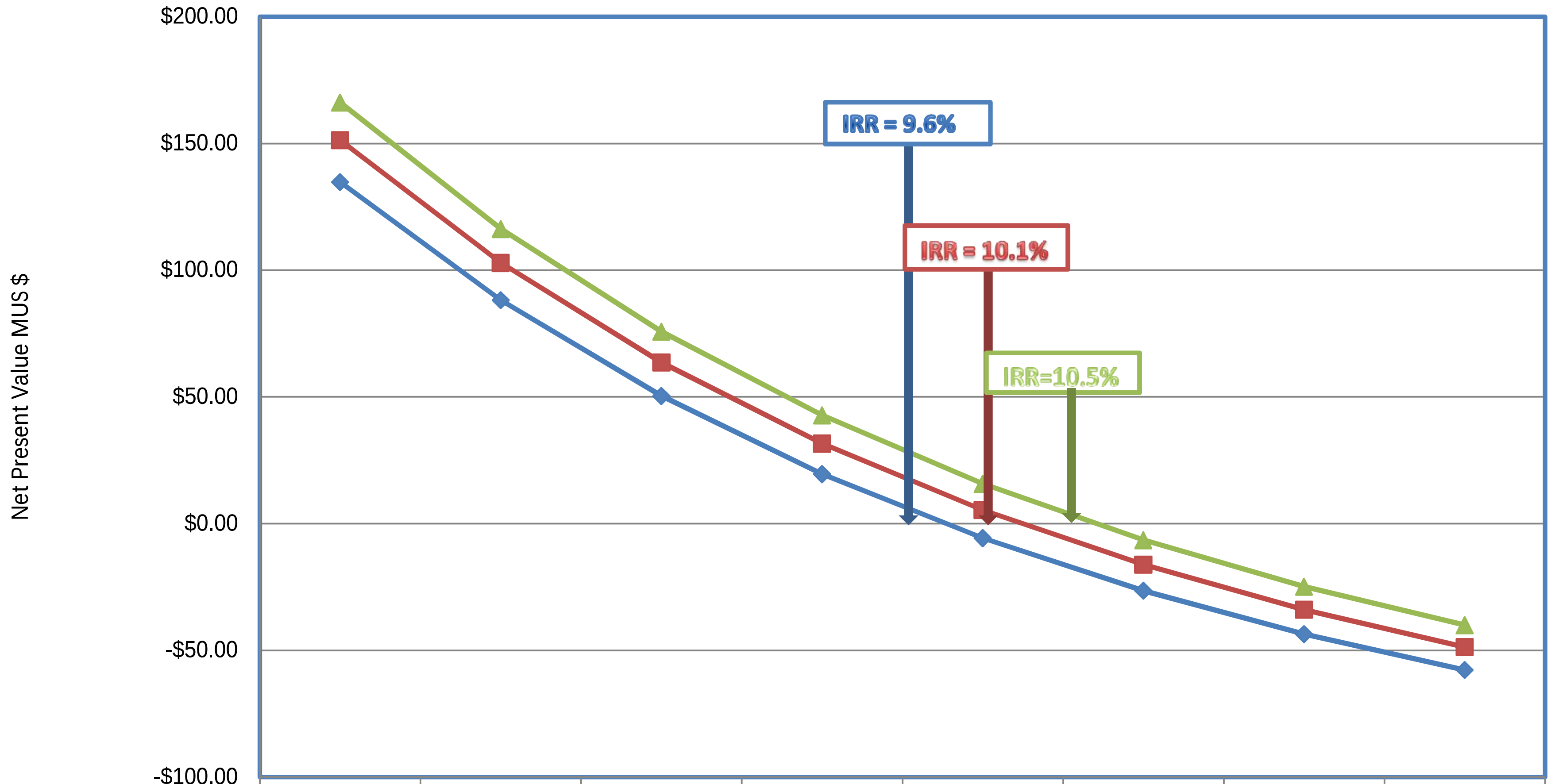
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	152.9617839	103.8884792	64.02512932	31.48460596	4.804382012	-17.15615968	-35.2921569	-50.31046081
Escalation Rate 4%	169.4709343	118.5899216	77.27647183	43.56074149	15.91800668	-6.839366723	-25.6422491	-41.22479525
Escalation Rate 3%	184.3082333	131.9394927	89.42309058	54.72423165	26.26921544	2.833275375	-16.54276695	-32.61476736

Figure 6.21: Internal Rate of Return Determination
(El. = 464m, Release = 7m3/s, Data Series = 65 Years)



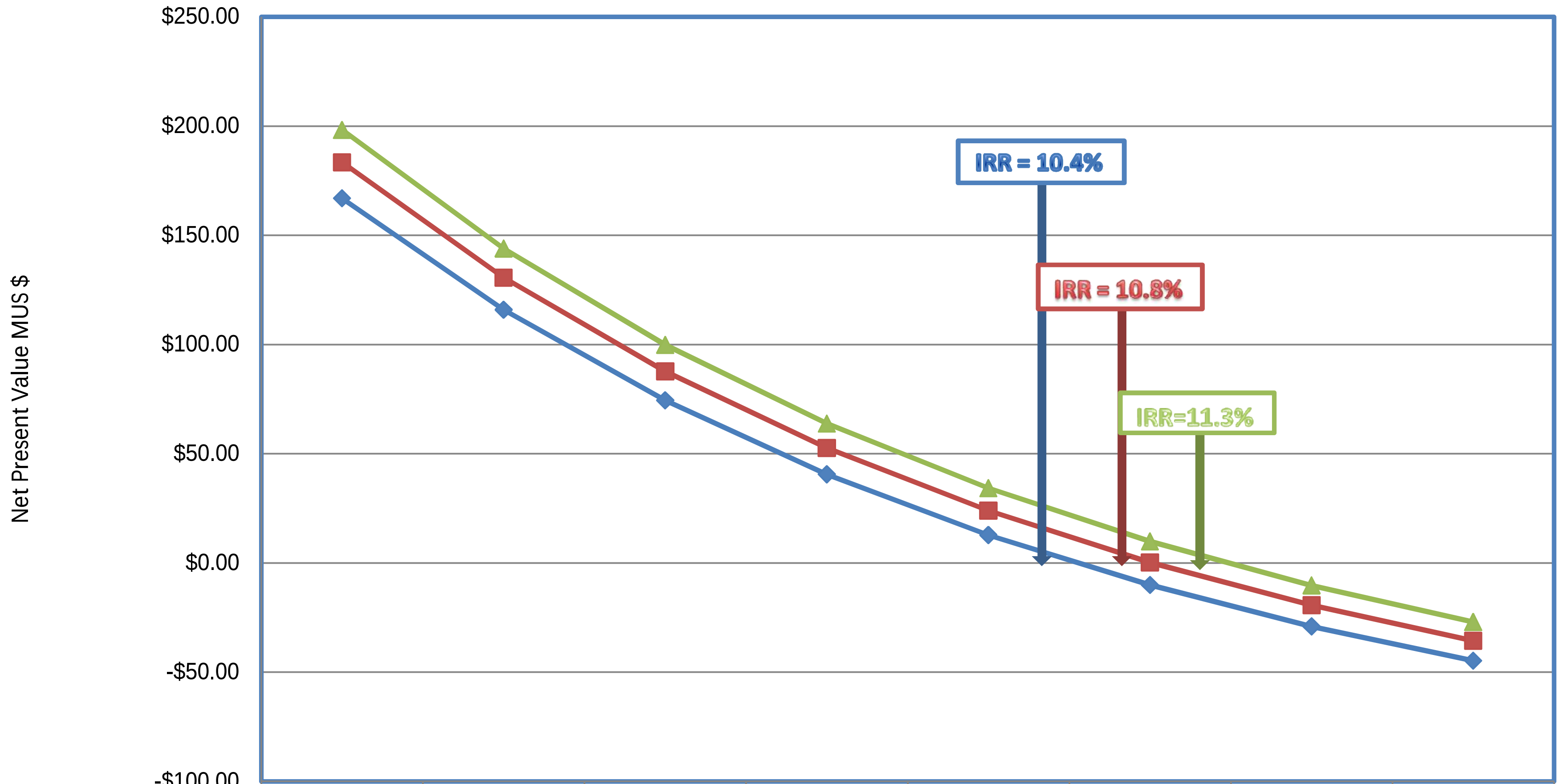
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	209.9408402	153.0632733	106.7631526	68.87340056	37.71502037	11.97893416	-9.361936563	-27.11844157
Escalation Rate 4%	226.4499906	167.7647156	120.0144951	80.9495361	48.82864503	22.29572712	0.287971244	-18.03277601
Escalation Rate 3%	241.2872896	181.1142867	132.1611138	92.11302625	59.1798538	31.96836922	9.387453389	-9.422748129

Figure 6.22: Internal Rate of Return Determination
(El. = 464m, Release = 6m3/s, Data Series = 20 Years)



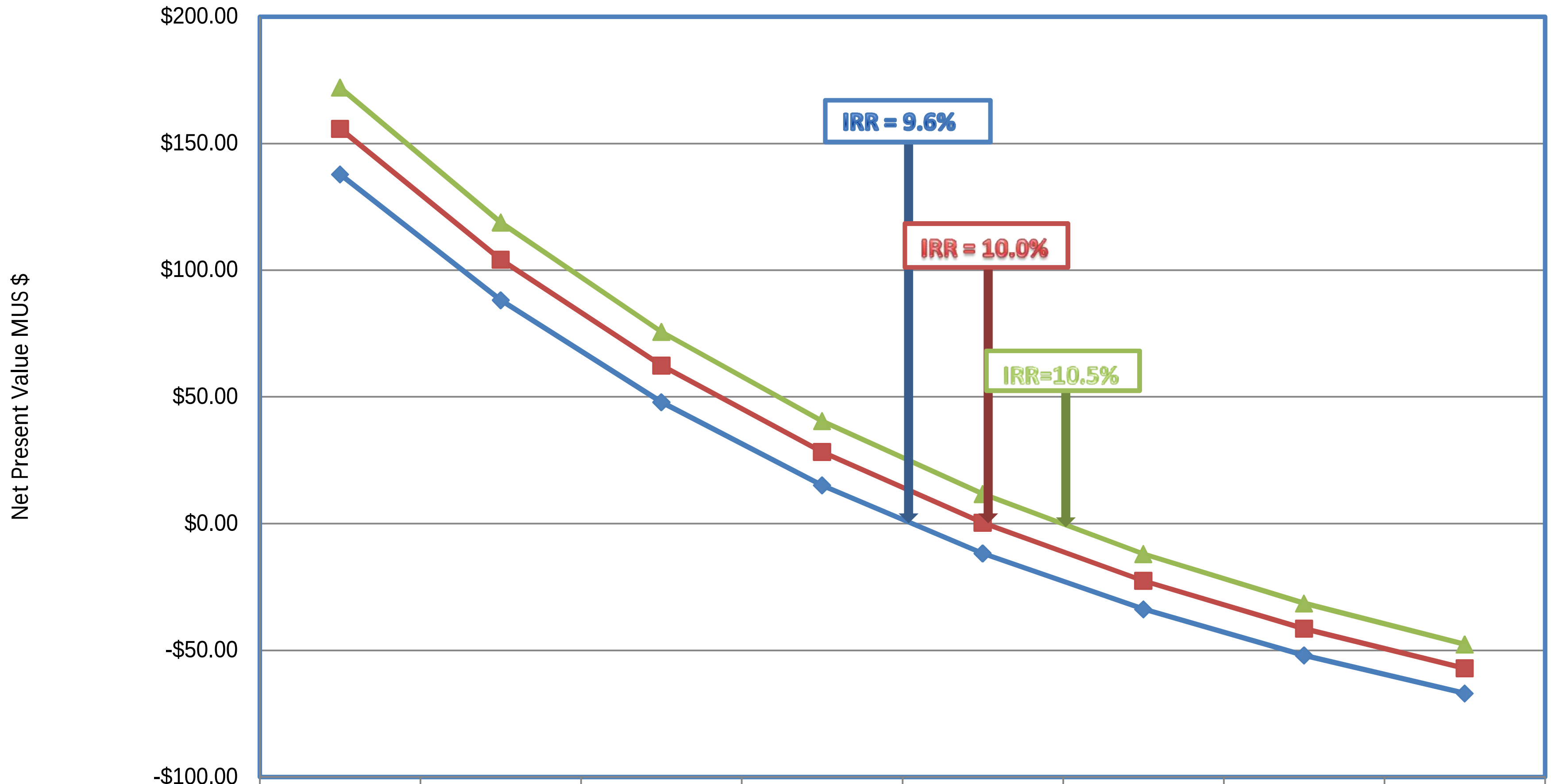
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	134.7548335	88.17528398	50.36872431	19.53748059	-5.711804097	-26.46591739	-43.57783706	-57.72118277
Escalation Rate 4%	151.2639839	102.8767263	63.62006682	31.61361612	5.401820571	-16.14912443	-33.92792925	-48.63551721
Escalation Rate 3%	166.1012829	116.2262975	75.76668557	42.77710628	15.75302933	-6.476482334	-24.8284471	-40.02548932

Figure 6.23: Internal Rate of Return Determination
(El. = 464m, Release = 7m3/s, Data Series = 20 Years)



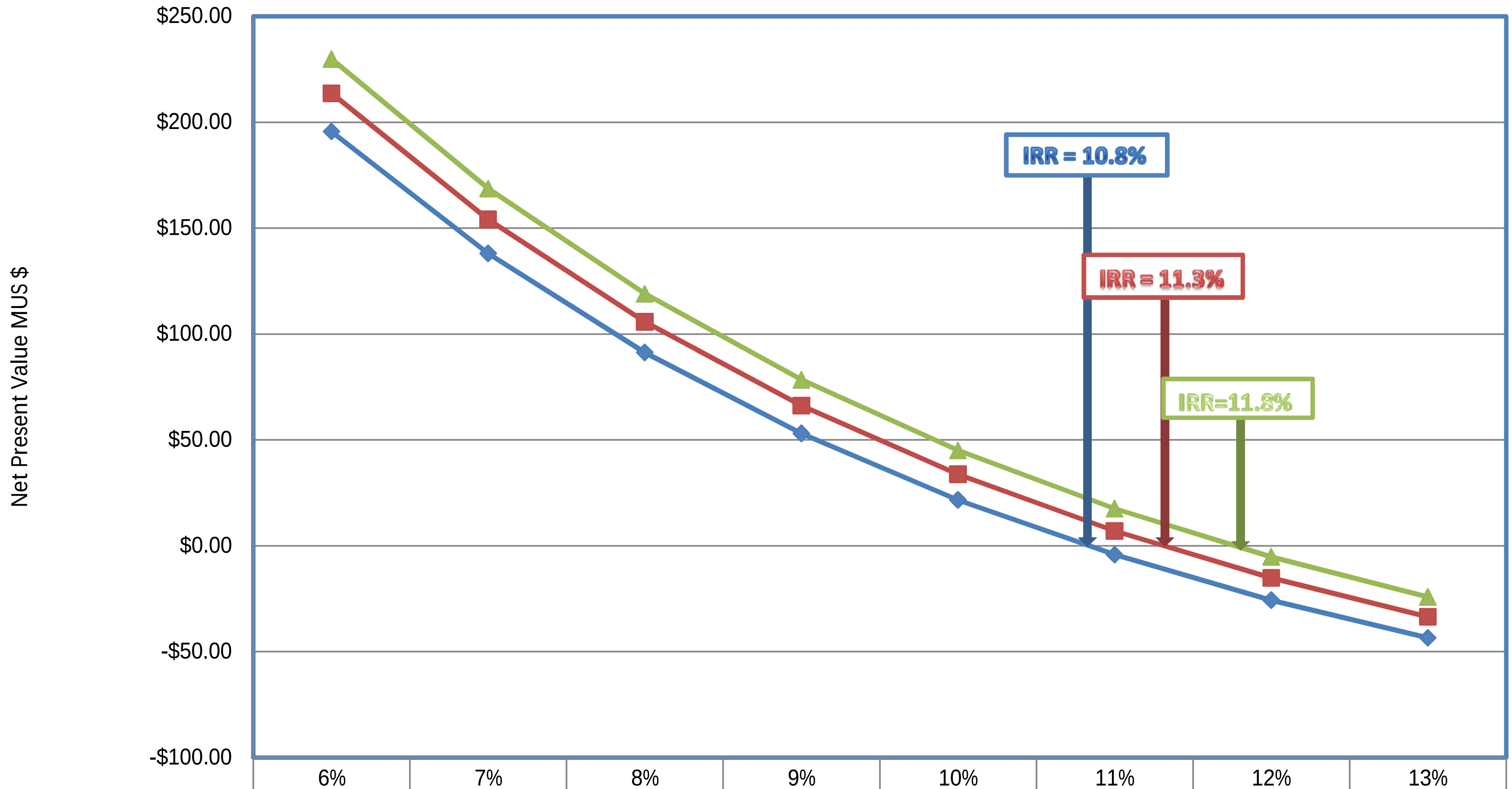
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	166.8792956	115.8997481	74.46417438	40.61706651	12.84302326	-10.03972017	-28.95852896	-44.6456566
Escalation Rate 4%	183.388446	130.6011905	87.71551689	52.69320205	23.95664793	0.277072788	-19.30862115	-35.55999104
Escalation Rate 3%	198.2257449	143.9507616	99.86213564	63.8566922	34.30785669	9.949714886	-10.20913901	-26.94996316

Figure 6.24: Internal Rate of Return Determination
(El. = 469m, Release = 6m3/s, Data Series = 65 Years)



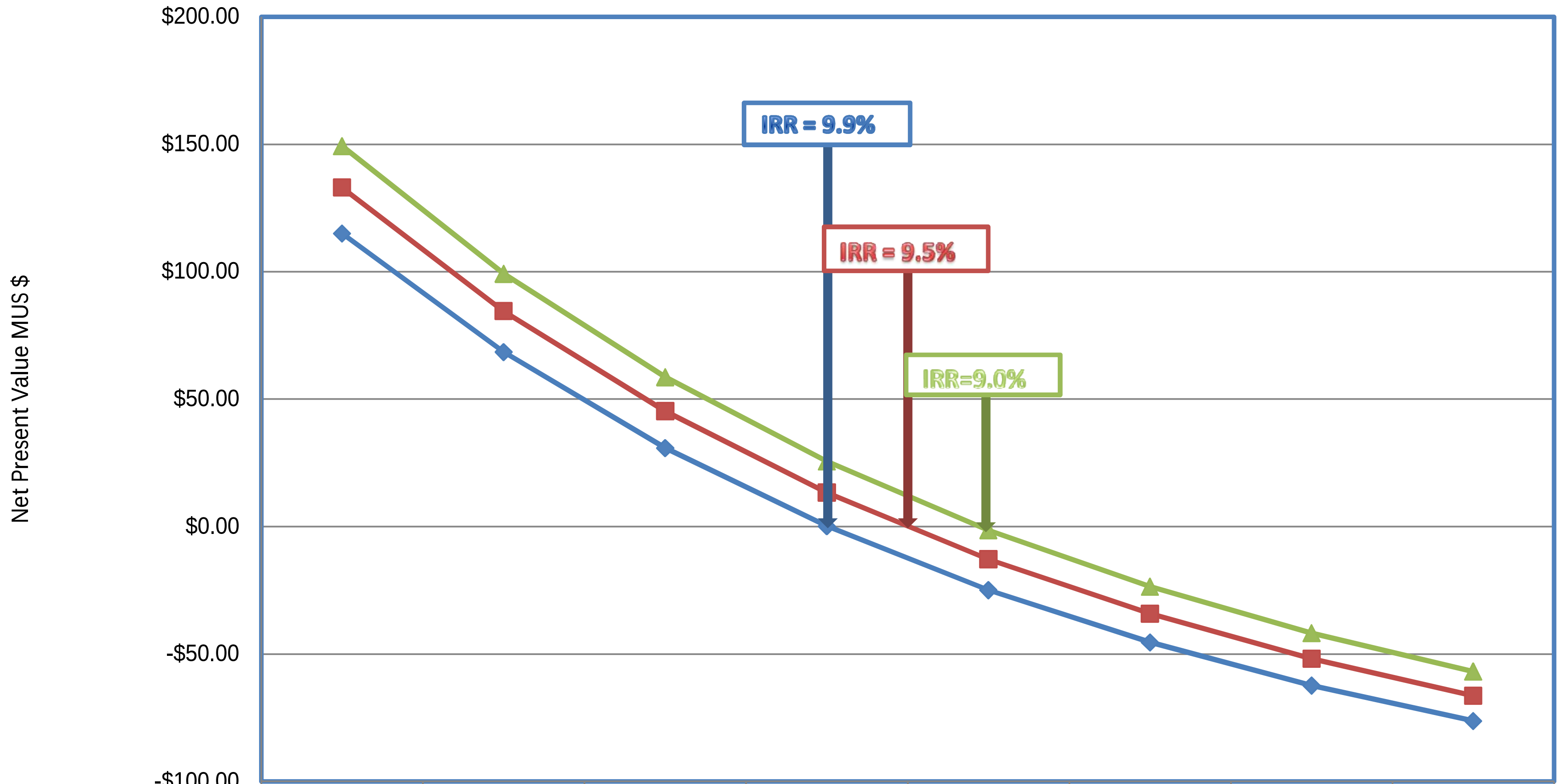
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	137.7271116	88.13534192	47.9009879	15.10657692	-11.73418865	-33.78065178	-51.94278242	-66.93924167
Escalation Rate 4%	155.7655769	104.1986433	62.37986028	28.30137777	0.40893973	-22.50816912	-41.3989614	-57.01193113
Escalation Rate 3%	171.9773198	118.7848436	75.65167351	40.49899089	11.71902628	-11.93950783	-31.45655439	-47.60431866

Figure 6.25: Internal Rate of Return Determination
(El. = 469m, Release = 7m3/s, Data Series = 65 Years)



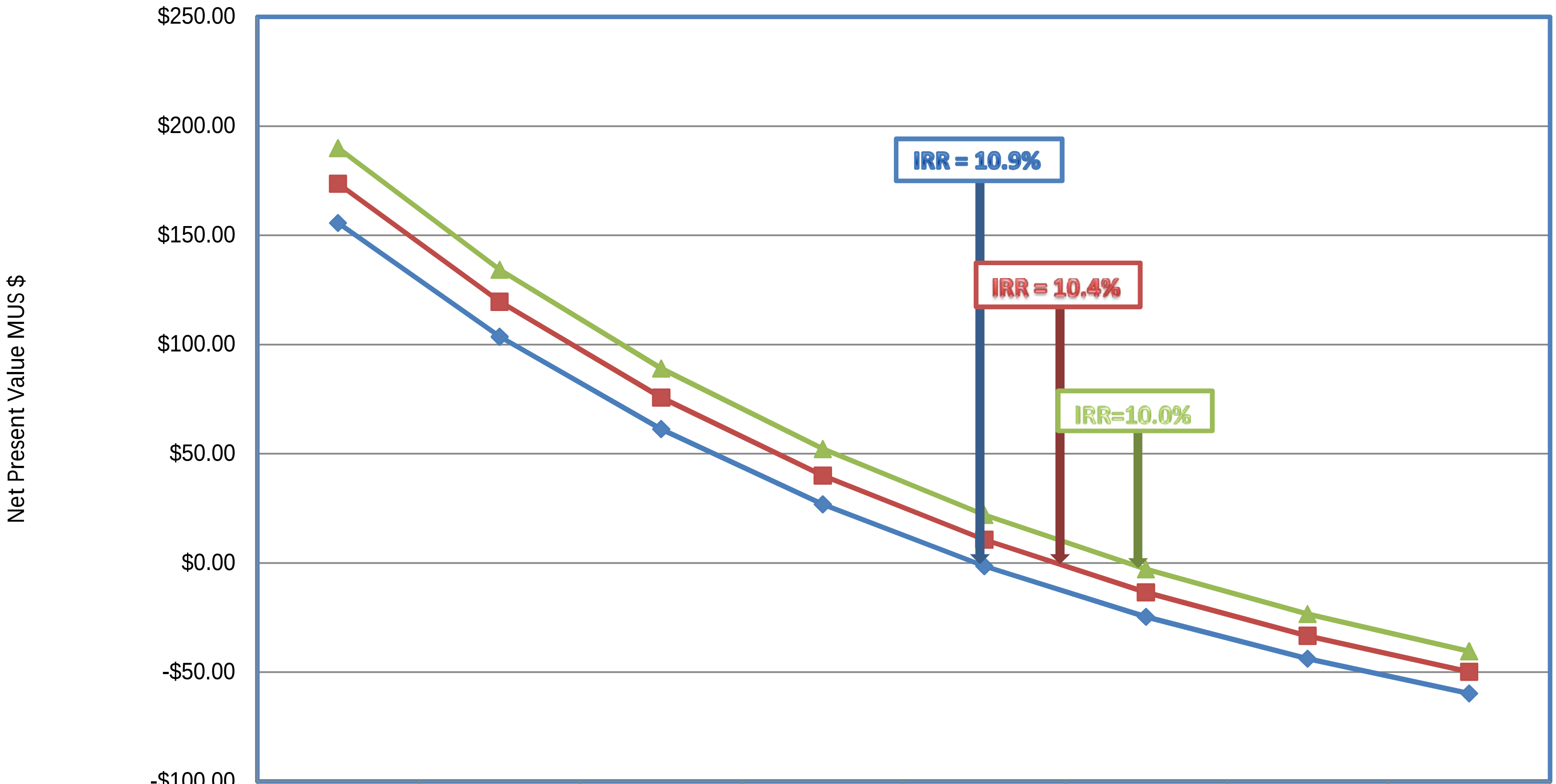
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	195.5584148	138.0456529	91.27825212	53.05460302	21.66870054	-4.209778652	-25.62471871	-43.40033488
Escalation Rate 4%	213.5968801	154.1089543	105.7571245	66.24940387	33.81182892	7.062704005	-15.0808977	-33.47302434
Escalation Rate 3%	229.808623	168.6951546	119.0289377	78.44701699	45.12191547	17.63136529	-5.138490679	-24.06541188

Figure 6.26: Internal Rate of Return Determination
(El. = 469m, Release = 6m3/s, Data Series = 20 Years)



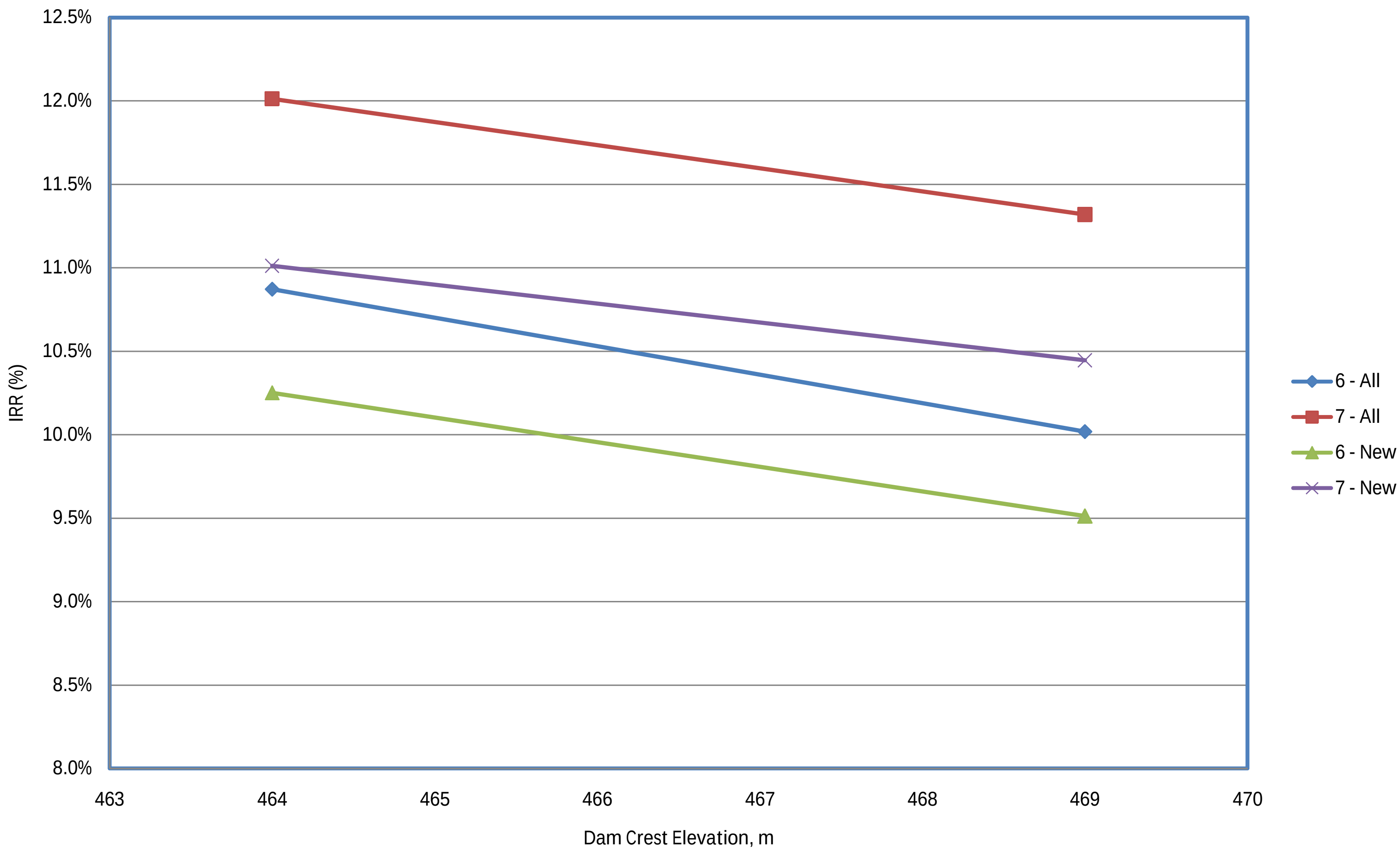
	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	114.9593715	68.48603565	30.82369201	0.166730392	-24.88464968	-45.4224775	-62.30400205	-76.20632855
Escalation Rate 4%	132.9978368	84.549337	45.30256439	13.36153124	-12.7415213	-34.14999484	-51.76018103	-66.27901801
Escalation Rate 3%	149.2095797	99.13553734	58.57437761	25.55914436	-1.43143475	-23.58133356	-41.81777401	-56.87140555

Figure 6.27: Internal Rate of Return Determination
(El. = 469m, Release = 7m3/s, Data Series = 20 Years)



	6%	7%	8%	9%	10%	11%	12%	13%
Escalation Rate 5%	155.6025268	103.5624114	61.30871978	26.83615389	-1.409494588	-24.64041794	-43.80797844	-59.66346353
Escalation Rate 4%	173.6409921	119.6257127	75.78759216	40.03095474	10.73363379	-13.36793528	-33.26415742	-49.73615299
Escalation Rate 3%	189.852735	134.2119131	89.05940539	52.22856786	22.04372034	-2.799273994	-23.3217504	-40.32854052

Figure 6.28: Internal Rate of Return



Appendix A - __Monthly Reservoir Operation__

Figure A1: **Monthly reservoir operations (all data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 90 Mm³

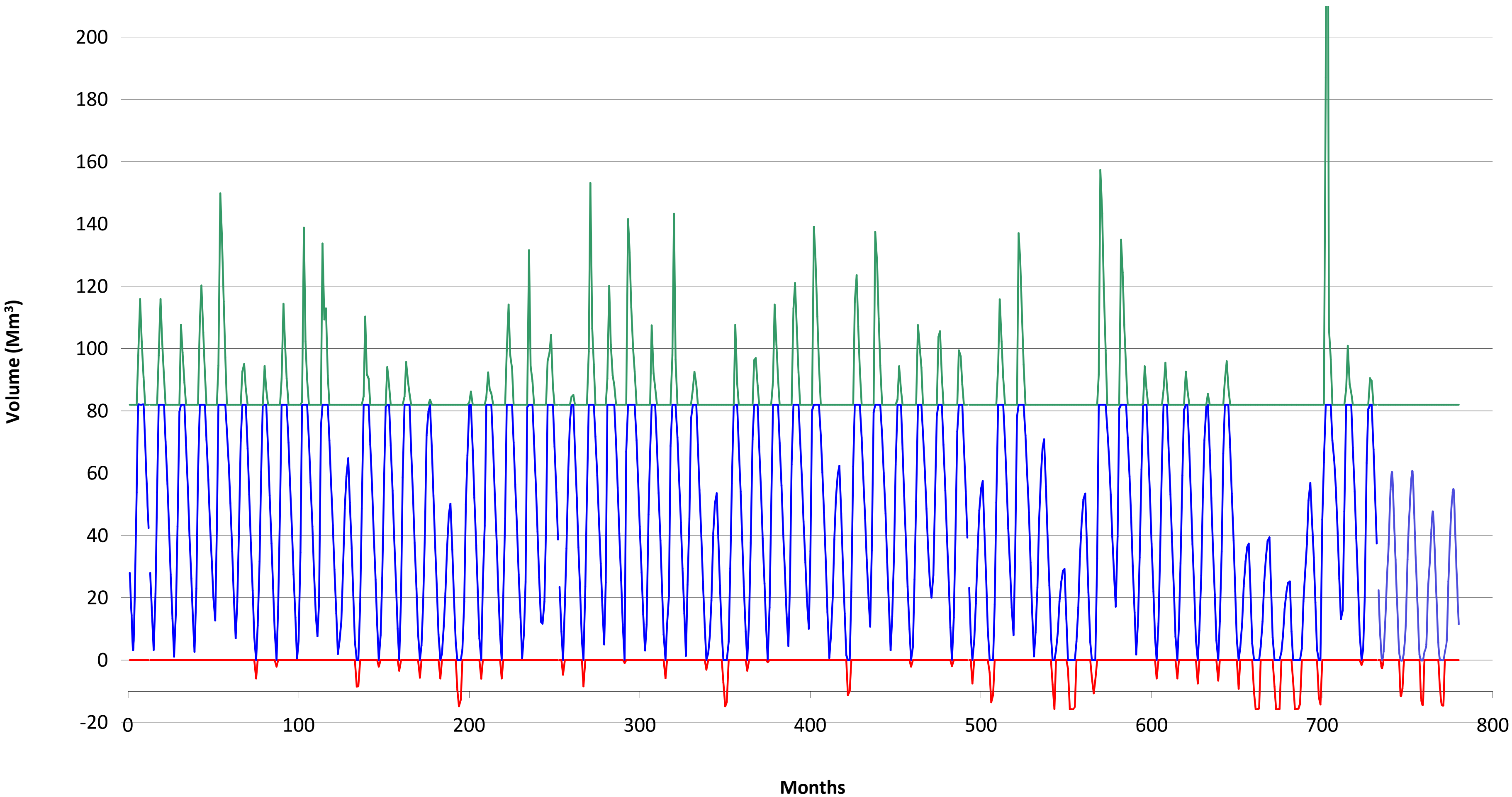


Figure A2: **Monthly reservoir operations (all data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 100 Mm³

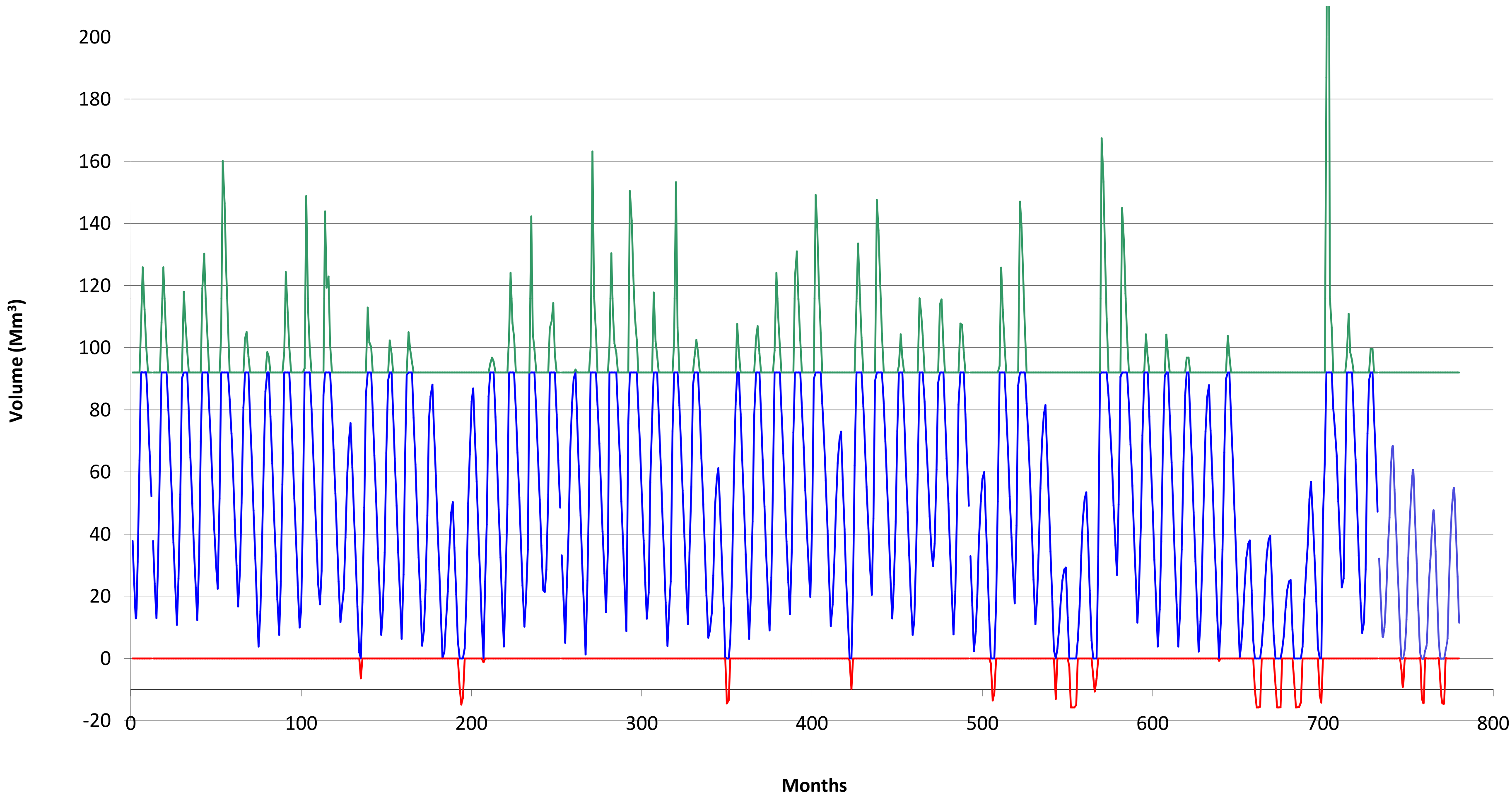


Figure A3: Monthly reservoir operations (all data)
Release rate 6 m³/s - Behaviour plot reservoir
Storage 110 Mm³

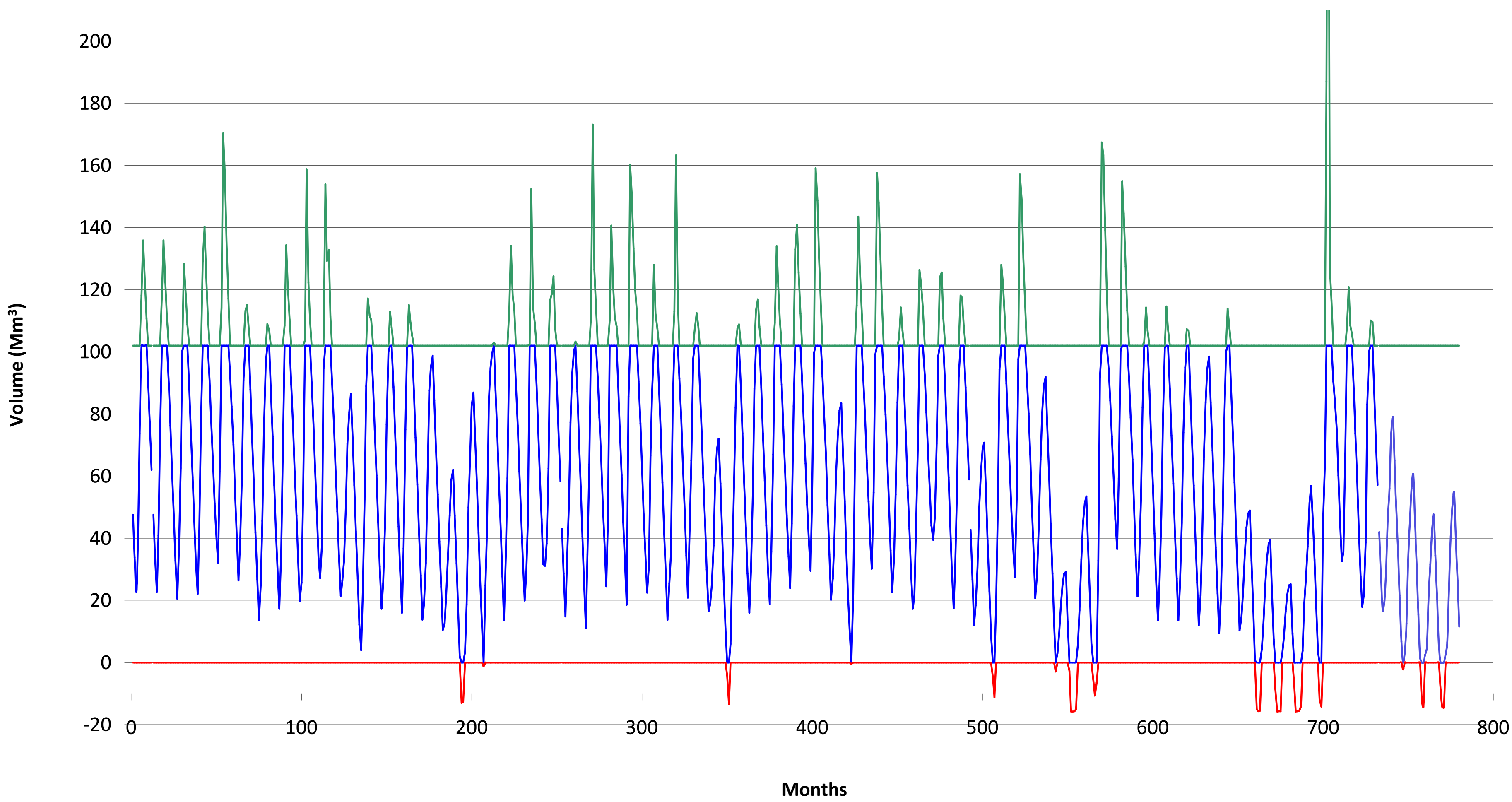


Figure A4: **Monthly reservoir operations (all data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 120 Mm³

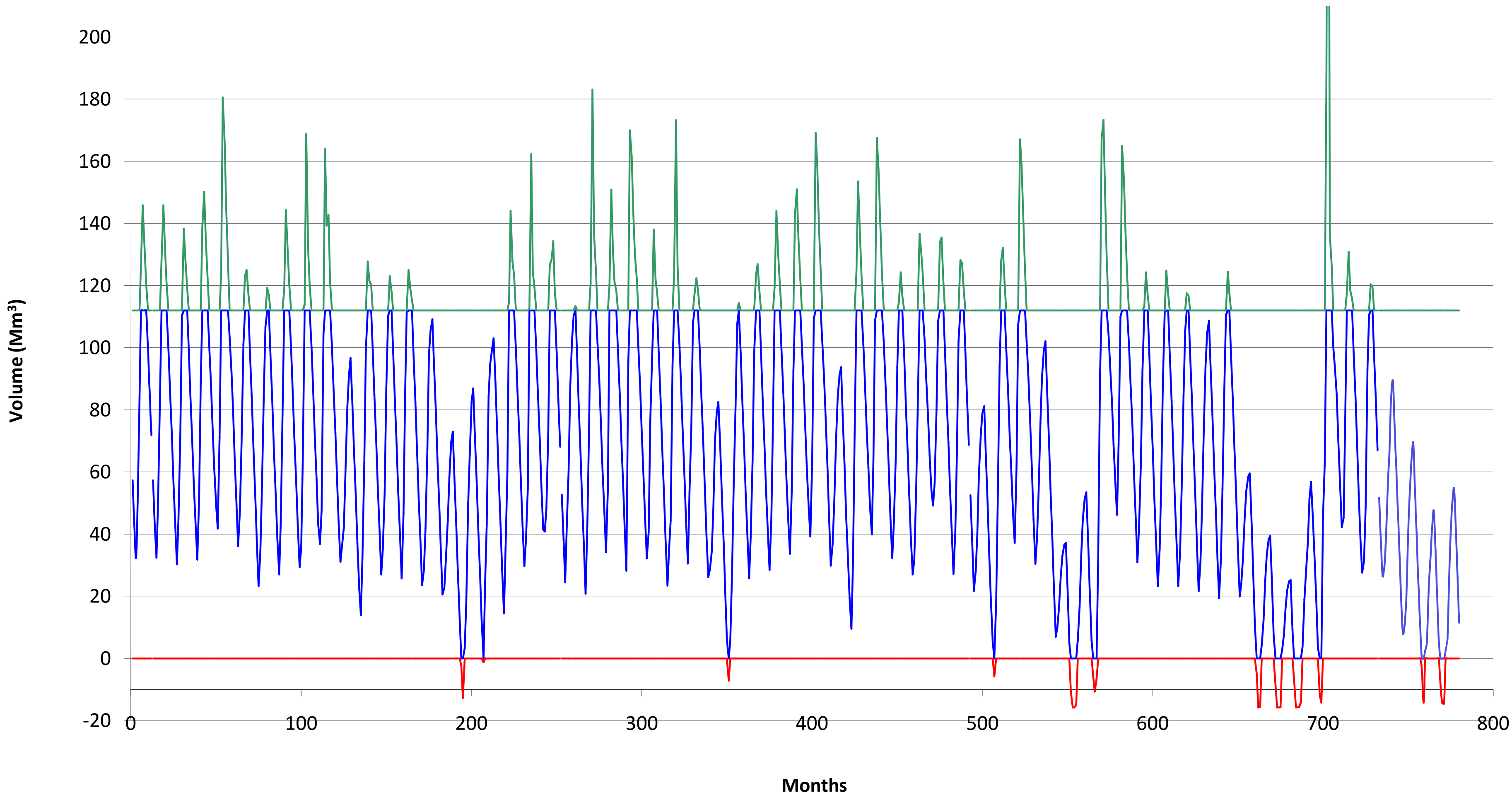


Figure A5: **Monthly reservoir operations (all data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 130 Mm³

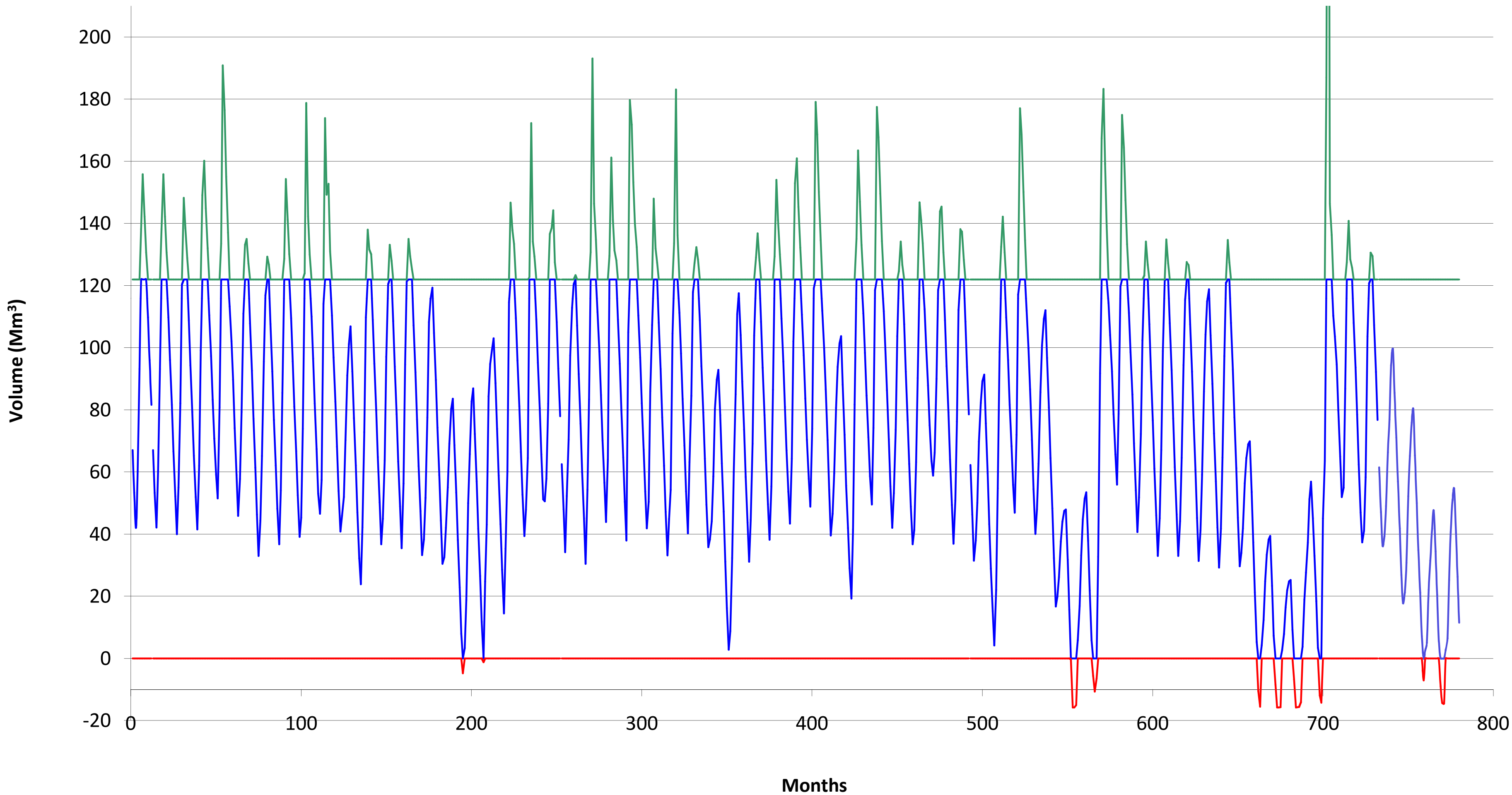


Figure A6: Monthly reservoir operations (all data)
Release rate 6 m^3/s - Behaviour plot reservoir
Storage 140 Mm^3

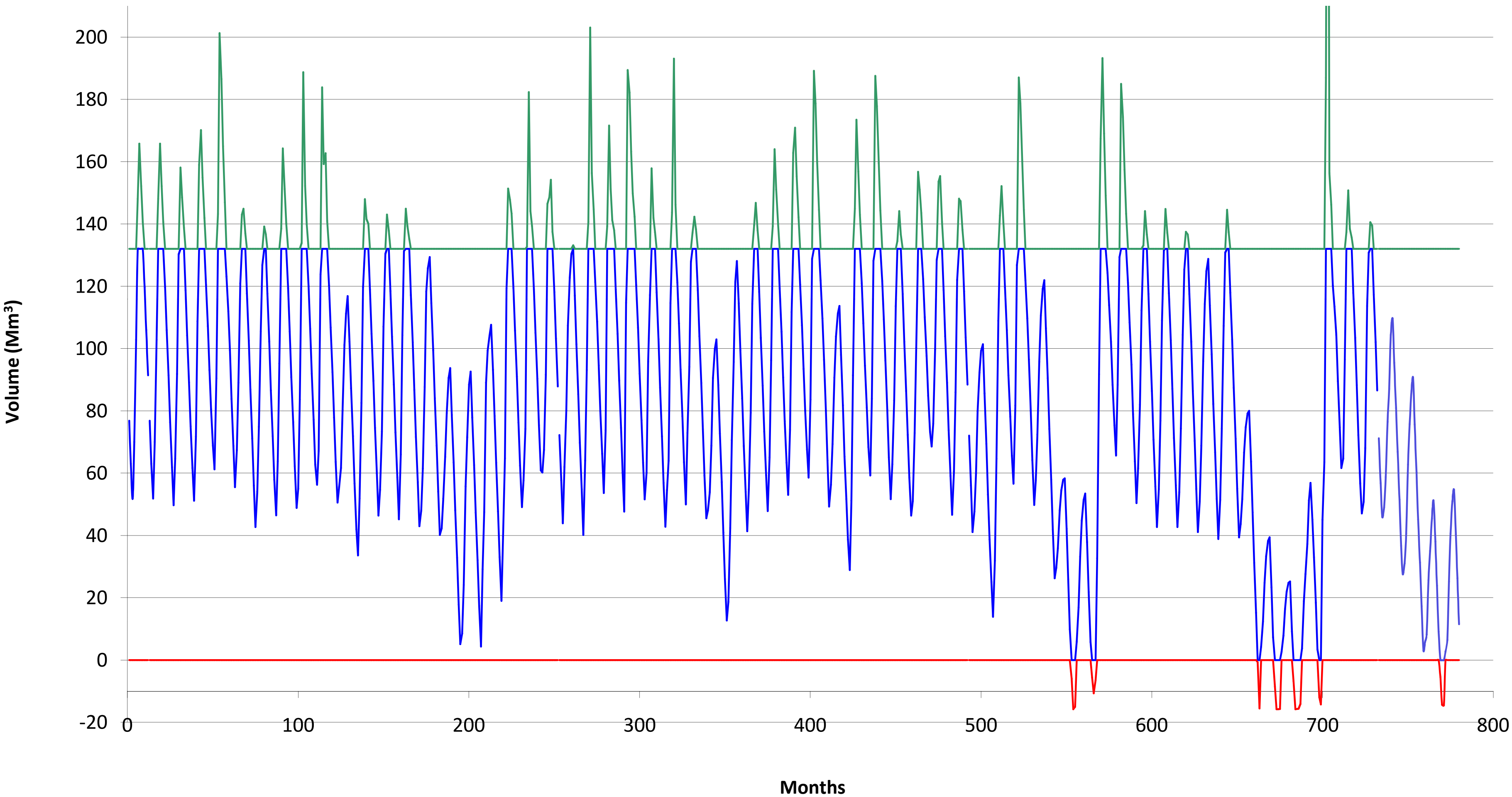


Figure A7: **Monthly reservoir operations (all data)**
Release rate 6 m^3/s - Behaviour plot reservoir
Storage 150 Mm^3

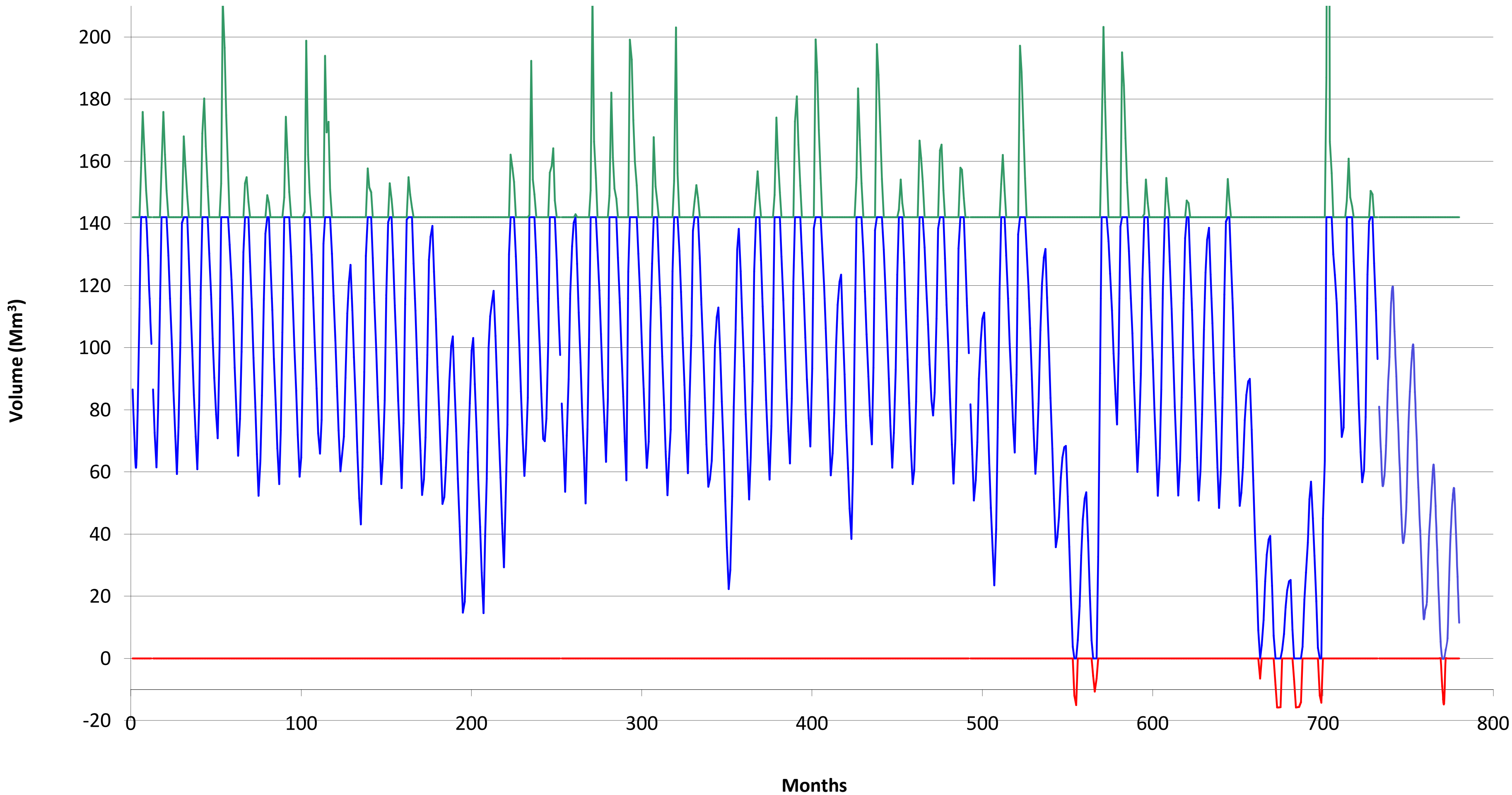


Figure A8: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 90 Mm³

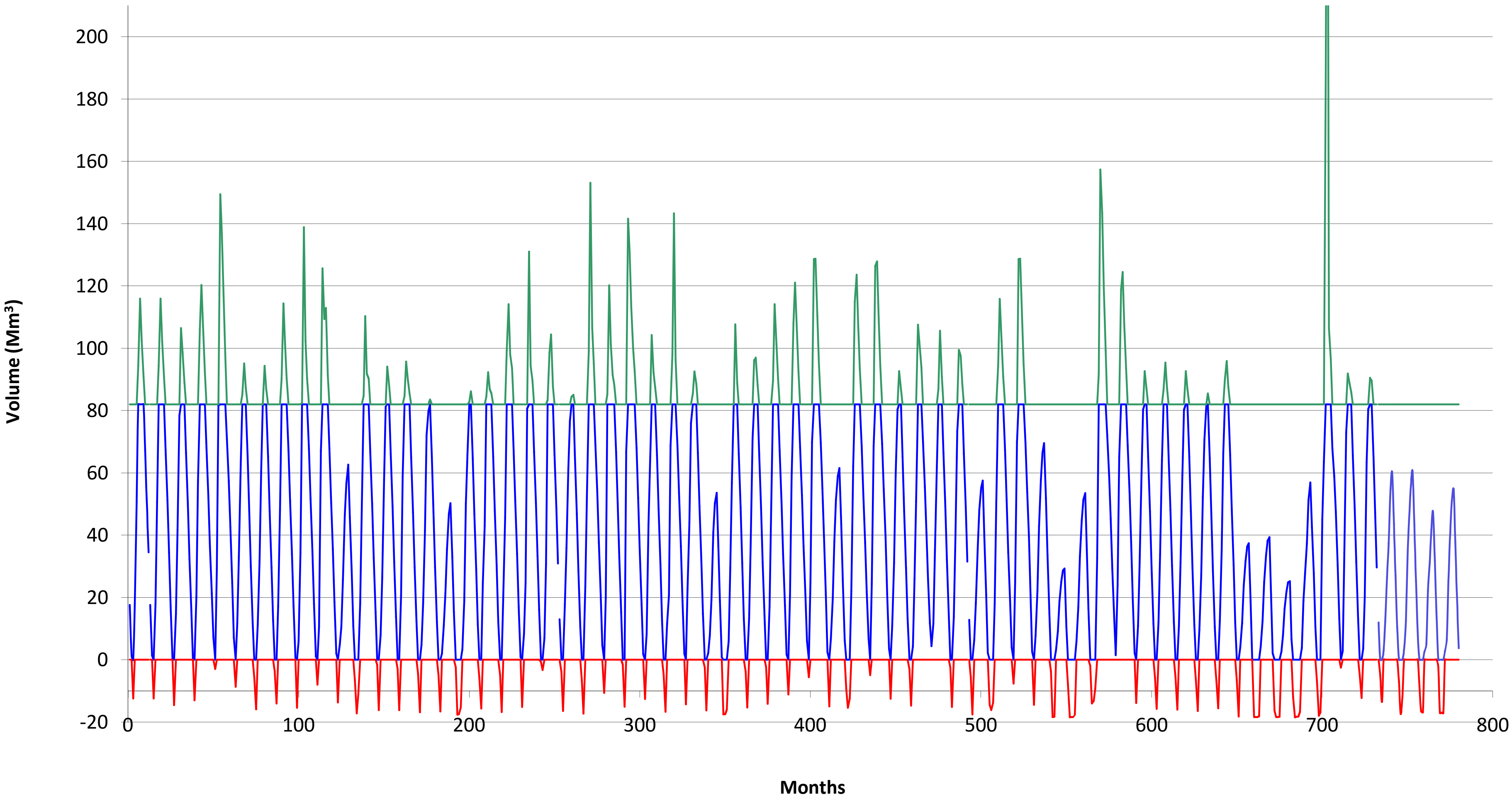


Figure A9: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 100 Mm³

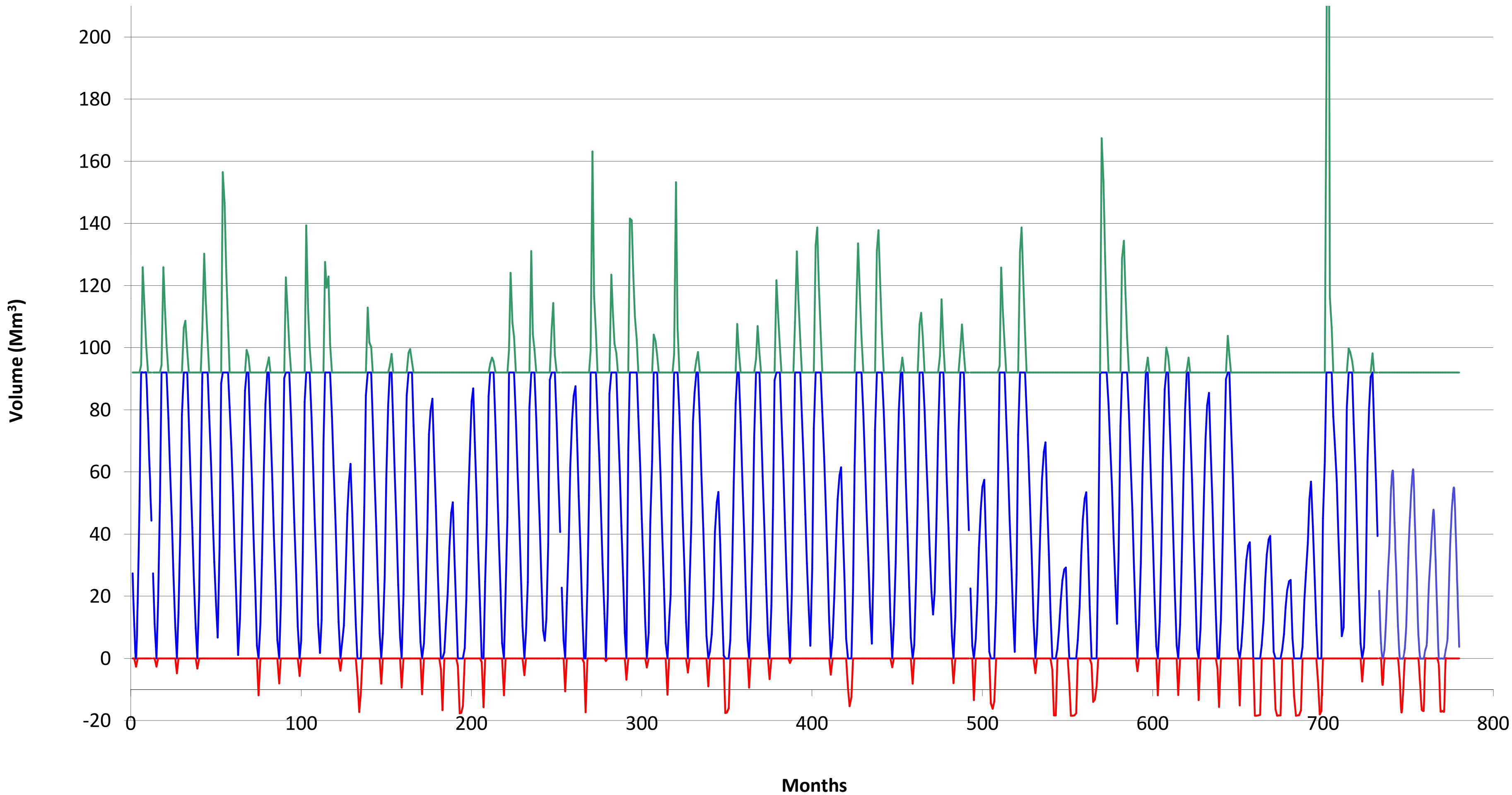


Figure A10: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 110 Mm³

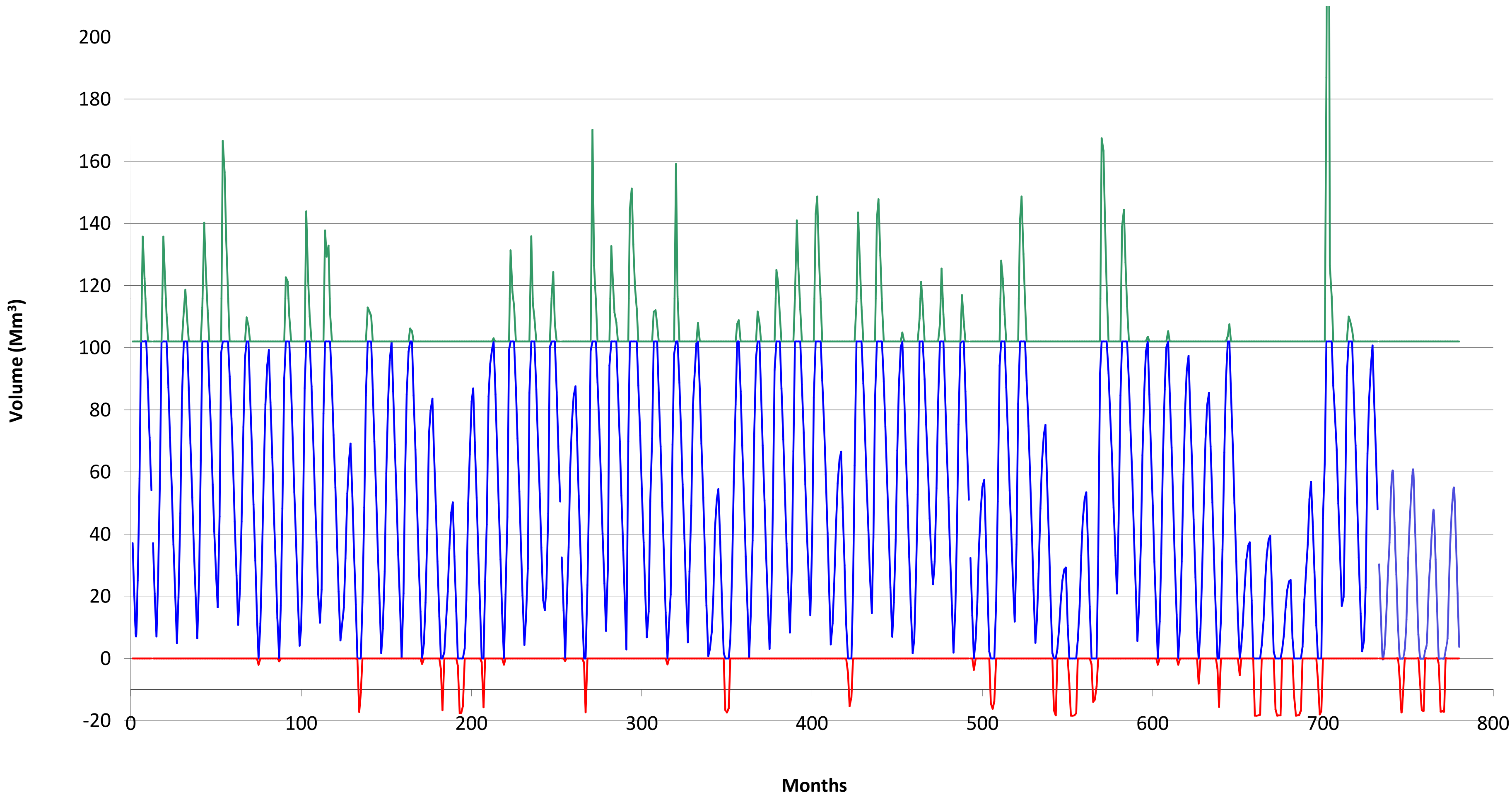


Figure A11: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 120 Mm³

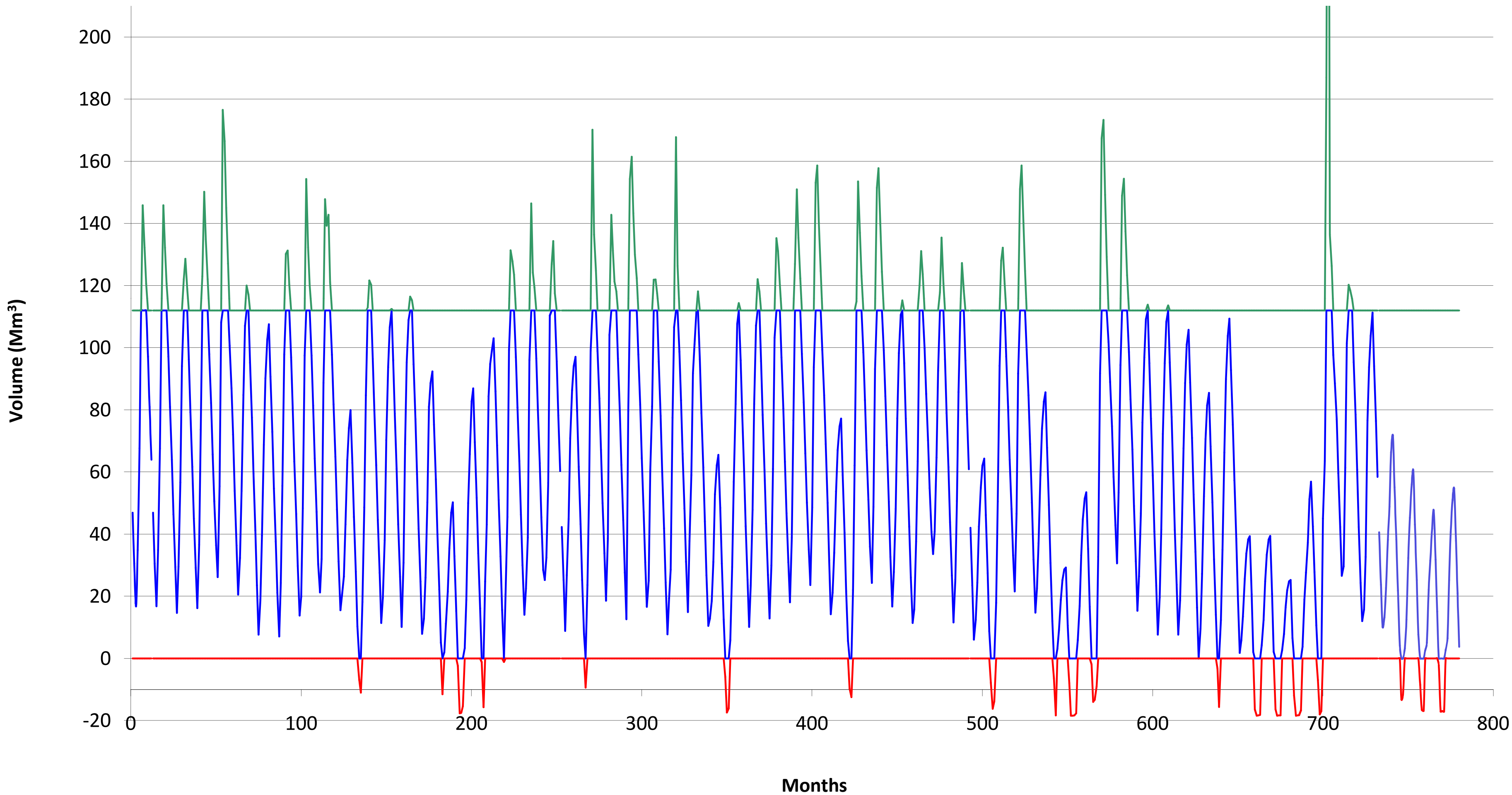


Figure A12: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 130 Mm³

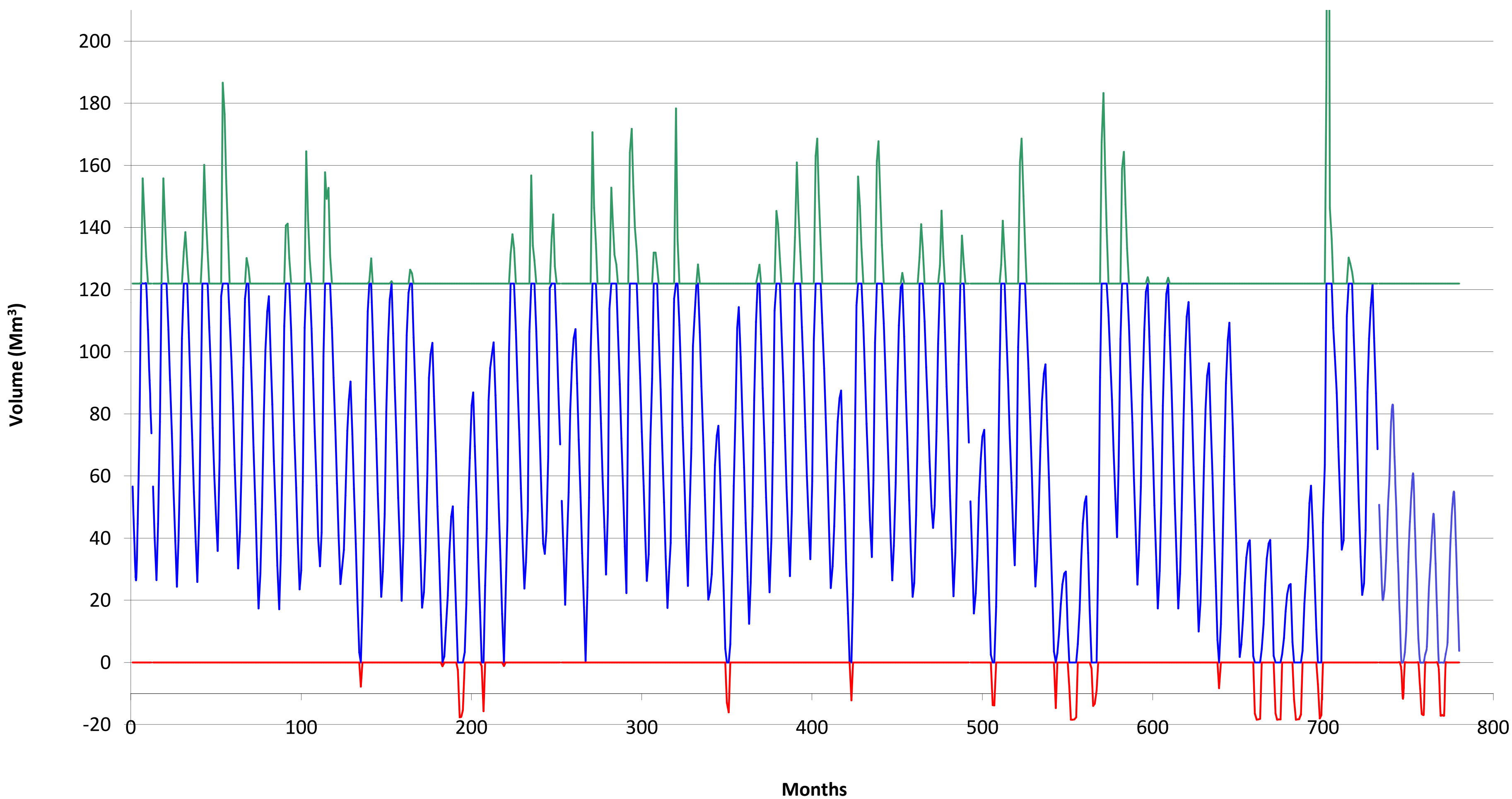


Figure A13: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 140 Mm³

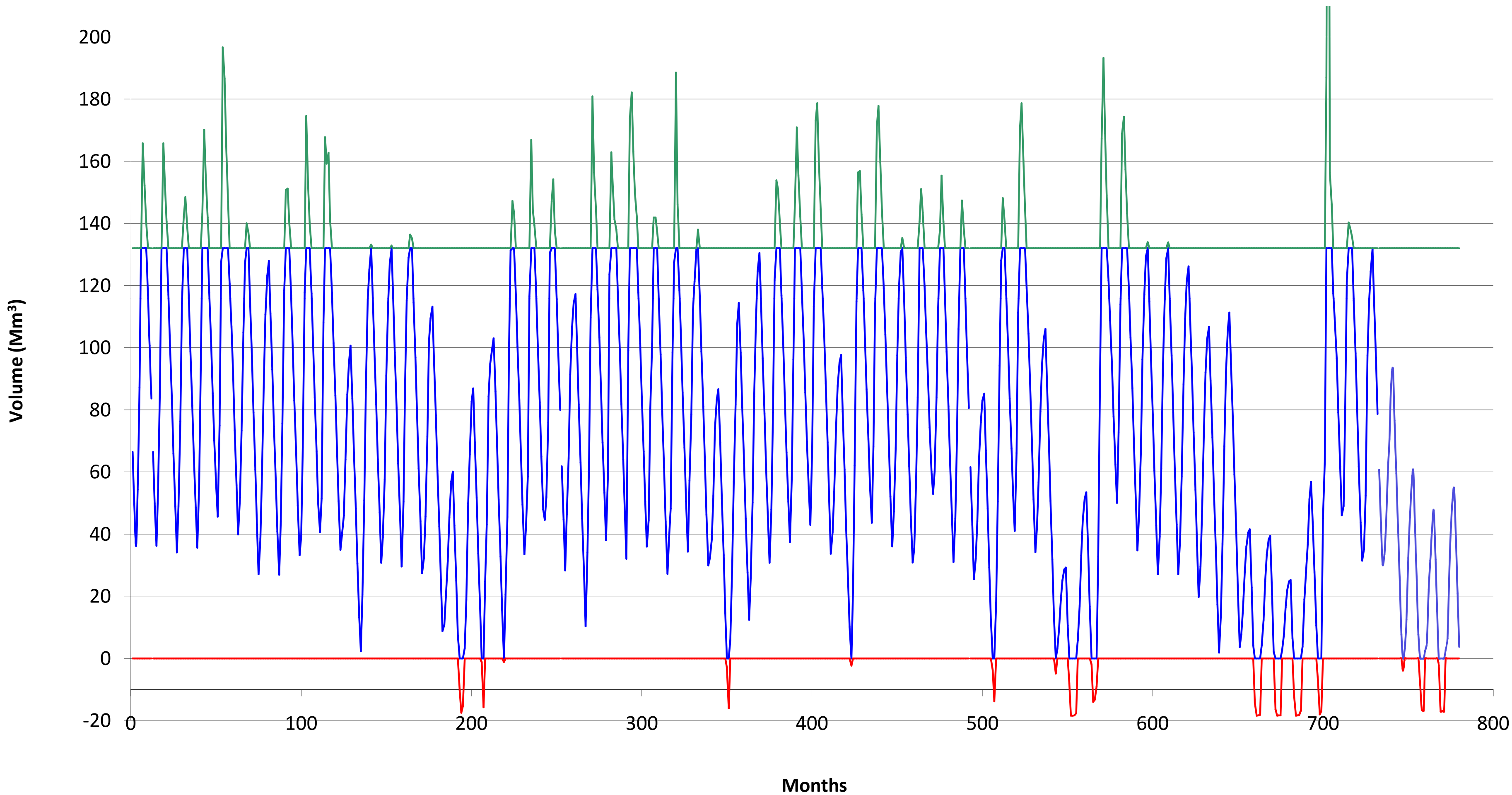


Figure A14: **Monthly reservoir operations (all data)**
Release rate 7 m³/s - Behaviour plot reservoir
Storage 150 Mm³

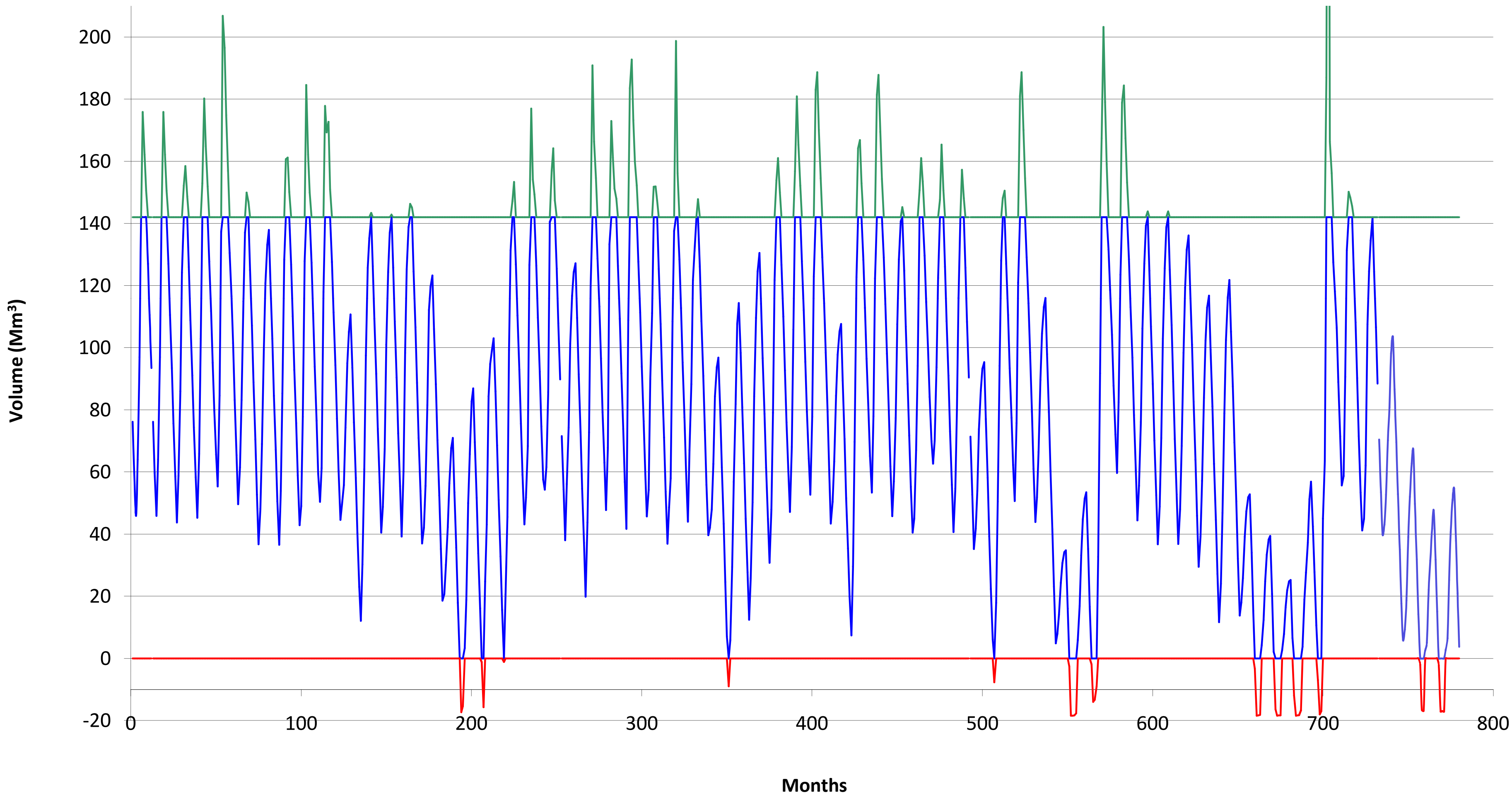


Figure A15: **Monthly reservoir operations (new data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 90 Mm³

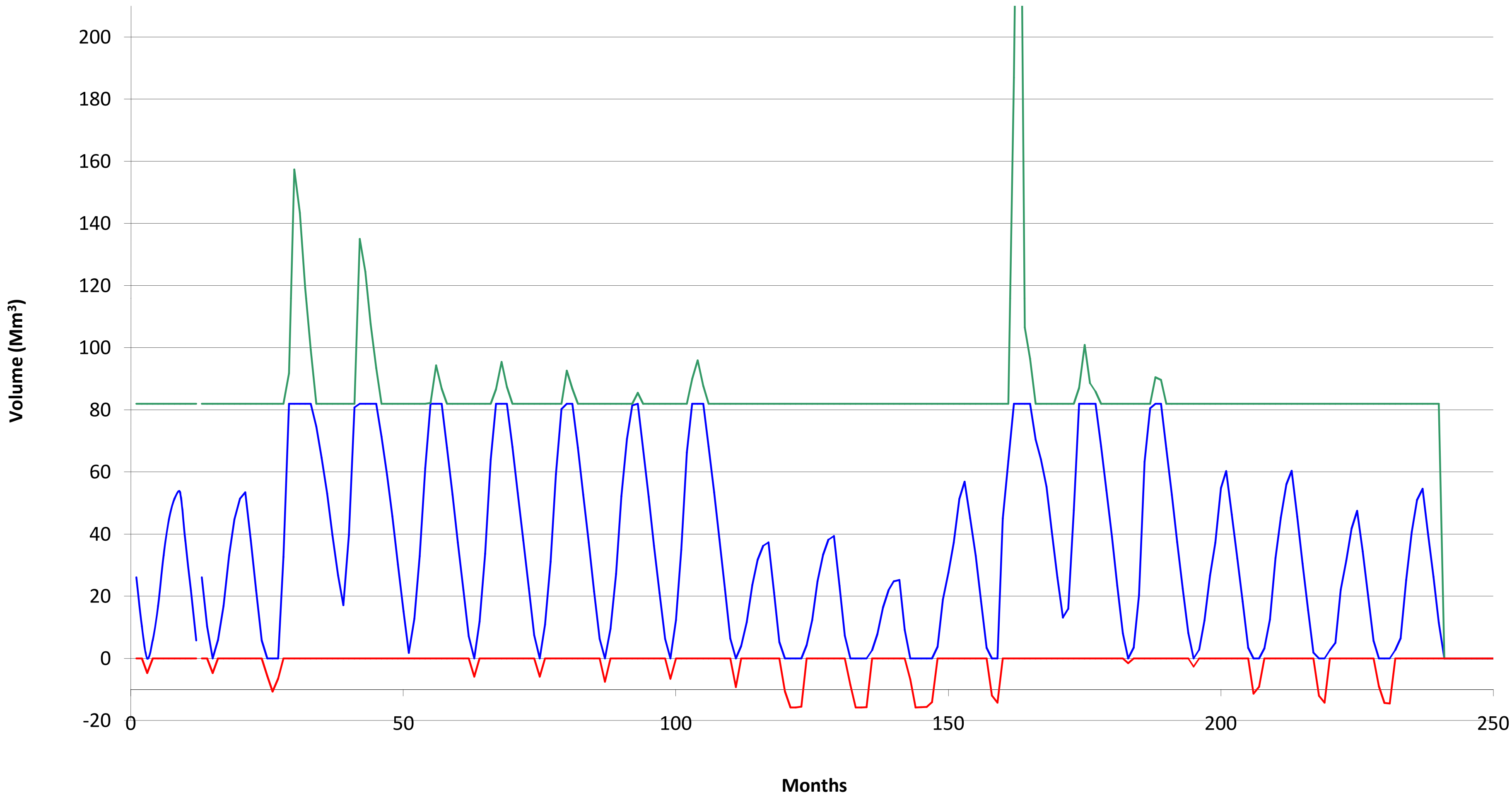


Figure A16: **Monthly reservoir operations (new data)**
Release rate 6 m^3/s - Behaviour plot reservoir
Storage 100 Mm^3

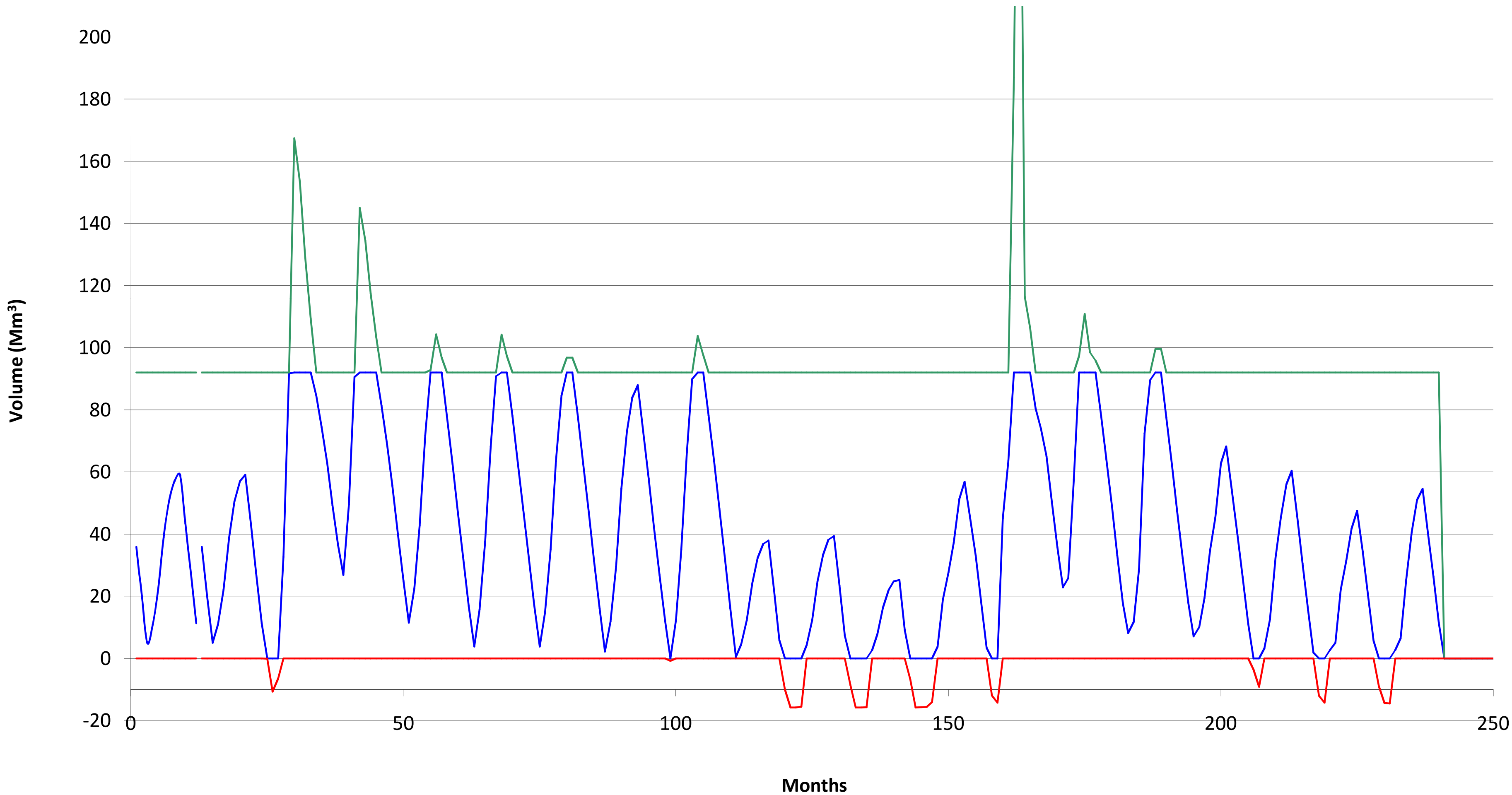


Figure A17: **Monthly reservoir operations (new data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 110 Mm³

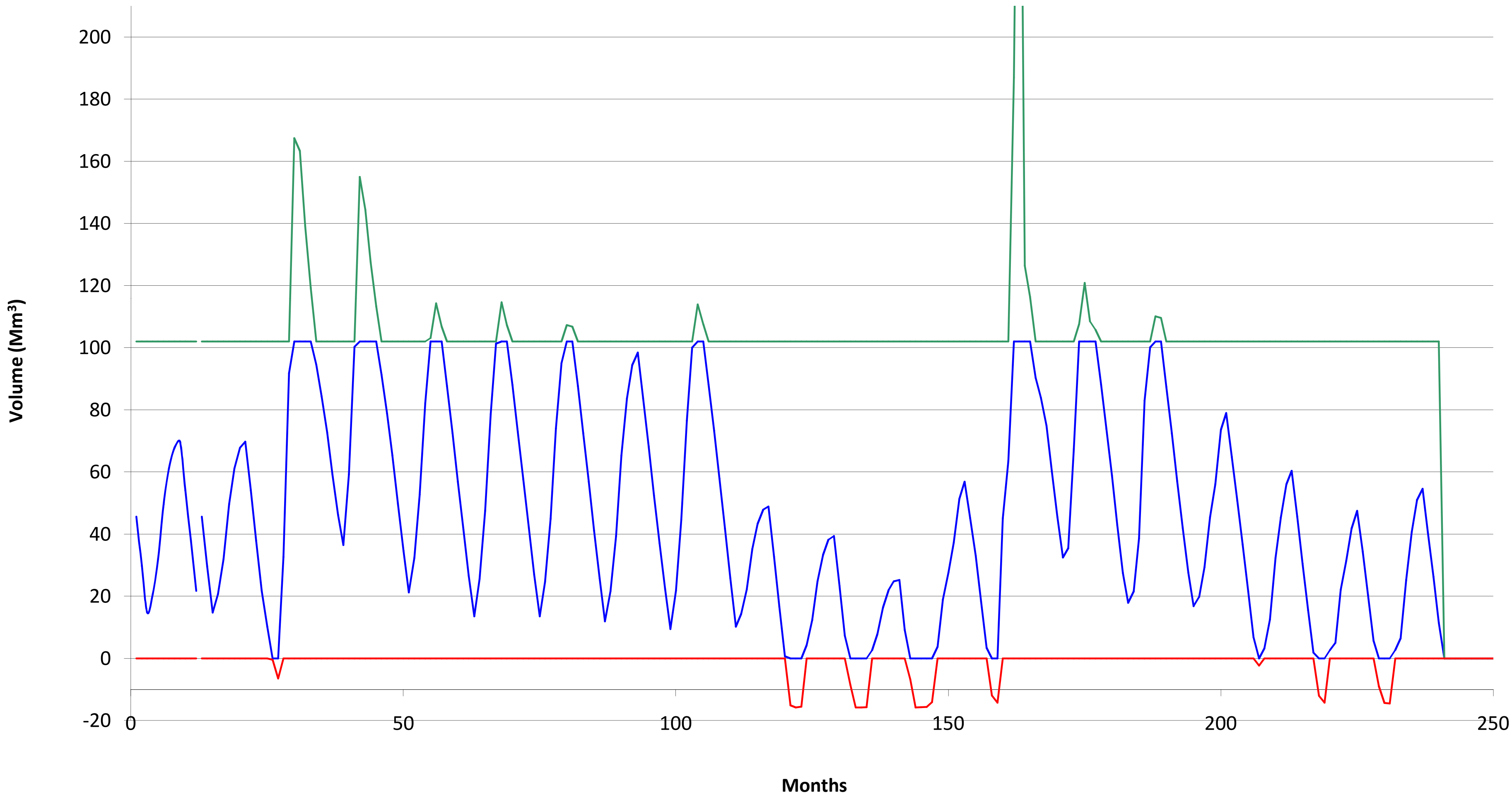


Figure A18: **Monthly reservoir operations (new data)**
Release rate 6 m³/s - Behaviour plot reservoir
Storage 120 Mm³

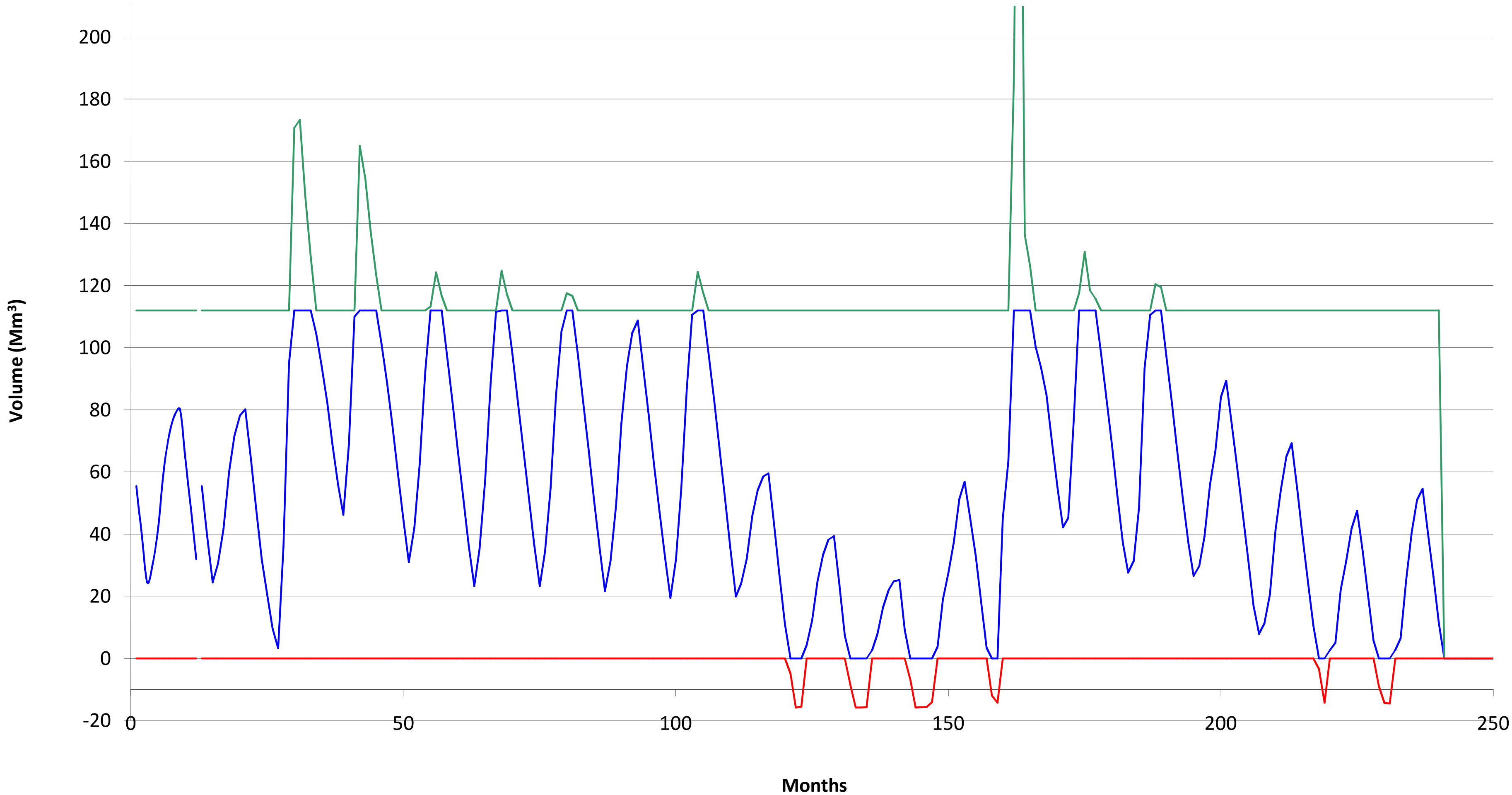


Figure A19: Monthly reservoir operations (new data)
Release rate 6 m³/s - Behaviour plot reservoir
Storage 130 Mm3

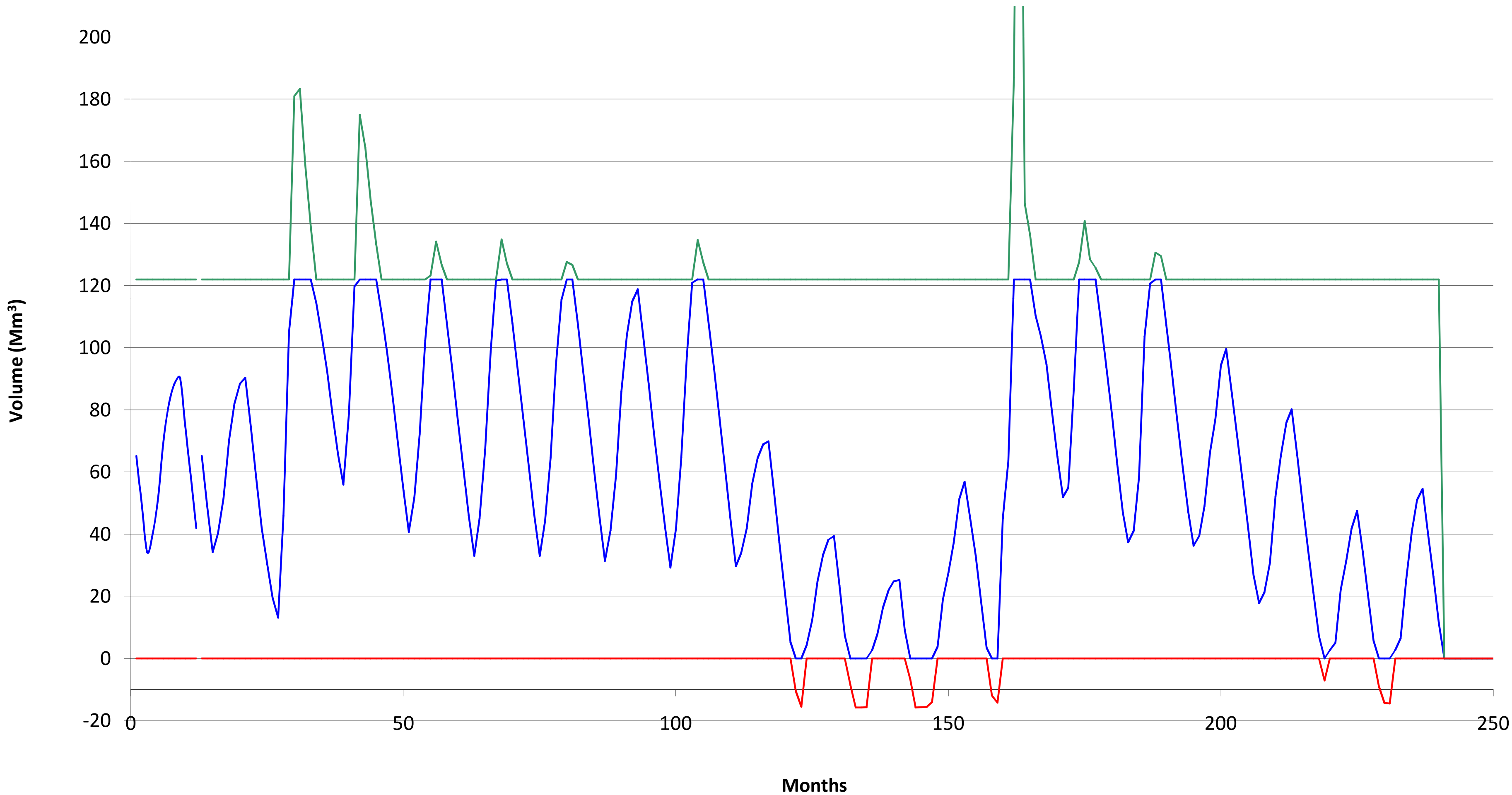


Figure A20: **Monthly reservoir operations (new data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 140 Mm3

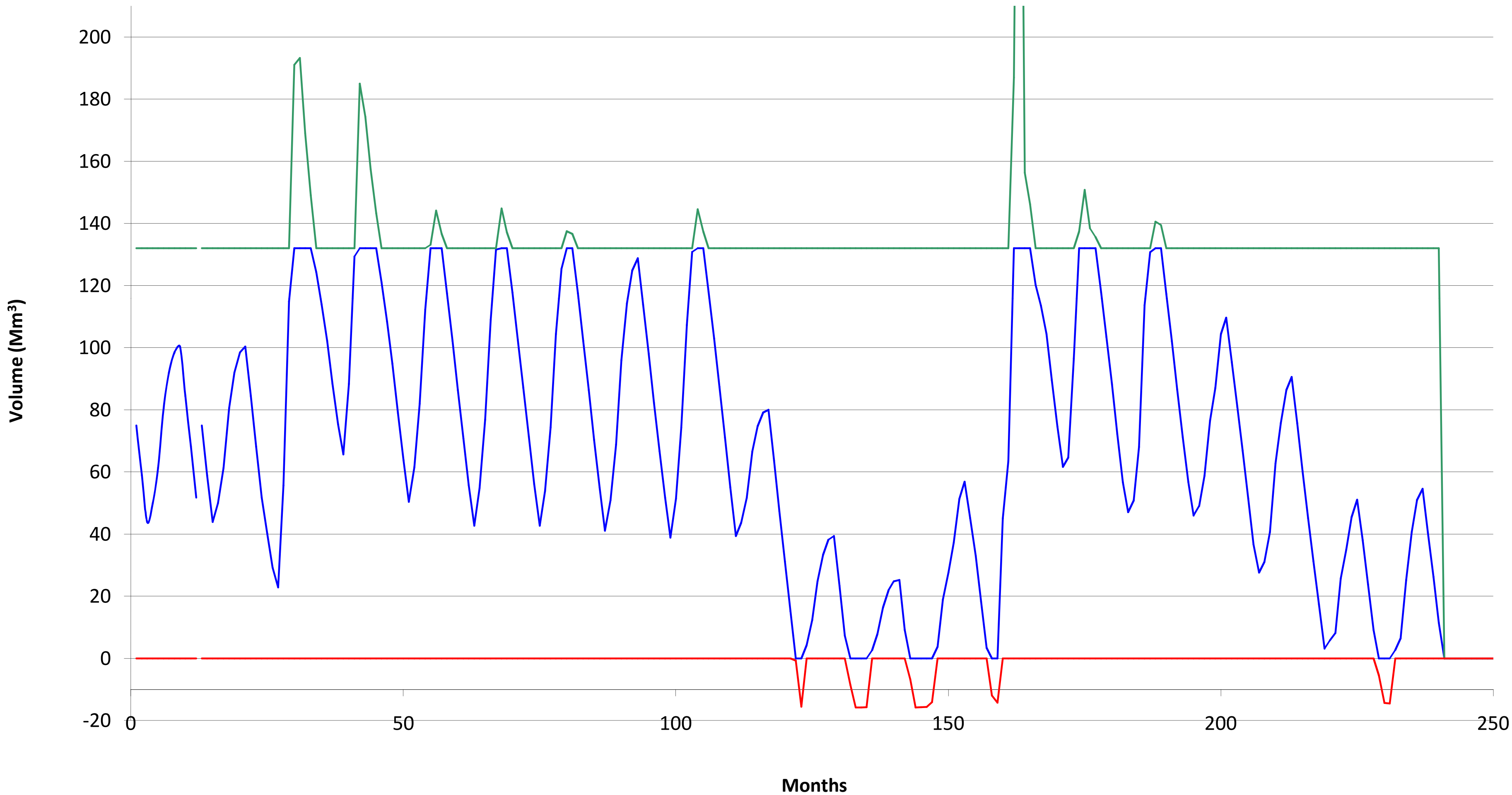


Figure A21: **Monthly reservoir operations (new data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 150 Mm3

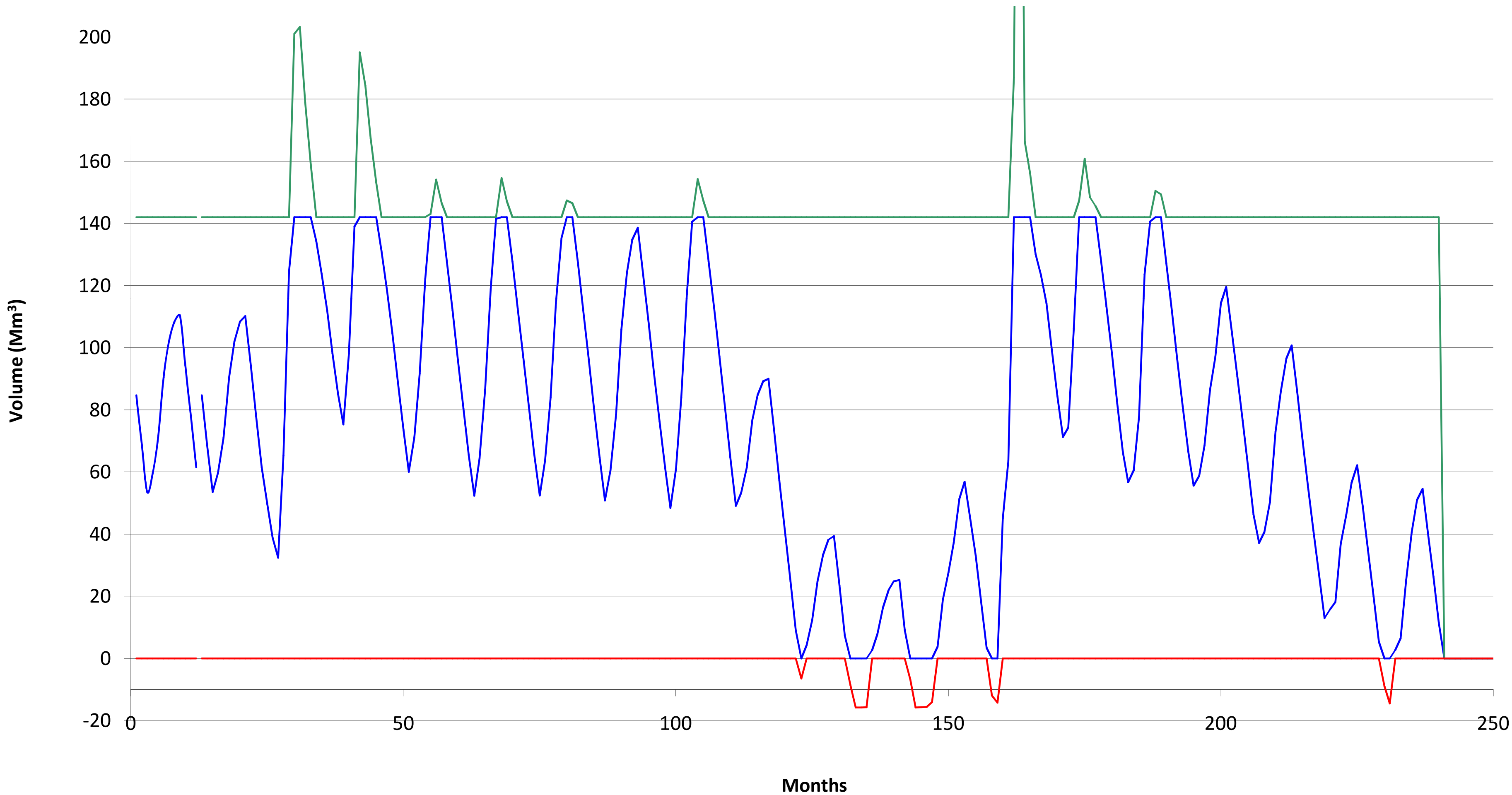


Figure A22: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 90 Mm3

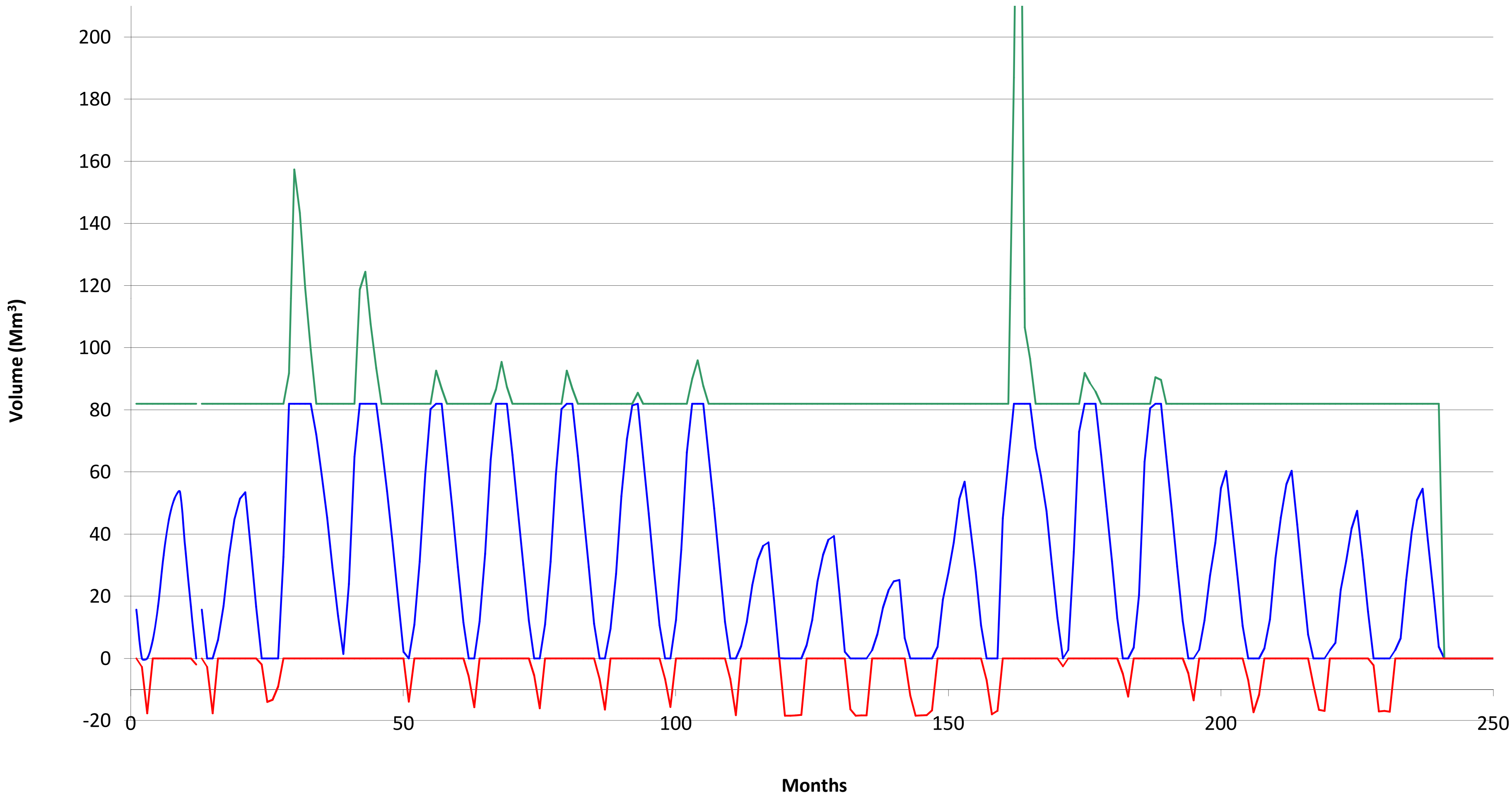


Figure A23: Monthly reservoir operations (new data)
Release rate 7 m3/s - Behaviour plot reservoir
Storage 100 Mm3

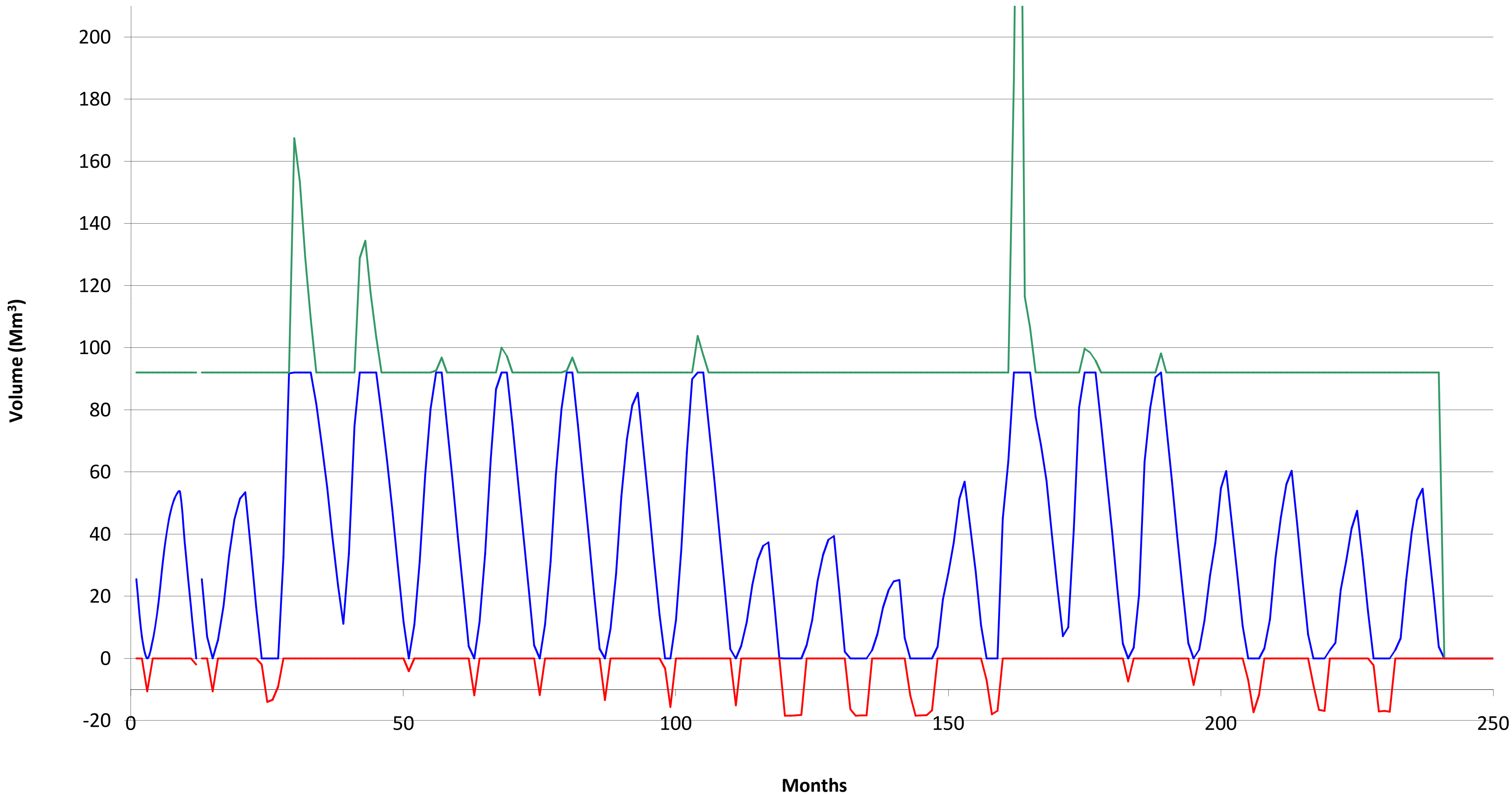


Figure A24: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 110 Mm3

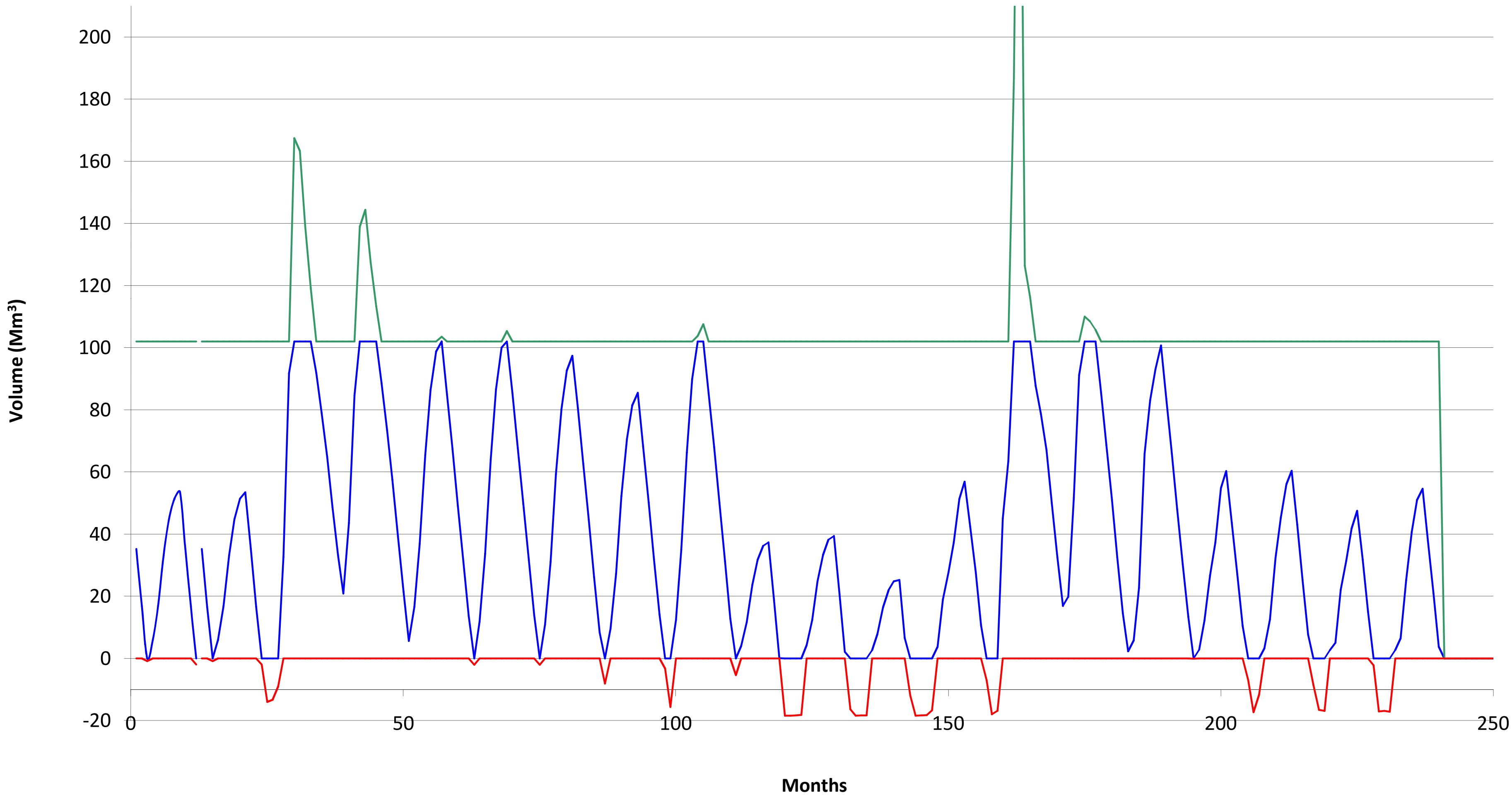


Figure A25: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 120 Mm3

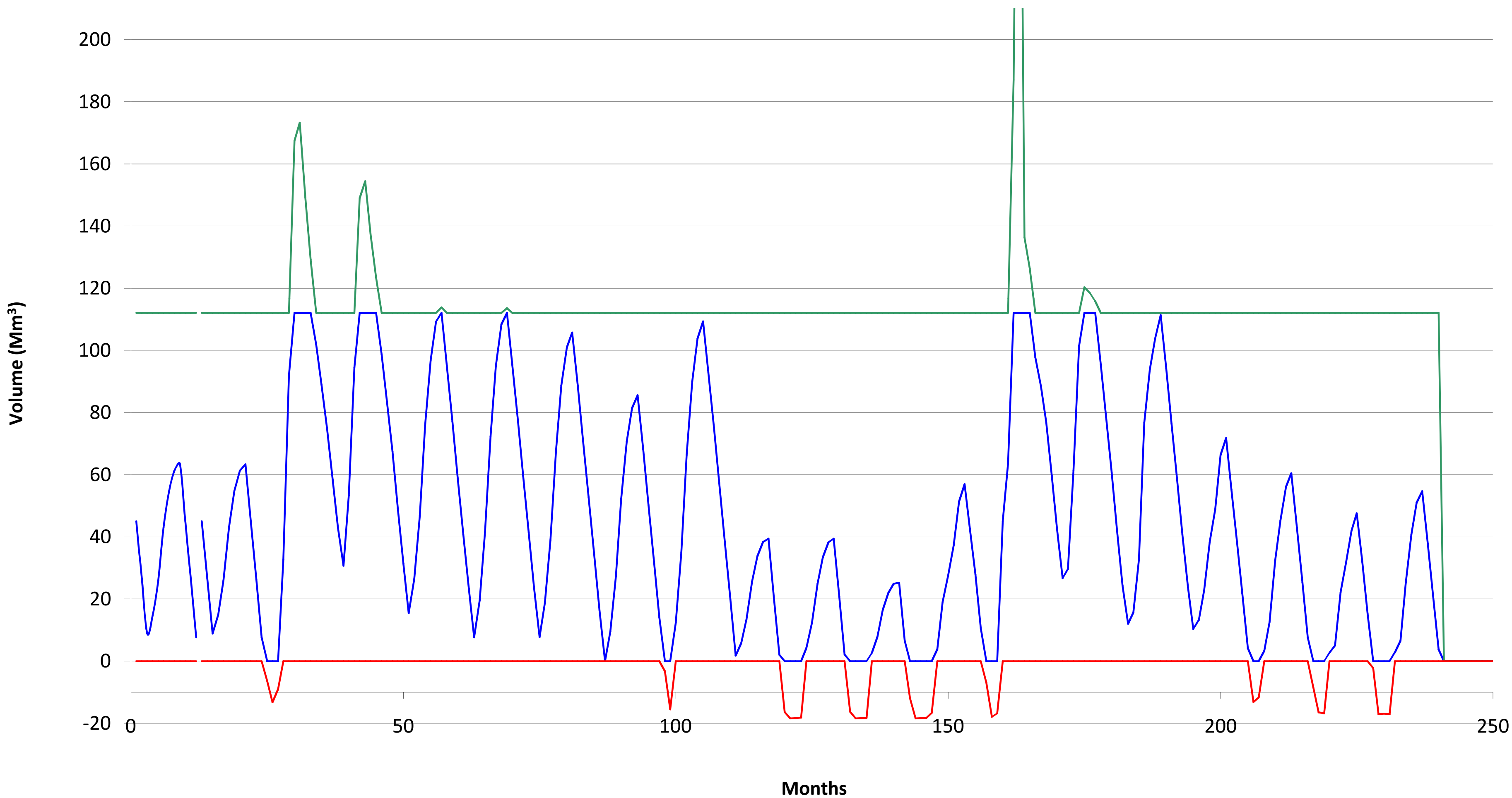


Figure A26: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 130 Mm3

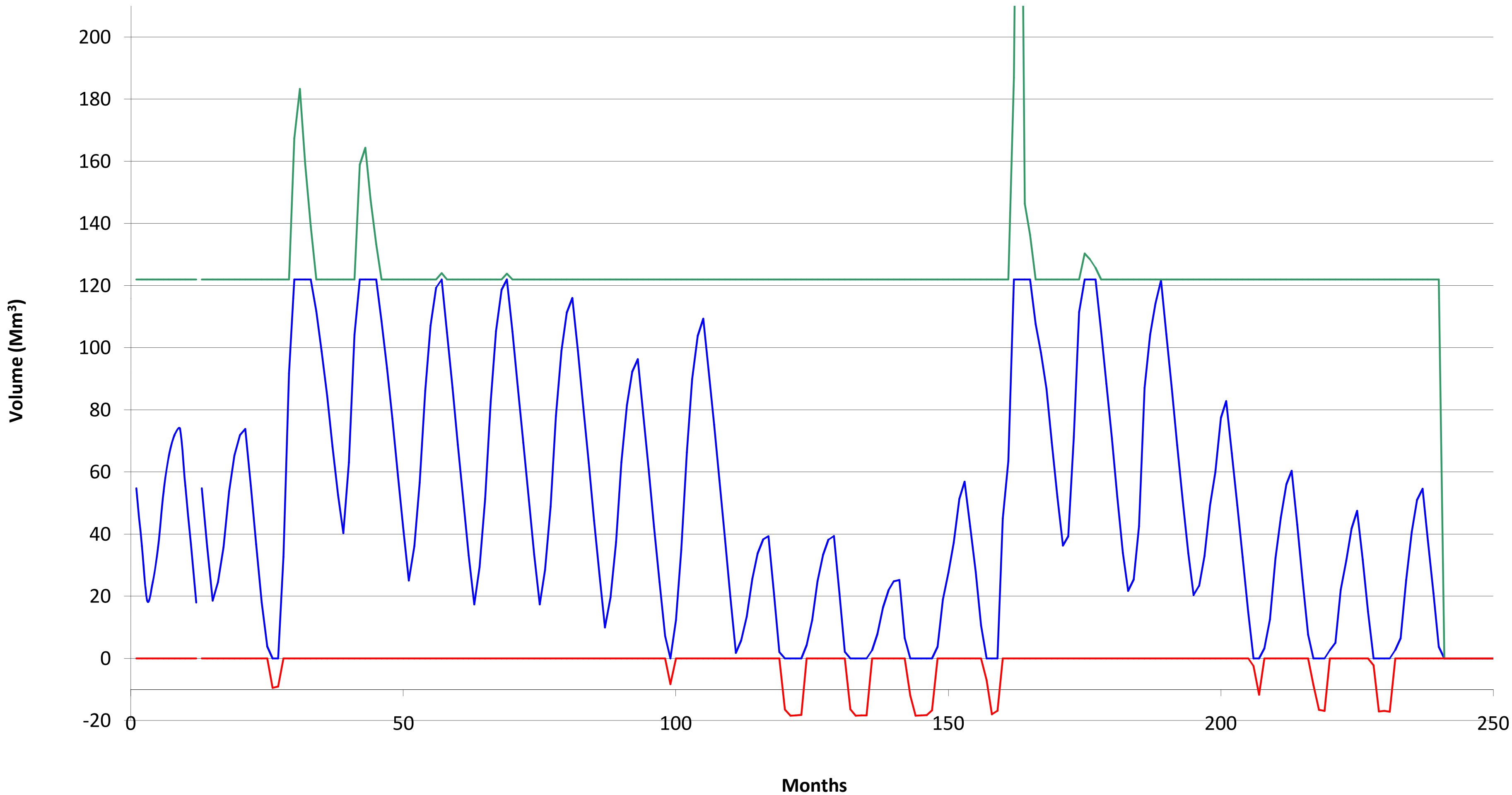


Figure A27: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 140 Mm3

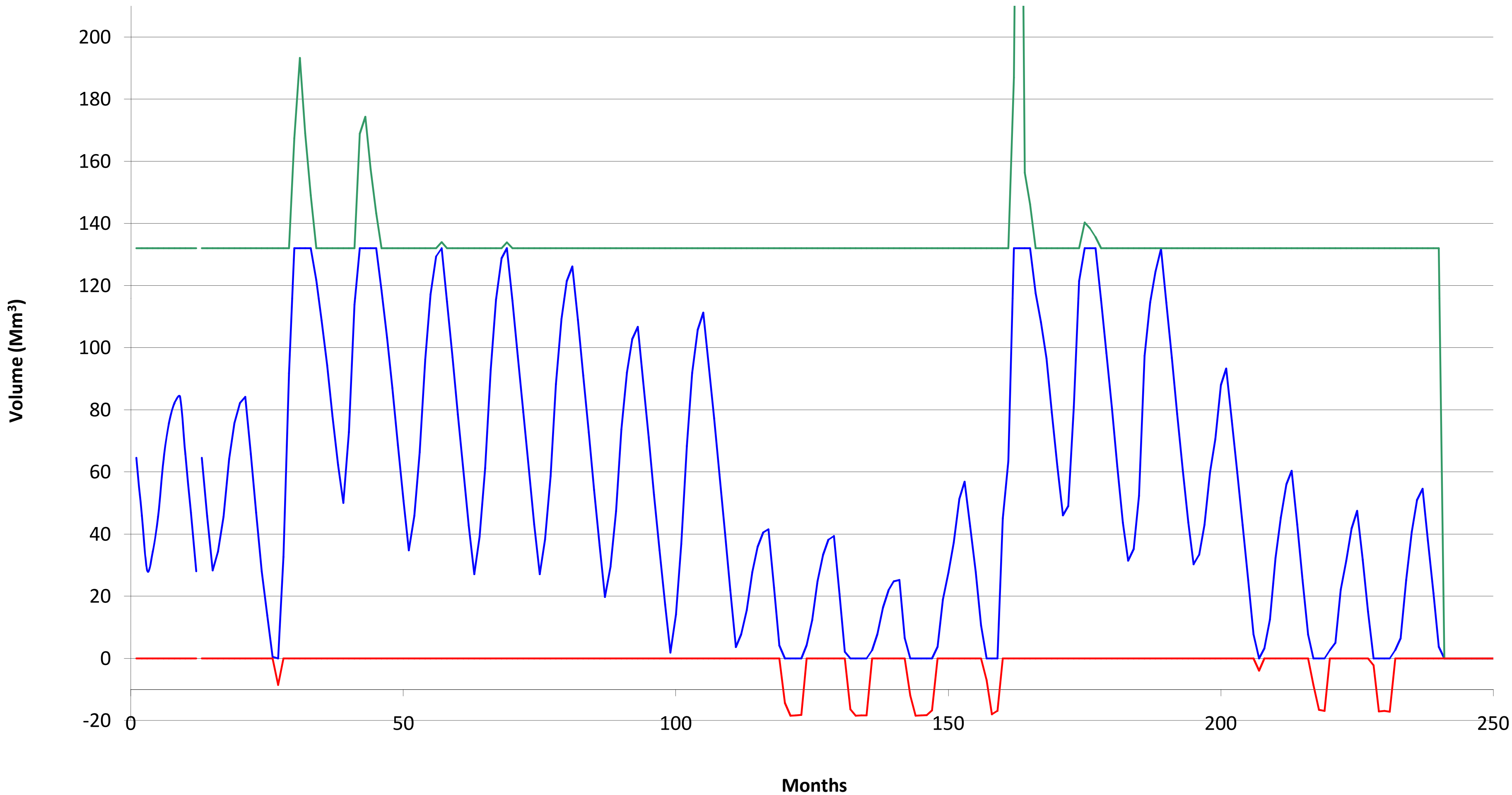


Figure A28: **Monthly reservoir operations (new data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 150 Mm3

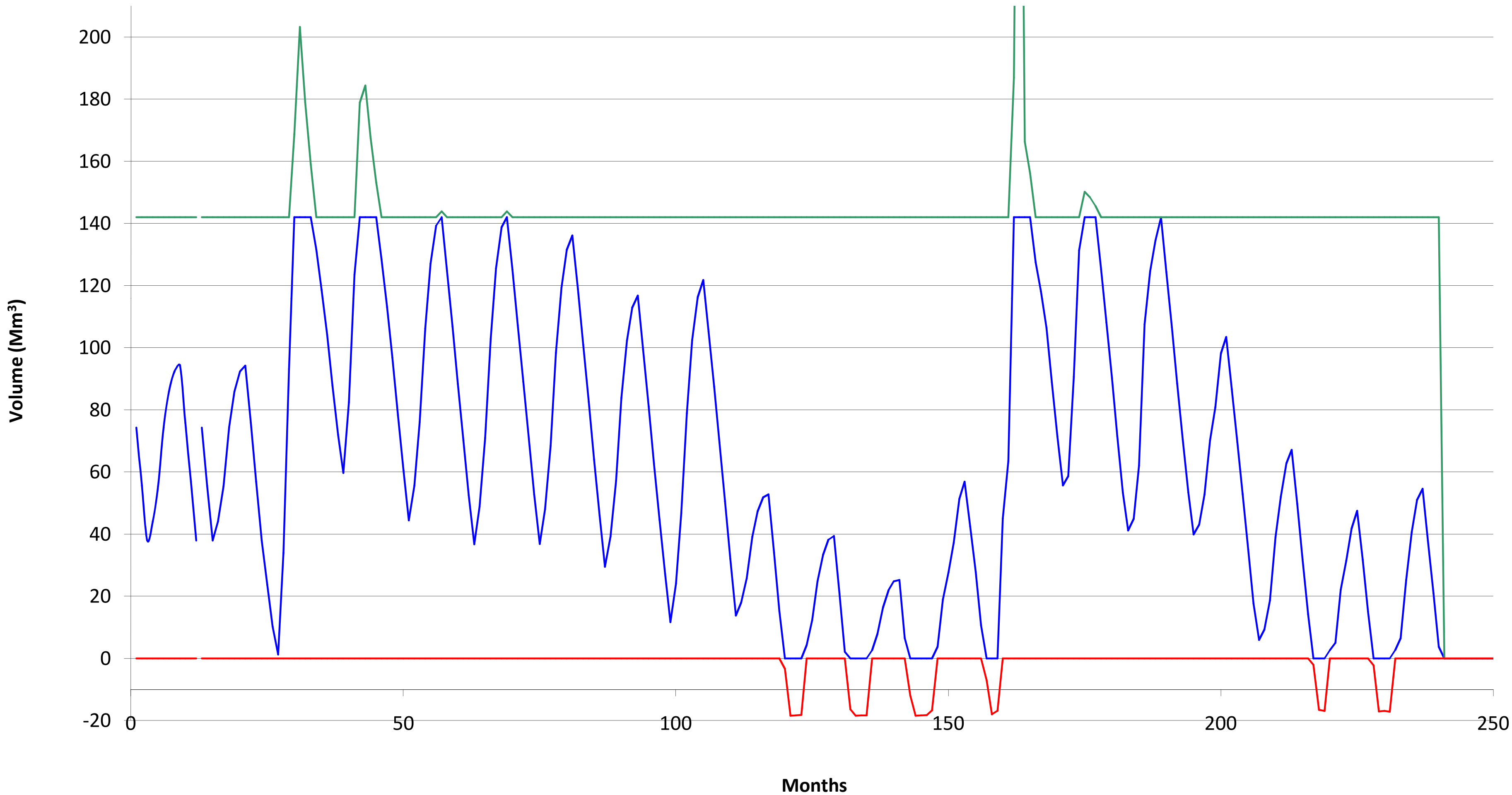


Figure A29: **Monthly reservoir operations (old data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 90 Mm3

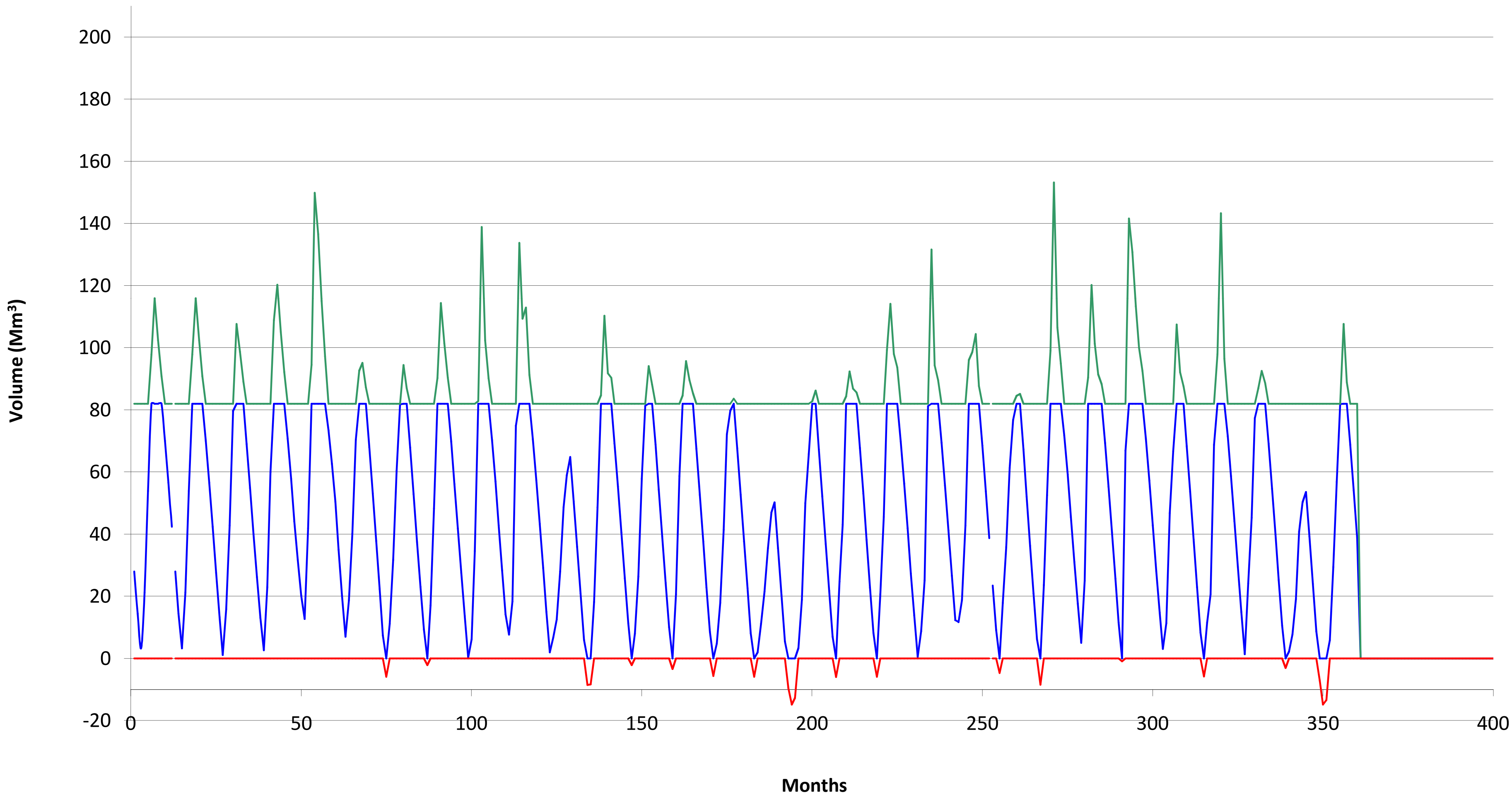


Figure A30: **Monthly reservoir operations (old data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 100 Mm3

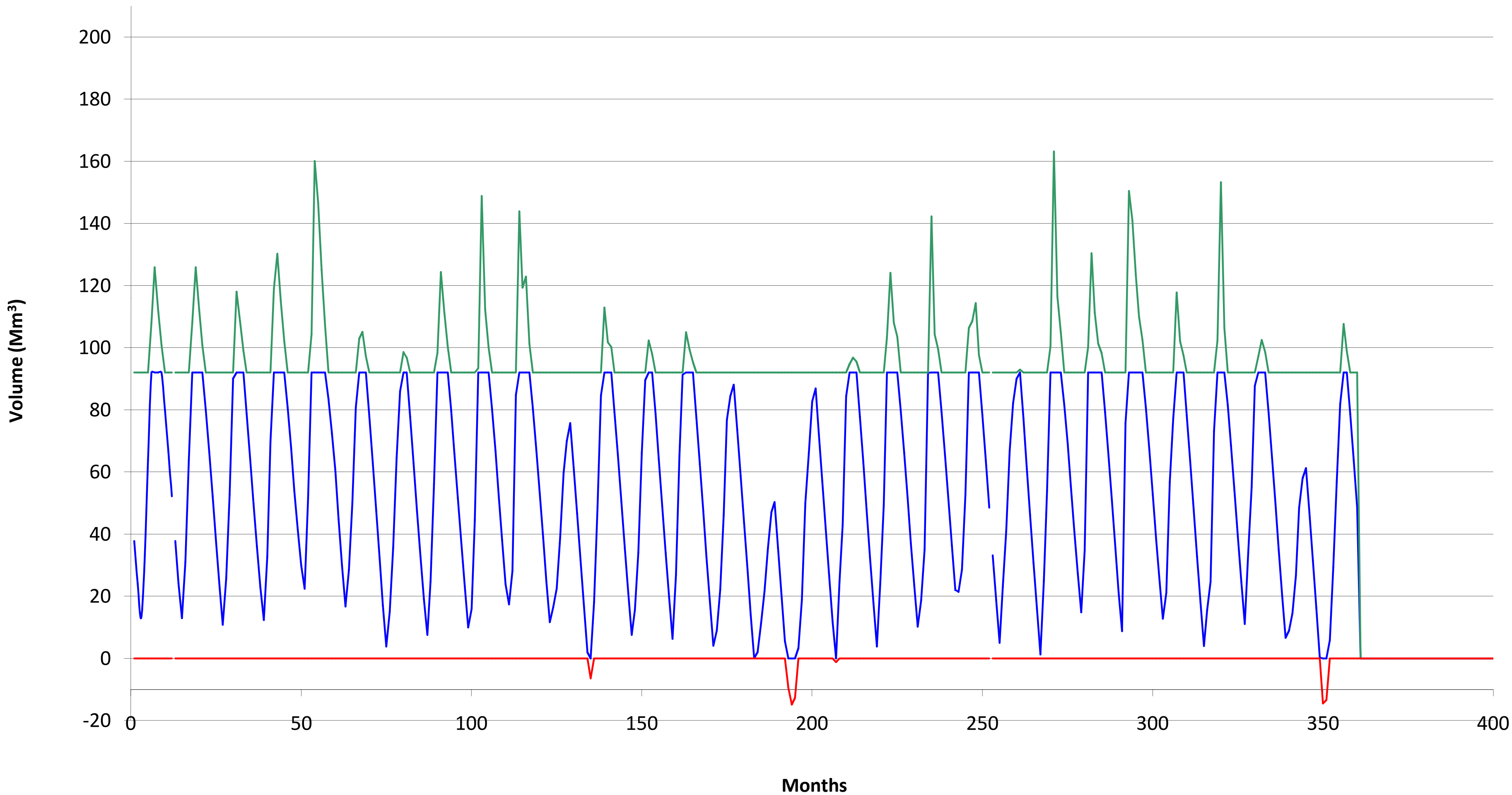


Figure A31: Monthly reservoir operations (old data)
Release rate 6 m3/s - Behaviour plot reservoir
Storage 110 Mm3

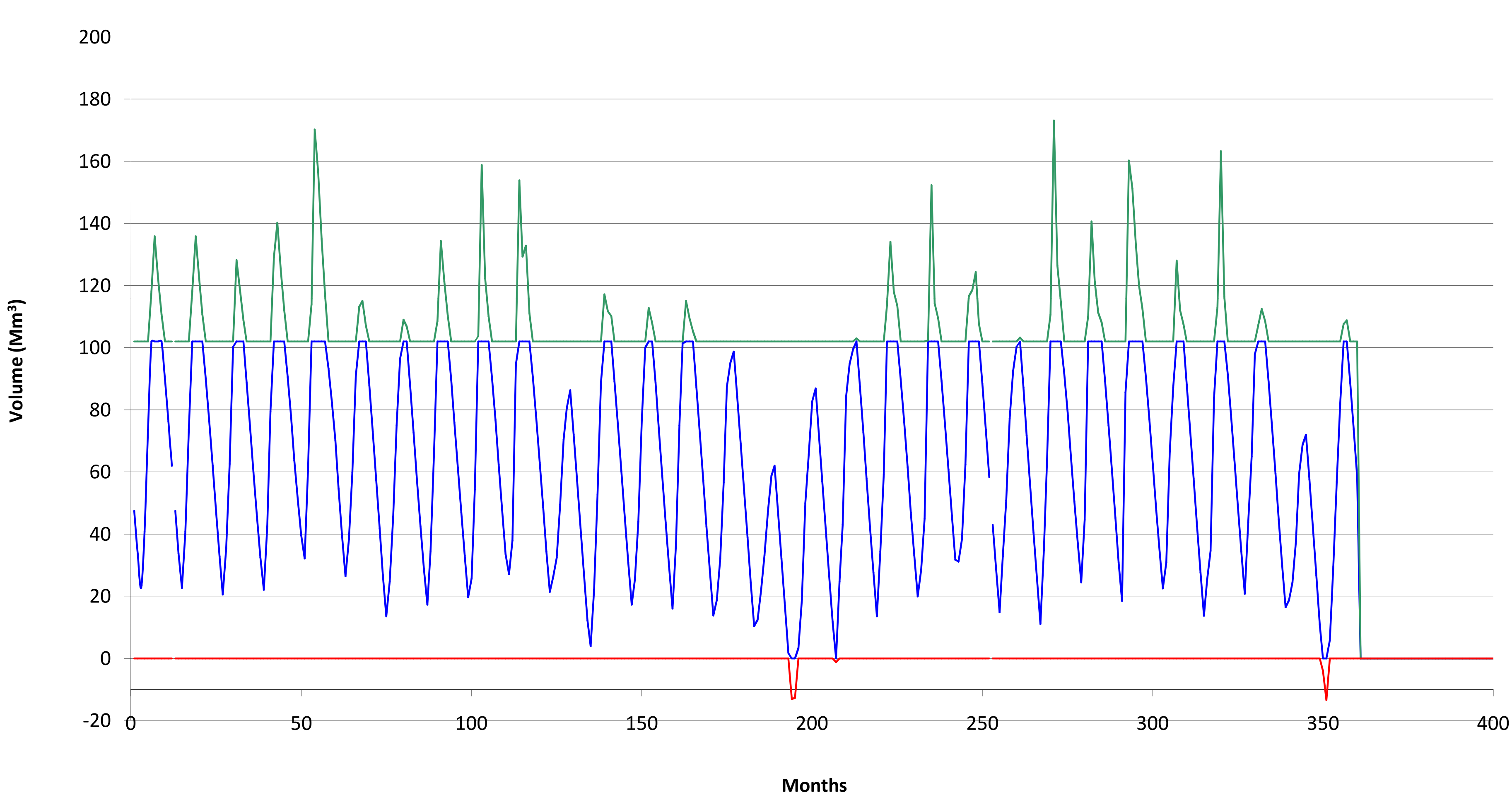


Figure A32: **Monthly reservoir operations (old data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 120 Mm3

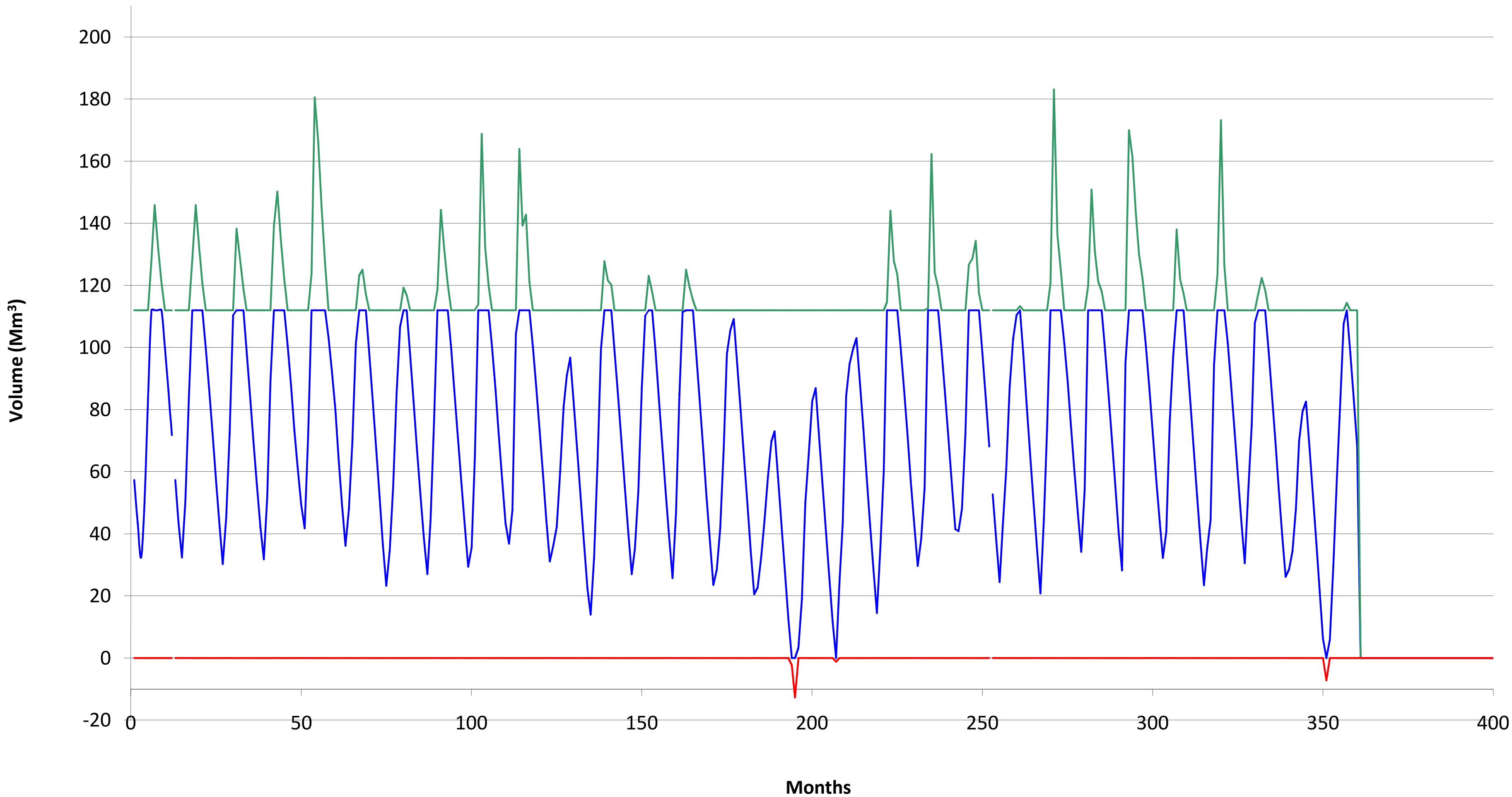


Figure A33: **Monthly reservoir operations (old data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 130 Mm3

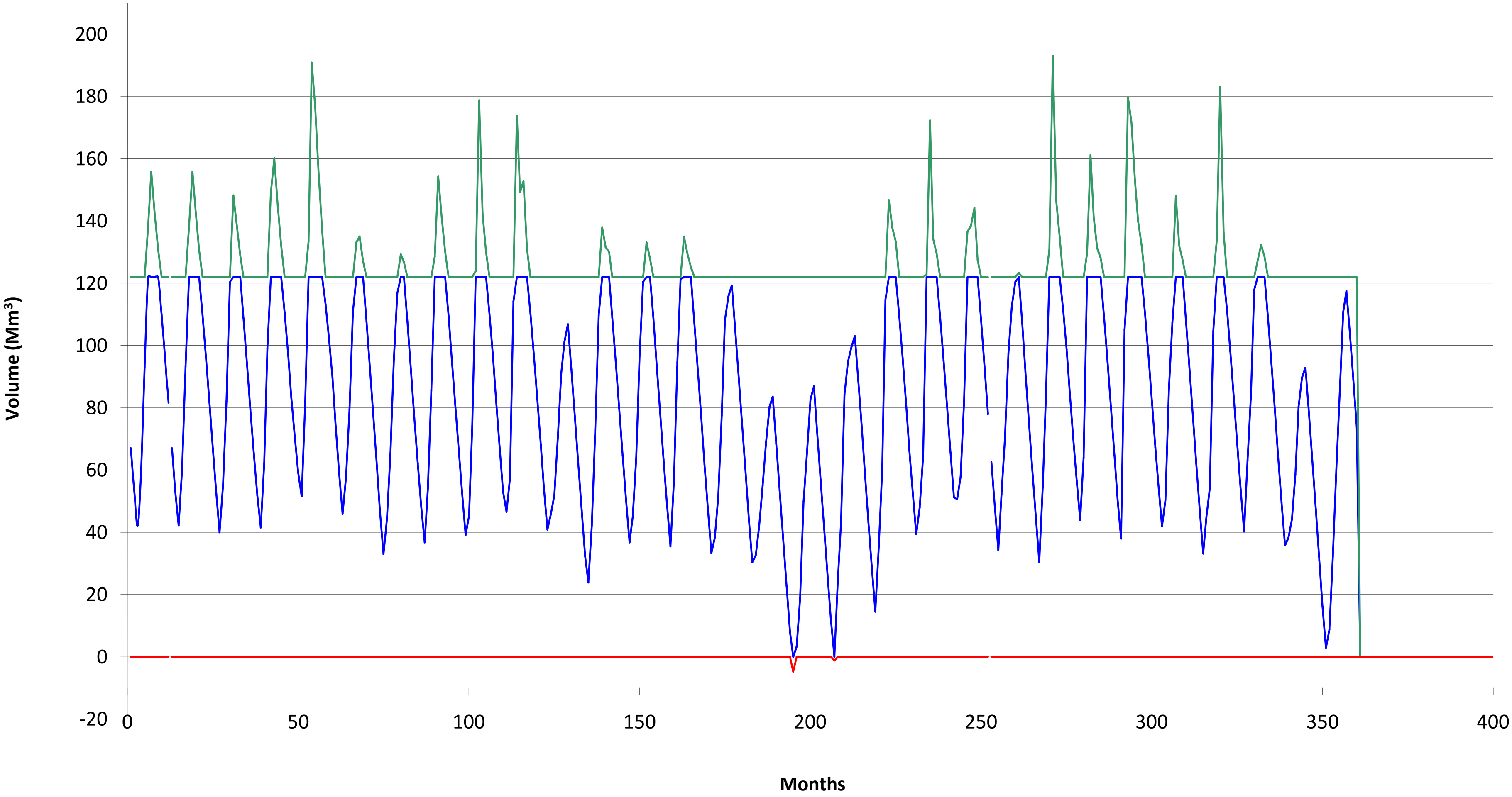


Figure A34: **Monthly reservoir operations (old data)**
Release rate 6 m3/s - Behaviour plot reservoir
Storage 140 Mm3

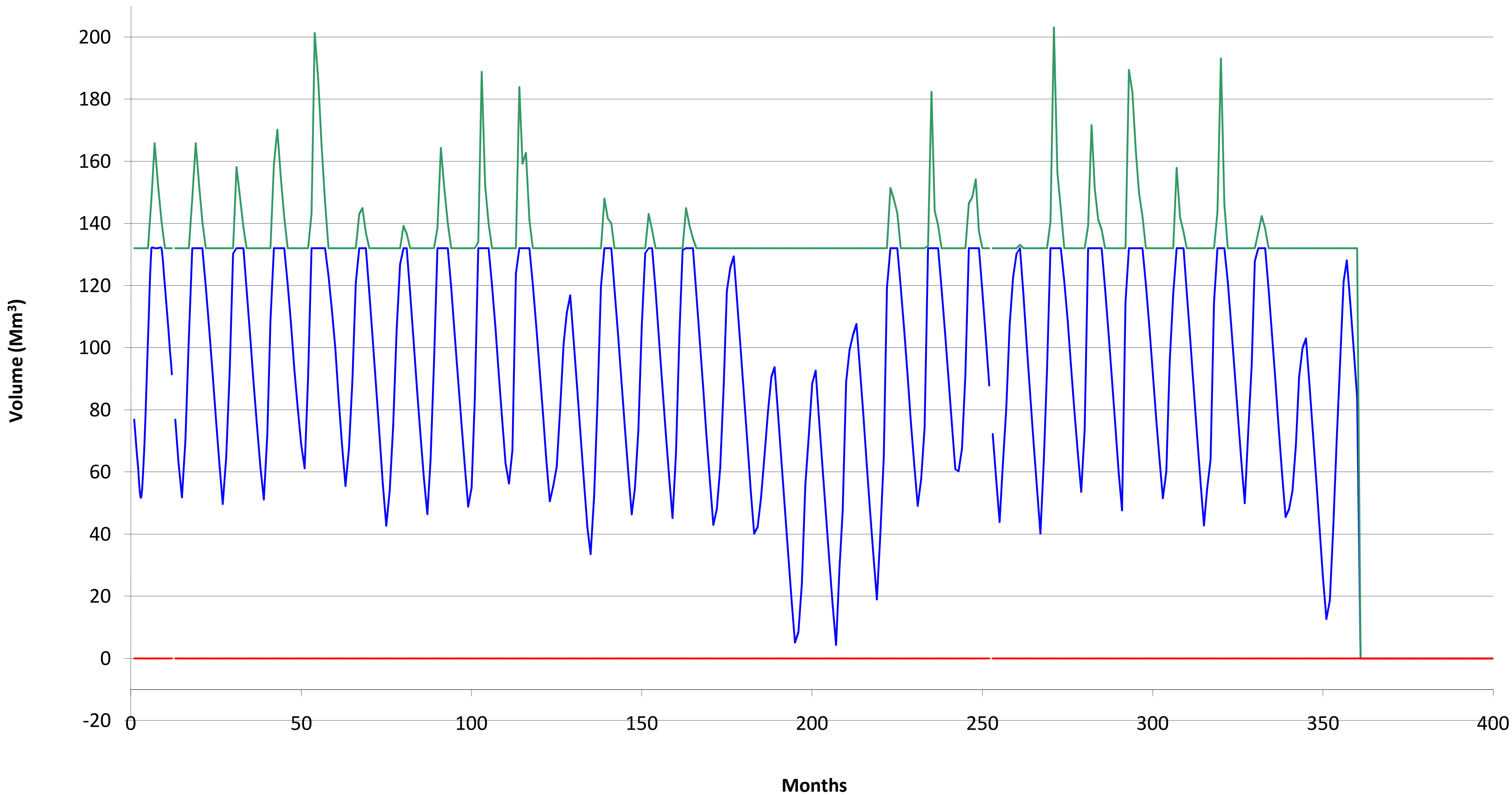


Figure A35: Monthly reservoir operations (old data)
Release rate 6 m3/s - Behaviour plot reservoir
Storage 150 Mm3

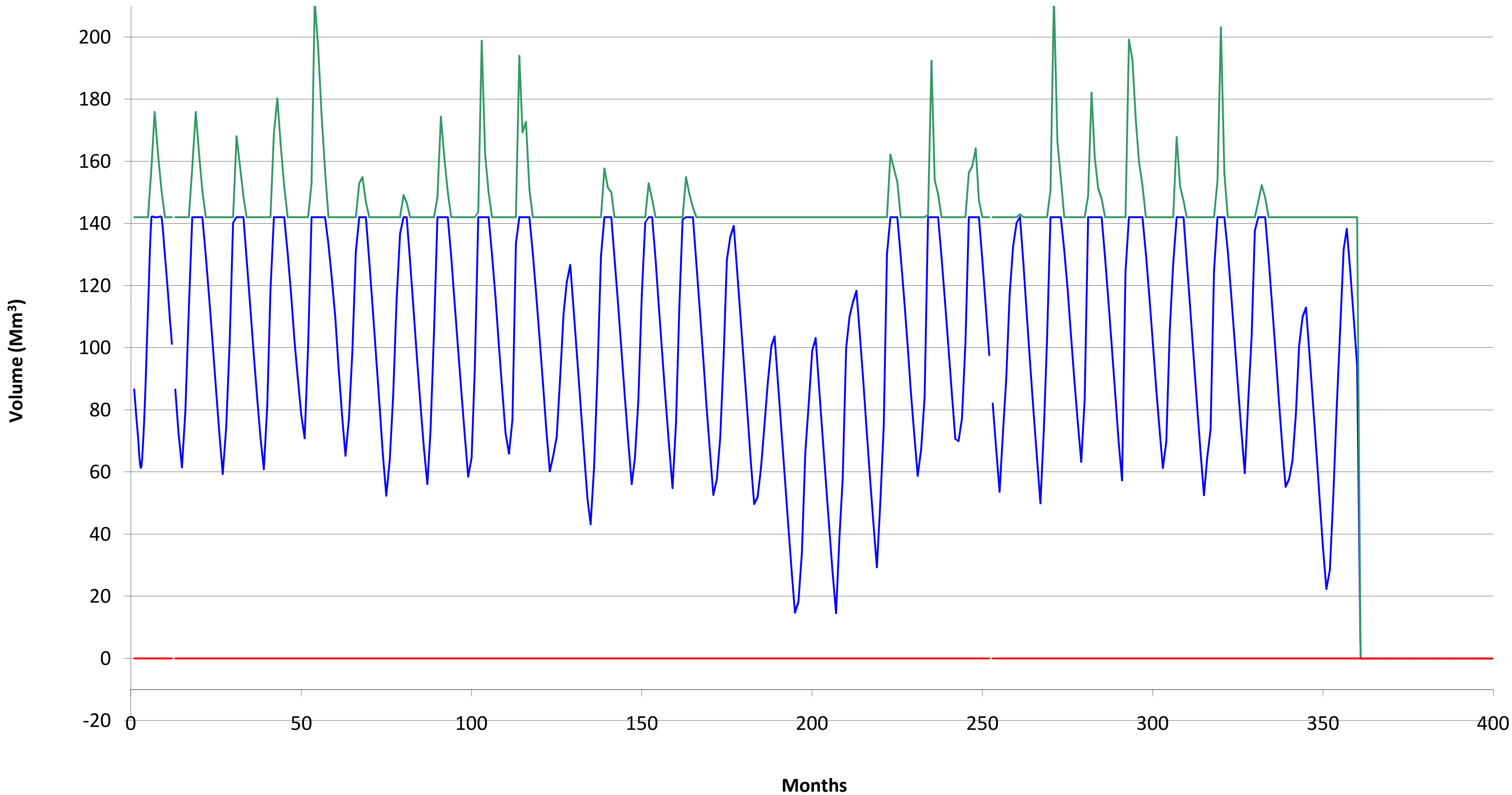


Figure A36: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 90 Mm3

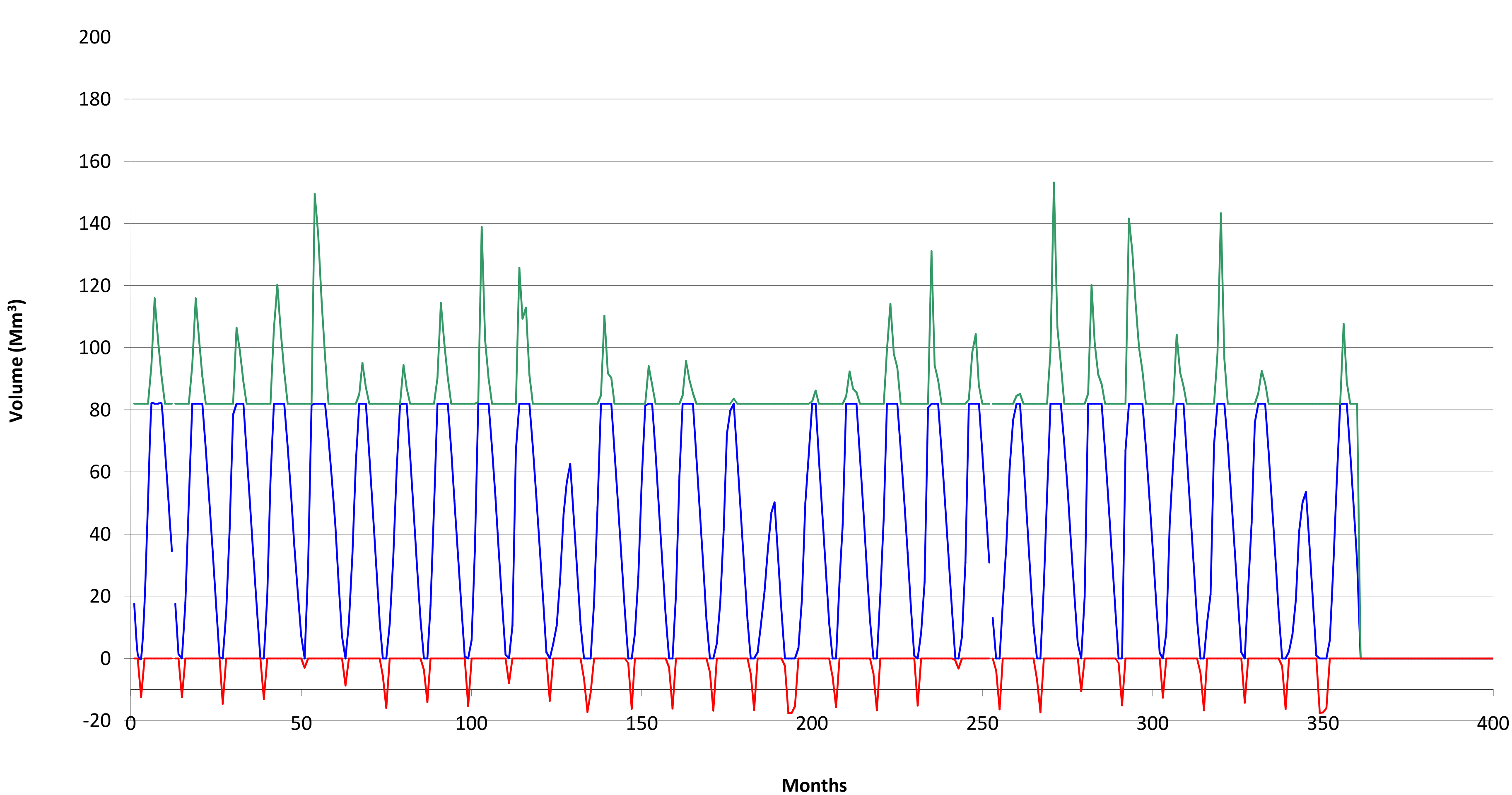


Figure A37: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 100 Mm3

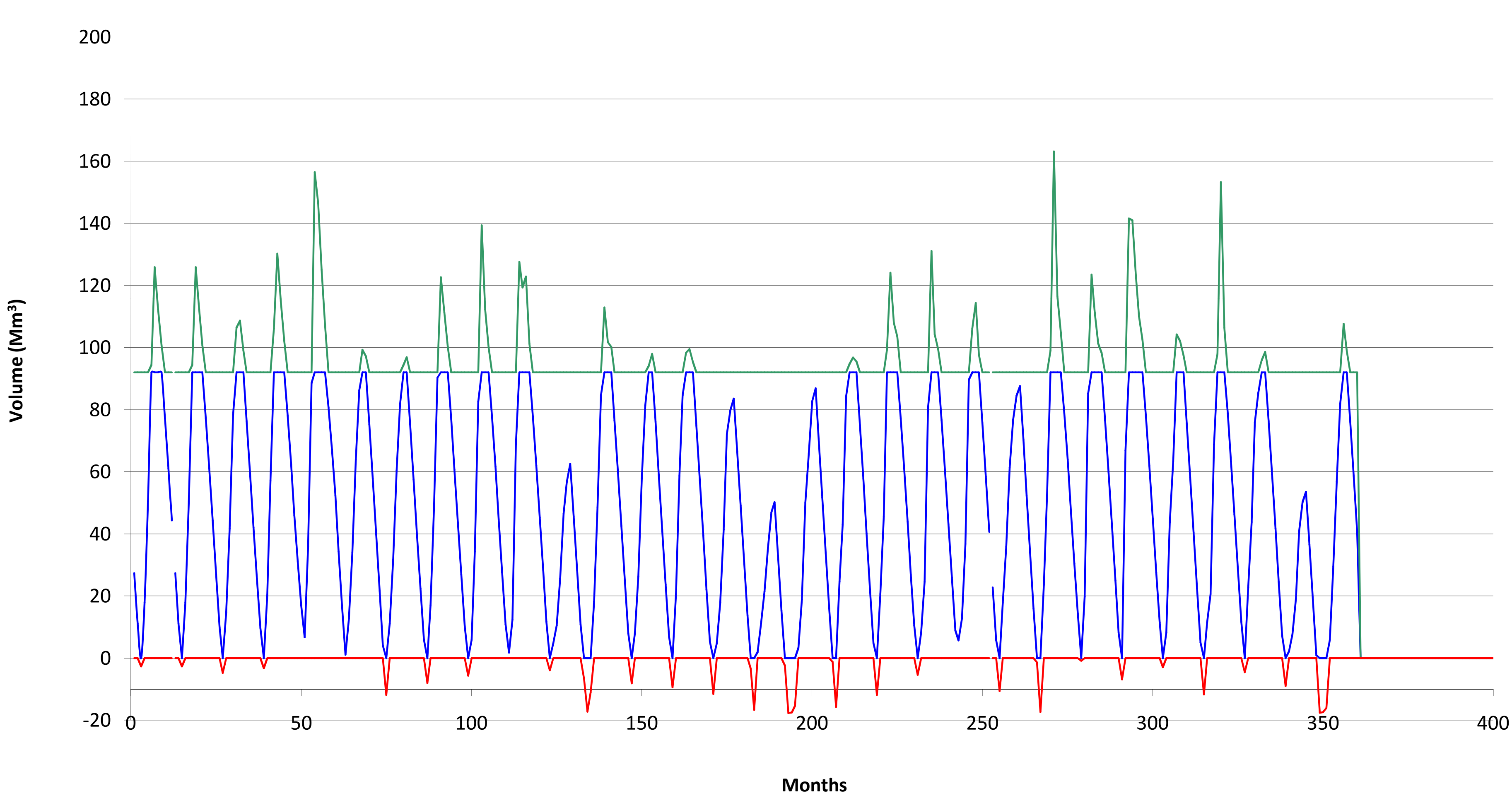


Figure A38: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 110 Mm3

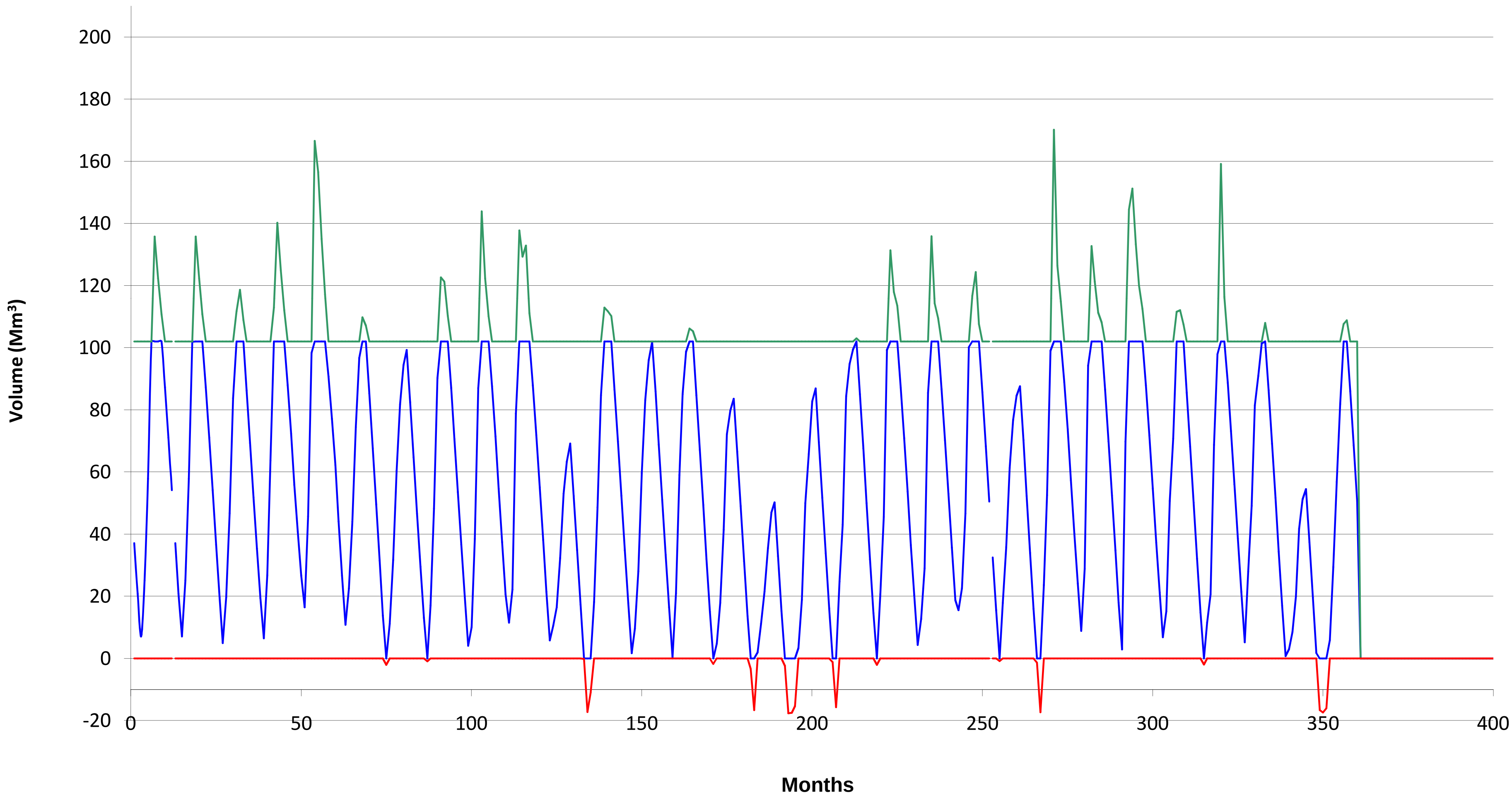


Figure A39: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 120 Mm3

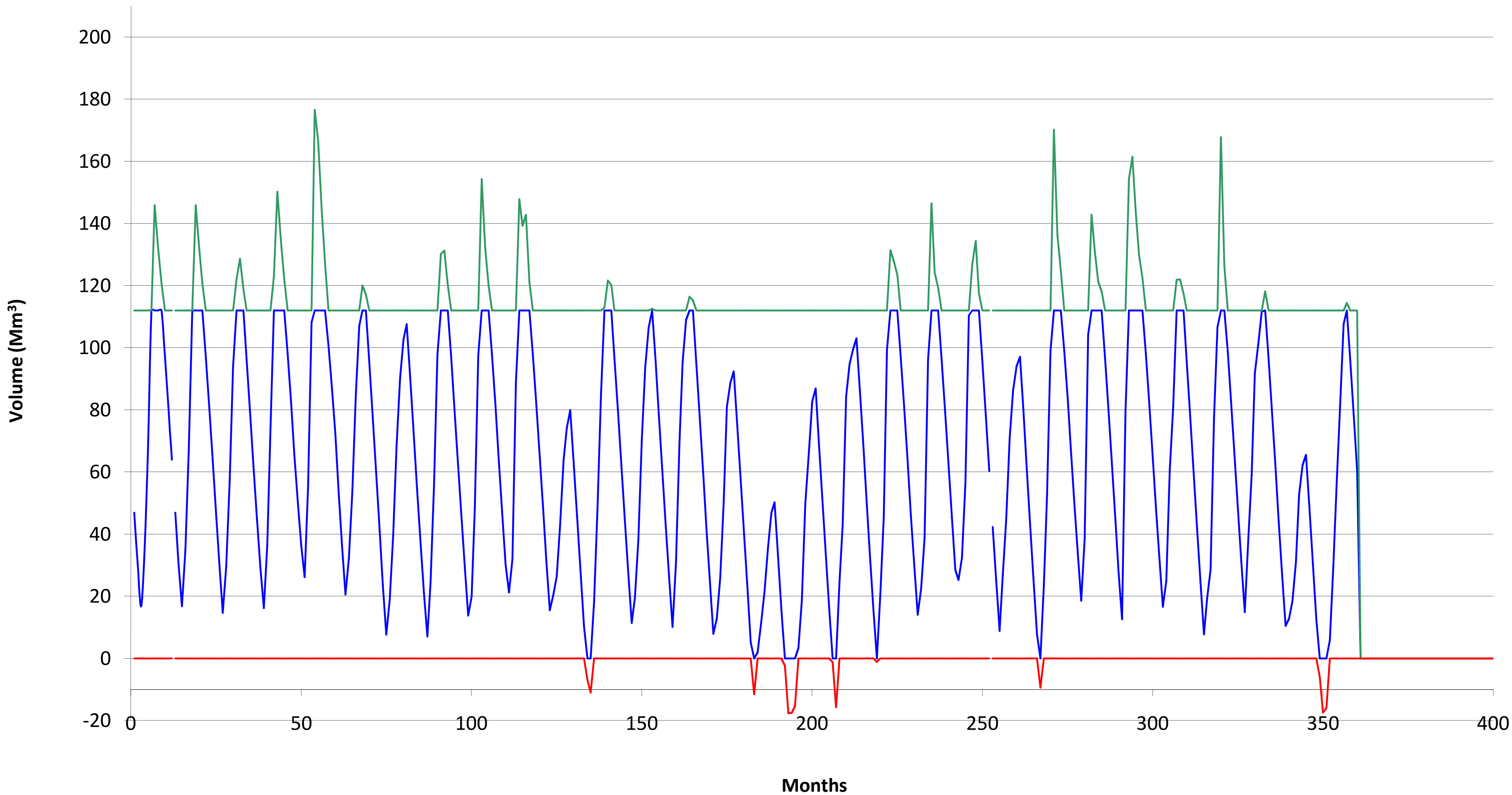


Figure A40: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 130 Mm3

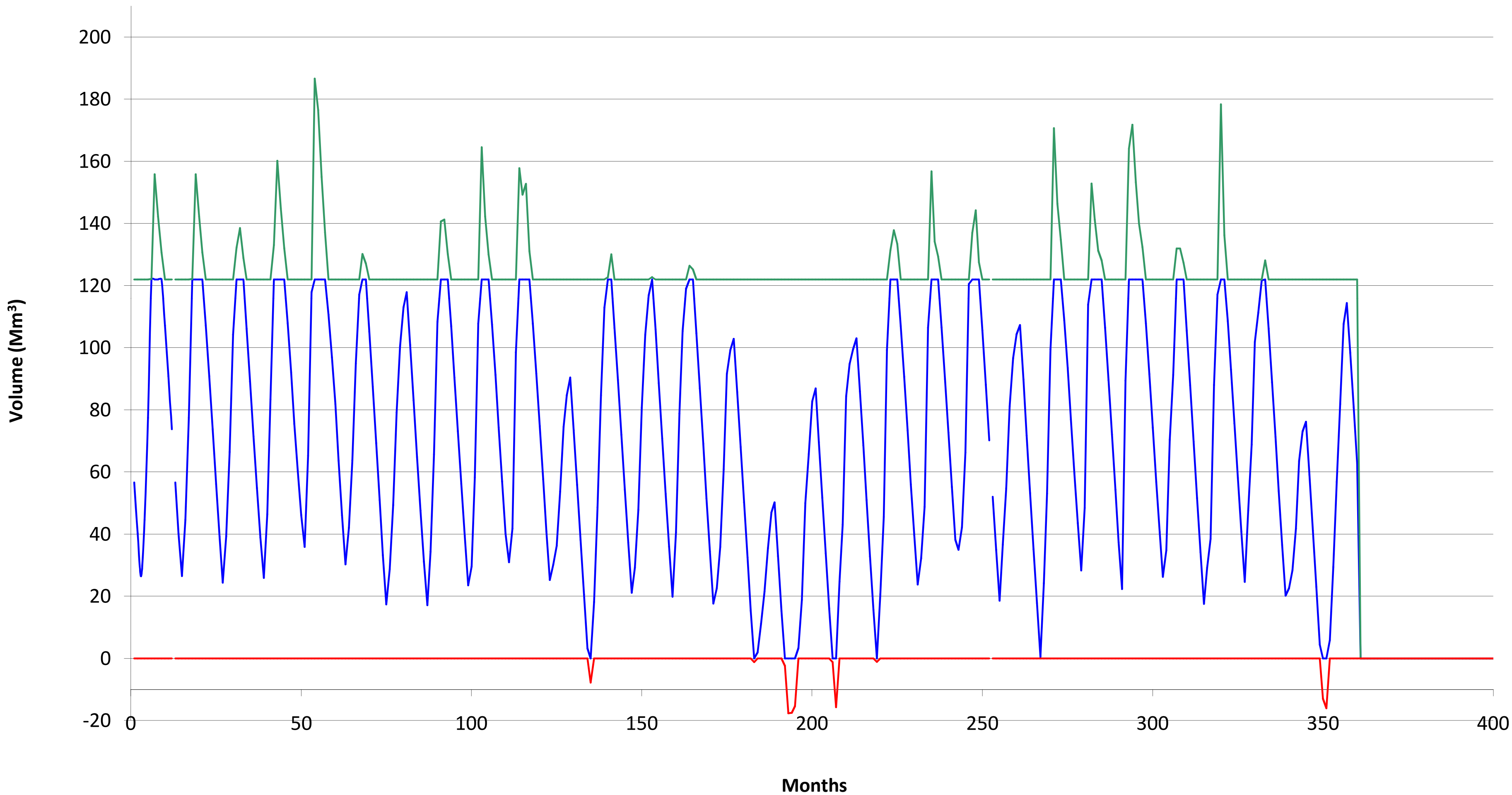


Figure A41: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 140 Mm3

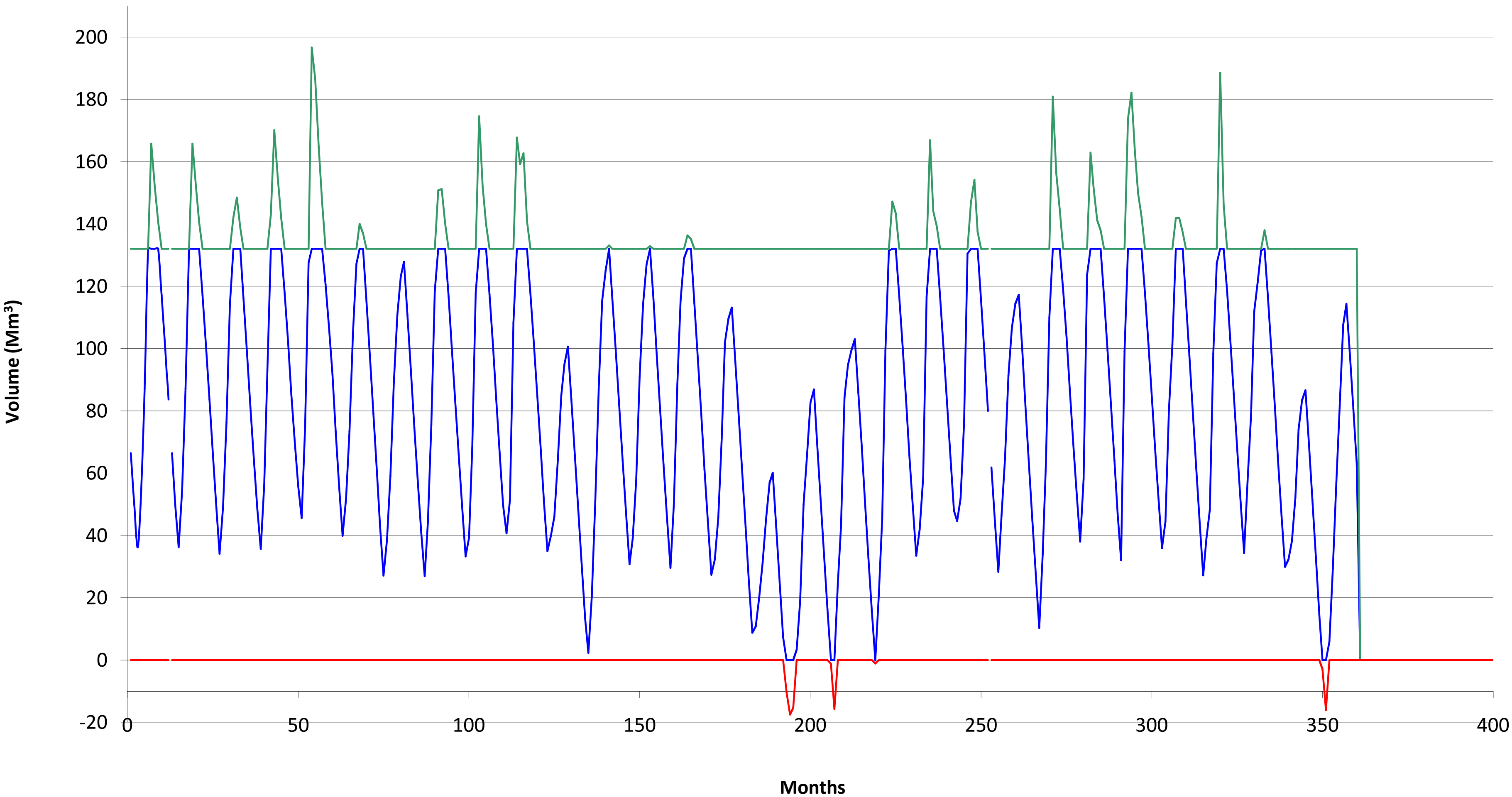
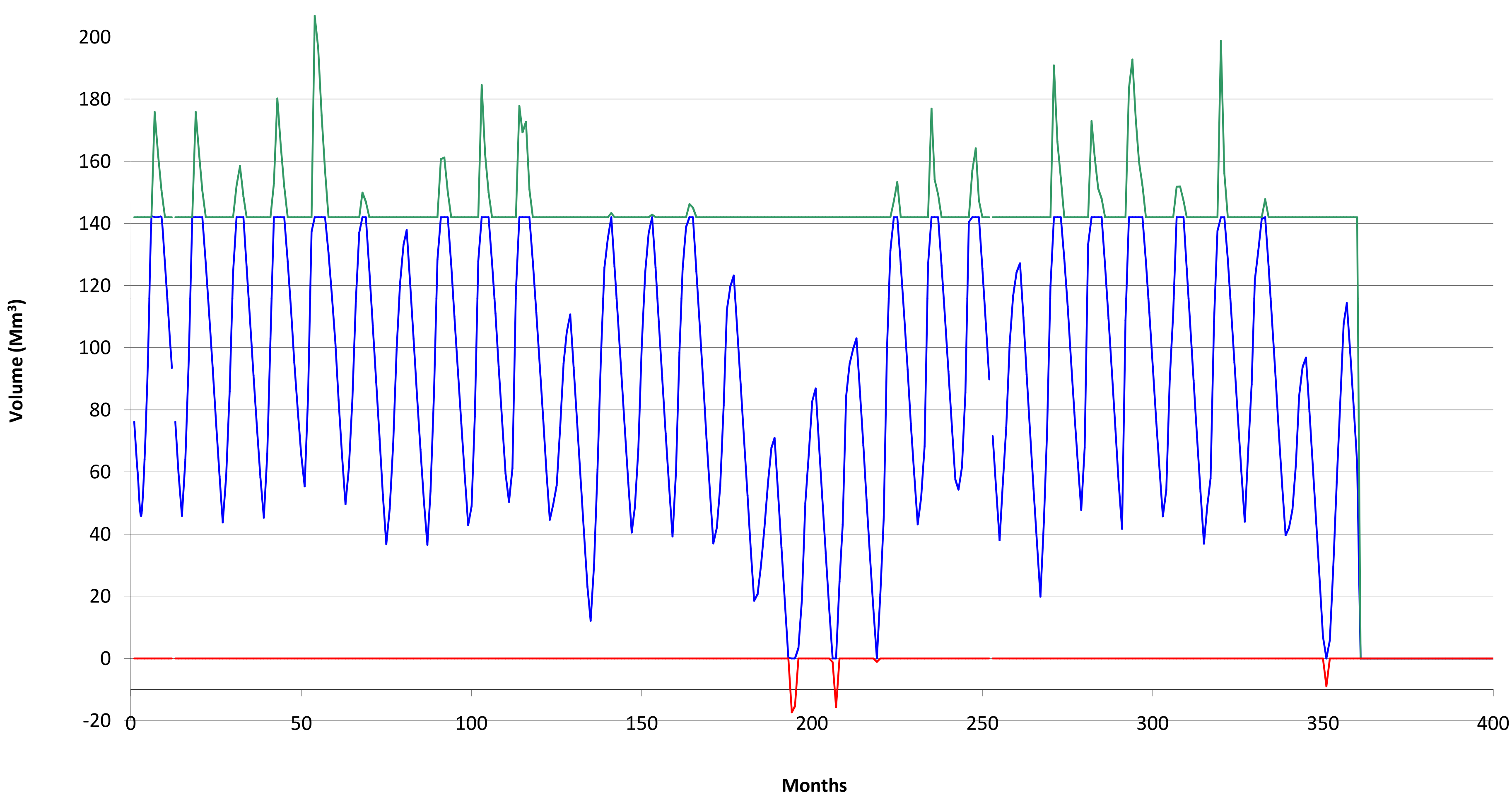


Figure A42: **Monthly reservoir operations (old data)**
Release rate 7 m3/s - Behaviour plot reservoir
Storage 150 Mm3



Appendix B - Annual Water Management (Reservoir Volume = 110Mm^3, Release Rate = 6m^3/s, All Data)

Table B1: Water Management Interannual results

	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
Derived Virgin Flows at Damsite (Mm^3)	168.0	169.0	137.6	192.1	278.6	106.9	102.3	160.8	178.5	209.1
Precipitations (Mm^3)	11.4	10.0	9.6	10.2	11.0	9.6	8.5	9.6	9.1	10.6
Total Volumes (Mm^3)	179.4	179.0	147.2	202.3	289.6	116.5	110.8	170.4	187.6	219.7
Evaporation (Mm^3)	1.0	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Infiltration (Mm^3)	5.4	4.3	4.2	4.3	4.7	4.2	3.7	4.1	4.1	4.4
Total Losses (Mm^3)	6.4	5.2	5.1	5.2	5.6	5.2	4.7	5.0	5.0	5.3
Reservoir Area (Mm^2)	3.4	3.1	3.0	3.1	3.2	3.1	2.9	3.0	3.0	3.1
Reservoir Volume (Mm^3)	86.8	71.2	69.0	71.9	78.4	69.5	62.1	68.7	68.1	73.3
Irrigation Needs (Mm^3)										
Irrigation Efficiency (%)										
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overflow (Mm^3)	118.5	79.1	49.8	98.4	183.0	29.4	11.9	66.5	86.9	119.2
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Derived Virgin Flows at Damsite (Mm^3)	70.1	141.8	106.5	111.9	88.3	54.3	91.2	106.9	165.2	160.7
Precipitations (Mm^3)	7.6	8.6	8.5	9.9	7.4	6.2	5.5	8.0	9.3	8.7
Total Volumes (Mm^3)	77.7	150.4	115.0	121.8	95.7	60.5	96.7	114.9	174.5	169.4
Evaporation (Mm^3)	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.9	0.9	0.9
Infiltration (Mm^3)	3.2	3.6	3.8	4.1	3.4	2.2	2.3	3.4	4.0	4.0
Total Losses (Mm^3)	4.1	4.5	4.8	5.1	4.3	3.0	3.1	4.4	5.0	5.0
Reservoir Area (Mm^2)	2.8	2.7	2.9	3.0	2.8	2.4	2.1	2.7	3.0	3.0
Reservoir Volume (Mm^3)	51.8	61.4	63.8	68.8	56.7	33.8	40.0	58.7	67.7	67.3
Irrigation Needs (Mm^3)										
Irrigation Efficiency (%)										
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	25.7	1.2	0.0	0.0
Overflow (Mm^3)	0.0	33.1	16.8	23.9	0.0	0.0	0.0	1.0	71.2	70.5
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	27%	1%	0%	0%

Table B1: Water Management Interannual results

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Derived Virgin Flows at Damsite (Mm^3)	146.6	89.3	216.3	165.8	258.5	127.0	184.0	108.0	58.7	118.4
Precipitations (Mm^3)	9.7	8.9	9.5	10.8	11.0	9.7	7.8	9.7	6.7	6.6
Total Volumes (Mm^3)	156.3	98.2	225.8	176.6	269.5	136.6	191.8	117.7	65.4	125.0
Evaporation (Mm^3)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9
Infiltration (Mm^3)	4.2	3.8	4.1	4.5	4.6	4.1	3.8	4.2	2.7	2.9
Total Losses (Mm^3)	5.1	4.7	5.0	5.4	5.5	5.0	4.8	5.2	3.5	3.8
Reservoir Area (Mm^2)	3.1	2.9	3.0	3.1	3.1	3.0	2.9	3.1	2.6	2.4
Reservoir Volume (Mm^3)	69.8	63.1	68.3	74.3	76.7	67.9	63.9	70.0	41.6	50.8
Irrigation Needs (Mm^3)										
Irrigation Efficiency (%)										
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.4
Overflow (Mm^3)	59.0	1.3	117.0	81.4	167.2	41.5	86.6	22.3	0.0	12.4
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Derived Virgin Flows at Damsite (Mm^3)	123.0	159.5	195.9	237.0	59.3	209.6	232.4	100.2	157.5	135.5
Precipitations (Mm^3)	9.0	9.7	10.3	10.9	8.2	9.0	10.9	9.2	8.4	10.2
Total Volumes (Mm^3)	132.0	169.2	206.2	247.9	67.5	218.6	243.3	109.4	165.9	145.6
Evaporation (Mm^3)	0.9	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9	1.0
Infiltration (Mm^3)	3.9	4.1	4.4	4.6	3.3	3.6	4.6	4.1	3.8	4.5
Total Losses (Mm^3)	4.9	5.1	5.3	5.5	4.2	4.6	5.6	5.0	4.7	5.4
Reservoir Area (Mm^2)	2.9	3.0	3.1	3.2	2.8	2.7	3.2	3.0	2.9	3.2
Reservoir Volume (Mm^3)	65.5	69.2	72.8	76.7	52.2	63.2	76.8	67.0	64.3	73.7
Irrigation Needs (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation Efficiency (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Overflow (Mm^3)	32.4	66.8	103.6	144.7	0.0	90.6	141.5	19.5	55.3	54.2
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B1: Water Management Interannual results

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Derived Virgin Flows at Damsite (Mm^3)	127.5	54.9	168.6	237.0	68.3	25.9	50.6	314.5	214.2	100.2
Precipitations (Mm^3)	9.2	7.2	8.3	10.8	8.5	4.1	5.1	9.8	11.0	9.1
Total Volumes (Mm^3)	136.7	62.1	176.8	247.8	76.7	30.0	55.8	324.3	225.2	109.3
Evaporation (Mm^3)	0.9	0.8	0.9	1.0	0.9	0.5	0.6	0.8	1.0	0.9
Infiltration (Mm^3)	4.0	2.7	3.3	4.5	3.5	1.1	1.3	3.6	4.8	4.0
Total Losses (Mm^3)	4.9	3.5	4.2	5.5	4.5	1.6	1.9	4.4	5.7	5.0
Reservoir Area (Mm^2)	3.0	2.6	2.5	3.2	2.9	1.6	1.7	2.5	3.3	3.0
Reservoir Volume (Mm^3)	66.6	41.4	58.8	75.8	57.2	14.0	22.6	65.3	78.7	66.3
Irrigation Needs (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation Efficiency (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	15.9	0.0	0.0	21.5	46.6	22.7	0.0	0.0
Overflow (Mm^3)	37.9	0.0	55.0	142.7	0.0	0.0	0.0	181.1	132.3	18.1
Potable Water Shortage (%)	0%	0%	17%	0%	0%	23%	49%	24%	0%	0%
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Derived Virgin Flows at Damsite (Mm^3)	109.3	100.2	86.5	113.9	33.8	35.9	22.0	64.4	487.1	108.7
Precipitations (Mm^3)	8.6	8.4	8.0	8.3	6.2	4.5	3.8	5.3	9.1	9.9
Total Volumes (Mm^3)	117.9	108.6	94.5	122.2	40.0	40.4	25.7	69.7	496.3	118.6
Evaporation (Mm^3)	0.9	0.9	0.9	0.9	0.7	0.5	0.3	0.6	0.9	1.0
Infiltration (Mm^3)	3.8	3.7	3.5	3.6	2.0	0.9	0.5	1.4	3.6	4.4
Total Losses (Mm^3)	4.7	4.7	4.4	4.6	2.7	1.4	0.9	2.0	4.4	5.4
Reservoir Area (Mm^2)	2.9	2.9	2.8	2.8	2.3	1.5	1.2	1.7	2.6	3.2
Reservoir Volume (Mm^3)	63.1	61.9	57.2	61.3	28.3	15.3	9.0	24.4	64.1	72.5
Irrigation Needs (Mm^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation Efficiency (%)	0%	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Potable Water Deficit (Mm^3)	0.0	0.0	0.0	0.0	0.0	55.0	69.8	45.4	26.2	0.0
Overflow (Mm^3)	17.9	10.0	0.0	17.5	0.0	0.0	0.0	0.0	366.9	34.7
Potable Water Shortage (%)	0%	0%	0%	0%	0%	4%	74%	48%	28%	0%

Table B1: Water Management Interannual results										
	2004	**2005**	**2006**	**2007**	**2008**					
Derived Virgin Flows at Damsite (Mm^3)	105.2	70.7	68.9	56.7	61.0					
Precipitations (Mm^3)	8.1	7.2	4.7	3.5	3.7					
Total Volumes (Mm^3)	113.3	77.9	73.6	60.2	64.7					
Evaporation (Mm^3)	0.9	0.9	0.7	0.6	0.6					
Infiltration (Mm^3)	3.8	2.8	1.8	1.1	1.3					
Total Losses (Mm^3)	4.7	3.7	2.5	1.7	1.9					
Reservoir Area (Mm^2)	2.9	2.6	2.0	1.6	1.7					
Reservoir Volume (Mm^3)	62.7	45.2	27.5	17.7	21.6					
Irrigation Needs (Mm^3)	0.0	0.0	0.0	0.0	0.0					
Irrigation Efficiency (%)	-	-	-	-	-					
Potable Water Needs (Mm^3)	94.6	94.6	94.6	94.6	94.6					
Potable Water Deficit (Mm^3)	0.0	0.0	2.3	26.3	37.7					
Overflow (Mm^3)	15.7	0.0	0.0	0.0	0.0					
Potable Water Shortage (%)	0%	0%	2%	28%	40%					

Table B2: Annual Water Management of Bisri Reservoir for the year 1944 (All Data)

Irrigation Water Demand:	**0**	m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:	**0**	ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**102.0**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.82	2.19	4.48	17.66	32.10	37.51	33.48	20.36	9.18	4.35	2.86	2.06
Precipitations (Mm^3)	0.01	0.14	0.42	0.72	0.98	8.00	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.83	2.32	4.90	18.39	33.08	45.50	34.21	20.67	9.28	4.36	2.86	2.06
Evaporation (Mm^3)	0.19	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.51	0.44	0.37	0.31	0.40	0.51	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.70	0.47	0.37	0.31	0.40	0.51	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	3.57	3.40	3.23	3.06	3.32	3.57	3.57	3.57	3.57	3.57	3.43	3.27
Reservoir Volume (Mm^3)	87.36	73.45	62.21	80.29	102.00	102.00	102.00	102.00	102.00	89.84	76.25	61.93
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	10.96	44.99	33.70	20.16	8.70	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B3: Annual Water Management of Bisri Reservoir for the year 1945 (All Data)

Irrigation Water Demand:	-	m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:	-	ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	61.9	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.84	2.20	4.51	17.76	32.27	37.70	33.66	20.47	9.23	4.38	2.88	2.08
Precipitations (Mm^3)	0.00	0.11	0.30	0.46	0.76	7.23	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.84	2.32	4.81	18.22	33.03	44.94	34.39	20.78	9.33	4.39	2.88	2.08
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.17	0.11	0.20	0.37	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.47	0.26	0.17	0.11	0.20	0.37	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	3.05	2.76	2.37	1.94	2.58	3.23	3.57	3.57	3.57	3.57	3.43	3.27
Reservoir Volume (Mm^3)	47.54	33.82	22.70	40.80	73.63	102.00	102.00	102.00	102.00	89.87	76.30	62.00
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	16.20	33.88	20.27	8.76	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B4: Annual Water Management of Bisri Reservoir for the year 1946 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**62.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.28	1.58	3.49	14.57	26.59	31.10	27.74	16.82	7.40	3.39	2.14	1.48
Precipitations (Mm^3)	0.00	0.11	0.30	0.44	0.71	6.86	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.28	1.69	3.79	15.01	27.31	37.96	28.47	17.12	7.50	3.39	2.14	1.48
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.16	0.10	0.18	0.31	0.50	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.47	0.26	0.16	0.10	0.18	0.31	0.50	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.06	2.75	2.33	1.85	2.42	3.07	3.55	3.57	3.57	3.57	3.42	3.24
Reservoir Volume (Mm^3)	47.05	32.71	20.57	35.48	62.61	100.25	102.00	102.00	102.00	88.87	74.57	59.68
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	26.22	16.61	6.93	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B5: Annual Water Management of Bisri Reservoir for the year 1947 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**59.7**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	2.25	2.66	5.26	20.11	36.45	42.57	38.02	23.16	10.58	5.11	3.42	2.52
Precipitations (Mm^3)	0.00	0.11	0.30	0.45	0.78	7.40	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.25	2.77	5.56	20.56	37.23	49.98	38.75	23.46	10.68	5.12	3.42	2.52
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.30	0.23	0.16	0.11	0.21	0.40	0.51	0.51	0.51	0.51	0.45	0.39
Total Losses (Mm^3)	0.46	0.25	0.16	0.11	0.21	0.40	0.51	0.51	0.57	0.75	0.68	0.62
Reservoir Area (Mm^2)	3.02	2.71	2.32	1.91	2.63	3.31	3.57	3.57	3.57	3.57	3.44	3.28
Reservoir Volume (Mm^3)	45.71	32.47	22.09	42.54	79.55	102.00	102.00	102.00	102.00	90.60	77.57	63.71
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	27.13	38.24	22.95	10.10	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B6: Annual Water Management of Bisri Reservoir for the year 1948 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**63.7**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	3.79	4.37	8.06	28.89	52.09	60.78	54.31	33.22	15.61	7.86	5.46	4.17
Precipitations (Mm^3)	0.00	0.12	0.33	0.54	0.90	8.00	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	3.79	4.49	8.39	29.43	52.99	68.78	55.05	33.53	15.71	7.86	5.46	4.17
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.32	0.26	0.20	0.16	0.31	0.51	0.51	0.51	0.51	0.51	0.47	0.41
Total Losses (Mm^3)	0.48	0.28	0.20	0.16	0.31	0.51	0.51	0.51	0.57	0.75	0.70	0.65
Reservoir Area (Mm^2)	3.08	2.85	2.55	2.31	3.05	3.57	3.57	3.57	3.57	3.57	3.47	3.34
Reservoir Volume (Mm^3)	51.25	39.69	32.12	61.39	102.00	102.00	102.00	102.00	102.00	93.34	82.33	70.09
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	12.07	68.27	54.54	33.02	15.14	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B7: Annual Water Management of Bisri Reservoir for the year 1949 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**70.1**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.73	0.98	2.50	11.46	21.05	24.64	21.97	13.25	5.62	2.41	1.42	0.89
Precipitations (Mm^3)	0.00	0.12	0.33	0.49	0.74	6.75	0.70	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.74	1.09	2.83	11.95	21.79	31.40	22.67	13.56	5.72	2.42	1.42	0.89
Evaporation (Mm^3)	0.17	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.35	0.27	0.20	0.13	0.19	0.30	0.45	0.51	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.52	0.30	0.20	0.13	0.19	0.30	0.45	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.18	2.92	2.55	2.09	2.51	3.02	3.44	3.57	3.57	3.57	3.41	3.22
Reservoir Volume (Mm^3)	54.54	39.57	26.43	38.25	59.85	90.95	102.00	102.00	102.00	87.90	72.89	57.42
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	11.17	13.05	5.14	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B8: Annual Water Management of Bisri Reservoir for the year 1950 (All Data)

Irrigation Water Demand:		m^3/ha	
Irrigated Area:		ha	
Potable Water Demand:	6.00	m^3/s	
Reservoir Storage:	110.0	Mm^3	
Reservoir active Storage:	102.0	Mm^3	
Reservoir carryover Storage:	57.4	Mm^3	

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.65	0.88	2.35	10.99	20.22	23.67	21.10	12.71	5.35	2.27	1.31	0.80
Precipitations (Mm^3)	0.00	0.11	0.27	0.36	0.60	6.07	0.67	0.30	0.10	0.00	-	-
Total Volumes (Mm^3)	0.66	0.99	2.62	11.35	20.82	29.74	21.77	13.02	5.45	2.27	1.31	0.80
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.13	0.07	0.12	0.23	0.38	0.48	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.44	0.23	0.13	0.07	0.12	0.23	0.38	0.48	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	2.97	2.61	2.11	1.51	2.03	2.71	3.25	3.51	3.57	3.57	3.41	3.22
Reservoir Volume (Mm^3)	41.87	26.86	13.58	24.86	45.55	75.06	96.45	102.00	102.00	87.76	72.63	57.08
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	6.99	4.88	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B9: Annual Water Management of Bisri Reservoir for the year 1951 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**57.1**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.69	2.04	4.24	16.93	30.79	35.98	32.12	19.52	8.75	4.12	2.69	1.92
Precipitations (Mm^3)	0.00	0.11	0.28	0.40	0.71	6.98	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.70	2.15	4.53	17.33	31.50	42.96	32.85	19.82	8.85	4.13	2.69	1.92
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.14	0.09	0.17	0.33	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.44	0.24	0.14	0.09	0.17	0.33	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	2.97	2.63	2.18	1.69	2.39	3.12	3.57	3.57	3.57	3.57	3.43	3.26
Reservoir Volume (Mm^3)	42.57	28.72	17.33	34.57	65.89	102.00	102.00	102.00	102.00	89.61	75.85	61.40
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	6.53	32.34	19.31	8.28	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B10: Annual Water Management of Bisri Reservoir for the year 1952 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**61.4**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.95	1.86	2.30	5.72	28.13	43.07	56.59	20.51	8.56	4.69	3.03	2.07
Precipitations (Mm^3)	0.00	0.11	0.30	0.43	0.61	6.52	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.95	1.98	2.60	6.14	28.74	49.59	57.32	20.81	8.66	4.70	3.03	2.07
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.17	0.10	0.13	0.27	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.47	0.26	0.17	0.10	0.13	0.27	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	3.05	2.75	2.34	1.81	2.07	2.91	3.57	3.57	3.57	3.57	3.43	3.27
Reservoir Volume (Mm^3)	47.12	33.06	19.73	25.78	54.39	102.00	102.00	102.00	102.00	90.18	76.75	62.44
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	1.71	56.81	20.30	8.09	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B11: Annual Water Management of Bisri Reservoir for the year 1953 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**62.4**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.64	1.68	9.18	10.41	56.15	51.94	27.08	31.04	9.63	4.97	3.12	2.21
Precipitations (Mm^3)	0.00	0.11	0.30	0.50	0.74	7.80	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.64	1.79	9.49	10.92	56.88	59.74	27.81	31.35	9.73	4.98	3.12	2.21
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.17	0.14	0.19	0.47	0.51	0.51	0.51	0.51	0.45	0.39
Total Losses (Mm^3)	0.47	0.26	0.17	0.14	0.19	0.47	0.51	0.51	0.57	0.75	0.68	0.62
Reservoir Area (Mm^2)	3.06	2.77	2.36	2.12	2.50	3.49	3.57	3.57	3.57	3.57	3.44	3.28
Reservoir Volume (Mm^3)	47.85	33.61	27.16	37.94	94.63	102.00	102.00	102.00	102.00	90.46	77.13	62.96
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	51.90	27.30	30.84	9.16	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B12: Annual Water Management of Bisri Reservoir for the year 1954 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**63.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.85	1.82	2.59	4.59	5.52	12.20	20.46	10.26	6.14	2.06	1.48	1.15
Precipitations (Mm^3)	0.00	0.11	0.31	0.44	0.62	5.18	0.57	0.28	0.09	0.00	-	-
Total Volumes (Mm^3)	1.86	1.94	2.90	5.04	6.14	17.38	21.03	10.54	6.24	2.06	1.48	1.15
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.23	0.22	0.21
Infiltration (Mm^3)	0.31	0.24	0.17	0.11	0.13	0.16	0.25	0.35	0.40	0.43	0.36	0.29
Total Losses (Mm^3)	0.47	0.27	0.17	0.11	0.13	0.16	0.25	0.35	0.46	0.66	0.57	0.49
Reservoir Area (Mm^2)	3.07	2.79	2.39	1.88	2.09	2.32	2.81	3.19	3.32	3.39	3.21	2.97
Reservoir Volume (Mm^3)	48.57	34.48	21.43	26.36	32.37	49.59	70.38	80.56	86.33	71.97	57.10	41.99
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B13: Annual Water Management of Bisri Reservoir for the year 1955 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**42.0**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.07	1.19	7.31	17.97	30.05	30.10	27.99	9.90	8.67	3.60	2.45	1.47
Precipitations (Mm^3)	0.00	0.09	0.19	0.22	0.56	6.44	0.70	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.07	1.27	7.49	18.19	30.61	36.54	28.69	10.21	8.77	3.60	2.45	1.47
Evaporation (Mm^3)	0.14	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.21	0.13	0.06	0.02	0.11	0.26	0.44	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.35	0.15	0.06	0.02	0.11	0.26	0.44	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	2.62	2.12	1.44	0.95	1.92	2.88	3.42	3.57	3.57	3.57	3.42	3.25
Reservoir Volume (Mm^3)	26.94	12.29	3.96	22.13	52.63	88.91	102.00	102.00	102.00	89.08	75.09	60.19
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	15.15	9.70	8.20	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B14: Annual Water Management of Bisri Reservoir for the year 1956 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	60.2	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.28	1.45	2.14	7.83	18.07	26.87	23.14	12.95	6.46	3.19	1.89	1.20
Precipitations (Mm^3)	0.00	0.11	0.29	0.40	0.61	5.98	0.67	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.29	1.56	2.43	8.23	18.68	32.85	23.81	13.26	6.56	3.19	1.89	1.20
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.30	0.23	0.15	0.09	0.13	0.22	0.38	0.50	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.46	0.25	0.15	0.09	0.13	0.22	0.38	0.50	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.02	2.70	2.26	1.69	2.06	2.67	3.27	3.55	3.57	3.57	3.42	3.24
Reservoir Volume (Mm^3)	45.25	30.79	17.30	25.44	44.00	76.62	100.05	102.00	102.00	88.68	74.13	58.97
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	10.81	5.99	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B15: Annual Water Management of Bisri Reservoir for the year 1957 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**59.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.06	1.60	2.15	20.44	37.67	19.52	13.43	7.70	3.78	1.87	1.44	1.24
Precipitations (Mm^3)	0.00	0.11	0.28	0.38	0.73	7.27	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.06	1.71	2.44	20.82	38.39	26.79	14.16	8.01	3.88	1.88	1.44	1.24
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.22	0.15	0.08	0.18	0.37	0.51	0.51	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.45	0.24	0.15	0.08	0.18	0.37	0.51	0.51	0.57	0.75	0.66	0.59
Reservoir Area (Mm^2)	3.00	2.67	2.21	1.63	2.46	3.25	3.57	3.57	3.57	3.57	3.40	3.21
Reservoir Volume (Mm^3)	43.81	29.51	16.03	36.78	74.99	101.40	102.00	102.00	102.00	87.36	72.36	57.25
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	13.05	7.50	3.31	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B16: Annual Water Management of Bisri Reservoir for the year 1958 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	57.3	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.31	1.51	1.49	4.62	12.88	19.70	30.38	7.73	4.15	1.99	1.44	1.10
Precipitations (Mm^3)	0.00	0.11	0.28	0.36	0.52	5.16	0.61	0.29	0.10	0.00	-	-
Total Volumes (Mm^3)	1.32	1.62	1.76	4.98	13.40	24.86	30.99	8.03	4.25	1.99	1.44	1.10
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.22
Infiltration (Mm^3)	0.29	0.21	0.14	0.07	0.09	0.16	0.28	0.44	0.48	0.49	0.42	0.35
Total Losses (Mm^3)	0.44	0.24	0.14	0.07	0.09	0.16	0.28	0.44	0.54	0.73	0.65	0.57
Reservoir Area (Mm^2)	2.97	2.63	2.16	1.52	1.76	2.31	2.96	3.40	3.49	3.53	3.36	3.17
Reservoir Volume (Mm^3)	42.36	27.98	13.83	18.74	32.05	56.76	87.46	95.05	98.76	84.25	69.28	54.04
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B17: Annual Water Management of Bisri Reservoir for the year 1959 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	54.0	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.09	1.31	1.69	1.80	8.95	7.30	13.75	11.37	3.55	1.49	1.07	0.99
Precipitations (Mm^3)	0.00	0.10	0.26	0.32	0.43	4.25	0.48	0.24	0.08	0.00	-	-
Total Volumes (Mm^3)	1.09	1.41	1.95	2.11	9.38	11.55	14.23	11.61	3.63	1.49	1.07	0.99
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.05	0.20	0.18	0.16
Infiltration (Mm^3)	0.27	0.19	0.12	0.05	0.06	0.11	0.17	0.24	0.29	0.31	0.24	0.16
Total Losses (Mm^3)	0.42	0.22	0.12	0.05	0.06	0.11	0.17	0.24	0.35	0.51	0.42	0.32
Reservoir Area (Mm^2)	2.91	2.53	2.01	1.34	1.45	1.90	2.35	2.75	3.00	3.06	2.75	2.31
Reservoir Volume (Mm^3)	38.94	24.37	10.43	12.48	21.80	33.24	47.30	58.68	61.96	47.17	32.05	16.95
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B18: Annual Water Management of Bisri Reservoir for the year 1960 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**17.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.82	0.88	2.97	3.18	15.26	27.29	15.47	16.99	4.58	1.71	1.08	0.99
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.27	3.95	0.58	0.27	0.09	0.00	-	-
Total Volumes (Mm^3)	0.82	0.92	3.06	3.34	15.53	31.24	16.05	17.26	4.68	1.71	1.08	0.99
Evaporation (Mm^3)	0.09	0.01	-	-	-	-	-	-	0.06	0.23	0.22	0.21
Infiltration (Mm^3)	0.08	0.01	-	-	0.02	0.09	0.25	0.33	0.41	0.43	0.36	0.28
Total Losses (Mm^3)	0.17	0.02	-	-	0.02	0.09	0.25	0.33	0.47	0.66	0.58	0.49
Reservoir Area (Mm^2)	1.68	0.81	0.69	0.69	0.91	1.77	2.82	3.12	3.35	3.40	3.21	2.96
Reservoir Volume (Mm^3)	1.83	-	-	3.34	18.85	50.00	65.79	82.72	86.93	72.21	56.94	41.68
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	13.04	12.71	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	83%	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B19: Annual Water Management of Bisri Reservoir for the year 1961 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**41.7**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.95	1.12	2.65	24.56	17.83	35.65	10.07	4.93	3.97	2.13	1.67	1.34
Precipitations (Mm^3)	0.00	0.09	0.18	0.16	0.60	5.92	0.69	0.30	0.10	0.00	-	-
Total Volumes (Mm^3)	0.96	1.20	2.83	24.73	18.43	41.57	10.75	5.23	4.07	2.14	1.67	1.34
Evaporation (Mm^3)	0.14	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.21	0.13	0.06	-	0.12	0.22	0.42	0.47	0.50	0.51	0.44	0.36
Total Losses (Mm^3)	0.34	0.15	0.06	-	0.12	0.22	0.42	0.47	0.56	0.75	0.67	0.59
Reservoir Area (Mm^2)	2.61	2.10	1.41	0.69	2.03	2.64	3.37	3.49	3.54	3.57	3.40	3.22
Reservoir Volume (Mm^3)	26.52	11.80	-	24.73	43.03	84.39	94.72	99.48	102.00	87.62	72.86	57.84
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	1.19	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	1.00	-	-	-
Potable Water Shortage (%)	0%	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B20: Annual Water Management of Bisri Reservoir for the year 1962 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	57.8	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.64	1.24	1.57	20.49	24.45	47.87	31.88	16.13	12.00	4.18	2.88	1.82
Precipitations (Mm^3)	0.00	0.11	0.28	0.36	0.70	6.73	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.65	1.35	1.85	20.84	25.15	54.61	32.61	16.44	12.10	4.18	2.88	1.82
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.14	0.07	0.17	0.30	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.44	0.23	0.14	0.07	0.17	0.30	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	2.98	2.62	2.14	1.50	2.38	3.01	3.57	3.57	3.57	3.57	3.43	3.26
Reservoir Volume (Mm^3)	42.27	27.62	13.56	34.34	59.32	102.00	102.00	102.00	102.00	89.66	76.10	61.55
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	11.63	32.10	15.93	11.53	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B21: Annual Water Management of Bisri Reservoir for the year 1963 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**61.5**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.62	2.24	2.34	8.15	15.96	51.66	50.14	12.46	7.96	3.78	2.57	1.81
Precipitations (Mm^3)	0.00	0.11	0.30	0.43	0.64	6.03	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.63	2.35	2.64	8.58	16.60	57.69	50.87	12.77	8.06	3.78	2.57	1.81
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.23	0.17	0.10	0.14	0.22	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.47	0.26	0.17	0.10	0.14	0.22	0.51	0.51	0.57	0.75	0.68	0.60
Reservoir Area (Mm^2)	3.05	2.75	2.35	1.82	2.17	2.69	3.57	3.57	3.57	3.57	3.42	3.26
Reservoir Volume (Mm^3)	46.94	33.26	19.97	28.45	44.91	102.00	102.00	102.00	102.00	89.27	75.39	60.84
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	0.38	50.36	12.26	7.49	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B22: Annual Water Management of Bisri Reservoir for the year 1964 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**60.8**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.49	1.54	15.02	6.85	23.54	47.57	16.31	22.53	6.08	2.84	1.69	1.13
Precipitations (Mm^3)	0.00	0.11	0.30	0.54	0.74	6.86	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.49	1.65	15.32	7.39	24.28	54.43	17.04	22.84	6.18	2.85	1.69	1.13
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.30	0.23	0.16	0.16	0.19	0.31	0.51	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.46	0.25	0.16	0.16	0.19	0.31	0.51	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.04	2.72	2.29	2.27	2.51	3.06	3.57	3.57	3.57	3.57	3.41	3.23
Reservoir Volume (Mm^3)	46.10	31.73	31.12	38.35	62.44	102.00	102.00	102.00	102.00	88.33	73.58	58.34
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	14.56	16.53	22.33	5.60	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B23: Annual Water Management of Bisri Reservoir for the year 1965 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**58.3**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.82	1.49	1.89	17.68	17.56	20.22	15.12	7.86	3.47	1.72	0.99	0.52
Precipitations (Mm^3)	0.00	0.11	0.28	0.37	0.69	6.35	0.67	0.30	0.10	0.00	-	-
Total Volumes (Mm^3)	0.82	1.59	2.17	18.05	18.25	26.57	15.79	8.16	3.57	1.72	0.99	0.52
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.22
Infiltration (Mm^3)	0.29	0.21	0.14	0.07	0.16	0.25	0.39	0.46	0.50	0.51	0.44	0.36
Total Losses (Mm^3)	0.45	0.24	0.14	0.07	0.16	0.25	0.39	0.46	0.57	0.75	0.66	0.58
Reservoir Area (Mm^2)	2.99	2.64	2.18	1.57	2.33	2.84	3.28	3.46	3.55	3.57	3.40	3.21
Reservoir Volume (Mm^3)	42.95	28.54	14.80	32.77	50.86	77.17	92.58	100.27	102.00	87.20	71.76	55.93
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	1.27	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B24: Annual Water Management of Bisri Reservoir for the year 1966 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**55.9**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.72	1.13	0.99	23.50	28.43	40.27	70.89	24.63	13.32	6.10	3.86	2.52
Precipitations (Mm^3)	0.00	0.11	0.27	0.32	0.71	6.91	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.72	1.23	1.26	23.82	29.14	47.18	71.62	24.94	13.42	6.10	3.86	2.52
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.28	0.20	0.13	0.06	0.17	0.32	0.51	0.51	0.51	0.51	0.46	0.39
Total Losses (Mm^3)	0.43	0.23	0.13	0.06	0.17	0.32	0.51	0.51	0.57	0.75	0.69	0.63
Reservoir Area (Mm^2)	2.94	2.57	2.07	1.37	2.40	3.09	3.57	3.57	3.57	3.57	3.45	3.30
Reservoir Volume (Mm^3)	40.45	25.69	11.05	34.82	63.78	102.00	102.00	102.00	102.00	91.58	78.98	65.11
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	8.64	71.11	24.43	12.85	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B25: Annual Water Management of Bisri Reservoir for the year 1967 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**65.1**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.75	2.45	3.03	19.71	64.90	31.12	19.02	9.51	6.66	3.70	2.32	1.59
Precipitations (Mm^3)	0.00	0.12	0.32	0.48	0.79	8.00	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.75	2.57	3.34	20.19	65.69	39.12	19.76	9.82	6.76	3.71	2.32	1.59
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.33	0.25	0.19	0.12	0.22	0.51	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.49	0.28	0.19	0.12	0.22	0.51	0.51	0.51	0.57	0.75	0.68	0.60
Reservoir Area (Mm^2)	3.11	2.83	2.47	2.02	2.69	3.57	3.57	3.57	3.57	3.57	3.42	3.25
Reservoir Volume (Mm^3)	50.61	37.13	24.52	44.59	102.00	102.00	102.00	102.00	102.00	89.19	75.07	60.29
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	8.06	38.61	19.25	9.31	6.18	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B26: Annual Water Management of Bisri Reservoir for the year 1968 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**60.3**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.14	1.65	3.22	66.66	74.16	41.72	31.04	18.19	10.93	5.03	2.95	1.86
Precipitations (Mm^3)	0.00	0.11	0.29	0.41	1.00	8.00	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.14	1.76	3.51	67.08	75.16	49.71	31.77	18.50	11.03	5.03	2.95	1.86
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.30	0.23	0.15	0.09	0.43	0.51	0.51	0.51	0.51	0.51	0.45	0.39
Total Losses (Mm^3)	0.46	0.25	0.15	0.09	0.43	0.51	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	3.03	2.70	2.27	1.75	3.38	3.57	3.57	3.57	3.57	3.57	3.44	3.28
Reservoir Volume (Mm^3)	45.20	30.94	18.53	85.51	102.00	102.00	102.00	102.00	102.00	90.52	77.01	62.49
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	58.24	49.20	31.26	17.99	10.45	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B27: Annual Water Management of Bisri Reservoir for the year 1969 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**62.5**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.45	2.45	3.89	8.10	35.06	14.08	40.47	10.23	5.94	2.73	1.61	0.95
Precipitations (Mm^3)	0.00	0.11	0.31	0.46	0.67	7.00	0.70	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.45	2.57	4.19	8.56	35.73	21.08	41.16	10.54	6.04	2.73	1.61	0.95
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.17	0.11	0.15	0.33	0.44	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.47	0.26	0.17	0.11	0.15	0.33	0.44	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.06	2.76	2.38	1.93	2.27	3.13	3.40	3.57	3.57	3.57	3.41	3.23
Reservoir Volume (Mm^3)	47.71	34.24	22.50	30.94	66.51	87.26	102.00	102.00	102.00	88.21	73.39	57.98
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	25.99	10.03	5.47	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B28: Annual Water Management of Bisri Reservoir for the year 1970 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	58.0	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.73	1.15	1.59	11.32	8.80	44.09	28.88	61.42	14.81	5.86	3.55	1.81
Precipitations (Mm^3)	0.00	0.11	0.28	0.36	0.60	5.35	0.69	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.73	1.25	1.87	11.68	9.40	49.44	29.57	61.73	14.91	5.87	3.55	1.81
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.14	0.07	0.13	0.17	0.42	0.51	0.51	0.51	0.46	0.39
Total Losses (Mm^3)	0.45	0.24	0.14	0.07	0.13	0.17	0.42	0.51	0.57	0.75	0.69	0.62
Reservoir Area (Mm^2)	2.98	2.63	2.15	1.51	2.05	2.39	3.36	3.57	3.57	3.57	3.45	3.29
Reservoir Volume (Mm^3)	42.50	27.75	13.71	25.32	34.60	83.87	102.00	102.00	102.00	91.35	78.44	63.86
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	11.02	61.22	14.34	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B29: Annual Water Management of Bisri Reservoir for the year 1971 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**63.9**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.34	1.36	2.09	22.57	20.66	26.31	9.19	10.66	6.99	3.45	1.84	1.51
Precipitations (Mm^3)	0.00	0.11	0.31	0.44	0.79	6.95	0.72	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.34	1.47	2.39	23.01	21.45	33.26	9.92	10.97	7.09	3.46	1.84	1.51
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.32	0.24	0.17	0.10	0.22	0.32	0.49	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.48	0.27	0.17	0.10	0.22	0.32	0.49	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.09	2.79	2.38	1.86	2.66	3.11	3.52	3.57	3.57	3.57	3.42	3.24
Reservoir Volume (Mm^3)	48.95	34.39	20.84	43.74	64.97	97.90	102.00	102.00	102.00	88.94	74.34	59.49
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	5.33	10.46	6.51	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B30: Annual Water Management of Bisri Reservoir for the year 1972 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**59.5**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.51	1.14	2.04	2.04	5.32	8.70	21.43	9.47	3.56	1.86	0.92	0.75
Precipitations (Mm^3)	0.00	0.11	0.29	0.39	0.52	4.51	0.51	0.26	0.09	0.00	-	-
Total Volumes (Mm^3)	1.52	1.25	2.32	2.43	5.84	13.21	21.94	9.73	3.65	1.87	0.92	0.75
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.22	0.20	0.18
Infiltration (Mm^3)	0.30	0.22	0.15	0.08	0.09	0.12	0.19	0.30	0.34	0.36	0.29	0.21
Total Losses (Mm^3)	0.45	0.25	0.15	0.08	0.09	0.12	0.19	0.30	0.40	0.58	0.49	0.39
Reservoir Area (Mm^2)	3.01	2.69	2.23	1.65	1.76	2.02	2.49	3.01	3.16	3.21	2.98	2.62
Reservoir Volume (Mm^3)	44.78	30.02	16.42	18.77	24.51	37.60	59.35	68.78	72.03	57.55	42.22	26.80
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B31: Annual Water Management of Bisri Reservoir for the year 1973 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**26.8**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	0.94	2.29	5.76	23.24	22.56	24.79	25.84	7.28	3.12	1.63	1.00
Precipitations (Mm^3)	0.00	0.06	0.09	0.16	0.32	4.95	0.61	0.29	0.10	0.00	-	-
Total Volumes (Mm^3)	0.00	1.00	2.38	5.92	23.55	27.51	25.39	26.13	7.38	3.13	1.63	1.00
Evaporation (Mm^3)	0.11	0.01	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.13	0.05	-	-	0.03	0.15	0.28	0.41	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.24	0.07	-	-	0.03	0.15	0.28	0.41	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	2.11	1.36	0.69	0.69	1.07	2.21	2.96	3.34	3.57	3.57	3.42	3.23
Reservoir Volume (Mm^3)	10.80	-	-	5.92	29.44	56.80	81.91	102.00	102.00	88.61	73.80	58.44
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	4.04	13.39	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	5.63	6.80	-	-	-
Potable Water Shortage (%)	0%	26%	85%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B32: Annual Water Management of Bisri Reservoir for the year 1974 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**58.4**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.02	1.29	3.02	13.09	23.95	28.02	24.99	15.12	6.55	2.92	1.80	1.20
Precipitations (Mm^3)	0.00	0.11	0.28	0.38	0.65	6.50	0.70	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.02	1.40	3.30	13.47	24.60	34.52	25.69	15.43	6.65	2.93	1.80	1.20
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.22	0.14	0.08	0.15	0.27	0.44	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.45	0.24	0.14	0.08	0.15	0.27	0.44	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	2.99	2.65	2.18	1.63	2.21	2.90	3.41	3.57	3.57	3.57	3.41	3.23
Reservoir Volume (Mm^3)	43.25	28.64	16.03	29.42	53.88	88.12	102.00	102.00	102.00	88.41	73.77	58.61
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	11.37	14.92	6.08	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B33: Annual Water Management of Bisri Reservoir for the year 1975 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**58.6**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.67	2.02	4.20	16.79	30.55	35.70	31.87	19.36	8.68	4.08	2.66	1.89
Precipitations (Mm^3)	0.00	0.11	0.29	0.42	0.72	7.02	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.67	2.12	4.49	17.21	31.26	42.72	32.60	19.67	8.78	4.08	2.66	1.89
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.22	0.15	0.09	0.18	0.33	0.51	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.45	0.24	0.15	0.09	0.18	0.33	0.51	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	3.00	2.67	2.24	1.76	2.43	3.14	3.57	3.57	3.57	3.57	3.43	3.26
Reservoir Volume (Mm^3)	44.06	30.17	18.74	35.86	66.94	102.00	102.00	102.00	102.00	89.57	75.78	61.30
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	7.32	32.09	19.16	8.20	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B34: Annual Water Management of Bisri Reservoir for the year 1976 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0** Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0** Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**61.3** Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	2.32	2.74	5.38	20.49	37.14	43.38	38.74	23.60	10.80	5.24	3.51	2.59
Precipitations (Mm^3)	0.00	0.11	0.31	0.47	0.79	7.48	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.32	2.85	5.69	20.96	37.94	50.86	39.47	23.91	10.90	5.24	3.51	2.59
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.17	0.12	0.22	0.41	0.51	0.51	0.51	0.51	0.45	0.39
Total Losses (Mm^3)	0.46	0.26	0.17	0.12	0.22	0.41	0.51	0.51	0.57	0.75	0.68	0.62
Reservoir Area (Mm^2)	3.04	2.76	2.38	1.99	2.69	3.34	3.57	3.57	3.57	3.57	3.44	3.29
Reservoir Volume (Mm^3)	47.39	34.21	23.96	44.80	82.51	102.00	102.00	102.00	102.00	90.72	77.79	63.99
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	30.96	38.96	23.40	10.32	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B35: Annual Water Management of Bisri Reservoir for the year 1977 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	64.0	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	3.05	3.55	6.71	24.66	44.56	52.02	46.47	28.37	13.19	6.54	4.48	3.37
Precipitations (Mm^3)	0.00	0.12	0.32	0.52	0.86	7.93	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	3.05	3.67	7.04	25.18	45.42	59.95	47.20	28.68	13.29	6.54	4.48	3.37
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.32	0.25	0.19	0.15	0.27	0.50	0.51	0.51	0.51	0.51	0.46	0.40
Total Losses (Mm^3)	0.48	0.28	0.19	0.15	0.27	0.50	0.51	0.51	0.57	0.75	0.69	0.63
Reservoir Area (Mm^2)	3.09	2.84	2.51	2.21	2.92	3.54	3.57	3.57	3.57	3.57	3.45	3.31
Reservoir Volume (Mm^3)	50.79	38.41	29.49	54.52	99.67	102.00	102.00	102.00	102.00	92.02	80.04	67.02
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	57.12	46.69	28.17	12.71	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B36: Annual Water Management of Bisri Reservoir for the year 1978 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**67.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	0.03	0.95	6.61	12.41	14.58	12.96	7.69	2.84	0.90	0.30	-
Precipitations (Mm^3)	0.00	0.12	0.31	0.43	0.63	5.73	0.62	0.28	0.09	0.00	-	-
Total Volumes (Mm^3)	0.00	0.14	1.26	7.04	13.03	20.31	13.58	7.97	2.93	0.90	0.30	-
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.22	0.21	0.20
Infiltration (Mm^3)	0.34	0.25	0.17	0.10	0.14	0.20	0.30	0.37	0.41	0.42	0.34	0.26
Total Losses (Mm^3)	0.50	0.28	0.17	0.10	0.14	0.20	0.30	0.37	0.46	0.64	0.55	0.46
Reservoir Area (Mm^2)	3.14	2.84	2.40	1.83	2.12	2.56	3.02	3.23	3.33	3.36	3.15	2.86
Reservoir Volume (Mm^3)	50.76	34.85	20.17	27.11	40.01	60.12	73.40	81.01	83.47	67.97	51.95	35.72
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B37: Annual Water Management of Bisri Reservoir for the year 1979 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**35.7**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	2.56	3.01	5.83	21.88	39.62	46.26	41.32	25.19	11.60	5.67	3.84	2.85
Precipitations (Mm^3)	0.00	0.08	0.16	0.16	0.56	6.84	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.56	3.09	5.99	22.05	40.18	53.10	42.05	25.50	11.70	5.67	3.84	2.85
Evaporation (Mm^3)	0.13	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.18	0.11	0.05	-	0.11	0.31	0.51	0.51	0.51	0.51	0.46	0.39
Total Losses (Mm^3)	0.30	0.13	0.05	-	0.11	0.31	0.51	0.51	0.57	0.75	0.69	0.62
Reservoir Area (Mm^2)	2.43	1.92	1.28	0.69	1.91	3.06	3.57	3.57	3.57	3.57	3.44	3.30
Reservoir Volume (Mm^3)	22.21	9.40	-	22.05	62.12	102.00	102.00	102.00	102.00	91.16	78.54	65.00
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	0.42	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	12.91	41.54	24.99	11.12	-	-	-
Potable Water Shortage (%)	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B38: Annual Water Management of Bisri Reservoir for the year 1980 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	65.0	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	2.97	3.46	6.56	24.20	43.74	51.06	45.61	27.84	12.92	6.39	4.37	3.29
Precipitations (Mm^3)	0.00	0.12	0.33	0.53	0.86	7.92	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.97	3.58	6.89	24.73	44.60	58.97	46.34	28.15	13.02	6.40	4.37	3.29
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.32	0.26	0.20	0.15	0.27	0.50	0.51	0.51	0.51	0.51	0.46	0.40
Total Losses (Mm^3)	0.49	0.28	0.20	0.15	0.27	0.50	0.51	0.51	0.57	0.75	0.69	0.63
Reservoir Area (Mm^2)	3.11	2.86	2.54	2.24	2.92	3.54	3.57	3.57	3.57	3.57	3.45	3.31
Reservoir Volume (Mm^3)	51.72	39.24	30.17	54.74	99.07	102.00	102.00	102.00	102.00	91.88	79.79	66.68
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	55.55	45.83	27.64	12.45	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B39: Annual Water Management of Bisri Reservoir for the year 1981 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**66.7**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76
Precipitations (Mm^3)	0.00	0.12	0.31	0.46	0.70	6.50	0.69	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.62	0.96	2.59	11.23	20.53	29.73	21.38	12.77	5.33	2.20	1.26	0.76
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.33	0.26	0.18	0.11	0.17	0.27	0.42	0.51	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.50	0.28	0.18	0.11	0.17	0.27	0.42	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.13	2.84	2.44	1.94	2.36	2.91	3.36	3.57	3.57	3.57	3.40	3.22
Reservoir Volume (Mm^3)	51.03	35.94	22.59	33.71	54.07	83.52	102.00	102.00	102.00	87.69	72.52	56.92
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	2.49	12.26	4.75	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B40: Annual Water Management of Bisri Reservoir for the year 1982 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	56.9	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	2.34	2.23	3.56	4.12	21.38	20.47	56.32	19.36	12.19	7.02	4.40	4.16
Precipitations (Mm^3)	0.00	0.11	0.28	0.40	0.56	5.95	0.65	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.34	2.34	3.84	4.52	21.94	26.42	56.97	19.67	12.29	7.02	4.40	4.16
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.28	0.22	0.15	0.09	0.11	0.22	0.35	0.51	0.51	0.51	0.46	0.40
Total Losses (Mm^3)	0.44	0.24	0.15	0.09	0.11	0.22	0.35	0.51	0.57	0.75	0.69	0.63
Reservoir Area (Mm^2)	2.96	2.65	2.21	1.69	1.90	2.66	3.18	3.57	3.57	3.57	3.46	3.32
Reservoir Volume (Mm^3)	43.06	29.39	17.31	21.74	43.57	69.77	102.00	102.00	102.00	92.51	80.45	68.20
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	24.40	19.16	11.71	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B41: Annual Water Management of Bisri Reservoir for the year 1983 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**68.2**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	3.60	4.49	11.05	6.91	23.19	21.36	25.00	23.70	9.25	3.49	1.76	1.67
Precipitations (Mm^3)	0.00	0.12	0.34	0.60	0.81	7.14	0.72	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	3.60	4.61	11.40	7.51	24.00	28.50	25.72	24.01	9.35	3.49	1.76	1.67
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.34	0.28	0.22	0.20	0.23	0.35	0.49	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.51	0.30	0.22	0.20	0.23	0.35	0.49	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.16	2.94	2.67	2.54	2.74	3.19	3.53	3.57	3.57	3.57	3.42	3.24
Reservoir Volume (Mm^3)	55.53	44.07	39.48	46.80	70.56	98.71	102.00	102.00	102.00	88.98	74.29	59.59
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	21.94	23.50	8.78	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B42: Annual Water Management of Bisri Reservoir for the year 1984 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**59.6**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.10	1.38	3.17	13.55	24.78	28.98	25.85	15.65	6.82	3.07	1.91	1.28
Precipitations (Mm^3)	0.00	0.11	0.29	0.40	0.67	6.62	0.71	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.10	1.49	3.45	13.95	25.45	35.60	26.56	15.96	6.92	3.07	1.91	1.28
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.30	0.22	0.15	0.09	0.16	0.28	0.46	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.45	0.25	0.15	0.09	0.16	0.28	0.46	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.01	2.68	2.23	1.70	2.28	2.96	3.45	3.57	3.57	3.57	3.41	3.24
Reservoir Volume (Mm^3)	44.47	29.95	17.49	31.35	56.65	91.96	102.00	102.00	102.00	88.55	74.02	58.94
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	16.06	15.45	6.34	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B43: Annual Water Management of Bisri Reservoir for the year 1985 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	58.9	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	-	0.80	6.15	11.58	13.62	12.11	7.16	2.57	0.75	0.19	-
Precipitations (Mm^3)	0.00	0.11	0.27	0.34	0.52	5.03	0.57	0.26	0.09	0.00	-	-
Total Volumes (Mm^3)	0.00	0.11	1.07	6.48	12.10	18.65	12.68	7.42	2.66	0.76	0.19	-
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.21	0.20	0.18
Infiltration (Mm^3)	0.29	0.21	0.13	0.06	0.09	0.15	0.24	0.31	0.34	0.35	0.28	0.20
Total Losses (Mm^3)	0.45	0.24	0.13	0.06	0.09	0.15	0.24	0.31	0.40	0.57	0.47	0.37
Reservoir Area (Mm^2)	3.00	2.64	2.11	1.42	1.75	2.25	2.79	3.04	3.16	3.19	2.93	2.53
Reservoir Volume (Mm^3)	42.73	26.83	12.00	18.42	30.43	48.93	61.36	68.48	70.74	55.16	39.12	22.98
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B44: Annual Water Management of Bisri Reservoir for the year 1986 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**23.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.83	2.20	4.50	17.72	32.20	37.62	33.58	20.42	9.21	4.37	2.87	2.07
Precipitations (Mm^3)	0.00	0.05	0.09	0.16	0.51	6.33	0.71	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.83	2.25	4.59	17.88	32.70	43.95	34.30	20.73	9.31	4.37	2.87	2.07
Evaporation (Mm^3)	0.10	0.01	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.11	0.04	-	-	0.09	0.25	0.47	0.51	0.51	0.51	0.45	0.38
Total Losses (Mm^3)	0.22	0.06	-	-	0.09	0.25	0.47	0.51	0.57	0.75	0.68	0.61
Reservoir Area (Mm^2)	1.95	1.24	0.69	0.69	1.72	2.83	3.48	3.57	3.57	3.57	3.43	3.27
Reservoir Volume (Mm^3)	8.83	-	-	17.88	50.49	94.19	102.00	102.00	102.00	89.86	76.28	61.97
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	4.75	11.18	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	26.02	20.22	8.73	-	-	-
Potable Water Shortage (%)	0%	30%	71%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B45: Annual Water Management of Bisri Reservoir for the year 1987 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**62.0**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	3.05	3.55	6.71	24.66	44.56	52.02	46.47	28.37	13.19	6.54	4.48	3.37
Precipitations (Mm^3)	0.00	0.11	0.32	0.50	0.85	7.88	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	3.05	3.66	7.03	25.16	45.41	59.90	47.20	28.68	13.29	6.54	4.48	3.37
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.31	0.24	0.18	0.14	0.26	0.49	0.51	0.51	0.51	0.51	0.46	0.40
Total Losses (Mm^3)	0.47	0.27	0.18	0.14	0.26	0.49	0.51	0.51	0.57	0.75	0.69	0.63
Reservoir Area (Mm^2)	3.06	2.79	2.45	2.14	2.87	3.52	3.57	3.57	3.57	3.57	3.45	3.31
Reservoir Volume (Mm^3)	48.79	36.41	27.49	52.52	97.67	102.00	102.00	102.00	102.00	92.02	80.04	67.02
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	55.07	46.69	28.17	12.71	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B46: Annual Water Management of Bisri Reservoir for the year 1988 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**67.0**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.05	0.21	1.25	7.53	14.06	16.50	14.68	8.75	3.37	1.19	0.51	0.15
Precipitations (Mm^3)	0.00	0.12	0.31	0.44	0.64	5.92	0.64	0.29	0.10	0.00	-	-
Total Volumes (Mm^3)	0.05	0.33	1.56	7.97	14.70	22.43	15.32	9.04	3.46	1.19	0.51	0.15
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.23	0.22	0.21
Infiltration (Mm^3)	0.34	0.25	0.18	0.10	0.14	0.22	0.33	0.40	0.44	0.46	0.38	0.30
Total Losses (Mm^3)	0.50	0.28	0.18	0.10	0.14	0.22	0.33	0.40	0.51	0.69	0.60	0.52
Reservoir Area (Mm^2)	3.14	2.84	2.41	1.85	2.18	2.65	3.11	3.32	3.42	3.45	3.27	3.03
Reservoir Volume (Mm^3)	50.80	35.08	20.69	28.56	43.12	65.33	80.32	88.96	91.91	76.65	60.79	44.66
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B47: Annual Water Management of Bisri Reservoir for the year 1989 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0** Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0** Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**44.7** Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	-	-	2.91	5.81	6.90	6.09	3.45	0.71	-	-	-
Precipitations (Mm^3)	0.00	0.09	0.19	0.16	0.26	2.82	0.36	0.18	0.06	0.00	-	-
Total Volumes (Mm^3)	0.00	0.09	0.19	3.07	6.08	9.73	6.45	3.63	0.78	0.00	-	-
Evaporation (Mm^3)	0.14	0.02	-	-	-	-	-	-	0.04	0.15	0.10	0.05
Infiltration (Mm^3)	0.22	0.14	0.06	-	0.02	0.05	0.09	0.13	0.14	0.15	0.07	-
Total Losses (Mm^3)	0.36	0.16	0.06	-	0.02	0.05	0.09	0.13	0.18	0.29	0.17	0.05
Reservoir Area (Mm^2)	2.69	2.18	1.46	0.69	0.89	1.26	1.76	2.04	2.18	2.20	1.49	0.69
Reservoir Volume (Mm^3)	28.53	12.69	-	3.07	9.13	18.81	25.17	28.67	29.26	13.20	-	-
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	2.95	-	-	-	-	-	-	-	2.73	15.82
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	19%	0%	0%	0%	0%	0%	0%	0%	17%	100%

Table B48: Annual Water Management of Bisri Reservoir for the year 1990 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**0.0**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	-	-	0.66	5.68	10.76	12.66	11.25	6.63	2.31	0.61	0.09	-
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.32	3.74	0.48	0.23	0.08	0.00	-	-
Total Volumes (Mm^3)	0.00	0.03	0.74	5.85	11.08	16.41	11.73	6.86	2.39	0.61	0.09	-
Evaporation (Mm^3)	0.04	0.01	-	-	-	-	-	-	0.05	0.19	0.17	0.13
Infiltration (Mm^3)	-	-	-	-	0.03	0.08	0.17	0.22	0.26	0.27	0.19	0.11
Total Losses (Mm^3)	0.04	0.01	-	-	0.03	0.08	0.17	0.22	0.31	0.46	0.36	0.24
Reservoir Area (Mm^2)	0.69	0.69	0.69	0.69	1.07	1.67	2.35	2.69	2.85	2.89	2.50	1.90
Reservoir Volume (Mm^3)	-	-	-	5.85	16.89	33.21	44.77	51.41	53.49	37.88	21.84	5.83
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	15.80	15.75	15.02	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	100%	100%	95%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B49: Annual Water Management of Bisri Reservoir for the year 1991 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**5.8**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	4.43	5.09	9.22	32.53	58.58	68.33	61.07	37.39	17.70	8.99	6.30	4.86
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.69	7.73	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	4.43	5.11	9.31	32.69	59.26	76.06	61.81	37.70	17.80	9.00	6.30	4.86
Evaporation (Mm^3)	0.06	0.01	-	-	-	-	-	-	0.06	0.24	0.23	0.24
Infiltration (Mm^3)	0.03	-	-	-	0.16	0.46	0.51	0.51	0.51	0.51	0.47	0.42
Total Losses (Mm^3)	0.08	0.01	-	-	0.16	0.46	0.51	0.51	0.57	0.75	0.71	0.66
Reservoir Area (Mm^2)	1.07	0.69	0.69	0.69	2.33	3.45	3.57	3.57	3.57	3.57	3.48	3.37
Reservoir Volume (Mm^3)	-	-	-	32.69	91.79	102.00	102.00	102.00	102.00	94.48	84.31	72.74
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	5.60	10.66	6.45	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	65.39	61.30	37.19	17.22	-	-	-
Potable Water Shortage (%)	35%	68%	41%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B50: Annual Water Management of Bisri Reservoir for the year 1992 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**72.7**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	2.64	3.10	5.97	22.35	40.44	47.22	42.17	25.72	11.86	5.81	3.94	2.94
Precipitations (Mm^3)	0.00	0.12	0.35	0.58	0.89	7.95	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	2.65	3.22	6.33	22.93	41.33	55.17	42.91	26.03	11.96	5.82	3.94	2.94
Evaporation (Mm^3)	0.17	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.36	0.30	0.23	0.18	0.30	0.50	0.51	0.51	0.51	0.51	0.46	0.39
Total Losses (Mm^3)	0.53	0.32	0.23	0.18	0.30	0.50	0.51	0.51	0.57	0.75	0.69	0.62
Reservoir Area (Mm^2)	3.22	3.00	2.73	2.45	3.01	3.55	3.57	3.57	3.57	3.57	3.45	3.30
Reservoir Volume (Mm^3)	59.09	46.22	36.54	59.29	100.32	102.00	102.00	102.00	102.00	91.30	78.79	65.33
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	52.98	42.40	25.52	11.39	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B51: Annual Water Management of Bisri Reservoir for the year 1993 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	65.3	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76
Precipitations (Mm^3)	0.00	0.11	0.31	0.44	0.68	6.44	0.68	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.62	0.96	2.59	11.22	20.51	29.66	21.38	12.77	5.33	2.20	1.26	0.76
Evaporation (Mm^3)	0.16	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.33	0.25	0.17	0.11	0.16	0.26	0.41	0.51	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.49	0.27	0.17	0.11	0.16	0.26	0.41	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.11	2.81	2.39	1.88	2.32	2.88	3.34	3.57	3.57	3.57	3.40	3.22
Reservoir Volume (Mm^3)	49.70	34.61	21.26	32.37	52.72	82.12	102.00	102.00	102.00	87.69	72.52	56.92
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	1.09	12.26	4.75	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B52: Annual Water Management of Bisri Reservoir for the year 1994 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**56.9**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.78	1.02	2.58	11.70	21.48	25.14	22.42	13.53	5.76	2.49	1.48	0.94
Precipitations (Mm^3)	0.00	0.11	0.27	0.36	0.61	6.18	0.67	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.78	1.13	2.85	12.06	22.09	31.32	23.09	13.83	5.86	2.49	1.48	0.94
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.28	0.21	0.13	0.07	0.13	0.24	0.39	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.44	0.23	0.13	0.07	0.13	0.24	0.39	0.51	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	2.96	2.60	2.10	1.50	2.06	2.76	3.30	3.56	3.57	3.57	3.41	3.22
Reservoir Volume (Mm^3)	41.50	26.63	13.57	25.56	47.52	78.59	101.29	102.00	102.00	87.98	73.02	57.60
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	12.62	5.28	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B53: Annual Water Management of Bisri Reservoir for the year 1995 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**57.6**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.61	0.84	2.28	10.77	19.83	23.22	20.70	12.46	5.23	2.20	1.26	0.76
Precipitations (Mm^3)	0.00	0.11	0.27	0.36	0.60	6.03	0.66	0.30	0.10	0.00	-	-
Total Volumes (Mm^3)	0.62	0.95	2.55	11.13	20.43	29.25	21.36	12.77	5.33	2.20	1.26	0.76
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.13	0.07	0.12	0.22	0.37	0.47	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.44	0.23	0.13	0.07	0.12	0.22	0.37	0.47	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	2.98	2.62	2.12	1.51	2.02	2.70	3.24	3.49	3.57	3.57	3.40	3.22
Reservoir Volume (Mm^3)	42.00	26.95	13.60	24.66	44.96	73.99	94.98	102.00	102.00	87.69	72.52	56.92
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	5.27	4.75	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B54: Annual Water Management of Bisri Reservoir for the year 1996 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**56.9**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.37	0.57	1.84	9.39	17.36	20.34	18.12	10.87	4.43	1.77	0.94	0.50
Precipitations (Mm^3)	0.00	0.11	0.27	0.34	0.56	5.69	0.64	0.29	0.10	0.00	-	-
Total Volumes (Mm^3)	0.37	0.68	2.10	9.72	17.91	26.03	18.76	11.16	4.53	1.77	0.94	0.50
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.22
Infiltration (Mm^3)	0.28	0.21	0.13	0.06	0.11	0.20	0.33	0.42	0.47	0.49	0.42	0.34
Total Losses (Mm^3)	0.44	0.23	0.13	0.06	0.11	0.20	0.33	0.42	0.53	0.73	0.64	0.56
Reservoir Area (Mm^2)	2.96	2.59	2.07	1.42	1.89	2.54	3.11	3.36	3.48	3.53	3.36	3.16
Reservoir Volume (Mm^3)	41.09	25.77	11.98	21.64	39.44	65.28	83.71	94.45	98.45	83.72	68.25	52.42
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B55: Annual Water Management of Bisri Reservoir for the year 1997 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**52.4**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.86	1.11	2.72	12.16	22.30	26.10	23.27	14.06	6.02	2.63	1.59	1.02
Precipitations (Mm^3)	0.00	0.10	0.25	0.30	0.56	6.01	0.67	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.86	1.21	2.97	12.47	22.86	32.11	23.94	14.36	6.12	2.64	1.59	1.02
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.26	0.19	0.11	0.05	0.11	0.22	0.38	0.50	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.41	0.21	0.11	0.05	0.11	0.22	0.38	0.50	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	2.87	2.47	1.92	1.28	1.90	2.69	3.27	3.55	3.57	3.57	3.41	3.23
Reservoir Volume (Mm^3)	37.10	22.34	9.43	21.85	44.60	76.49	100.05	102.00	102.00	88.12	73.27	57.93
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	11.92	5.55	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B56: Annual Water Management of Bisri Reservoir for the year 1998 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**57.9**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	-	0.06	3.83	7.46	8.82	7.81	4.51	1.25	0.03	-	-
Precipitations (Mm^3)	0.00	0.11	0.27	0.31	0.46	4.29	0.49	0.23	0.08	0.00	-	-
Total Volumes (Mm^3)	0.00	0.11	0.33	4.14	7.92	13.12	8.30	4.74	1.32	0.04	-	-
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.05	0.19	0.16	0.12
Infiltration (Mm^3)	0.29	0.21	0.13	0.05	0.07	0.11	0.18	0.22	0.24	0.24	0.16	0.08
Total Losses (Mm^3)	0.44	0.23	0.13	0.05	0.07	0.11	0.18	0.22	0.29	0.43	0.32	0.20
Reservoir Area (Mm^2)	2.98	2.61	2.07	1.33	1.55	1.92	2.41	2.65	2.77	2.79	2.33	1.66
Reservoir Volume (Mm^3)	41.72	25.83	10.26	14.36	22.20	35.21	43.34	47.86	48.89	32.73	16.64	0.67
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B57: Annual Water Management of Bisri Reservoir for the year 1999 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**0.7**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	-	0.14	4.06	7.87	9.30	8.24	4.77	1.38	0.10	-	-
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.29	3.23	0.42	0.20	0.07	0.00	-	-
Total Volumes (Mm^3)	0.00	0.03	0.23	4.23	8.16	12.53	8.66	4.98	1.45	0.11	-	-
Evaporation (Mm^3)	0.04	0.01	-	-	-	-	-	-	0.05	0.17	0.13	0.08
Infiltration (Mm^3)	0.00	-	-	-	0.02	0.06	0.12	0.17	0.19	0.20	0.12	0.04
Total Losses (Mm^3)	0.04	0.01	-	-	0.02	0.06	0.12	0.17	0.24	0.37	0.25	0.12
Reservoir Area (Mm^2)	0.74	0.69	0.69	0.69	0.97	1.44	2.03	2.35	2.51	2.54	1.97	1.16
Reservoir Volume (Mm^3)	-	-	-	4.23	12.37	24.83	33.36	38.17	39.39	23.36	7.34	-
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	15.14	15.75	15.54	-	-	-	-	-	-	-	-	8.55
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	96%	100%	99%	0%	0%	0%	0%	0%	0%	0%	0%	54%

Table B58: Annual Water Management of Bisri Reservoir for the year 2000 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**0.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	-	-	-	2.44	4.99	5.94	5.23	2.92	0.45	-	-	-
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.25	2.66	0.34	0.16	0.06	0.00	-	-
Total Volumes (Mm^3)	0.00	0.03	0.09	2.61	5.24	8.60	5.57	3.08	0.51	0.00	-	-
Evaporation (Mm^3)	0.04	0.01	-	-	-	-	-	-	0.04	0.14	0.08	0.05
Infiltration (Mm^3)	-	-	-	-	0.01	0.04	0.08	0.11	0.12	0.13	0.05	-
Total Losses (Mm^3)	0.04	0.01	-	-	0.01	0.04	0.08	0.11	0.16	0.26	0.13	0.05
Reservoir Area (Mm^2)	0.69	0.69	0.69	0.69	0.86	1.19	1.65	1.90	2.03	2.05	1.26	0.69
Reservoir Volume (Mm^3)	-	-	-	2.61	7.84	16.40	21.89	24.86	25.20	9.18	-	-
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	15.80	15.75	15.68	-	-	-	-	-	-	-	6.72	15.82
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	100%	100%	99%	0%	0%	0%	0%	0%	0%	0%	43%	100%

Table B59: Annual Water Management of Bisri Reservoir for the year 2001 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**0.0**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.09	0.12	1.62	3.59	14.92	4.80	9.39	13.97	5.84	4.48	4.04	1.55
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.28	3.96	0.44	0.21	0.08	0.00	-	-
Total Volumes (Mm^3)	0.09	0.15	1.71	3.75	15.20	8.76	9.83	14.18	5.92	4.49	4.04	1.55
Evaporation (Mm^3)	0.04	0.01	-	-	-	-	-	-	0.05	0.20	0.18	0.16
Infiltration (Mm^3)	-	-	-	-	0.02	0.09	0.14	0.19	0.26	0.28	0.23	0.16
Total Losses (Mm^3)	0.04	0.01	-	-	0.02	0.09	0.14	0.19	0.31	0.48	0.41	0.33
Reservoir Area (Mm^2)	0.69	0.69	0.69	0.69	0.94	1.77	2.14	2.48	2.85	2.96	2.70	2.34
Reservoir Volume (Mm^3)	-	-	-	3.75	18.94	27.61	37.29	51.29	56.90	45.14	33.00	18.46
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	15.71	15.63	14.06	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	100%	99%	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B60: Annual Water Management of Bisri Reservoir for the year 2002 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**18.5**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.90	0.40	1.45	44.85	17.96	116.85	242.97	24.61	14.83	4.87	9.96	7.48
Precipitations (Mm^3)	0.00	0.04	0.09	0.16	0.80	6.90	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.90	0.43	1.54	45.02	18.76	123.75	243.70	24.92	14.93	4.87	9.96	7.48
Evaporation (Mm^3)	0.09	0.01	-	-	-	-	-	-	0.06	0.24	0.23	0.24
Infiltration (Mm^3)	0.09	0.02	-	-	0.23	0.32	0.51	0.51	0.51	0.51	0.45	0.42
Total Losses (Mm^3)	0.18	0.03	-	-	0.23	0.32	0.51	0.51	0.57	0.75	0.68	0.65
Reservoir Area (Mm^2)	1.75	0.92	0.69	0.69	2.70	3.08	3.57	3.57	3.57	3.57	3.44	3.36
Reservoir Volume (Mm^3)	3.40	-	-	45.02	63.55	102.00	102.00	102.00	102.00	90.36	83.86	74.92
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	11.96	14.23	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	84.98	243.19	24.41	14.36	-	-	-
Potable Water Shortage (%)	0%	76%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B61: Annual Water Management of Bisri Reservoir for the year 2003 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**74.9**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	1.68	1.27	2.60	2.58	31.31	33.49	18.63	6.70	4.26	2.59	2.20	1.34
Precipitations (Mm^3)	0.00	0.12	0.35	0.55	0.71	7.03	0.73	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	1.68	1.39	2.95	3.13	32.03	40.52	19.37	7.00	4.36	2.59	2.20	1.34
Evaporation (Mm^3)	0.17	0.03	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.37	0.30	0.23	0.16	0.18	0.34	0.51	0.51	0.51	0.51	0.44	0.37
Total Losses (Mm^3)	0.54	0.33	0.23	0.16	0.18	0.34	0.51	0.51	0.57	0.75	0.67	0.60
Reservoir Area (Mm^2)	3.25	3.03	2.71	2.32	2.42	3.14	3.57	3.57	3.57	3.57	3.41	3.23
Reservoir Volume (Mm^3)	60.29	45.58	32.53	35.50	67.35	102.00	102.00	102.00	102.00	88.07	73.84	58.81
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	5.54	18.86	6.49	3.79	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B62: Annual Water Management of Bisri Reservoir for the year 2004 (All Data)

Irrigation Water Demand:		m^3/ha	Reservoir Storage:	110.0	Mm^3
Irrigated Area:		ha	Reservoir active Storage:	102.0	Mm^3
Potable Water Demand:	6.00	m^3/s	Reservoir carryover Storage:	58.8	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	0.32	0.52	6.02	3.36	16.62	38.90	16.86	10.17	8.04	1.95	1.41	1.04
Precipitations (Mm^3)	0.00	0.11	0.28	0.41	0.56	5.64	0.69	0.31	0.10	0.00	-	-
Total Volumes (Mm^3)	0.32	0.63	6.29	3.77	17.17	44.54	17.55	10.47	8.14	1.96	1.41	1.04
Evaporation (Mm^3)	0.16	0.02	-	-	-	-	-	-	0.06	0.24	0.23	0.23
Infiltration (Mm^3)	0.29	0.21	0.14	0.09	0.11	0.19	0.42	0.50	0.51	0.51	0.44	0.36
Total Losses (Mm^3)	0.45	0.24	0.14	0.09	0.11	0.19	0.42	0.50	0.57	0.75	0.67	0.59
Reservoir Area (Mm^2)	3.00	2.64	2.14	1.72	1.89	2.52	3.35	3.55	3.57	3.57	3.40	3.22
Reservoir Volume (Mm^3)	42.92	27.54	17.93	21.61	38.67	83.02	100.15	102.00	102.00	87.44	72.41	57.10
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	8.13	7.57	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B63: Annual Water Management of Bisri Reservoir for the year 2005 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**57.1**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.04	1.63	4.79	2.69	9.12	11.30	10.33	17.46	5.73	2.33	2.03	2.27
Precipitations (Mm^3)	0.00	0.11	0.28	0.39	0.53	4.94	0.55	0.25	0.09	0.00	-	-
Total Volumes (Mm^3)	1.04	1.73	5.07	3.09	9.65	16.24	10.89	17.71	5.82	2.33	2.03	2.27
Evaporation (Mm^3)	0.15	0.02	-	-	-	-	-	-	0.06	0.22	0.21	0.20
Infiltration (Mm^3)	0.29	0.21	0.14	0.08	0.10	0.15	0.23	0.28	0.37	0.39	0.32	0.25
Total Losses (Mm^3)	0.44	0.23	0.14	0.08	0.10	0.15	0.23	0.28	0.43	0.62	0.53	0.45
Reservoir Area (Mm^2)	2.97	2.61	2.14	1.67	1.81	2.21	2.71	2.95	3.23	3.30	3.10	2.83
Reservoir Volume (Mm^3)	41.93	27.67	16.83	19.83	29.38	45.47	56.14	73.57	78.96	64.91	50.64	36.69
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B64: Annual Water Management of Bisri Reservoir for the year 2006 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**36.7**	Mm^3

	Sep.	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**
Derived Virgin Flows at Damsite (Mm^3)	0.98	1.02	6.59	3.11	9.05	16.56	12.63	10.78	4.62	1.53	1.00	1.07
Precipitations (Mm^3)	0.00	0.08	0.14	0.16	0.27	3.25	0.47	0.23	0.08	0.00	-	-
Total Volumes (Mm^3)	0.98	1.10	6.74	3.27	9.32	19.81	13.11	11.01	4.70	1.53	1.00	1.07
Evaporation (Mm^3)	0.13	0.02	-	-	-	-	-	-	0.05	0.20	0.18	0.16
Infiltration (Mm^3)	0.18	0.11	0.03	-	0.02	0.06	0.16	0.23	0.28	0.30	0.23	0.15
Total Losses (Mm^3)	0.31	0.12	0.03	-	0.02	0.06	0.16	0.23	0.33	0.50	0.41	0.31
Reservoir Area (Mm^2)	2.46	1.89	1.13	0.69	0.91	1.45	2.31	2.70	2.95	3.03	2.71	2.25
Reservoir Volume (Mm^3)	21.59	6.80	-	3.27	12.57	32.31	45.26	56.04	60.41	45.67	30.49	15.48
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	-	2.26	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B65: Annual Water Management of Bisri Reservoir for the year 2007 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**15.5**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	2.31	1.85	1.46	2.50	2.09	14.85	9.09	10.32	5.89	3.12	1.99	1.24
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.26	2.27	0.39	0.20	0.07	0.00	-	-
Total Volumes (Mm^3)	2.31	1.88	1.55	2.66	2.34	17.13	9.48	10.52	5.96	3.12	1.99	1.24
Evaporation (Mm^3)	0.08	0.01	-	-	-	-	-	-	0.05	0.18	0.16	0.13
Infiltration (Mm^3)	0.08	0.01	-	-	0.01	0.02	0.11	0.16	0.21	0.24	0.17	0.10
Total Losses (Mm^3)	0.16	0.02	-	-	0.01	0.02	0.11	0.16	0.26	0.42	0.33	0.23
Reservoir Area (Mm^2)	1.60	0.82	0.69	0.69	0.87	1.02	1.91	2.28	2.61	2.76	2.39	1.84
Reservoir Volume (Mm^3)	1.87	-	-	2.66	4.99	22.09	31.46	41.82	47.53	34.46	20.35	5.59
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	-	12.04	14.22	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	0%	76%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table B66: Annual Water Management of Bisri Reservoir for the year 2008 (All Data)

Irrigation Water Demand:		m^3/ha	**Reservoir Storage:**	**110.0**	Mm^3
Irrigated Area:		ha	**Reservoir active Storage:**	**102.0**	Mm^3
Potable Water Demand:	**6.00**	m^3/s	**Reservoir carryover Storage:**	**5.6**	Mm^3

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Derived Virgin Flows at Damsite (Mm^3)	1.34	1.45	1.17	2.57	3.53	16.27	15.16	10.30	3.83	2.09	1.93	1.33
Precipitations (Mm^3)	0.00	0.03	0.09	0.16	0.26	2.48	0.42	0.22	0.08	0.00	-	-
Total Volumes (Mm^3)	1.34	1.47	1.26	2.73	3.79	18.75	15.58	10.52	3.91	2.10	1.93	1.33
Evaporation (Mm^3)	0.05	0.01	-	-	-	-	-	-	0.05	0.20	0.17	0.15
Infiltration (Mm^3)	0.03	-	-	-	0.01	0.03	0.13	0.20	0.25	0.27	0.20	0.13
Total Losses (Mm^3)	0.08	0.01	-	-	0.01	0.03	0.13	0.20	0.31	0.47	0.37	0.28
Reservoir Area (Mm^2)	1.05	0.69	0.69	0.69	0.87	1.11	2.05	2.58	2.84	2.92	2.57	2.09
Reservoir Volume (Mm^3)	-	-	-	2.73	6.51	25.22	40.67	50.99	54.60	40.46	26.25	11.54
Irrigation Needs (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation Efficiency (%)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Needs (Mm^3)	15.77	15.77	15.77	-	-	-	-	-	-	15.77	15.77	15.77
Potable Water Deficit (Mm^3)	8.92	14.30	14.51	-	-	-	-	-	-	-	-	-
Overflow (Mm^3)	-	-	-	-	-	-	-	-	-	-	-	-
Potable Water Shortage (%)	57%	91%	92%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Appendix C - Results of the Financial Sensibility Analyses (Reservoir Volume = 110Mm^3, Release Rate = 6m^3/s, All Data)

TABLE C.1: Results of the Sensitivity Analyses (Cost of Money 13% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$65.97	million
Escalated Capital Cost (yr 2015)	$358.22	million
Capital Cost (yr 2010)	$280.67	million
Average unit Cost of Water (actual)	$0.61	/ m^3
Average Unit Cost of Water (yr 2010)	$0.25	/ m^3
Debt Service Cost (sum for 30 years)	$1,433.71	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	3.56						
2013	114.16	132.16	21.20						
2014	109.20	132.73	41.21						
2015				358.22	47.79	2.92	50.71	0.57	0.45
2016					47.79	3.07	50.86	0.57	0.43
2017					47.79	3.22	51.01	0.57	0.41
2018					47.79	3.38	51.17	0.57	0.39
2019					47.79	3.55	51.34	0.58	0.37
2020					47.79	3.73	51.52	0.58	0.36
2021					47.79	3.92	51.71	0.58	0.34
2022					47.79	4.11	51.90	0.58	0.32
2023					47.79	4.32	52.11	0.59	0.31
2024					47.79	4.53	52.32	0.59	0.30
2025					47.79	4.76	52.55	0.59	0.28
2026					47.79	5.00	52.79	0.59	0.27
2027					47.79	5.25	53.04	0.60	0.26
2028					47.79	5.51	53.30	0.60	0.25
2029					47.79	5.79	53.58	0.60	0.24
2030					47.79	6.08	53.87	0.61	0.23
2031					47.79	6.38	54.17	0.61	0.22
2032					47.79	6.70	54.49	0.61	0.21
2033					47.79	7.03	54.82	0.62	0.20
2034					47.79	7.39	55.18	0.62	0.19
2035					47.79	7.75	55.54	0.62	0.18
2036					47.79	8.14	55.93	0.63	0.18
2037					47.79	8.55	56.34	0.63	0.17
2038					47.79	8.98	56.77	0.64	0.16
2039					47.79	9.43	57.22	0.64	0.16
2040					47.79	9.90	57.69	0.65	0.15
2041					47.79	10.39	58.18	0.65	0.14
2042					47.79	10.91	58.70	0.66	0.14
2043					47.79	11.46	59.25	0.67	0.13
2044					47.79	12.03	59.82	0.67	0.13

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.2: Results of the Sensitivity Analyses (Cost of Money 12% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$60.63	million
Escalated Capital Cost (yr 2015)	$352.88	million
Capital Cost (yr 2010)	$276.49	million
Average unit Cost of Water (actual)	$0.56	/ m^3
Average Unit Cost of Water (yr 2010)	$0.23	/ m^3
Debt Service Cost (sum for 30 years)	$1,314.24	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	3.28						
2013	114.16	132.16	19.54						
2014	109.20	132.73	37.81						
2015				352.88	43.81	2.92	46.73	0.52	0.41
2016					43.81	3.07	46.88	0.53	0.39
2017					43.81	3.22	47.03	0.53	0.38
2018					43.81	3.38	47.19	0.53	0.36
2019					43.81	3.55	47.36	0.53	0.34
2020					43.81	3.73	47.54	0.53	0.33
2021					43.81	3.92	47.72	0.54	0.31
2022					43.81	4.11	47.92	0.54	0.30
2023					43.81	4.32	48.13	0.54	0.29
2024					43.81	4.53	48.34	0.54	0.27
2025					43.81	4.76	48.57	0.55	0.26
2026					43.81	5.00	48.81	0.55	0.25
2027					43.81	5.25	49.06	0.55	0.24
2028					43.81	5.51	49.32	0.55	0.23
2029					43.81	5.79	49.59	0.56	0.22
2030					43.81	6.08	49.88	0.56	0.21
2031					43.81	6.38	50.19	0.56	0.20
2032					43.81	6.70	50.51	0.57	0.19
2033					43.81	7.03	50.84	0.57	0.19
2034					43.81	7.39	51.19	0.58	0.18
2035					43.81	7.75	51.56	0.58	0.17
2036					43.81	8.14	51.95	0.58	0.16
2037					43.81	8.55	52.36	0.59	0.16
2038					43.81	8.98	52.78	0.59	0.15
2039					43.81	9.43	53.23	0.60	0.15
2040					43.81	9.90	53.70	0.60	0.14
2041					43.81	10.39	54.20	0.61	0.13
2042					43.81	10.91	54.72	0.61	0.13
2043					43.81	11.46	55.26	0.62	0.12
2044					43.81	12.03	55.84	0.63	0.12

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.3: Results of the Sensitivity Analyses (Cost of Money 11% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$55.33	million
Escalated Capital Cost (yr 2015)	$347.59	million
Capital Cost (yr 2010)	$272.34	million
Average unit Cost of Water (actual)	$0.52	/ m^3
Average Unit Cost of Water (yr 2010)	$0.22	/ m^3
Debt Service Cost (sum for 30 years)	$1,199.43	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	3.01						
2013	114.16	132.16	17.88						
2014	109.20	132.73	34.45						
2015				347.59	39.98	2.92	42.90	0.48	0.38
2016					39.98	3.07	43.05	0.48	0.36
2017					39.98	3.22	43.20	0.49	0.34
2018					39.98	3.38	43.36	0.49	0.33
2019					39.98	3.55	43.53	0.49	0.32
2020					39.98	3.73	43.71	0.49	0.30
2021					39.98	3.92	43.90	0.49	0.29
2022					39.98	4.11	44.09	0.50	0.28
2023					39.98	4.32	44.30	0.50	0.26
2024					39.98	4.53	44.51	0.50	0.25
2025					39.98	4.76	44.74	0.50	0.24
2026					39.98	5.00	44.98	0.51	0.23
2027					39.98	5.25	45.23	0.51	0.22
2028					39.98	5.51	45.49	0.51	0.21
2029					39.98	5.79	45.77	0.51	0.20
2030					39.98	6.08	46.06	0.52	0.19
2031					39.98	6.38	46.36	0.52	0.19
2032					39.98	6.70	46.68	0.52	0.18
2033					39.98	7.03	47.01	0.53	0.17
2034					39.98	7.39	47.37	0.53	0.16
2035					39.98	7.75	47.74	0.54	0.16
2036					39.98	8.14	48.12	0.54	0.15
2037					39.98	8.55	48.53	0.55	0.15
2038					39.98	8.98	48.96	0.55	0.14
2039					39.98	9.43	49.41	0.55	0.13
2040					39.98	9.90	49.88	0.56	0.13
2041					39.98	10.39	50.37	0.57	0.12
2042					39.98	10.91	50.89	0.57	0.12
2043					39.98	11.46	51.44	0.58	0.12
2044					39.98	12.03	52.01	0.58	0.11

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.4: Results of the Sensitivity Analyses (Cost of Money 10% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters

Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results

Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$50.08	million
Escalated Capital Cost (yr 2015)	$342.33	million
Capital Cost (yr 2010)	$268.23	million
Average unit Cost of Water (actual)	$0.48	/ m^3
Average Unit Cost of Water (yr 2010)	$0.20	/ m^3
Debt Service Cost (sum for 30 years)	$1,089.44	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	2.74						
2013	114.16	132.16	16.23						
2014	109.20	132.73	31.12						
2015				342.33	36.31	2.92	39.24	0.44	0.35
2016					36.31	3.07	39.38	0.44	0.33
2017					36.31	3.22	39.54	0.44	0.32
2018					36.31	3.38	39.70	0.45	0.30
2019					36.31	3.55	39.87	0.45	0.29
2020					36.31	3.73	40.04	0.45	0.28
2021					36.31	3.92	40.23	0.45	0.26
2022					36.31	4.11	40.43	0.45	0.25
2023					36.31	4.32	40.63	0.46	0.24
2024					36.31	4.53	40.85	0.46	0.23
2025					36.31	4.76	41.08	0.46	0.22
2026					36.31	5.00	41.31	0.46	0.21
2027					36.31	5.25	41.56	0.47	0.20
2028					36.31	5.51	41.83	0.47	0.20
2029					36.31	5.79	42.10	0.47	0.19
2030					36.31	6.08	42.39	0.48	0.18
2031					36.31	6.38	42.69	0.48	0.17
2032					36.31	6.70	43.01	0.48	0.17
2033					36.31	7.03	43.35	0.49	0.16
2034					36.31	7.39	43.70	0.49	0.15
2035					36.31	7.75	44.07	0.49	0.15
2036					36.31	8.14	44.46	0.50	0.14
2037					36.31	8.55	44.86	0.50	0.13
2038					36.31	8.98	45.29	0.51	0.13
2039					36.31	9.43	45.74	0.51	0.12
2040					36.31	9.90	46.21	0.52	0.12
2041					36.31	10.39	46.71	0.52	0.12
2042					36.31	10.91	47.23	0.53	0.11
2043					36.31	11.46	47.77	0.54	0.11
2044					36.31	12.03	48.34	0.54	0.10

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.5: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$44.88	million
Escalated Capital Cost (yr 2015)	$337.13	million
Capital Cost (yr 2010)	$264.15	million
Average unit Cost of Water (actual)	$0.44	/ m^3
Average Unit Cost of Water (yr 2010)	$0.18	/ m^3
Debt Service Cost (sum for 30 years)	$984.45	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	2.46						
2013	114.16	132.16	14.58						
2014	109.20	132.73	27.84						
2015				337.13	32.81	2.92	35.74	0.40	0.31
2016					32.81	3.07	35.88	0.40	0.30
2017					32.81	3.22	36.04	0.40	0.29
2018					32.81	3.38	36.20	0.41	0.28
2019					32.81	3.55	36.37	0.41	0.26
2020					32.81	3.73	36.54	0.41	0.25
2021					32.81	3.92	36.73	0.41	0.24
2022					32.81	4.11	36.93	0.41	0.23
2023					32.81	4.32	37.13	0.42	0.22
2024					32.81	4.53	37.35	0.42	0.21
2025					32.81	4.76	37.58	0.42	0.20
2026					32.81	5.00	37.81	0.42	0.19
2027					32.81	5.25	38.06	0.43	0.19
2028					32.81	5.51	38.33	0.43	0.18
2029					32.81	5.79	38.60	0.43	0.17
2030					32.81	6.08	38.89	0.44	0.16
2031					32.81	6.38	39.19	0.44	0.16
2032					32.81	6.70	39.51	0.44	0.15
2033					32.81	7.03	39.85	0.45	0.15
2034					32.81	7.39	40.20	0.45	0.14
2035					32.81	7.75	40.57	0.46	0.13
2036					32.81	8.14	40.96	0.46	0.13
2037					32.81	8.55	41.36	0.46	0.12
2038					32.81	8.98	41.79	0.47	0.12
2039					32.81	9.43	42.24	0.47	0.12
2040					32.81	9.90	42.71	0.48	0.11
2041					32.81	10.39	43.21	0.49	0.11
2042					32.81	10.91	43.73	0.49	0.10
2043					32.81	11.46	44.27	0.50	0.10
2044					32.81	12.03	44.84	0.50	0.10

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.6: Results of the Sensitivity Analyses (Cost of Money 8% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$39.72	million
Escalated Capital Cost (yr 2015)	$331.97	million
Capital Cost (yr 2010)	$260.11	million
Average unit Cost of Water (actual)	$0.40	/ m^3
Average Unit Cost of Water (yr 2010)	$0.17	/ m^3
Debt Service Cost (sum for 30 years)	$884.64	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	2.19						
2013	114.16	132.16	12.94						
2014	109.20	132.73	24.59						
2015				331.97	29.49	2.92	32.41	0.36	0.29
2016					29.49	3.07	32.56	0.37	0.27
2017					29.49	3.22	32.71	0.37	0.26
2018					29.49	3.38	32.87	0.37	0.25
2019					29.49	3.55	33.04	0.37	0.24
2020					29.49	3.73	33.22	0.37	0.23
2021					29.49	3.92	33.40	0.38	0.22
2022					29.49	4.11	33.60	0.38	0.21
2023					29.49	4.32	33.81	0.38	0.20
2024					29.49	4.53	34.02	0.38	0.19
2025					29.49	4.76	34.25	0.38	0.19
2026					29.49	5.00	34.49	0.39	0.18
2027					29.49	5.25	34.74	0.39	0.17
2028					29.49	5.51	35.00	0.39	0.16
2029					29.49	5.79	35.27	0.40	0.16
2030					29.49	6.08	35.56	0.40	0.15
2031					29.49	6.38	35.87	0.40	0.14
2032					29.49	6.70	36.19	0.41	0.14
2033					29.49	7.03	36.52	0.41	0.13
2034					29.49	7.39	36.87	0.41	0.13
2035					29.49	7.75	37.24	0.42	0.12
2036					29.49	8.14	37.63	0.42	0.12
2037					29.49	8.55	38.04	0.43	0.11
2038					29.49	8.98	38.46	0.43	0.11
2039					29.49	9.43	38.91	0.44	0.11
2040					29.49	9.90	39.38	0.44	0.10
2041					29.49	10.39	39.88	0.45	0.10
2042					29.49	10.91	40.40	0.45	0.10
2043					29.49	11.46	40.94	0.46	0.09
2044					29.49	12.03	41.52	0.47	0.09

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.7: Results of the Sensitivity Analyses (Cost of Money 7% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$34.60	million
Escalated Capital Cost (yr 2015)	$326.85	million
Capital Cost (yr 2010)	$256.10	million
Average unit Cost of Water (actual)	$0.37	/ m^3
Average Unit Cost of Water (yr 2010)	$0.15	/ m^3
Debt Service Cost (sum for 30 years)	$790.19	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	1.92						
2013	114.16	132.16	11.30						
2014	109.20	132.73	21.38						
2015				326.85	26.34	2.92	29.26	0.33	0.26
2016					26.34	3.07	29.41	0.33	0.25
2017					26.34	3.22	29.56	0.33	0.24
2018					26.34	3.38	29.72	0.33	0.23
2019					26.34	3.55	29.89	0.34	0.22
2020					26.34	3.73	30.07	0.34	0.21
2021					26.34	3.92	30.26	0.34	0.20
2022					26.34	4.11	30.45	0.34	0.19
2023					26.34	4.32	30.66	0.34	0.18
2024					26.34	4.53	30.87	0.35	0.18
2025					26.34	4.76	31.10	0.35	0.17
2026					26.34	5.00	31.34	0.35	0.16
2027					26.34	5.25	31.59	0.35	0.15
2028					26.34	5.51	31.85	0.36	0.15
2029					26.34	5.79	32.13	0.36	0.14
2030					26.34	6.08	32.42	0.36	0.14
2031					26.34	6.38	32.72	0.37	0.13
2032					26.34	6.70	33.04	0.37	0.13
2033					26.34	7.03	33.37	0.37	0.12
2034					26.34	7.39	33.72	0.38	0.12
2035					26.34	7.75	34.09	0.38	0.11
2036					26.34	8.14	34.48	0.39	0.11
2037					26.34	8.55	34.89	0.39	0.10
2038					26.34	8.98	35.32	0.40	0.10
2039					26.34	9.43	35.77	0.40	0.10
2040					26.34	9.90	36.24	0.41	0.09
2041					26.34	10.39	36.73	0.41	0.09
2042					26.34	10.91	37.25	0.42	0.09
2043					26.34	11.46	37.80	0.42	0.08
2044					26.34	12.03	38.37	0.43	0.08

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.8: Results of the Sensitivity Analyses (Cost of Money 6% / Escalation 5%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6.00%	
Time Period	30	years
Escalation	5.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$29.53	million
Escalated Capital Cost (yr 2015)	$321.78	million
Capital Cost (yr 2010)	$252.12	million
Average unit Cost of Water (actual)	$0.34	/ m^3
Average Unit Cost of Water (yr 2010)	$0.14	/ m^3
Debt Service Cost (sum for 30 years)	$701.30	million
O,M, & R Cost (sum for 30 years)	$194.17	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	27.36	1.64						
2013	114.16	132.16	9.67						
2014	109.20	132.73	18.21						
2015				321.78	23.38	2.92	26.30	0.30	0.23
2016					23.38	3.07	26.45	0.30	0.22
2017					23.38	3.22	26.60	0.30	0.21
2018					23.38	3.38	26.76	0.30	0.20
2019					23.38	3.55	26.93	0.30	0.19
2020					23.38	3.73	27.11	0.30	0.19
2021					23.38	3.92	27.29	0.31	0.18
2022					23.38	4.11	27.49	0.31	0.17
2023					23.38	4.32	27.69	0.31	0.16
2024					23.38	4.53	27.91	0.31	0.16
2025					23.38	4.76	28.14	0.32	0.15
2026					23.38	5.00	28.38	0.32	0.15
2027					23.38	5.25	28.63	0.32	0.14
2028					23.38	5.51	28.89	0.32	0.13
2029					23.38	5.79	29.16	0.33	0.13
2030					23.38	6.08	29.45	0.33	0.12
2031					23.38	6.38	29.76	0.33	0.12
2032					23.38	6.70	30.08	0.34	0.12
2033					23.38	7.03	30.41	0.34	0.11
2034					23.38	7.39	30.76	0.35	0.11
2035					23.38	7.75	31.13	0.35	0.10
2036					23.38	8.14	31.52	0.35	0.10
2037					23.38	8.55	31.93	0.36	0.10
2038					23.38	8.98	32.35	0.36	0.09
2039					23.38	9.43	32.80	0.37	0.09
2040					23.38	9.90	33.27	0.37	0.09
2041					23.38	10.39	33.77	0.38	0.08
2042					23.38	10.91	34.29	0.39	0.08
2043					23.38	11.46	34.83	0.39	0.08
2044					23.38	12.03	35.41	0.40	0.08

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.9: Results of the Sensitivity Analyses (Cost of Money 13% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$64.05	million
Escalated Capital Cost (yr 2015)	$347.06	million
Capital Cost (yr 2010)	$285.26	million
Average unit Cost of Water (actual)	$0.58	/ m^3
Average Unit Cost of Water (yr 2010)	$0.28	/ m^3
Debt Service Cost (sum for 30 years)	$1,389.06	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	3.49						
2013	114.16	128.42	20.64						
2014	109.20	127.75	39.93						
2015				347.06	46.30	2.83	49.13	0.55	0.45
2016					46.30	2.94	49.25	0.55	0.44
2017					46.30	3.06	49.36	0.55	0.42
2018					46.30	3.18	49.49	0.56	0.41
2019					46.30	3.31	49.61	0.56	0.39
2020					46.30	3.44	49.75	0.56	0.38
2021					46.30	3.58	49.88	0.56	0.36
2022					46.30	3.72	50.03	0.56	0.35
2023					46.30	3.87	50.18	0.56	0.34
2024					46.30	4.03	50.33	0.57	0.33
2025					46.30	4.19	50.49	0.57	0.31
2026					46.30	4.36	50.66	0.57	0.30
2027					46.30	4.53	50.83	0.57	0.29
2028					46.30	4.71	51.01	0.57	0.28
2029					46.30	4.90	51.20	0.58	0.27
2030					46.30	5.10	51.40	0.58	0.26
2031					46.30	5.30	51.60	0.58	0.25
2032					46.30	5.51	51.81	0.58	0.25
2033					46.30	5.73	52.04	0.58	0.24
2034					46.30	5.96	52.26	0.59	0.23
2035					46.30	6.20	52.50	0.59	0.22
2036					46.30	6.45	52.75	0.59	0.21
2037					46.30	6.71	53.01	0.60	0.21
2038					46.30	6.98	53.28	0.60	0.20
2039					46.30	7.25	53.56	0.60	0.19
2040					46.30	7.54	53.85	0.60	0.19
2041					46.30	7.85	54.15	0.61	0.18
2042					46.30	8.16	54.46	0.61	0.17
2043					46.30	8.49	54.79	0.62	0.17
2044					46.30	8.83	55.13	0.62	0.16

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.10: Results of the Sensitivity Analyses (Cost of Money 12% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$58.87	million
Escalated Capital Cost (yr 2015)	$341.88	million
Capital Cost (yr 2010)	$281.00	million
Average unit Cost of Water (actual)	$0.54	/ m^3
Average Unit Cost of Water (yr 2010)	$0.26	/ m^3
Debt Service Cost (sum for 30 years)	$1,273.26	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	3.22						
2013	114.16	128.42	19.02						
2014	109.20	127.75	36.63						
2015				341.88	42.44	2.83	45.27	0.51	0.42
2016					42.44	2.94	45.39	0.51	0.40
2017					42.44	3.06	45.50	0.51	0.39
2018					42.44	3.18	45.63	0.51	0.37
2019					42.44	3.31	45.75	0.51	0.36
2020					42.44	3.44	45.89	0.52	0.35
2021					42.44	3.58	46.02	0.52	0.34
2022					42.44	3.72	46.17	0.52	0.32
2023					42.44	3.87	46.32	0.52	0.31
2024					42.44	4.03	46.47	0.52	0.30
2025					42.44	4.19	46.63	0.52	0.29
2026					42.44	4.36	46.80	0.53	0.28
2027					42.44	4.53	46.97	0.53	0.27
2028					42.44	4.71	47.15	0.53	0.26
2029					42.44	4.90	47.34	0.53	0.25
2030					42.44	5.10	47.54	0.53	0.24
2031					42.44	5.30	47.74	0.54	0.24
2032					42.44	5.51	47.95	0.54	0.23
2033					42.44	5.73	48.18	0.54	0.22
2034					42.44	5.96	48.40	0.54	0.21
2035					42.44	6.20	48.64	0.55	0.20
2036					42.44	6.45	48.89	0.55	0.20
2037					42.44	6.71	49.15	0.55	0.19
2038					42.44	6.98	49.42	0.56	0.19
2039					42.44	7.25	49.70	0.56	0.18
2040					42.44	7.54	49.99	0.56	0.17
2041					42.44	7.85	50.29	0.56	0.17
2042					42.44	8.16	50.60	0.57	0.16
2043					42.44	8.49	50.93	0.57	0.16
2044					42.44	8.83	51.27	0.58	0.15

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.11: Results of the Sensitivity Analyses (Cost of Money 11% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$53.73	million
Escalated Capital Cost (yr 2015)	$336.73	million
Capital Cost (yr 2010)	$276.77	million
Average unit Cost of Water (actual)	$0.49	/ m^3
Average Unit Cost of Water (yr 2010)	$0.24	/ m^3
Debt Service Cost (sum for 30 years)	$1,161.98	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.95						
2013	114.16	128.42	17.40						
2014	109.20	127.75	33.37						
2015				336.73	38.73	2.83	41.56	0.47	0.38
2016					38.73	2.94	41.68	0.47	0.37
2017					38.73	3.06	41.79	0.47	0.36
2018					38.73	3.18	41.92	0.47	0.34
2019					38.73	3.31	42.04	0.47	0.33
2020					38.73	3.44	42.18	0.47	0.32
2021					38.73	3.58	42.31	0.48	0.31
2022					38.73	3.72	42.46	0.48	0.30
2023					38.73	3.87	42.61	0.48	0.29
2024					38.73	4.03	42.76	0.48	0.28
2025					38.73	4.19	42.92	0.48	0.27
2026					38.73	4.36	43.09	0.48	0.26
2027					38.73	4.53	43.26	0.49	0.25
2028					38.73	4.71	43.45	0.49	0.24
2029					38.73	4.90	43.63	0.49	0.23
2030					38.73	5.10	43.83	0.49	0.22
2031					38.73	5.30	44.03	0.49	0.22
2032					38.73	5.51	44.25	0.50	0.21
2033					38.73	5.73	44.47	0.50	0.20
2034					38.73	5.96	44.70	0.50	0.20
2035					38.73	6.20	44.93	0.50	0.19
2036					38.73	6.45	45.18	0.51	0.18
2037					38.73	6.71	45.44	0.51	0.18
2038					38.73	6.98	45.71	0.51	0.17
2039					38.73	7.25	45.99	0.52	0.17
2040					38.73	7.54	46.28	0.52	0.16
2041					38.73	7.85	46.58	0.52	0.16
2042					38.73	8.16	46.89	0.53	0.15
2043					38.73	8.49	47.22	0.53	0.15
2044					38.73	8.83	47.56	0.53	0.14

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.12: Results of the Sensitivity Analyses (Cost of Money 10% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$48.63	million
Escalated Capital Cost (yr 2015)	$331.64	million
Capital Cost (yr 2010)	$272.58	million
Average unit Cost of Water (actual)	$0.45	/ m^3
Average Unit Cost of Water (yr 2010)	$0.22	/ m^3
Debt Service Cost (sum for 30 years)	$1,055.39	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.68						
2013	114.16	128.42	15.79						
2014	109.20	127.75	30.15						
2015				331.64	35.18	2.83	38.01	0.43	0.35
2016					35.18	2.94	38.12	0.43	0.34
2017					35.18	3.06	38.24	0.43	0.33
2018					35.18	3.18	38.36	0.43	0.31
2019					35.18	3.31	38.49	0.43	0.30
2020					35.18	3.44	38.62	0.43	0.29
2021					35.18	3.58	38.76	0.44	0.28
2022					35.18	3.72	38.90	0.44	0.27
2023					35.18	3.87	39.05	0.44	0.26
2024					35.18	4.03	39.21	0.44	0.25
2025					35.18	4.19	39.37	0.44	0.25
2026					35.18	4.36	39.54	0.44	0.24
2027					35.18	4.53	39.71	0.45	0.23
2028					35.18	4.71	39.89	0.45	0.22
2029					35.18	4.90	40.08	0.45	0.21
2030					35.18	5.10	40.28	0.45	0.21
2031					35.18	5.30	40.48	0.45	0.20
2032					35.18	5.51	40.69	0.46	0.19
2033					35.18	5.73	40.91	0.46	0.19
2034					35.18	5.96	41.14	0.46	0.18
2035					35.18	6.20	41.38	0.46	0.17
2036					35.18	6.45	41.63	0.47	0.17
2037					35.18	6.71	41.89	0.47	0.16
2038					35.18	6.98	42.16	0.47	0.16
2039					35.18	7.25	42.43	0.48	0.15
2040					35.18	7.54	42.72	0.48	0.15
2041					35.18	7.85	43.03	0.48	0.14
2042					35.18	8.16	43.34	0.49	0.14
2043					35.18	8.49	43.67	0.49	0.13
2044					35.18	8.83	44.01	0.49	0.13

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.13: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$43.57	million
Escalated Capital Cost (yr 2015)	$326.58	million
Capital Cost (yr 2010)	$268.43	million
Average unit Cost of Water (actual)	$0.42	/ m^3
Average Unit Cost of Water (yr 2010)	$0.20	/ m^3
Debt Service Cost (sum for 30 years)	$953.64	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.42						
2013	114.16	128.42	14.19						
2014	109.20	127.75	26.97						
2015				326.58	31.79	2.83	34.62	0.39	0.32
2016					31.79	2.94	34.73	0.39	0.31
2017					31.79	3.06	34.85	0.39	0.30
2018					31.79	3.18	34.97	0.39	0.29
2019					31.79	3.31	35.10	0.39	0.28
2020					31.79	3.44	35.23	0.40	0.27
2021					31.79	3.58	35.37	0.40	0.26
2022					31.79	3.72	35.51	0.40	0.25
2023					31.79	3.87	35.66	0.40	0.24
2024					31.79	4.03	35.82	0.40	0.23
2025					31.79	4.19	35.98	0.40	0.22
2026					31.79	4.36	36.14	0.41	0.22
2027					31.79	4.53	36.32	0.41	0.21
2028					31.79	4.71	36.50	0.41	0.20
2029					31.79	4.90	36.69	0.41	0.20
2030					31.79	5.10	36.88	0.41	0.19
2031					31.79	5.30	37.09	0.42	0.18
2032					31.79	5.51	37.30	0.42	0.18
2033					31.79	5.73	37.52	0.42	0.17
2034					31.79	5.96	37.75	0.42	0.17
2035					31.79	6.20	37.99	0.43	0.16
2036					31.79	6.45	38.24	0.43	0.15
2037					31.79	6.71	38.50	0.43	0.15
2038					31.79	6.98	38.76	0.44	0.15
2039					31.79	7.25	39.04	0.44	0.14
2040					31.79	7.54	39.33	0.44	0.14
2041					31.79	7.85	39.63	0.45	0.13
2042					31.79	8.16	39.95	0.45	0.13
2043					31.79	8.49	40.27	0.45	0.12
2044					31.79	8.83	40.61	0.46	0.12

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.14: Results of the Sensitivity Analyses (Cost of Money 8% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters

Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results

Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$38.56	million
Escalated Capital Cost (yr 2015)	$321.57	million
Capital Cost (yr 2010)	$264.31	million
Average unit Cost of Water (actual)	$0.38	/ m^3
Average Unit Cost of Water (yr 2010)	$0.18	/ m^3
Debt Service Cost (sum for 30 years)	$856.92	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	2.15						
2013	114.16	128.42	12.59						
2014	109.20	127.75	23.82						
2015				321.57	28.56	2.83	31.39	0.35	0.29
2016					28.56	2.94	31.51	0.35	0.28
2017					28.56	3.06	31.63	0.36	0.27
2018					28.56	3.18	31.75	0.36	0.26
2019					28.56	3.31	31.87	0.36	0.25
2020					28.56	3.44	32.01	0.36	0.24
2021					28.56	3.58	32.15	0.36	0.23
2022					28.56	3.72	32.29	0.36	0.23
2023					28.56	3.87	32.44	0.36	0.22
2024					28.56	4.03	32.59	0.37	0.21
2025					28.56	4.19	32.75	0.37	0.20
2026					28.56	4.36	32.92	0.37	0.20
2027					28.56	4.53	33.10	0.37	0.19
2028					28.56	4.71	33.28	0.37	0.18
2029					28.56	4.90	33.46	0.38	0.18
2030					28.56	5.10	33.66	0.38	0.17
2031					28.56	5.30	33.86	0.38	0.17
2032					28.56	5.51	34.08	0.38	0.16
2033					28.56	5.73	34.30	0.39	0.16
2034					28.56	5.96	34.53	0.39	0.15
2035					28.56	6.20	34.77	0.39	0.15
2036					28.56	6.45	35.01	0.39	0.14
2037					28.56	6.71	35.27	0.40	0.14
2038					28.56	6.98	35.54	0.40	0.13
2039					28.56	7.25	35.82	0.40	0.13
2040					28.56	7.54	36.11	0.41	0.13
2041					28.56	7.85	36.41	0.41	0.12
2042					28.56	8.16	36.72	0.41	0.12
2043					28.56	8.49	37.05	0.42	0.11
2044					28.56	8.83	37.39	0.42	0.11

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.15: Results of the Sensitivity Analyses (Cost of Money 7% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$33.59	million
Escalated Capital Cost (yr 2015)	$316.60	million
Capital Cost (yr 2010)	$260.22	million
Average unit Cost of Water (actual)	$0.35	/ m^3
Average Unit Cost of Water (yr 2010)	$0.17	/ m^3
Debt Service Cost (sum for 30 years)	$765.41	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	1.88						
2013	114.16	128.42	11.00						
2014	109.20	127.75	20.71						
2015				316.60	25.51	2.83	28.34	0.32	0.26
2016					25.51	2.94	28.46	0.32	0.25
2017					25.51	3.06	28.57	0.32	0.24
2018					25.51	3.18	28.70	0.32	0.24
2019					25.51	3.31	28.82	0.32	0.23
2020					25.51	3.44	28.96	0.33	0.22
2021					25.51	3.58	29.09	0.33	0.21
2022					25.51	3.72	29.24	0.33	0.21
2023					25.51	3.87	29.39	0.33	0.20
2024					25.51	4.03	29.54	0.33	0.19
2025					25.51	4.19	29.70	0.33	0.19
2026					25.51	4.36	29.87	0.34	0.18
2027					25.51	4.53	30.04	0.34	0.17
2028					25.51	4.71	30.23	0.34	0.17
2029					25.51	4.90	30.41	0.34	0.16
2030					25.51	5.10	30.61	0.34	0.16
2031					25.51	5.30	30.81	0.35	0.15
2032					25.51	5.51	31.03	0.35	0.15
2033					25.51	5.73	31.25	0.35	0.14
2034					25.51	5.96	31.48	0.35	0.14
2035					25.51	6.20	31.71	0.36	0.13
2036					25.51	6.45	31.96	0.36	0.13
2037					25.51	6.71	32.22	0.36	0.13
2038					25.51	6.98	32.49	0.36	0.12
2039					25.51	7.25	32.77	0.37	0.12
2040					25.51	7.54	33.06	0.37	0.11
2041					25.51	7.85	33.36	0.37	0.11
2042					25.51	8.16	33.67	0.38	0.11
2043					25.51	8.49	34.00	0.38	0.10
2044					25.51	8.83	34.34	0.39	0.10

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.16: Results of the Sensitivity Analyses (Cost of Money 6% / Escalation 4%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6.00%	
Time Period	30	years
Escalation	4.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$28.66	million
Escalated Capital Cost (yr 2015)	$311.67	million
Capital Cost (yr 2010)	$256.17	million
Average unit Cost of Water (actual)	$0.31	/ m^3
Average Unit Cost of Water (yr 2010)	$0.15	/ m^3
Debt Service Cost (sum for 30 years)	$679.28	million
O,M, & R Cost (sum for 30 years)	$158.73	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.84	1.61						
2013	114.16	128.42	9.41						
2014	109.20	127.75	17.64						
2015				311.67	22.64	2.83	25.47	0.29	0.24
2016					22.64	2.94	25.59	0.29	0.23
2017					22.64	3.06	25.70	0.29	0.22
2018					22.64	3.18	25.83	0.29	0.21
2019					22.64	3.31	25.95	0.29	0.20
2020					22.64	3.44	26.09	0.29	0.20
2021					22.64	3.58	26.22	0.29	0.19
2022					22.64	3.72	26.37	0.30	0.18
2023					22.64	3.87	26.52	0.30	0.18
2024					22.64	4.03	26.67	0.30	0.17
2025					22.64	4.19	26.83	0.30	0.17
2026					22.64	4.36	27.00	0.30	0.16
2027					22.64	4.53	27.17	0.31	0.16
2028					22.64	4.71	27.36	0.31	0.15
2029					22.64	4.90	27.54	0.31	0.15
2030					22.64	5.10	27.74	0.31	0.14
2031					22.64	5.30	27.94	0.31	0.14
2032					22.64	5.51	28.16	0.32	0.13
2033					22.64	5.73	28.38	0.32	0.13
2034					22.64	5.96	28.61	0.32	0.13
2035					22.64	6.20	28.84	0.32	0.12
2036					22.64	6.45	29.09	0.33	0.12
2037					22.64	6.71	29.35	0.33	0.11
2038					22.64	6.98	29.62	0.33	0.11
2039					22.64	7.25	29.90	0.34	0.11
2040					22.64	7.54	30.19	0.34	0.10
2041					22.64	7.85	30.49	0.34	0.10
2042					22.64	8.16	30.80	0.35	0.10
2043					22.64	8.49	31.13	0.35	0.10
2044					22.64	8.83	31.47	0.35	0.09

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.17: Results of the Sensitivity Analyses (Cost of Money 13% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$62.18	million
Escalated Capital Cost (yr 2015)	$336.16	million
Capital Cost (yr 2010)	$289.98	million
Average unit Cost of Water (actual)	$0.55	/ m^3
Average Unit Cost of Water (yr 2010)	$0.32	/ m^3
Debt Service Cost (sum for 30 years)	$1,345.44	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	3.42						
2013	114.16	124.75	20.09						
2014	109.20	122.90	38.67						
2015				336.16	44.85	2.74	47.59	0.53	0.46
2016					44.85	2.82	47.67	0.54	0.45
2017					44.85	2.91	47.75	0.54	0.44
2018					44.85	2.99	47.84	0.54	0.42
2019					44.85	3.08	47.93	0.54	0.41
2020					44.85	3.18	48.02	0.54	0.40
2021					44.85	3.27	48.12	0.54	0.39
2022					44.85	3.37	48.22	0.54	0.38
2023					44.85	3.47	48.32	0.54	0.37
2024					44.85	3.57	48.42	0.54	0.36
2025					44.85	3.68	48.53	0.55	0.35
2026					44.85	3.79	48.64	0.55	0.34
2027					44.85	3.91	48.75	0.55	0.33
2028					44.85	4.02	48.87	0.55	0.32
2029					44.85	4.14	48.99	0.55	0.31
2030					44.85	4.27	49.12	0.55	0.31
2031					44.85	4.40	49.24	0.55	0.30
2032					44.85	4.53	49.38	0.55	0.29
2033					44.85	4.66	49.51	0.56	0.28
2034					44.85	4.80	49.65	0.56	0.27
2035					44.85	4.95	49.80	0.56	0.27
2036					44.85	5.10	49.94	0.56	0.26
2037					44.85	5.25	50.10	0.56	0.25
2038					44.85	5.41	50.26	0.56	0.25
2039					44.85	5.57	50.42	0.57	0.24
2040					44.85	5.74	50.58	0.57	0.23
2041					44.85	5.91	50.76	0.57	0.23
2042					44.85	6.09	50.93	0.57	0.22
2043					44.85	6.27	51.12	0.57	0.22
2044					44.85	6.46	51.30	0.58	0.21

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.18: Results of the Sensitivity Analyses (Cost of Money 12% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$57.15	million
Escalated Capital Cost (yr 2015)	$331.13	million
Capital Cost (yr 2010)	$285.63	million
Average unit Cost of Water (actual)	$0.51	/ m^3
Average Unit Cost of Water (yr 2010)	$0.29	/ m^3
Debt Service Cost (sum for 30 years)	$1,233.23	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	3.16						
2013	114.16	124.75	18.51						
2014	109.20	122.90	35.48						
2015				331.13	41.11	2.74	43.85	0.49	0.42
2016					41.11	2.82	43.93	0.49	0.41
2017					41.11	2.91	44.01	0.49	0.40
2018					41.11	2.99	44.10	0.50	0.39
2019					41.11	3.08	44.19	0.50	0.38
2020					41.11	3.18	44.28	0.50	0.37
2021					41.11	3.27	44.38	0.50	0.36
2022					41.11	3.37	44.48	0.50	0.35
2023					41.11	3.47	44.58	0.50	0.34
2024					41.11	3.57	44.68	0.50	0.33
2025					41.11	3.68	44.79	0.50	0.32
2026					41.11	3.79	44.90	0.50	0.31
2027					41.11	3.91	45.01	0.51	0.31
2028					41.11	4.02	45.13	0.51	0.30
2029					41.11	4.14	45.25	0.51	0.29
2030					41.11	4.27	45.38	0.51	0.28
2031					41.11	4.40	45.50	0.51	0.27
2032					41.11	4.53	45.64	0.51	0.27
2033					41.11	4.66	45.77	0.51	0.26
2034					41.11	4.80	45.91	0.52	0.25
2035					41.11	4.95	46.06	0.52	0.25
2036					41.11	5.10	46.20	0.52	0.24
2037					41.11	5.25	46.36	0.52	0.23
2038					41.11	5.41	46.51	0.52	0.23
2039					41.11	5.57	46.68	0.52	0.22
2040					41.11	5.74	46.84	0.53	0.22
2041					41.11	5.91	47.02	0.53	0.21
2042					41.11	6.09	47.19	0.53	0.21
2043					41.11	6.27	47.38	0.53	0.20
2044					41.11	6.46	47.56	0.53	0.20

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.19: Results of the Sensitivity Analyses (Cost of Money 11% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$52.15	million
Escalated Capital Cost (yr 2015)	$326.14	million
Capital Cost (yr 2010)	$281.33	million
Average unit Cost of Water (actual)	$0.47	/ m^3
Average Unit Cost of Water (yr 2010)	$0.27	/ m^3
Debt Service Cost (sum for 30 years)	$1,125.41	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	2.90						
2013	114.16	124.75	16.94						
2014	109.20	122.90	32.32						
2015				326.14	37.51	2.74	40.25	0.45	0.39
2016					37.51	2.82	40.34	0.45	0.38
2017					37.51	2.91	40.42	0.45	0.37
2018					37.51	2.99	40.51	0.45	0.36
2019					37.51	3.08	40.60	0.46	0.35
2020					37.51	3.18	40.69	0.46	0.34
2021					37.51	3.27	40.79	0.46	0.33
2022					37.51	3.37	40.88	0.46	0.32
2023					37.51	3.47	40.98	0.46	0.31
2024					37.51	3.57	41.09	0.46	0.31
2025					37.51	3.68	41.20	0.46	0.30
2026					37.51	3.79	41.31	0.46	0.29
2027					37.51	3.91	41.42	0.47	0.28
2028					37.51	4.02	41.54	0.47	0.27
2029					37.51	4.14	41.66	0.47	0.27
2030					37.51	4.27	41.78	0.47	0.26
2031					37.51	4.40	41.91	0.47	0.25
2032					37.51	4.53	42.04	0.47	0.25
2033					37.51	4.66	42.18	0.47	0.24
2034					37.51	4.80	42.32	0.48	0.23
2035					37.51	4.95	42.46	0.48	0.23
2036					37.51	5.10	42.61	0.48	0.22
2037					37.51	5.25	42.76	0.48	0.22
2038					37.51	5.41	42.92	0.48	0.21
2039					37.51	5.57	43.08	0.48	0.21
2040					37.51	5.74	43.25	0.49	0.20
2041					37.51	5.91	43.42	0.49	0.20
2042					37.51	6.09	43.60	0.49	0.19
2043					37.51	6.27	43.78	0.49	0.19
2044					37.51	6.46	43.97	0.49	0.18

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.20: Results of the Sensitivity Analyses (Cost of Money 10% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters

Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results

Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$47.20	million
Escalated Capital Cost (yr 2015)	$321.19	million
Capital Cost (yr 2010)	$277.06	million
Average unit Cost of Water (actual)	$0.43	/ m^3
Average Unit Cost of Water (yr 2010)	$0.25	/ m^3
Debt Service Cost (sum for 30 years)	$1,022.13	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	2.63						
2013	114.16	124.75	15.37						
2014	109.20	122.90	29.20						
2015				321.19	34.07	2.74	36.81	0.41	0.36
2016					34.07	2.82	36.89	0.41	0.35
2017					34.07	2.91	36.98	0.42	0.34
2018					34.07	2.99	37.07	0.42	0.33
2019					34.07	3.08	37.15	0.42	0.32
2020					34.07	3.18	37.25	0.42	0.31
2021					34.07	3.27	37.34	0.42	0.30
2022					34.07	3.37	37.44	0.42	0.29
2023					34.07	3.47	37.54	0.42	0.29
2024					34.07	3.57	37.65	0.42	0.28
2025					34.07	3.68	37.75	0.42	0.27
2026					34.07	3.79	37.86	0.43	0.27
2027					34.07	3.91	37.98	0.43	0.26
2028					34.07	4.02	38.09	0.43	0.25
2029					34.07	4.14	38.22	0.43	0.24
2030					34.07	4.27	38.34	0.43	0.24
2031					34.07	4.40	38.47	0.43	0.23
2032					34.07	4.53	38.60	0.43	0.23
2033					34.07	4.66	38.74	0.44	0.22
2034					34.07	4.80	38.88	0.44	0.21
2035					34.07	4.95	39.02	0.44	0.21
2036					34.07	5.10	39.17	0.44	0.20
2037					34.07	5.25	39.32	0.44	0.20
2038					34.07	5.41	39.48	0.44	0.19
2039					34.07	5.57	39.64	0.45	0.19
2040					34.07	5.74	39.81	0.45	0.18
2041					34.07	5.91	39.98	0.45	0.18
2042					34.07	6.09	40.16	0.45	0.18
2043					34.07	6.27	40.34	0.45	0.17
2044					34.07	6.46	40.53	0.46	0.17

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.21: Results of the Sensitivity Analyses (Cost of Money 9% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$42.29	million
Escalated Capital Cost (yr 2015)	$316.28	million
Capital Cost (yr 2010)	$272.82	million
Average unit Cost of Water (actual)	$0.39	/ m^3
Average Unit Cost of Water (yr 2010)	$0.23	/ m^3
Debt Service Cost (sum for 30 years)	$923.56	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	2.37						
2013	114.16	124.75	13.81						
2014	109.20	122.90	26.11						
2015				316.28	30.79	2.74	33.53	0.38	0.32
2016					30.79	2.82	33.61	0.38	0.32
2017					30.79	2.91	33.69	0.38	0.31
2018					30.79	2.99	33.78	0.38	0.30
2019					30.79	3.08	33.87	0.38	0.29
2020					30.79	3.18	33.96	0.38	0.28
2021					30.79	3.27	34.06	0.38	0.28
2022					30.79	3.37	34.15	0.38	0.27
2023					30.79	3.47	34.26	0.38	0.26
2024					30.79	3.57	34.36	0.39	0.26
2025					30.79	3.68	34.47	0.39	0.25
2026					30.79	3.79	34.58	0.39	0.24
2027					30.79	3.91	34.69	0.39	0.24
2028					30.79	4.02	34.81	0.39	0.23
2029					30.79	4.14	34.93	0.39	0.22
2030					30.79	4.27	35.05	0.39	0.22
2031					30.79	4.40	35.18	0.40	0.21
2032					30.79	4.53	35.31	0.40	0.21
2033					30.79	4.66	35.45	0.40	0.20
2034					30.79	4.80	35.59	0.40	0.20
2035					30.79	4.95	35.73	0.40	0.19
2036					30.79	5.10	35.88	0.40	0.19
2037					30.79	5.25	36.04	0.40	0.18
2038					30.79	5.41	36.19	0.41	0.18
2039					30.79	5.57	36.35	0.41	0.17
2040					30.79	5.74	36.52	0.41	0.17
2041					30.79	5.91	36.69	0.41	0.16
2042					30.79	6.09	36.87	0.41	0.16
2043					30.79	6.27	37.05	0.42	0.16
2044					30.79	6.46	37.24	0.42	0.15

Notes :
1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.22: Results of the Sensitivity Analyses (Cost of Money 8% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$37.43	million
Escalated Capital Cost (yr 2015)	$311.41	million
Capital Cost (yr 2010)	$268.63	million
Average unit Cost of Water (actual)	$0.36	/ m^3
Average Unit Cost of Water (yr 2010)	$0.21	/ m^3
Debt Service Cost (sum for 30 years)	$829.86	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	2.11						
2013	114.16	124.75	12.25						
2014	109.20	122.90	23.07						
2015				311.41	27.66	2.74	30.40	0.34	0.29
2016					27.66	2.82	30.48	0.34	0.29
2017					27.66	2.91	30.57	0.34	0.28
2018					27.66	2.99	30.66	0.34	0.27
2019					27.66	3.08	30.75	0.35	0.26
2020					27.66	3.18	30.84	0.35	0.26
2021					27.66	3.27	30.93	0.35	0.25
2022					27.66	3.37	31.03	0.35	0.24
2023					27.66	3.47	31.13	0.35	0.24
2024					27.66	3.57	31.24	0.35	0.23
2025					27.66	3.68	31.34	0.35	0.23
2026					27.66	3.79	31.45	0.35	0.22
2027					27.66	3.91	31.57	0.35	0.21
2028					27.66	4.02	31.69	0.36	0.21
2029					27.66	4.14	31.81	0.36	0.20
2030					27.66	4.27	31.93	0.36	0.20
2031					27.66	4.40	32.06	0.36	0.19
2032					27.66	4.53	32.19	0.36	0.19
2033					27.66	4.66	32.33	0.36	0.18
2034					27.66	4.80	32.47	0.36	0.18
2035					27.66	4.95	32.61	0.37	0.17
2036					27.66	5.10	32.76	0.37	0.17
2037					27.66	5.25	32.91	0.37	0.17
2038					27.66	5.41	33.07	0.37	0.16
2039					27.66	5.57	33.23	0.37	0.16
2040					27.66	5.74	33.40	0.38	0.15
2041					27.66	5.91	33.57	0.38	0.15
2042					27.66	6.09	33.75	0.38	0.15
2043					27.66	6.27	33.93	0.38	0.14
2044					27.66	6.46	34.12	0.38	0.14

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.23: Results of the Sensitivity Analyses (Cost of Money 7% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$32.60	million
Escalated Capital Cost (yr 2015)	$306.59	million
Capital Cost (yr 2010)	$264.47	million
Average unit Cost of Water (actual)	$0.33	/ m^3
Average Unit Cost of Water (yr 2010)	$0.19	/ m^3
Debt Service Cost (sum for 30 years)	$741.20	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	1.84						
2013	114.16	124.75	10.70						
2014	109.20	122.90	20.06						
2015				306.59	24.71	2.74	27.45	0.31	0.27
2016					24.71	2.82	27.53	0.31	0.26
2017					24.71	2.91	27.61	0.31	0.25
2018					24.71	2.99	27.70	0.31	0.25
2019					24.71	3.08	27.79	0.31	0.24
2020					24.71	3.18	27.88	0.31	0.23
2021					24.71	3.27	27.98	0.31	0.23
2022					24.71	3.37	28.08	0.32	0.22
2023					24.71	3.47	28.18	0.32	0.22
2024					24.71	3.57	28.28	0.32	0.21
2025					24.71	3.68	28.39	0.32	0.20
2026					24.71	3.79	28.50	0.32	0.20
2027					24.71	3.91	28.61	0.32	0.19
2028					24.71	4.02	28.73	0.32	0.19
2029					24.71	4.14	28.85	0.32	0.18
2030					24.71	4.27	28.98	0.33	0.18
2031					24.71	4.40	29.10	0.33	0.18
2032					24.71	4.53	29.24	0.33	0.17
2033					24.71	4.66	29.37	0.33	0.17
2034					24.71	4.80	29.51	0.33	0.16
2035					24.71	4.95	29.66	0.33	0.16
2036					24.71	5.10	29.80	0.33	0.16
2037					24.71	5.25	29.96	0.34	0.15
2038					24.71	5.41	30.11	0.34	0.15
2039					24.71	5.57	30.28	0.34	0.14
2040					24.71	5.74	30.44	0.34	0.14
2041					24.71	5.91	30.62	0.34	0.14
2042					24.71	6.09	30.79	0.35	0.13
2043					24.71	6.27	30.98	0.35	0.13
2044					24.71	6.46	31.16	0.35	0.13

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

TABLE C.24: Results of the Sensitivity Analyses (Cost of Money 6% / Escalation 3%)

Construction Cost: $248.18 million Water Supply: 94.6 Mm3/yr

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	464.0	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6.00%	
Time Period	30	years
Escalation	3.00%	
O,M, & R	1.00%	
Water Supply	94.6	million m^3/yr
Release Rate	6	m3/sec
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$27.82	million
Escalated Capital Cost (yr 2015)	$301.81	million
Capital Cost (yr 2010)	$260.34	million
Average unit Cost of Water (actual)	$0.30	/ m^3
Average Unit Cost of Water (yr 2010)	$0.17	/ m^3
Debt Service Cost (sum for 30 years)	$657.78	million
O,M, & R Cost (sum for 30 years)	$130.35	million

Year	Construction Cost 2010 ($10E6)	Construction Cost Escalated ($10E6)	IDC cost ($10E6)	Capital Cost Escalated ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Annual Cost ($10E6)	Unit Cost of Water ($/$m^3$)	2010 Unit Cost of Water ($/$m^3$)
2012	24.82	26.33	1.58						
2013	114.16	124.75	9.16						
2014	109.20	122.90	17.08						
2015				301.81	21.93	2.74	24.67	0.28	0.24
2016					21.93	2.82	24.75	0.28	0.23
2017					21.93	2.91	24.83	0.28	0.23
2018					21.93	2.99	24.92	0.28	0.22
2019					21.93	3.08	25.01	0.28	0.22
2020					21.93	3.18	25.10	0.28	0.21
2021					21.93	3.27	25.20	0.28	0.20
2022					21.93	3.37	25.30	0.28	0.20
2023					21.93	3.47	25.40	0.29	0.19
2024					21.93	3.57	25.50	0.29	0.19
2025					21.93	3.68	25.61	0.29	0.18
2026					21.93	3.79	25.72	0.29	0.18
2027					21.93	3.91	25.83	0.29	0.18
2028					21.93	4.02	25.95	0.29	0.17
2029					21.93	4.14	26.07	0.29	0.17
2030					21.93	4.27	26.19	0.29	0.16
2031					21.93	4.40	26.32	0.30	0.16
2032					21.93	4.53	26.45	0.30	0.16
2033					21.93	4.66	26.59	0.30	0.15
2034					21.93	4.80	26.73	0.30	0.15
2035					21.93	4.95	26.87	0.30	0.14
2036					21.93	5.10	27.02	0.30	0.14
2037					21.93	5.25	27.18	0.31	0.14
2038					21.93	5.41	27.33	0.31	0.13
2039					21.93	5.57	27.50	0.31	0.13
2040					21.93	5.74	27.66	0.31	0.13
2041					21.93	5.91	27.83	0.31	0.13
2042					21.93	6.09	28.01	0.31	0.12
2043					21.93	6.27	28.19	0.32	0.12
2044					21.93	6.46	28.38	0.32	0.12

Notes :

1 All costs are in US dollars
2 Constrcution Cost means the amount of money required in 2010 to construct the dam projec
3 O,M, & R means operation, maintenance, and replacement, calculated as a percentage of the escalated constrcution cos
4 IDC means interest during construction
5 Escalated Capital Cost means the summation of each year's escalated and IDC costs
6 Water Supply means the yearly water supply prior to accounting for any shortages
7 Shortage means the percentage of the average water supply not provided over a long-term perioc
8 Annual Costs means the summation of the annual dept service and O,M,&R costs
9 Unit Costs are based in water supply minus shortage

Appendix D - Results of the Financial IRR Analysis (Reservoir Volume=110Mm^3, Release Rate = 6m^3/s, All Data)

TABLE D.1: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr

Cost of Money: 13% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Real Unit Cost of Water in 2010	$0.41	/ m^3
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.6	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$65.97	million
Capital Cost (yr 2015)	$358.22	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	($50.31)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-3.56			0.42				
2013	-132.16	-21.20			0.42				
2014	-132.73	-41.21			0.43				
2015			-47.79	-2.92	0.43	38.36	-50.71	-12.35	-6.70
2016			-47.79	-3.07	0.44	38.75	-50.86	-12.11	-5.82
2017			-47.79	-3.22	0.44	39.14	-51.01	-11.88	-5.05
2018			-47.79	-3.38	0.44	39.53	-51.17	-11.65	-4.38
2019			-47.79	-3.55	0.45	39.92	-51.34	-11.42	-3.80
2020			-47.79	-3.73	0.45	40.32	-51.52	-11.20	-3.30
2021			-47.79	-3.92	0.46	40.72	-51.71	-10.98	-2.86
2022			-47.79	-4.11	0.46	41.13	-51.90	-10.77	-2.48
2023			-47.79	-4.32	0.47	41.54	-52.11	-10.57	-2.16
2024			-47.79	-4.53	0.47	41.96	-52.32	-10.37	-1.87
2025			-47.79	-4.76	0.48	42.38	-52.55	-10.17	-1.63
2026			-47.79	-5.00	0.48	42.80	-52.79	-9.99	-1.41
2027			-47.79	-5.25	0.49	43.23	-53.04	-9.81	-1.23
2028			-47.79	-5.51	0.49	43.66	-53.30	-9.64	-1.07
2029			-47.79	-5.79	0.50	44.10	-53.58	-9.48	-0.93
2030			-47.79	-6.08	0.50	44.54	-53.87	-9.33	-0.81
2031			-47.79	-6.38	0.51	44.99	-54.17	-9.18	-0.71
2032			-47.79	-6.70	0.51	45.43	-54.49	-9.05	-0.62
2033			-47.79	-7.03	0.52	45.89	-54.82	-8.93	-0.54
2034			-47.79	-7.39	0.52	46.35	-55.18	-8.83	-0.47
2035			-47.79	-7.75	0.53	46.81	-55.54	-8.73	-0.41
2036			-47.79	-8.14	0.53	47.28	-55.93	-8.65	-0.36
2037			-47.79	-8.55	0.54	47.75	-56.34	-8.59	-0.32
2038			-47.79	-8.98	0.54	48.23	-56.77	-8.54	-0.28
2039			-47.79	-9.43	0.55	48.71	-57.22	-8.50	-0.25
2040			-47.79	-9.90	0.55	49.20	-57.69	-8.49	-0.22
2041			-47.79	-10.39	0.56	49.69	-58.18	-8.49	-0.19
2042			-47.79	-10.91	0.56	50.19	-58.70	-8.51	-0.17
2043			-47.79	-11.46	0.57	50.69	-59.25	-8.56	-0.15
2044			-47.79	-12.03	0.58	51.20	-59.82	-8.62	-0.14
								NPV	-50.31

TABLE D.2: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 12% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Real Unit Cost of Water in 2010	$0.41	/ m^3
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$60.63	million
Capital Cost (yr 2015)	$352.88	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	($35.29)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-3.28			0.42				
2013	-132.16	-19.54			0.42				
2014	-132.73	-37.81			0.43				
2015			-43.81	-2.92	0.43	38.36	-46.73	-8.37	-4.75
2016			-43.81	-3.07	0.44	38.75	-46.88	-8.13	-4.12
2017			-43.81	-3.22	0.44	39.14	-47.03	-7.89	-3.57
2018			-43.81	-3.38	0.44	39.53	-47.19	-7.66	-3.10
2019			-43.81	-3.55	0.45	39.92	-47.36	-7.44	-2.68
2020			-43.81	-3.73	0.45	40.32	-47.54	-7.22	-2.32
2021			-43.81	-3.92	0.46	40.72	-47.72	-7.00	-2.01
2022			-43.81	-4.11	0.46	41.13	-47.92	-6.79	-1.74
2023			-43.81	-4.32	0.47	41.54	-48.13	-6.58	-1.51
2024			-43.81	-4.53	0.47	41.96	-48.34	-6.38	-1.31
2025			-43.81	-4.76	0.48	42.38	-48.57	-6.19	-1.13
2026			-43.81	-5.00	0.48	42.80	-48.81	-6.00	-0.98
2027			-43.81	-5.25	0.49	43.23	-49.06	-5.83	-0.85
2028			-43.81	-5.51	0.49	43.66	-49.32	-5.66	-0.74
2029			-43.81	-5.79	0.50	44.10	-49.59	-5.50	-0.64
2030			-43.81	-6.08	0.50	44.54	-49.88	-5.34	-0.55
2031			-43.81	-6.38	0.51	44.99	-50.19	-5.20	-0.48
2032			-43.81	-6.70	0.51	45.43	-50.51	-5.07	-0.42
2033			-43.81	-7.03	0.52	45.89	-50.84	-4.95	-0.37
2034			-43.81	-7.39	0.52	46.35	-51.19	-4.84	-0.32
2035			-43.81	-7.75	0.53	46.81	-51.56	-4.75	-0.28
2036			-43.81	-8.14	0.53	47.28	-51.95	-4.67	-0.25
2037			-43.81	-8.55	0.54	47.75	-52.36	-4.60	-0.22
2038			-43.81	-8.98	0.54	48.23	-52.78	-4.55	-0.19
2039			-43.81	-9.43	0.55	48.71	-53.23	-4.52	-0.17
2040			-43.81	-9.90	0.55	49.20	-53.70	-4.51	-0.15
2041			-43.81	-10.39	0.56	49.69	-54.20	-4.51	-0.13
2042			-43.81	-10.91	0.56	50.19	-54.72	-4.53	-0.12
2043			-43.81	-11.46	0.57	50.69	-55.26	-4.57	-0.11
2044			-43.81	-12.03	0.58	51.20	-55.84	-4.64	-0.10

TABLE D.3: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 11%   Escalation: 5%   Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Real Unit Cost of Water in 2010	$0.41	/ m^3
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$55.33	million
Capital Cost (yr 2015)	$347.59	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	($17.16)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-3.01			0.42				
2013	-132.16	-17.88			0.42				
2014	-132.73	-34.45			0.43				
2015			-39.98	-2.92	0.43	38.36	-42.90	-4.54	-2.69
2016			-39.98	-3.07	0.44	38.75	-43.05	-4.30	-2.30
2017			-39.98	-3.22	0.44	39.14	-43.20	-4.07	-1.96
2018			-39.98	-3.38	0.44	39.53	-43.36	-3.84	-1.67
2019			-39.98	-3.55	0.45	39.92	-43.53	-3.61	-1.41
2020			-39.98	-3.73	0.45	40.32	-43.71	-3.39	-1.19
2021			-39.98	-3.92	0.46	40.72	-43.90	-3.17	-1.01
2022			-39.98	-4.11	0.46	41.13	-44.09	-2.96	-0.85
2023			-39.98	-4.32	0.47	41.54	-44.30	-2.76	-0.71
2024			-39.98	-4.53	0.47	41.96	-44.51	-2.56	-0.59
2025			-39.98	-4.76	0.48	42.38	-44.74	-2.36	-0.49
2026			-39.98	-5.00	0.48	42.80	-44.98	-2.18	-0.41
2027			-39.98	-5.25	0.49	43.23	-45.23	-2.00	-0.34
2028			-39.98	-5.51	0.49	43.66	-45.49	-1.83	-0.28
2029			-39.98	-5.79	0.50	44.10	-45.77	-1.67	-0.23
2030			-39.98	-6.08	0.50	44.54	-46.06	-1.52	-0.19
2031			-39.98	-6.38	0.51	44.99	-46.36	-1.38	-0.15
2032			-39.98	-6.70	0.51	45.43	-46.68	-1.24	-0.13
2033			-39.98	-7.03	0.52	45.89	-47.01	-1.13	-0.10
2034			-39.98	-7.39	0.52	46.35	-47.37	-1.02	-0.08
2035			-39.98	-7.75	0.53	46.81	-47.74	-0.92	-0.07
2036			-39.98	-8.14	0.53	47.28	-48.12	-0.84	-0.06
2037			-39.98	-8.55	0.54	47.75	-48.53	-0.78	-0.05
2038			-39.98	-8.98	0.54	48.23	-48.96	-0.73	-0.04
2039			-39.98	-9.43	0.55	48.71	-49.41	-0.69	-0.03
2040			-39.98	-9.90	0.55	49.20	-49.88	-0.68	-0.03
2041			-39.98	-10.39	0.56	49.69	-50.37	-0.68	-0.03
2042			-39.98	-10.91	0.56	50.19	-50.89	-0.70	-0.02
2043			-39.98	-11.46	0.57	50.69	-51.44	-0.75	-0.02
2044			-39.98	-12.03	0.58	51.20	-52.01	-0.81	-0.02
								NPV	-17.16

TABLE D.4: Results of the IRR Analyses **Water Supply: 94.608 million m3/yr** D

Cost of Money: 10% **Escalation: 5%** **Construction Cost: $ 248.18**

Financial Parameters		
Current Year	2010	
Real Unit Cost of Water in 2010	$0.41	/ m^3
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$50.08	million
Capital Cost (yr 2015)	$342.33	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	$4.80	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-2.74			0.42				
2013	-132.16	-16.23			0.42				
2014	-132.73	-31.12			0.43				
2015			-36.31	-2.92	0.43	38.36	-39.24	-0.87	-0.54
2016			-36.31	-3.07	0.44	38.75	-39.38	-0.64	-0.36
2017			-36.31	-3.22	0.44	39.14	-39.54	-0.40	-0.21
2018			-36.31	-3.38	0.44	39.53	-39.70	-0.17	-0.08
2019			-36.31	-3.55	0.45	39.92	-39.87	0.05	0.02
2020			-36.31	-3.73	0.45	40.32	-40.04	0.28	0.11
2021			-36.31	-3.92	0.46	40.72	-40.23	0.49	0.17
2022			-36.31	-4.11	0.46	41.13	-40.43	0.70	0.22
2023			-36.31	-4.32	0.47	41.54	-40.63	0.91	0.26
2024			-36.31	-4.53	0.47	41.96	-40.85	1.11	0.29
2025			-36.31	-4.76	0.48	42.38	-41.08	1.30	0.31
2026			-36.31	-5.00	0.48	42.80	-41.31	1.49	0.32
2027			-36.31	-5.25	0.49	43.23	-41.56	1.67	0.33
2028			-36.31	-5.51	0.49	43.66	-41.83	1.84	0.33
2029			-36.31	-5.79	0.50	44.10	-42.10	2.00	0.33
2030			-36.31	-6.08	0.50	44.54	-42.39	2.15	0.32
2031			-36.31	-6.38	0.51	44.99	-42.69	2.29	0.31
2032			-36.31	-6.70	0.51	45.43	-43.01	2.42	0.30
2033			-36.31	-7.03	0.52	45.89	-43.35	2.54	0.28
2034			-36.31	-7.39	0.52	46.35	-43.70	2.65	0.27
2035			-36.31	-7.75	0.53	46.81	-44.07	2.74	0.25
2036			-36.31	-8.14	0.53	47.28	-44.46	2.82	0.24
2037			-36.31	-8.55	0.54	47.75	-44.86	2.89	0.22
2038			-36.31	-8.98	0.54	48.23	-45.29	2.94	0.20
2039			-36.31	-9.43	0.55	48.71	-45.74	2.97	0.19
2040			-36.31	-9.90	0.55	49.20	-46.21	2.99	0.17
2041			-36.31	-10.39	0.56	49.69	-46.71	2.99	0.16
2042			-36.31	-10.91	0.56	50.19	-47.23	2.96	0.14
2043			-36.31	-11.46	0.57	50.69	-47.77	2.92	0.13
2044			-36.31	-12.03	0.58	51.20	-48.34	2.85	0.11
								NPV	4.80

TABLE D.5: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 9% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$44.88	million
Capital Cost (yr 2015)	$337.13	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	$31.48	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-2.46			0.42				
2013	-132.16	-14.58			0.42				
2014	-132.73	-27.84			0.43				
2015			-32.81	-2.92	0.43	38.36	-35.74	2.63	1.71
2016			-32.81	-3.07	0.44	38.75	-35.88	2.86	1.71
2017			-32.81	-3.22	0.44	39.14	-36.04	3.10	1.69
2018			-32.81	-3.38	0.44	39.53	-36.20	3.33	1.67
2019			-32.81	-3.55	0.45	39.92	-36.37	3.55	1.64
2020			-32.81	-3.73	0.45	40.32	-36.54	3.78	1.60
2021			-32.81	-3.92	0.46	40.72	-36.73	3.99	1.55
2022			-32.81	-4.11	0.46	41.13	-36.93	4.20	1.49
2023			-32.81	-4.32	0.47	41.54	-37.13	4.41	1.44
2024			-32.81	-4.53	0.47	41.96	-37.35	4.61	1.38
2025			-32.81	-4.76	0.48	42.38	-37.58	4.80	1.32
2026			-32.81	-5.00	0.48	42.80	-37.81	4.99	1.26
2027			-32.81	-5.25	0.49	43.23	-38.06	5.17	1.19
2028			-32.81	-5.51	0.49	43.66	-38.33	5.34	1.13
2029			-32.81	-5.79	0.50	44.10	-38.60	5.50	1.07
2030			-32.81	-6.08	0.50	44.54	-38.89	5.65	1.01
2031			-32.81	-6.38	0.51	44.99	-39.19	5.79	0.95
2032			-32.81	-6.70	0.51	45.43	-39.51	5.92	0.89
2033			-32.81	-7.03	0.52	45.89	-39.85	6.04	0.83
2034			-32.81	-7.39	0.52	46.35	-40.20	6.15	0.78
2035			-32.81	-7.75	0.53	46.81	-40.57	6.24	0.72
2036			-32.81	-8.14	0.53	47.28	-40.96	6.32	0.67
2037			-32.81	-8.55	0.54	47.75	-41.36	6.39	0.62
2038			-32.81	-8.98	0.54	48.23	-41.79	6.44	0.58
2039			-32.81	-9.43	0.55	48.71	-42.24	6.47	0.53
2040			-32.81	-9.90	0.55	49.20	-42.71	6.49	0.49
2041			-32.81	-10.39	0.56	49.69	-43.21	6.48	0.45
2042			-32.81	-10.91	0.56	50.19	-43.73	6.46	0.41
2043			-32.81	-11.46	0.57	50.69	-44.27	6.42	0.37
2044			-32.81	-12.03	0.58	51.20	-44.84	6.35	0.34
								NPV	31.48

TABLE D.6: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 8% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$39.72	million
Capital Cost (yr 2015)	$331.97	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	$64.03	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-2.19			0.42				
2013	-132.16	-12.94			0.42				
2014	-132.73	-24.59			0.43				
2015			-29.49	-2.92	0.43	38.36	-32.41	5.95	4.05
2016			-29.49	-3.07	0.44	38.75	-32.56	6.19	3.90
2017			-29.49	-3.22	0.44	39.14	-32.71	6.43	3.75
2018			-29.49	-3.38	0.44	39.53	-32.87	6.66	3.60
2019			-29.49	-3.55	0.45	39.92	-33.04	6.88	3.44
2020			-29.49	-3.73	0.45	40.32	-33.22	7.10	3.29
2021			-29.49	-3.92	0.46	40.72	-33.40	7.32	3.14
2022			-29.49	-4.11	0.46	41.13	-33.60	7.53	2.99
2023			-29.49	-4.32	0.47	41.54	-33.81	7.74	2.84
2024			-29.49	-4.53	0.47	41.96	-34.02	7.94	2.70
2025			-29.49	-4.76	0.48	42.38	-34.25	8.13	2.56
2026			-29.49	-5.00	0.48	42.80	-34.49	8.32	2.43
2027			-29.49	-5.25	0.49	43.23	-34.74	8.49	2.30
2028			-29.49	-5.51	0.49	43.66	-35.00	8.66	2.17
2029			-29.49	-5.79	0.50	44.10	-35.27	8.82	2.04
2030			-29.49	-6.08	0.50	44.54	-35.56	8.98	1.93
2031			-29.49	-6.38	0.51	44.99	-35.87	9.12	1.81
2032			-29.49	-6.70	0.51	45.43	-36.19	9.25	1.70
2033			-29.49	-7.03	0.52	45.89	-36.52	9.37	1.60
2034			-29.49	-7.39	0.52	46.35	-36.87	9.48	1.49
2035			-29.49	-7.75	0.53	46.81	-37.24	9.57	1.40
2036			-29.49	-8.14	0.53	47.28	-37.63	9.65	1.30
2037			-29.49	-8.55	0.54	47.75	-38.04	9.72	1.22
2038			-29.49	-8.98	0.54	48.23	-38.46	9.77	1.13
2039			-29.49	-9.43	0.55	48.71	-38.91	9.80	1.05
2040			-29.49	-9.90	0.55	49.20	-39.38	9.81	0.98
2041			-29.49	-10.39	0.56	49.69	-39.88	9.81	0.90
2042			-29.49	-10.91	0.56	50.19	-40.40	9.79	0.83
2043			-29.49	-11.46	0.57	50.69	-40.94	9.75	0.77
2044			-29.49	-12.03	0.58	51.20	-41.52	9.68	0.71
								NPV	64.03

TABLE D.7: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 7% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$34.60	million
Capital Cost (yr 2015)	$326.85	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	$103.89	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-1.92			0.42				
2013	-132.16	-11.30			0.42				
2014	-132.73	-21.38			0.43				
2015			-26.34	-2.92	0.43	38.36	-29.26	9.10	6.49
2016			-26.34	-3.07	0.44	38.75	-29.41	9.34	6.22
2017			-26.34	-3.22	0.44	39.14	-29.56	9.57	5.96
2018			-26.34	-3.38	0.44	39.53	-29.72	9.80	5.71
2019			-26.34	-3.55	0.45	39.92	-29.89	10.03	5.46
2020			-26.34	-3.73	0.45	40.32	-30.07	10.25	5.21
2021			-26.34	-3.92	0.46	40.72	-30.26	10.47	4.97
2022			-26.34	-4.11	0.46	41.13	-30.45	10.68	4.74
2023			-26.34	-4.32	0.47	41.54	-30.66	10.89	4.52
2024			-26.34	-4.53	0.47	41.96	-30.87	11.08	4.30
2025			-26.34	-4.76	0.48	42.38	-31.10	11.28	4.09
2026			-26.34	-5.00	0.48	42.80	-31.34	11.46	3.88
2027			-26.34	-5.25	0.49	43.23	-31.59	11.64	3.69
2028			-26.34	-5.51	0.49	43.66	-31.85	11.81	3.49
2029			-26.34	-5.79	0.50	44.10	-32.13	11.97	3.31
2030			-26.34	-6.08	0.50	44.54	-32.42	12.12	3.13
2031			-26.34	-6.38	0.51	44.99	-32.72	12.27	2.96
2032			-26.34	-6.70	0.51	45.43	-33.04	12.40	2.80
2033			-26.34	-7.03	0.52	45.89	-33.37	12.52	2.64
2034			-26.34	-7.39	0.52	46.35	-33.72	12.62	2.49
2035			-26.34	-7.75	0.53	46.81	-34.09	12.72	2.34
2036			-26.34	-8.14	0.53	47.28	-34.48	12.80	2.20
2037			-26.34	-8.55	0.54	47.75	-34.89	12.86	2.07
2038			-26.34	-8.98	0.54	48.23	-35.32	12.91	1.94
2039			-26.34	-9.43	0.55	48.71	-35.77	12.95	1.82
2040			-26.34	-9.90	0.55	49.20	-36.24	12.96	1.70
2041			-26.34	-10.39	0.56	49.69	-36.73	12.96	1.59
2042			-26.34	-10.91	0.56	50.19	-37.25	12.94	1.48
2043			-26.34	-11.46	0.57	50.69	-37.80	12.89	1.38
2044			-26.34	-12.03	0.58	51.20	-38.37	12.83	1.29
								NPV	103.89

TABLE D.8: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 6% Escalation: 5% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6%	
Time Period	30	years
Escalation	5%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$292.25	million
Interest During Construction IDC (yr 2015)	$29.53	million
Capital Cost (yr 2015)	$321.78	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$194.17	million
Net Present Value	$152.96	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-27.36	-1.64			0.42				
2013	-132.16	-9.67			0.42				
2014	-132.73	-18.21			0.43				
2015			-23.38	-2.92	0.43	38.36	-26.30	12.06	9.02
2016			-23.38	-3.07	0.44	38.75	-26.45	12.30	8.67
2017			-23.38	-3.22	0.44	39.14	-26.60	12.54	8.34
2018			-23.38	-3.38	0.44	39.53	-26.76	12.77	8.01
2019			-23.38	-3.55	0.45	39.92	-26.93	12.99	7.69
2020			-23.38	-3.73	0.45	40.32	-27.11	13.21	7.38
2021			-23.38	-3.92	0.46	40.72	-27.29	13.43	7.08
2022			-23.38	-4.11	0.46	41.13	-27.49	13.64	6.78
2023			-23.38	-4.32	0.47	41.54	-27.69	13.85	6.49
2024			-23.38	-4.53	0.47	41.96	-27.91	14.05	6.21
2025			-23.38	-4.76	0.48	42.38	-28.14	14.24	5.94
2026			-23.38	-5.00	0.48	42.80	-28.38	14.43	5.68
2027			-23.38	-5.25	0.49	43.23	-28.63	14.60	5.42
2028			-23.38	-5.51	0.49	43.66	-28.89	14.77	5.18
2029			-23.38	-5.79	0.50	44.10	-29.16	14.94	4.94
2030			-23.38	-6.08	0.50	44.54	-29.45	15.09	4.70
2031			-23.38	-6.38	0.51	44.99	-29.76	15.23	4.48
2032			-23.38	-6.70	0.51	45.43	-30.08	15.36	4.26
2033			-23.38	-7.03	0.52	45.89	-30.41	15.48	4.05
2034			-23.38	-7.39	0.52	46.35	-30.76	15.59	3.85
2035			-23.38	-7.75	0.53	46.81	-31.13	15.68	3.65
2036			-23.38	-8.14	0.53	47.28	-31.52	15.76	3.46
2037			-23.38	-8.55	0.54	47.75	-31.93	15.83	3.28
2038			-23.38	-8.98	0.54	48.23	-32.35	15.88	3.11
2039			-23.38	-9.43	0.55	48.71	-32.80	15.91	2.94
2040			-23.38	-9.90	0.55	49.20	-33.27	15.93	2.77
2041			-23.38	-10.39	0.56	49.69	-33.77	15.92	2.62
2042			-23.38	-10.91	0.56	50.19	-34.29	15.90	2.46
2043			-23.38	-11.46	0.57	50.69	-34.83	15.86	2.32
2044			-23.38	-12.03	0.58	51.20	-35.41	15.79	2.18
								NPV	152.96

TABLE D.9: Results of the IRR Analyses **Water Supply: 94.608 million m3/yr** D

Cost of Money: 13% **Escalation: 4%** **Construction Cost: $ 248.18**

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$64.05	million
Capital Cost (yr 2015)	$347.06	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	($41.22)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-3.49			0.42				
2013	-128.42	-20.64			0.42				
2014	-127.75	-39.93			0.43				
2015			-46.30	-2.83	0.43	38.36	-49.13	-10.77	-5.84
2016			-46.30	-2.94	0.44	38.75	-49.25	-10.50	-5.04
2017			-46.30	-3.06	0.44	39.14	-49.36	-10.23	-4.35
2018			-46.30	-3.18	0.44	39.53	-49.49	-9.96	-3.75
2019			-46.30	-3.31	0.45	39.92	-49.61	-9.69	-3.23
2020			-46.30	-3.44	0.45	40.32	-49.75	-9.42	-2.78
2021			-46.30	-3.58	0.46	40.72	-49.88	-9.16	-2.39
2022			-46.30	-3.72	0.46	41.13	-50.03	-8.89	-2.05
2023			-46.30	-3.87	0.47	41.54	-50.18	-8.63	-1.76
2024			-46.30	-4.03	0.47	41.96	-50.33	-8.37	-1.51
2025			-46.30	-4.19	0.48	42.38	-50.49	-8.11	-1.30
2026			-46.30	-4.36	0.48	42.80	-50.66	-7.86	-1.11
2027			-46.30	-4.53	0.49	43.23	-50.83	-7.60	-0.95
2028			-46.30	-4.71	0.49	43.66	-51.01	-7.35	-0.81
2029			-46.30	-4.90	0.50	44.10	-51.20	-7.10	-0.70
2030			-46.30	-5.10	0.50	44.54	-51.40	-6.86	-0.60
2031			-46.30	-5.30	0.51	44.99	-51.60	-6.62	-0.51
2032			-46.30	-5.51	0.51	45.43	-51.81	-6.38	-0.43
2033			-46.30	-5.73	0.52	45.89	-52.04	-6.15	-0.37
2034			-46.30	-5.96	0.52	46.35	-52.26	-5.92	-0.31
2035			-46.30	-6.20	0.53	46.81	-52.50	-5.69	-0.27
2036			-46.30	-6.45	0.53	47.28	-52.75	-5.47	-0.23
2037			-46.30	-6.71	0.54	47.75	-53.01	-5.26	-0.19
2038			-46.30	-6.98	0.54	48.23	-53.28	-5.05	-0.16
2039			-46.30	-7.25	0.55	48.71	-53.56	-4.84	-0.14
2040			-46.30	-7.54	0.55	49.20	-53.85	-4.65	-0.12
2041			-46.30	-7.85	0.56	49.69	-54.15	-4.46	-0.10
2042			-46.30	-8.16	0.56	50.19	-54.46	-4.27	-0.09
2043			-46.30	-8.49	0.57	50.69	-54.79	-4.10	-0.07
2044			-46.30	-8.83	0.58	51.20	-55.13	-3.93	-0.06
								NPV	-41.22

TABLE D.10: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 12% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters

Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results

Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$58.87	million
Capital Cost (yr 2015)	$341.88	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	($25.64)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-3.22			0.42				
2013	-128.42	-19.02			0.42				
2014	-127.75	-36.63			0.43				
2015			-42.44	-2.83	0.43	38.36	-45.27	-6.91	-3.92
2016			-42.44	-2.94	0.44	38.75	-45.39	-6.64	-3.36
2017			-42.44	-3.06	0.44	39.14	-45.50	-6.37	-2.88
2018			-42.44	-3.18	0.44	39.53	-45.63	-6.10	-2.46
2019			-42.44	-3.31	0.45	39.92	-45.75	-5.83	-2.10
2020			-42.44	-3.44	0.45	40.32	-45.89	-5.56	-1.79
2021			-42.44	-3.58	0.46	40.72	-46.02	-5.30	-1.52
2022			-42.44	-3.72	0.46	41.13	-46.17	-5.03	-1.29
2023			-42.44	-3.87	0.47	41.54	-46.32	-4.77	-1.09
2024			-42.44	-4.03	0.47	41.96	-46.47	-4.51	-0.92
2025			-42.44	-4.19	0.48	42.38	-46.63	-4.25	-0.78
2026			-42.44	-4.36	0.48	42.80	-46.80	-4.00	-0.65
2027			-42.44	-4.53	0.49	43.23	-46.97	-3.74	-0.55
2028			-42.44	-4.71	0.49	43.66	-47.15	-3.49	-0.45
2029			-42.44	-4.90	0.50	44.10	-47.34	-3.24	-0.38
2030			-42.44	-5.10	0.50	44.54	-47.54	-3.00	-0.31
2031			-42.44	-5.30	0.51	44.99	-47.74	-2.76	-0.26
2032			-42.44	-5.51	0.51	45.43	-47.95	-2.52	-0.21
2033			-42.44	-5.73	0.52	45.89	-48.18	-2.29	-0.17
2034			-42.44	-5.96	0.52	46.35	-48.40	-2.06	-0.14
2035			-42.44	-6.20	0.53	46.81	-48.64	-1.83	-0.11
2036			-42.44	-6.45	0.53	47.28	-48.89	-1.61	-0.08
2037			-42.44	-6.71	0.54	47.75	-49.15	-1.40	-0.07
2038			-42.44	-6.98	0.54	48.23	-49.42	-1.19	-0.05
2039			-42.44	-7.25	0.55	48.71	-49.70	-0.98	-0.04
2040			-42.44	-7.54	0.55	49.20	-49.99	-0.79	-0.03
2041			-42.44	-7.85	0.56	49.69	-50.29	-0.60	-0.02
2042			-42.44	-8.16	0.56	50.19	-50.60	-0.41	-0.01
2043			-42.44	-8.49	0.57	50.69	-50.93	-0.24	-0.01
2044			-42.44	-8.83	0.58	51.20	-51.27	-0.07	0.00
								NPV	-25.64

TABLE D.11: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 11% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters

Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results

Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$53.73	million
Capital Cost (yr 2015)	$336.73	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	($6.84)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-2.95			0.42				
2013	-128.42	-17.40			0.42				
2014	-127.75	-33.37			0.43				
2015			-38.73	-2.83	0.43	38.36	-41.56	-3.20	-1.90
2016			-38.73	-2.94	0.44	38.75	-41.68	-2.93	-1.57
2017			-38.73	-3.06	0.44	39.14	-41.79	-2.66	-1.28
2018			-38.73	-3.18	0.44	39.53	-41.92	-2.39	-1.04
2019			-38.73	-3.31	0.45	39.92	-42.04	-2.12	-0.83
2020			-38.73	-3.44	0.45	40.32	-42.18	-1.85	-0.65
2021			-38.73	-3.58	0.46	40.72	-42.31	-1.59	-0.50
2022			-38.73	-3.72	0.46	41.13	-42.46	-1.33	-0.38
2023			-38.73	-3.87	0.47	41.54	-42.61	-1.06	-0.27
2024			-38.73	-4.03	0.47	41.96	-42.76	-0.80	-0.19
2025			-38.73	-4.19	0.48	42.38	-42.92	-0.54	-0.11
2026			-38.73	-4.36	0.48	42.80	-43.09	-0.29	-0.05
2027			-38.73	-4.53	0.49	43.23	-43.26	-0.03	-0.01
2028			-38.73	-4.71	0.49	43.66	-43.45	0.22	0.03
2029			-38.73	-4.90	0.50	44.10	-43.63	0.47	0.06
2030			-38.73	-5.10	0.50	44.54	-43.83	0.71	0.09
2031			-38.73	-5.30	0.51	44.99	-44.03	0.95	0.11
2032			-38.73	-5.51	0.51	45.43	-44.25	1.19	0.12
2033			-38.73	-5.73	0.52	45.89	-44.47	1.42	0.13
2034			-38.73	-5.96	0.52	46.35	-44.70	1.65	0.14
2035			-38.73	-6.20	0.53	46.81	-44.93	1.88	0.14
2036			-38.73	-6.45	0.53	47.28	-45.18	2.10	0.14
2037			-38.73	-6.71	0.54	47.75	-45.44	2.31	0.14
2038			-38.73	-6.98	0.54	48.23	-45.71	2.52	0.14
2039			-38.73	-7.25	0.55	48.71	-45.99	2.73	0.13
2040			-38.73	-7.54	0.55	49.20	-46.28	2.92	0.13
2041			-38.73	-7.85	0.56	49.69	-46.58	3.11	0.12
2042			-38.73	-8.16	0.56	50.19	-46.89	3.30	0.12
2043			-38.73	-8.49	0.57	50.69	-47.22	3.47	0.11
2044			-38.73	-8.83	0.58	51.20	-47.56	3.64	0.10
								NPV	-6.84

TABLE D.12: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 10% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters

Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results

Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$48.63	million
Capital Cost (yr 2015)	$331.64	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	$15.92	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-2.68			0.42				
2013	-128.42	-15.79			0.42				
2014	-127.75	-30.15			0.43				
2015			-35.18	-2.83	0.43	38.36	-38.01	0.35	0.22
2016			-35.18	-2.94	0.44	38.75	-38.12	0.62	0.35
2017			-35.18	-3.06	0.44	39.14	-38.24	0.89	0.46
2018			-35.18	-3.18	0.44	39.53	-38.36	1.16	0.54
2019			-35.18	-3.31	0.45	39.92	-38.49	1.43	0.61
2020			-35.18	-3.44	0.45	40.32	-38.62	1.70	0.65
2021			-35.18	-3.58	0.46	40.72	-38.76	1.96	0.69
2022			-35.18	-3.72	0.46	41.13	-38.90	2.23	0.71
2023			-35.18	-3.87	0.47	41.54	-39.05	2.49	0.72
2024			-35.18	-4.03	0.47	41.96	-39.21	2.75	0.72
2025			-35.18	-4.19	0.48	42.38	-39.37	3.01	0.72
2026			-35.18	-4.36	0.48	42.80	-39.54	3.27	0.71
2027			-35.18	-4.53	0.49	43.23	-39.71	3.52	0.70
2028			-35.18	-4.71	0.49	43.66	-39.89	3.77	0.68
2029			-35.18	-4.90	0.50	44.10	-40.08	4.02	0.66
2030			-35.18	-5.10	0.50	44.54	-40.28	4.26	0.63
2031			-35.18	-5.30	0.51	44.99	-40.48	4.50	0.61
2032			-35.18	-5.51	0.51	45.43	-40.69	4.74	0.58
2033			-35.18	-5.73	0.52	45.89	-40.91	4.98	0.56
2034			-35.18	-5.96	0.52	46.35	-41.14	5.21	0.53
2035			-35.18	-6.20	0.53	46.81	-41.38	5.43	0.50
2036			-35.18	-6.45	0.53	47.28	-41.63	5.65	0.47
2037			-35.18	-6.71	0.54	47.75	-41.89	5.87	0.45
2038			-35.18	-6.98	0.54	48.23	-42.16	6.07	0.42
2039			-35.18	-7.25	0.55	48.71	-42.43	6.28	0.40
2040			-35.18	-7.54	0.55	49.20	-42.72	6.48	0.37
2041			-35.18	-7.85	0.56	49.69	-43.03	6.67	0.35
2042			-35.18	-8.16	0.56	50.19	-43.34	6.85	0.32
2043			-35.18	-8.49	0.57	50.69	-43.67	7.02	0.30
2044			-35.18	-8.83	0.58	51.20	-44.01	7.19	0.28
								NPV	15.92

TABLE D.13: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 9% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$43.57	million
Capital Cost (yr 2015)	$326.58	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	$43.56	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-2.42			0.42				
2013	-128.42	-14.19			0.42				
2014	-127.75	-26.97			0.43				
2015			-31.79	-2.83	0.43	38.36	-34.62	3.75	2.43
2016			-31.79	-2.94	0.44	38.75	-34.73	4.02	2.39
2017			-31.79	-3.06	0.44	39.14	-34.85	4.29	2.34
2018			-31.79	-3.18	0.44	39.53	-34.97	4.56	2.29
2019			-31.79	-3.31	0.45	39.92	-35.10	4.82	2.22
2020			-31.79	-3.44	0.45	40.32	-35.23	5.09	2.15
2021			-31.79	-3.58	0.46	40.72	-35.37	5.36	2.08
2022			-31.79	-3.72	0.46	41.13	-35.51	5.62	2.00
2023			-31.79	-3.87	0.47	41.54	-35.66	5.88	1.92
2024			-31.79	-4.03	0.47	41.96	-35.82	6.14	1.84
2025			-31.79	-4.19	0.48	42.38	-35.98	6.40	1.76
2026			-31.79	-4.36	0.48	42.80	-36.14	6.66	1.68
2027			-31.79	-4.53	0.49	43.23	-36.32	6.91	1.60
2028			-31.79	-4.71	0.49	43.66	-36.50	7.16	1.52
2029			-31.79	-4.90	0.50	44.10	-36.69	7.41	1.44
2030			-31.79	-5.10	0.50	44.54	-36.88	7.65	1.37
2031			-31.79	-5.30	0.51	44.99	-37.09	7.90	1.29
2032			-31.79	-5.51	0.51	45.43	-37.30	8.13	1.22
2033			-31.79	-5.73	0.52	45.89	-37.52	8.37	1.15
2034			-31.79	-5.96	0.52	46.35	-37.75	8.60	1.09
2035			-31.79	-6.20	0.53	46.81	-37.99	8.82	1.02
2036			-31.79	-6.45	0.53	47.28	-38.24	9.04	0.96
2037			-31.79	-6.71	0.54	47.75	-38.50	9.26	0.90
2038			-31.79	-6.98	0.54	48.23	-38.76	9.47	0.85
2039			-31.79	-7.25	0.55	48.71	-39.04	9.67	0.79
2040			-31.79	-7.54	0.55	49.20	-39.33	9.87	0.74
2041			-31.79	-7.85	0.56	49.69	-39.63	10.06	0.70
2042			-31.79	-8.16	0.56	50.19	-39.95	10.24	0.65
2043			-31.79	-8.49	0.57	50.69	-40.27	10.42	0.61
2044			-31.79	-8.83	0.58	51.20	-40.61	10.58	0.57
								NPV	43.56

TABLE D.14: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 8% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$38.56	million
Capital Cost (yr 2015)	$321.57	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	$77.28	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-2.15			0.42				
2013	-128.42	-12.59			0.42				
2014	-127.75	-23.82			0.43				
2015			-28.56	-2.83	0.43	38.36	-31.39	6.97	4.74
2016			-28.56	-2.94	0.44	38.75	-31.51	7.24	4.56
2017			-28.56	-3.06	0.44	39.14	-31.63	7.51	4.38
2018			-28.56	-3.18	0.44	39.53	-31.75	7.78	4.20
2019			-28.56	-3.31	0.45	39.92	-31.87	8.05	4.03
2020			-28.56	-3.44	0.45	40.32	-32.01	8.31	3.85
2021			-28.56	-3.58	0.46	40.72	-32.15	8.58	3.68
2022			-28.56	-3.72	0.46	41.13	-32.29	8.84	3.51
2023			-28.56	-3.87	0.47	41.54	-32.44	9.11	3.35
2024			-28.56	-4.03	0.47	41.96	-32.59	9.37	3.19
2025			-28.56	-4.19	0.48	42.38	-32.75	9.62	3.03
2026			-28.56	-4.36	0.48	42.80	-32.92	9.88	2.88
2027			-28.56	-4.53	0.49	43.23	-33.10	10.13	2.74
2028			-28.56	-4.71	0.49	43.66	-33.28	10.39	2.60
2029			-28.56	-4.90	0.50	44.10	-33.46	10.63	2.46
2030			-28.56	-5.10	0.50	44.54	-33.66	10.88	2.33
2031			-28.56	-5.30	0.51	44.99	-33.86	11.12	2.21
2032			-28.56	-5.51	0.51	45.43	-34.08	11.36	2.09
2033			-28.56	-5.73	0.52	45.89	-34.30	11.59	1.97
2034			-28.56	-5.96	0.52	46.35	-34.53	11.82	1.86
2035			-28.56	-6.20	0.53	46.81	-34.77	12.05	1.76
2036			-28.56	-6.45	0.53	47.28	-35.01	12.27	1.66
2037			-28.56	-6.71	0.54	47.75	-35.27	12.48	1.56
2038			-28.56	-6.98	0.54	48.23	-35.54	12.69	1.47
2039			-28.56	-7.25	0.55	48.71	-35.82	12.89	1.38
2040			-28.56	-7.54	0.55	49.20	-36.11	13.09	1.30
2041			-28.56	-7.85	0.56	49.69	-36.41	13.28	1.22
2042			-28.56	-8.16	0.56	50.19	-36.72	13.46	1.15
2043			-28.56	-8.49	0.57	50.69	-37.05	13.64	1.08
2044			-28.56	-8.83	0.58	51.20	-37.39	13.81	1.01
								NPV	77.28

TABLE D.15: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 7% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$33.59	million
Capital Cost (yr 2015)	$316.60	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	$118.59	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-1.88			0.42				
2013	-128.42	-11.00			0.42				
2014	-127.75	-20.71			0.43				
2015			-25.51	-2.83	0.43	38.36	-28.34	10.02	7.14
2016			-25.51	-2.94	0.44	38.75	-28.46	10.29	6.86
2017			-25.51	-3.06	0.44	39.14	-28.57	10.56	6.58
2018			-25.51	-3.18	0.44	39.53	-28.70	10.83	6.30
2019			-25.51	-3.31	0.45	39.92	-28.82	11.10	6.04
2020			-25.51	-3.44	0.45	40.32	-28.96	11.36	5.78
2021			-25.51	-3.58	0.46	40.72	-29.09	11.63	5.53
2022			-25.51	-3.72	0.46	41.13	-29.24	11.89	5.28
2023			-25.51	-3.87	0.47	41.54	-29.39	12.16	5.04
2024			-25.51	-4.03	0.47	41.96	-29.54	12.42	4.82
2025			-25.51	-4.19	0.48	42.38	-29.70	12.68	4.59
2026			-25.51	-4.36	0.48	42.80	-29.87	12.93	4.38
2027			-25.51	-4.53	0.49	43.23	-30.04	13.19	4.17
2028			-25.51	-4.71	0.49	43.66	-30.23	13.44	3.98
2029			-25.51	-4.90	0.50	44.10	-30.41	13.68	3.78
2030			-25.51	-5.10	0.50	44.54	-30.61	13.93	3.60
2031			-25.51	-5.30	0.51	44.99	-30.81	14.17	3.42
2032			-25.51	-5.51	0.51	45.43	-31.03	14.41	3.25
2033			-25.51	-5.73	0.52	45.89	-31.25	14.64	3.09
2034			-25.51	-5.96	0.52	46.35	-31.48	14.87	2.93
2035			-25.51	-6.20	0.53	46.81	-31.71	15.10	2.78
2036			-25.51	-6.45	0.53	47.28	-31.96	15.32	2.64
2037			-25.51	-6.71	0.54	47.75	-32.22	15.53	2.50
2038			-25.51	-6.98	0.54	48.23	-32.49	15.74	2.37
2039			-25.51	-7.25	0.55	48.71	-32.77	15.94	2.24
2040			-25.51	-7.54	0.55	49.20	-33.06	16.14	2.12
2041			-25.51	-7.85	0.56	49.69	-33.36	16.33	2.01
2042			-25.51	-8.16	0.56	50.19	-33.67	16.51	1.89
2043			-25.51	-8.49	0.57	50.69	-34.00	16.69	1.79
2044			-25.51	-8.83	0.58	51.20	-34.34	16.86	1.69
								NPV	118.59

TABLE D.16: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 6% Escalation: 4% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6%	
Time Period	30	years
Escalation	4%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$283.01	million
Interest During Construction IDC (yr 2015)	$28.66	million
Capital Cost (yr 2015)	$311.67	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$158.73	million
Net Present Value	$169.47	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.84	-1.61			0.42				
2013	-128.42	-9.41			0.42				
2014	-127.75	-17.64			0.43				
2015			-22.64	-2.83	0.43	38.36	-25.47	12.89	9.63
2016			-22.64	-2.94	0.44	38.75	-25.59	13.16	9.28
2017			-22.64	-3.06	0.44	39.14	-25.70	13.43	8.93
2018			-22.64	-3.18	0.44	39.53	-25.83	13.70	8.60
2019			-22.64	-3.31	0.45	39.92	-25.95	13.97	8.27
2020			-22.64	-3.44	0.45	40.32	-26.09	14.24	7.95
2021			-22.64	-3.58	0.46	40.72	-26.22	14.50	7.64
2022			-22.64	-3.72	0.46	41.13	-26.37	14.76	7.34
2023			-22.64	-3.87	0.47	41.54	-26.52	15.03	7.05
2024			-22.64	-4.03	0.47	41.96	-26.67	15.29	6.76
2025			-22.64	-4.19	0.48	42.38	-26.83	15.55	6.49
2026			-22.64	-4.36	0.48	42.80	-27.00	15.80	6.22
2027			-22.64	-4.53	0.49	43.23	-27.17	16.06	5.96
2028			-22.64	-4.71	0.49	43.66	-27.36	16.31	5.71
2029			-22.64	-4.90	0.50	44.10	-27.54	16.56	5.47
2030			-22.64	-5.10	0.50	44.54	-27.74	16.80	5.24
2031			-22.64	-5.30	0.51	44.99	-27.94	17.04	5.01
2032			-22.64	-5.51	0.51	45.43	-28.16	17.28	4.80
2033			-22.64	-5.73	0.52	45.89	-28.38	17.51	4.58
2034			-22.64	-5.96	0.52	46.35	-28.61	17.74	4.38
2035			-22.64	-6.20	0.53	46.81	-28.84	17.97	4.19
2036			-22.64	-6.45	0.53	47.28	-29.09	18.19	4.00
2037			-22.64	-6.71	0.54	47.75	-29.35	18.40	3.82
2038			-22.64	-6.98	0.54	48.23	-29.62	18.61	3.64
2039			-22.64	-7.25	0.55	48.71	-29.90	18.82	3.47
2040			-22.64	-7.54	0.55	49.20	-30.19	19.01	3.31
2041			-22.64	-7.85	0.56	49.69	-30.49	19.20	3.15
2042			-22.64	-8.16	0.56	50.19	-30.80	19.39	3.00
2043			-22.64	-8.49	0.57	50.69	-31.13	19.56	2.86
2044			-22.64	-8.83	0.58	51.20	-31.47	19.73	2.72
								NPV	169.47

TABLE D.17: Results of the IRR Analyses **Water Supply: 94.608 million m3/yr** D

Cost of Money: 13% **Escalation: 3%** **Construction Cost: $ 248.18**

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	13%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$62.18	million
Capital Cost (yr 2015)	$336.16	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	($32.61)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-3.42			0.42				
2013	-124.75	-20.09			0.42				
2014	-122.90	-38.67			0.43				
2015			-44.85	-2.74	0.43	38.36	-47.59	-9.22	-5.01
2016			-44.85	-2.82	0.44	38.75	-47.67	-8.92	-4.29
2017			-44.85	-2.91	0.44	39.14	-47.75	-8.62	-3.66
2018			-44.85	-2.99	0.44	39.53	-47.84	-8.32	-3.13
2019			-44.85	-3.08	0.45	39.92	-47.93	-8.01	-2.67
2020			-44.85	-3.18	0.45	40.32	-48.02	-7.70	-2.27
2021			-44.85	-3.27	0.46	40.72	-48.12	-7.40	-1.93
2022			-44.85	-3.37	0.46	41.13	-48.22	-7.09	-1.63
2023			-44.85	-3.47	0.47	41.54	-48.32	-6.78	-1.38
2024			-44.85	-3.57	0.47	41.96	-48.42	-6.46	-1.17
2025			-44.85	-3.68	0.48	42.38	-48.53	-6.15	-0.98
2026			-44.85	-3.79	0.48	42.80	-48.64	-5.84	-0.83
2027			-44.85	-3.91	0.49	43.23	-48.75	-5.52	-0.69
2028			-44.85	-4.02	0.49	43.66	-48.87	-5.21	-0.58
2029			-44.85	-4.14	0.50	44.10	-48.99	-4.89	-0.48
2030			-44.85	-4.27	0.50	44.54	-49.12	-4.58	-0.40
2031			-44.85	-4.40	0.51	44.99	-49.24	-4.26	-0.33
2032			-44.85	-4.53	0.51	45.43	-49.38	-3.94	-0.27
2033			-44.85	-4.66	0.52	45.89	-49.51	-3.62	-0.22
2034			-44.85	-4.80	0.52	46.35	-49.65	-3.30	-0.18
2035			-44.85	-4.95	0.53	46.81	-49.80	-2.98	-0.14
2036			-44.85	-5.10	0.53	47.28	-49.94	-2.67	-0.11
2037			-44.85	-5.25	0.54	47.75	-50.10	-2.35	-0.09
2038			-44.85	-5.41	0.54	48.23	-50.26	-2.03	-0.07
2039			-44.85	-5.57	0.55	48.71	-50.42	-1.71	-0.05
2040			-44.85	-5.74	0.55	49.20	-50.58	-1.39	-0.04
2041			-44.85	-5.91	0.56	49.69	-50.76	-1.07	-0.02
2042			-44.85	-6.09	0.56	50.19	-50.93	-0.75	-0.01
2043			-44.85	-6.27	0.57	50.69	-51.12	-0.43	-0.01
2044			-44.85	-6.46	0.58	51.20	-51.30	-0.11	0.00
								NPV	-32.61

TABLE D.18: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 12% Escalation: 3% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	12%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$57.15	million
Capital Cost (yr 2015)	$331.13	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	($16.54)	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-3.16			0.42				
2013	-124.75	-18.51			0.42				
2014	-122.90	-35.48			0.43				
2015			-41.11	-2.74	0.43	38.36	-43.85	-5.48	-3.11
2016			-41.11	-2.82	0.44	38.75	-43.93	-5.18	-2.63
2017			-41.11	-2.91	0.44	39.14	-44.01	-4.88	-2.21
2018			-41.11	-2.99	0.44	39.53	-44.10	-4.57	-1.85
2019			-41.11	-3.08	0.45	39.92	-44.19	-4.27	-1.54
2020			-41.11	-3.18	0.45	40.32	-44.28	-3.96	-1.28
2021			-41.11	-3.27	0.46	40.72	-44.38	-3.65	-1.05
2022			-41.11	-3.37	0.46	41.13	-44.48	-3.35	-0.86
2023			-41.11	-3.47	0.47	41.54	-44.58	-3.04	-0.70
2024			-41.11	-3.57	0.47	41.96	-44.68	-2.72	-0.56
2025			-41.11	-3.68	0.48	42.38	-44.79	-2.41	-0.44
2026			-41.11	-3.79	0.48	42.80	-44.90	-2.10	-0.34
2027			-41.11	-3.91	0.49	43.23	-45.01	-1.78	-0.26
2028			-41.11	-4.02	0.49	43.66	-45.13	-1.47	-0.19
2029			-41.11	-4.14	0.50	44.10	-45.25	-1.15	-0.13
2030			-41.11	-4.27	0.50	44.54	-45.38	-0.84	-0.09
2031			-41.11	-4.40	0.51	44.99	-45.50	-0.52	-0.05
2032			-41.11	-4.53	0.51	45.43	-45.64	-0.20	-0.02
2033			-41.11	-4.66	0.52	45.89	-45.77	0.12	0.01
2034			-41.11	-4.80	0.52	46.35	-45.91	0.44	0.03
2035			-41.11	-4.95	0.53	46.81	-46.06	0.76	0.04
2036			-41.11	-5.10	0.53	47.28	-46.20	1.08	0.06
2037			-41.11	-5.25	0.54	47.75	-46.36	1.40	0.07
2038			-41.11	-5.41	0.54	48.23	-46.51	1.72	0.07
2039			-41.11	-5.57	0.55	48.71	-46.68	2.04	0.08
2040			-41.11	-5.74	0.55	49.20	-46.84	2.36	0.08
2041			-41.11	-5.91	0.56	49.69	-47.02	2.68	0.08
2042			-41.11	-6.09	0.56	50.19	-47.19	2.99	0.08
2043			-41.11	-6.27	0.57	50.69	-47.38	3.31	0.08
2044			-41.11	-6.46	0.58	51.20	-47.56	3.63	0.08
								NPV	-16.54

TABLE D.19: Results of the IRR Analyses **Water Supply: 94.608 million m3/yr** D

Cost of Money: 11% **Escalation: 3%** **Construction Cost: $ 248.18**

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	11%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$52.15	million
Capital Cost (yr 2015)	$326.14	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$2.83	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-2.90			0.42				
2013	-124.75	-16.94			0.42				
2014	-122.90	-32.32			0.43				
2015			-37.51	-2.74	0.43	38.36	-40.25	-1.89	-1.12
2016			-37.51	-2.82	0.44	38.75	-40.34	-1.59	-0.85
2017			-37.51	-2.91	0.44	39.14	-40.42	-1.29	-0.62
2018			-37.51	-2.99	0.44	39.53	-40.51	-0.98	-0.43
2019			-37.51	-3.08	0.45	39.92	-40.60	-0.68	-0.26
2020			-37.51	-3.18	0.45	40.32	-40.69	-0.37	-0.13
2021			-37.51	-3.27	0.46	40.72	-40.79	-0.06	-0.02
2022			-37.51	-3.37	0.46	41.13	-40.88	0.25	0.07
2023			-37.51	-3.47	0.47	41.54	-40.98	0.56	0.14
2024			-37.51	-3.57	0.47	41.96	-41.09	0.87	0.20
2025			-37.51	-3.68	0.48	42.38	-41.20	1.18	0.25
2026			-37.51	-3.79	0.48	42.80	-41.31	1.50	0.28
2027			-37.51	-3.91	0.49	43.23	-41.42	1.81	0.31
2028			-37.51	-4.02	0.49	43.66	-41.54	2.12	0.32
2029			-37.51	-4.14	0.50	44.10	-41.66	2.44	0.34
2030			-37.51	-4.27	0.50	44.54	-41.78	2.76	0.34
2031			-37.51	-4.40	0.51	44.99	-41.91	3.07	0.34
2032			-37.51	-4.53	0.51	45.43	-42.04	3.39	0.34
2033			-37.51	-4.66	0.52	45.89	-42.18	3.71	0.34
2034			-37.51	-4.80	0.52	46.35	-42.32	4.03	0.33
2035			-37.51	-4.95	0.53	46.81	-42.46	4.35	0.32
2036			-37.51	-5.10	0.53	47.28	-42.61	4.67	0.31
2037			-37.51	-5.25	0.54	47.75	-42.76	4.99	0.30
2038			-37.51	-5.41	0.54	48.23	-42.92	5.31	0.29
2039			-37.51	-5.57	0.55	48.71	-43.08	5.63	0.27
2040			-37.51	-5.74	0.55	49.20	-43.25	5.95	0.26
2041			-37.51	-5.91	0.56	49.69	-43.42	6.27	0.25
2042			-37.51	-6.09	0.56	50.19	-43.60	6.59	0.23
2043			-37.51	-6.27	0.57	50.69	-43.78	6.91	0.22
2044			-37.51	-6.46	0.58	51.20	-43.97	7.23	0.21
								NPV	2.83

TABLE D.20: Results of the IRR Analyses   Water Supply: 94.608 million m3/yr D

Cost of Money: 10%   Escalation: 3%   Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	10%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$47.20	million
Capital Cost (yr 2015)	$321.19	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$26.27	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-2.63			0.42				
2013	-124.75	-15.37			0.42				
2014	-122.90	-29.20			0.43				
2015			-34.07	-2.74	0.43	38.36	-36.81	1.55	0.96
2016			-34.07	-2.82	0.44	38.75	-36.89	1.85	1.05
2017			-34.07	-2.91	0.44	39.14	-36.98	2.16	1.11
2018			-34.07	-2.99	0.44	39.53	-37.07	2.46	1.15
2019			-34.07	-3.08	0.45	39.92	-37.15	2.77	1.17
2020			-34.07	-3.18	0.45	40.32	-37.25	3.07	1.19
2021			-34.07	-3.27	0.46	40.72	-37.34	3.38	1.19
2022			-34.07	-3.37	0.46	41.13	-37.44	3.69	1.18
2023			-34.07	-3.47	0.47	41.54	-37.54	4.00	1.16
2024			-34.07	-3.57	0.47	41.96	-37.65	4.31	1.14
2025			-34.07	-3.68	0.48	42.38	-37.75	4.62	1.11
2026			-34.07	-3.79	0.48	42.80	-37.86	4.94	1.07
2027			-34.07	-3.91	0.49	43.23	-37.98	5.25	1.04
2028			-34.07	-4.02	0.49	43.66	-38.09	5.57	1.00
2029			-34.07	-4.14	0.50	44.10	-38.22	5.88	0.96
2030			-34.07	-4.27	0.50	44.54	-38.34	6.20	0.92
2031			-34.07	-4.40	0.51	44.99	-38.47	6.52	0.88
2032			-34.07	-4.53	0.51	45.43	-38.60	6.84	0.84
2033			-34.07	-4.66	0.52	45.89	-38.74	7.15	0.80
2034			-34.07	-4.80	0.52	46.35	-38.88	7.47	0.76
2035			-34.07	-4.95	0.53	46.81	-39.02	7.79	0.72
2036			-34.07	-5.10	0.53	47.28	-39.17	8.11	0.68
2037			-34.07	-5.25	0.54	47.75	-39.32	8.43	0.64
2038			-34.07	-5.41	0.54	48.23	-39.48	8.75	0.61
2039			-34.07	-5.57	0.55	48.71	-39.64	9.07	0.57
2040			-34.07	-5.74	0.55	49.20	-39.81	9.39	0.54
2041			-34.07	-5.91	0.56	49.69	-39.98	9.71	0.51
2042			-34.07	-6.09	0.56	50.19	-40.16	10.03	0.48
2043			-34.07	-6.27	0.57	50.69	-40.34	10.35	0.45
2044			-34.07	-6.46	0.58	51.20	-40.53	10.67	0.42
								NPV	26.27

TABLE D.21: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 9% Escalation: 3% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	9%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$42.29	million
Capital Cost (yr 2015)	$316.28	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$54.72	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-2.37			0.42				
2013	-124.75	-13.81			0.42				
2014	-122.90	-26.11			0.43				
2015			-30.79	-2.74	0.43	38.36	-33.53	4.84	3.15
2016			-30.79	-2.82	0.44	38.75	-33.61	5.14	3.07
2017			-30.79	-2.91	0.44	39.14	-33.69	5.44	2.98
2018			-30.79	-2.99	0.44	39.53	-33.78	5.75	2.88
2019			-30.79	-3.08	0.45	39.92	-33.87	6.05	2.79
2020			-30.79	-3.18	0.45	40.32	-33.96	6.36	2.69
2021			-30.79	-3.27	0.46	40.72	-34.06	6.67	2.58
2022			-30.79	-3.37	0.46	41.13	-34.15	6.98	2.48
2023			-30.79	-3.47	0.47	41.54	-34.26	7.29	2.38
2024			-30.79	-3.57	0.47	41.96	-34.36	7.60	2.27
2025			-30.79	-3.68	0.48	42.38	-34.47	7.91	2.17
2026			-30.79	-3.79	0.48	42.80	-34.58	8.22	2.07
2027			-30.79	-3.91	0.49	43.23	-34.69	8.54	1.97
2028			-30.79	-4.02	0.49	43.66	-34.81	8.85	1.88
2029			-30.79	-4.14	0.50	44.10	-34.93	9.17	1.78
2030			-30.79	-4.27	0.50	44.54	-35.05	9.49	1.69
2031			-30.79	-4.40	0.51	44.99	-35.18	9.80	1.60
2032			-30.79	-4.53	0.51	45.43	-35.31	10.12	1.52
2033			-30.79	-4.66	0.52	45.89	-35.45	10.44	1.44
2034			-30.79	-4.80	0.52	46.35	-35.59	10.76	1.36
2035			-30.79	-4.95	0.53	46.81	-35.73	11.08	1.28
2036			-30.79	-5.10	0.53	47.28	-35.88	11.40	1.21
2037			-30.79	-5.25	0.54	47.75	-36.04	11.72	1.14
2038			-30.79	-5.41	0.54	48.23	-36.19	12.04	1.08
2039			-30.79	-5.57	0.55	48.71	-36.35	12.36	1.02
2040			-30.79	-5.74	0.55	49.20	-36.52	12.68	0.96
2041			-30.79	-5.91	0.56	49.69	-36.69	13.00	0.90
2042			-30.79	-6.09	0.56	50.19	-36.87	13.32	0.84
2043			-30.79	-6.27	0.57	50.69	-37.05	13.64	0.79
2044			-30.79	-6.46	0.58	51.20	-37.24	13.96	0.75
								NPV	54.72

TABLE D.22: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 8% Escalation: 3% Construction Cost: $ 248.18

Financial Parameters

Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	8%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results

Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$37.43	million
Capital Cost (yr 2015)	$311.41	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$89.42	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-2.11			0.42				
2013	-124.75	-12.25			0.42				
2014	-122.90	-23.07			0.43				
2015			-27.66	-2.74	0.43	38.36	-30.40	7.96	5.42
2016			-27.66	-2.82	0.44	38.75	-30.48	8.26	5.21
2017			-27.66	-2.91	0.44	39.14	-30.57	8.57	5.00
2018			-27.66	-2.99	0.44	39.53	-30.66	8.87	4.79
2019			-27.66	-3.08	0.45	39.92	-30.75	9.18	4.59
2020			-27.66	-3.18	0.45	40.32	-30.84	9.48	4.39
2021			-27.66	-3.27	0.46	40.72	-30.93	9.79	4.20
2022			-27.66	-3.37	0.46	41.13	-31.03	10.10	4.01
2023			-27.66	-3.47	0.47	41.54	-31.13	10.41	3.83
2024			-27.66	-3.57	0.47	41.96	-31.24	10.72	3.65
2025			-27.66	-3.68	0.48	42.38	-31.34	11.03	3.48
2026			-27.66	-3.79	0.48	42.80	-31.45	11.35	3.31
2027			-27.66	-3.91	0.49	43.23	-31.57	11.66	3.15
2028			-27.66	-4.02	0.49	43.66	-31.69	11.98	3.00
2029			-27.66	-4.14	0.50	44.10	-31.81	12.29	2.85
2030			-27.66	-4.27	0.50	44.54	-31.93	12.61	2.71
2031			-27.66	-4.40	0.51	44.99	-32.06	12.93	2.57
2032			-27.66	-4.53	0.51	45.43	-32.19	13.24	2.44
2033			-27.66	-4.66	0.52	45.89	-32.33	13.56	2.31
2034			-27.66	-4.80	0.52	46.35	-32.47	13.88	2.19
2035			-27.66	-4.95	0.53	46.81	-32.61	14.20	2.07
2036			-27.66	-5.10	0.53	47.28	-32.76	14.52	1.96
2037			-27.66	-5.25	0.54	47.75	-32.91	14.84	1.86
2038			-27.66	-5.41	0.54	48.23	-33.07	15.16	1.76
2039			-27.66	-5.57	0.55	48.71	-33.23	15.48	1.66
2040			-27.66	-5.74	0.55	49.20	-33.40	15.80	1.57
2041			-27.66	-5.91	0.56	49.69	-33.57	16.12	1.48
2042			-27.66	-6.09	0.56	50.19	-33.75	16.44	1.40
2043			-27.66	-6.27	0.57	50.69	-33.93	16.76	1.32
2044			-27.66	-6.46	0.58	51.20	-34.12	17.08	1.25
								NPV	89.42

TABLE D.23: Results of the IRR Analyses Water Supply: 94.608 million m3/yr D

Cost of Money: 7% Escalation: 3% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	7%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	6%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$32.60	million
Capital Cost (yr 2015)	$306.59	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$131.94	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/$m^3$)	Total Cost of Water Sold ($/$m^3$)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-1.84			0.42				
2013	-124.75	-10.70			0.42				
2014	-122.90	-20.06			0.43				
2015			-24.71	-2.74	0.43	38.36	-27.45	10.92	7.78
2016			-24.71	-2.82	0.44	38.75	-27.53	11.22	7.48
2017			-24.71	-2.91	0.44	39.14	-27.61	11.52	7.18
2018			-24.71	-2.99	0.44	39.53	-27.70	11.83	6.88
2019			-24.71	-3.08	0.45	39.92	-27.79	12.13	6.60
2020			-24.71	-3.18	0.45	40.32	-27.88	12.44	6.32
2021			-24.71	-3.27	0.46	40.72	-27.98	12.75	6.06
2022			-24.71	-3.37	0.46	41.13	-28.08	13.06	5.80
2023			-24.71	-3.47	0.47	41.54	-28.18	13.37	5.55
2024			-24.71	-3.57	0.47	41.96	-28.28	13.68	5.30
2025			-24.71	-3.68	0.48	42.38	-28.39	13.99	5.07
2026			-24.71	-3.79	0.48	42.80	-28.50	14.30	4.84
2027			-24.71	-3.91	0.49	43.23	-28.61	14.62	4.63
2028			-24.71	-4.02	0.49	43.66	-28.73	14.93	4.42
2029			-24.71	-4.14	0.50	44.10	-28.85	15.25	4.22
2030			-24.71	-4.27	0.50	44.54	-28.98	15.56	4.02
2031			-24.71	-4.40	0.51	44.99	-29.10	15.88	3.84
2032			-24.71	-4.53	0.51	45.43	-29.24	16.20	3.66
2033			-24.71	-4.66	0.52	45.89	-29.37	16.52	3.48
2034			-24.71	-4.80	0.52	46.35	-29.51	16.84	3.32
2035			-24.71	-4.95	0.53	46.81	-29.66	17.16	3.16
2036			-24.71	-5.10	0.53	47.28	-29.80	17.48	3.01
2037			-24.71	-5.25	0.54	47.75	-29.96	17.80	2.86
2038			-24.71	-5.41	0.54	48.23	-30.11	18.12	2.72
2039			-24.71	-5.57	0.55	48.71	-30.28	18.44	2.59
2040			-24.71	-5.74	0.55	49.20	-30.44	18.76	2.46
2041			-24.71	-5.91	0.56	49.69	-30.62	19.08	2.34
2042			-24.71	-6.09	0.56	50.19	-30.79	19.40	2.23
2043			-24.71	-6.27	0.57	50.69	-30.98	19.71	2.11
2044			-24.71	-6.46	0.58	51.20	-31.16	20.03	2.01
								NPV	131.94

TABLE D.24: Results of the IRR Analyses — Water Supply: 94.608 million m3/yr D

Cost of Money: 6% Escalation: 3% Construction Cost: $ 248.18

Financial Parameters		
Current Year	2010	
Dam Crest Elevation	$0.41	m
Construction Cost (yr 2010)	$248.18	million
Cost of Money	6%	
Time Period	30	years
Escalation	3%	
O,M, & R	1%	
Raise in the Unit Cost of Water	1%	
Water Supply	94.61	million m^3/yr
Shortage	5.9%	

Financial Results		
Escalated Construction Cost	$273.98	million
Interest During Construction IDC (yr 2015)	$27.82	million
Capital Cost (yr 2015)	$301.81	million
Average unit Cost of Water (actual)	$0.50	/ m^3
O,M, & R Cost (sum for 30 years)	$130.35	million
Net Present Value	$184.31	million

Year	Construction Cost ($10E6)	IDC Cost ($10E6)	Debt Service Cost ($10E6)	O,M, & R Cost ($10E6)	Unit Cost of Water ($/m³)	Total Cost of Water Sold ($/m³)	Total Expenses ($10E6)	Cashflow ($10E6)	PV Cashflow ($10E6)
2010					0.41				
2011					0.41				
2012	-26.33	-1.58			0.42				
2013	-124.75	-9.16			0.42				
2014	-122.90	-17.08			0.43				
2015			-21.93	-2.74	0.43	38.36	-24.67	13.70	10.24
2016			-21.93	-2.82	0.44	38.75	-24.75	14.00	9.87
2017			-21.93	-2.91	0.44	39.14	-24.83	14.30	9.51
2018			-21.93	-2.99	0.44	39.53	-24.92	14.61	9.16
2019			-21.93	-3.08	0.45	39.92	-25.01	14.91	8.83
2020			-21.93	-3.18	0.45	40.32	-25.10	15.22	8.50
2021			-21.93	-3.27	0.46	40.72	-25.20	15.53	8.18
2022			-21.93	-3.37	0.46	41.13	-25.30	15.84	7.87
2023			-21.93	-3.47	0.47	41.54	-25.40	16.15	7.57
2024			-21.93	-3.57	0.47	41.96	-25.50	16.46	7.28
2025			-21.93	-3.68	0.48	42.38	-25.61	16.77	7.00
2026			-21.93	-3.79	0.48	42.80	-25.72	17.08	6.72
2027			-21.93	-3.91	0.49	43.23	-25.83	17.40	6.46
2028			-21.93	-4.02	0.49	43.66	-25.95	17.71	6.21
2029			-21.93	-4.14	0.50	44.10	-26.07	18.03	5.96
2030			-21.93	-4.27	0.50	44.54	-26.19	18.35	5.72
2031			-21.93	-4.40	0.51	44.99	-26.32	18.66	5.49
2032			-21.93	-4.53	0.51	45.43	-26.45	18.98	5.27
2033			-21.93	-4.66	0.52	45.89	-26.59	19.30	5.05
2034			-21.93	-4.80	0.52	46.35	-26.73	19.62	4.85
2035			-21.93	-4.95	0.53	46.81	-26.87	19.94	4.65
2036			-21.93	-5.10	0.53	47.28	-27.02	20.26	4.45
2037			-21.93	-5.25	0.54	47.75	-27.18	20.58	4.27
2038			-21.93	-5.41	0.54	48.23	-27.33	20.90	4.09
2039			-21.93	-5.57	0.55	48.71	-27.50	21.22	3.92
2040			-21.93	-5.74	0.55	49.20	-27.66	21.54	3.75
2041			-21.93	-5.91	0.56	49.69	-27.83	21.86	3.59
2042			-21.93	-6.09	0.56	50.19	-28.01	22.18	3.44
2043			-21.93	-6.27	0.57	50.69	-28.19	22.50	3.29
2044			-21.93	-6.46	0.58	51.20	-28.38	22.81	3.15
								NPV	184.31