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Kurram Tangi Dam Construction

Supplemental Report on Hydrology
Final Report

December, 2013
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Map to Kurram Tangi Dam Project Documents

Shown below is the suite of documents submitted to USAID under Contract AID-391-C-13-00002 for the KTDP. This report is shaded in red in order to show its relationship to the full set of documentation.

ENVIRONMENTAL ASSESSMENT	
	VOLUME I: MAIN REPORT
	VOLUME II: PROJECT ECONOMIC BENEFITS
	VOLUME III: MAPS
ENVIRONMENTAL MITIGATION AND MONITORING PLAN	
	MAIN REPORT
	ANNEX I: HEALTH AND SAFETY PLAN FRAMEWORK
	ANNEX II: WATERSHED MANAGEMENT PLAN
	ANNEX III: WASTE MANAGEMENT PLAN
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LAND ACQUISITION AND RESETTLEMENT	
	RESETTLEMENT POLICY FRAMEWORK
	RESETTLEMENT ACTION PLAN (COMPONENT I)
CULTURAL HERITAGE PRESERVATION PLAN	
VULNERABLE TRIBES PLAN	
GENDER PLAN	
KEY SUPPORTING TECHNICAL REPORTS	
	SUPPLEMENTAL REPORT ON GEOLOGY
	SUPPLEMENTAL REPORT ON GEOTECHNICAL ASPECTS
	SUPPLEMENTAL REPORT ON SEISMIC HAZARD
	SUPPLEMENTAL REPORT ON HYDROLOGY
	SUPPLEMENTAL REPORT ON CLIMATE CHANGE

All documents may be read as stand-alone documents, but the reader should be aware of the full set of documents available. Any one document may reference other documents in the suite in order to avoid duplication.

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Kurram Tangi Dam Construction
Supplemental Report on Hydrology

USAID Environmental Assessment of Kurram Tangi Dam Construction
Contract Number: AID-391-C-13-00002
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Author: MWH Americas, Inc.

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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List of Acronyms

Acronym	Term
ACE	Associated Consulting Engineers
ADB	Asian Development Bank
AOI	Area of Influence
CCA	Cultivable Command Area
CFR	Code of Federal Regulations
CFRD	Concrete Faced Rockfill Dam
CHPP	Cultural Heritage Preservation Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CGD	Concrete Gravity Dam
DCO	District Coordination Officers
DEM	Digital Elevation Model
DO	Dissolved Oxygen
EA	Environmental Assessment
ECA	Employment of Child Act 1977 and 1991
EIA	Environmental Impact Assessment
EHS	Environmental Health and Safety
EMMP	Environmental Mitigation and Monitoring Plan
ESIA	Environmental and Social Impact Assessment
FATA	Federally Administered Tribal Areas
FCR	Frontier Crimes Regulations
F.R.	Frontier Region
FWO	Frontier Works Organization
GCM	Global Circulation Model
GIS	Geographic Information System
GPS	Global Positioning System
ICOLD	International Commission on Large Dams
IDC	International Development Consultants
IEE	Initial Environmental Examination
IFI	International Financing Institution
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature and Natural Resources
KP	Khyber Pakhtunkhwa
KTDC	Kurram Tangi Dam Consultants
KTMDP	Kurram Tangi Multipurpose Dam Project
KTDP	Kurram Tangi Dam Project
LAA	Land Acquisition Act, 1894
LAC	Land Acquisition Collector
MDE	Maximum Design Event
MMP	Mott MacDonald Pakistan
MWH	MWH Global, Inc. or MWH, Inc.

NESPAK	National Engineering Services Pakistan
NEQS	National Environmental Quality Standards
NGO	Non-governmental Organization
OBE	Operating Basis Earthquake
PAP	Project Affected Person
Pak-EPA	Pakistan Environmental Protection Agency
PERSUAP	Pakistan Pesticide Evaluation Report and Surface Use Action Plan
PHABSIM	Physical Habitat Simulation Model
PID	Provincial irrigation Department
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PPERSUAP	Pakistan Programmatic Umbrella Pesticide Evaluation Report and Safer Use Action Plan
RAP	Resettlement Action Plan
RCCD	Roller Compacted Concrete Dam
RCM	Regional Climate Model
REA	Rapid Environmental Assessment
RPF	Resettlement Policy Framework
RTS	Reservoir-triggered seismicity
SAFRON	Federal Ministry of States and Frontier Regions
SEE	Safety Evaluation Event
SSEA	Strategic/Sector Environmental and Social Assessment
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
UN	United Nations
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
USAID/Pak	United States Agency for International Development/Pakistan
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
VTP	Vulnerable Tribes Plan
WAPDA	Water and Power Development Authority
WUA	Water Users Associations
WWF-P	World Wide Fund for Nature – Pakistan

Supplemental Report on Hydrology

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1. INTRODUCTION

This document focused on a review of the hydrology assessment of the proposed Kurram Tangi Dam Project (KTDP). Hydrological parameters such as water availability, construction period floods, spillway design flood, reservoir sedimentation, and sediment management during construction period have significant effects on the design of project features (e.g. spillway sizing, diversion tunnel sizing, effective reservoir life, free board). As such, it is important to carefully consider the hydrology assessment.

The reader of this document is encouraged to read the separate supplemental report on Climate Change, which is another key supporting technical report that was prepared under this study. This Hydrology report focused on historical data whereas the Climate Change report also addresses expected trends in precipitation and temperature.

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2. DOCUMENTS REVIEWED

Table 2-1 below, lists the data sources identified, made available, and consulted as part of the review of the hydrological studies.

Table 2-1: Relevant Data Sources

No.	Document	Reference	Chapter No.	Remarks
1	Feasibility Report (2004)	Annexure to Main Report. Annexure-3	Chapter -1: Introduction; Chapter -4: Hydrology and Sedimentation Studies	Feasibility Report comprises a main report, annexures and appendices. The findings of feasibility studies are given in the main report, while details of the studies and analyses are provided in the annexures and appendices. Chapter 4 mainly discusses river flows, catchment area, climate, mass curves and flow capacity.
2	Detailed Design Report (2011)	Volume – 1	Chapter- 1: Introduction; Chapter -2: Hydrology and Sedimentation	The Detailed Design Report consists of Volume-1 (text) and Volume-2 (drawings).
3	Feasibility Report (2004)	Environmental Impact Assessment and Resettlement Action Plan	Chapter 5: Watershed Environmental Baseline	Chapter 5 provides short description of relief, hydrography and land use.

Recent flow data was obtained from the Surface Water Hydrology (SWH) Department of WAPDA for the Thal gauge on the Kurram River and from the Provincial Irrigation Department (PID) for the Kaitu River gauge at Spinwam and for the gauge at the Kurram Garhi Headworks.

A series of Tables with monthly and 10-day flow data is presented in the Annexes.

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3. WATER AVAILABILITY STUDIES

3.1 Introduction

The proposed Kurram Tangi (KT) dam would be located on the Kurram River at Tangi, and would provide storage for inflows from both the Kurram and Kaitu Rivers, through a diversion of some of the Kaitu inflows into the proposed KT reservoir via a power plant. The Kaitu River is a tributary to the Kurram River and meets downstream of the proposed KT dam.

The Kaitu River has a gauge at Spinwam, which is maintained by the Provincial Irrigation Department (PID). The catchment area of Kaitu River at Spinwam is 1,962 square miles. The Kurram River is gauged at Thal by the Surface Water Hydrology (SWH) Department of WAPDA, and at Kurram Garhi Headworks (K.G Headworks), downstream of the confluence with the Kaitu River by the PID. The catchment areas at Thal and K.G Headworks are 2,006 square miles and 4,632 square miles, respectively.

The availability of discharge data records is presented in Table 3-1, and a summary of flow at Spinwam, Thal, and K.G Headworks is presented in Table 3-1infers that the Design Consultants used the PID records for their analyses, leaving the SWH (WAPDA) data aside. The SWH data are generally of good quality. A visit to the Office of the Director, SWH and discussions with the technical staff indicate the procedures used to compute flow data are reasonable. SWH are computing daily mean discharges at Thal by application of mean gauge heights to rating curves prepared from stage-discharge curves based on discharge measurements. A discussion regarding hydrometeorological/hydrological data selection has been mentioned in the proceeding sections.

Location of stream gauges is shown in Figure 3-1 (Source: Google earth imagery).

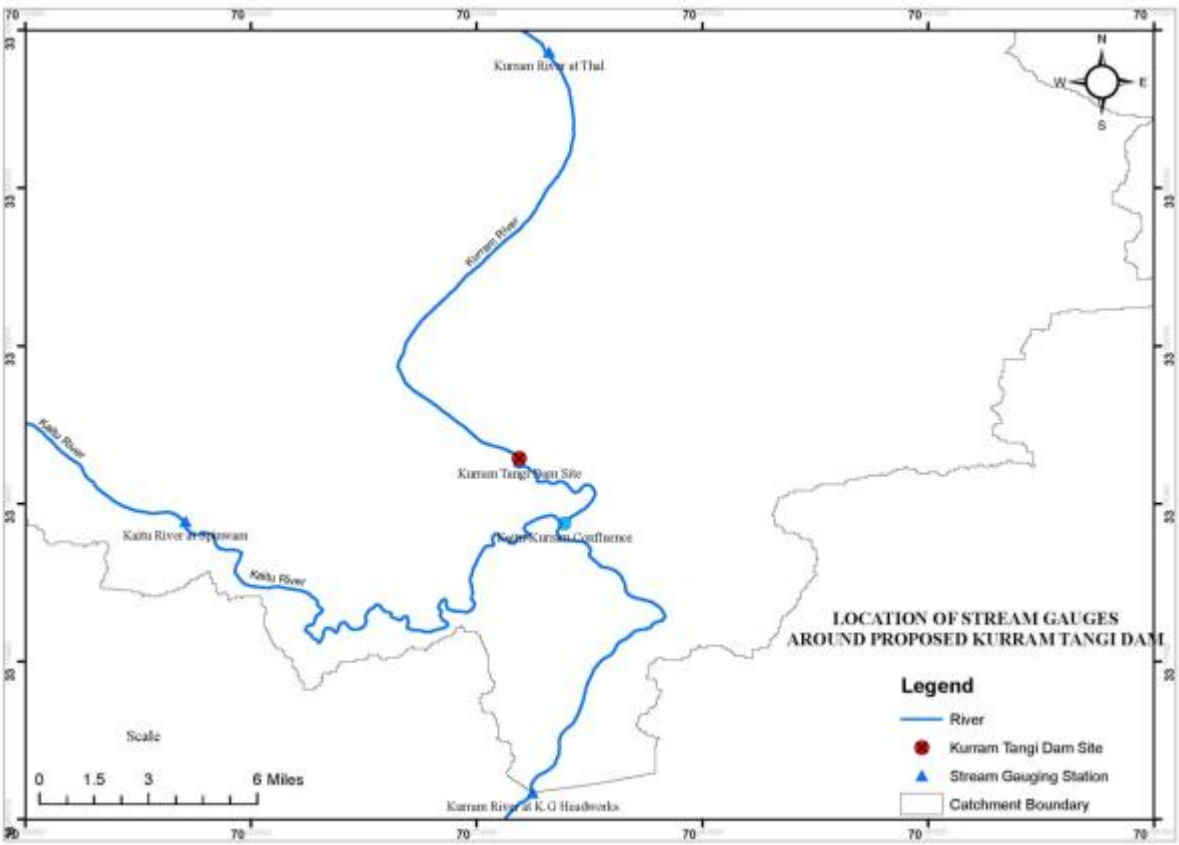

Figure 3-1: Location of stream gauges

Table 3-1: Hydrologic Data used by Design Consultants

Sr. No	Station	River	Agency	Type of Data	Period of Record	Data used for Analysis
Recorded Flows						
1	Thal	Kurram	SWH, WAPDA	Daily Average	1968-2002	-
2	K.G Headworks	Kurram	PID, KPK	Daily Average	1971-2001	1971-2001
3	Spinwam	Kaitu	PID, KPK	Daily Average	1980-1981, 1985-2002	-
4	Thal	Kurram	SWH, WAPDA	Average	1971-2000	-
5	K.G Headworks	Kurram	PID, KPK	Average	1971-2001	1971-2001
6	Spinwam	Kaitu	PID, KPK	Average	1980-2001	-
Synthesized Flows						
7	Kurram Tangi Dam	Kurram		Average	1971-2001	1971-2001
8	Thal	Kurram		Average	1971-2001	1971-2001
9	K.G Headworks	Kurram		Average	1971-2001	1971-2001
10	Spinwam	Kaitu		Average	1971-2001	1971-2001
Revised Synthesized Flows						
11	Kurram Tangi Dam	Kurram		Average	1971-2005	1971-2005
12	K.G Headworks	Kurram		Average	1971-2005	1971-2005

3.2 Analyses Performed by the Design Consultants

As indicated in Table 3-2, above, the Design Consultants selected the Kurram River historic flows at K.G Headworks for water availability studies, and estimated all other data (flows at various sites) therefrom.

3.2.1 Kurram River at Thal

After analyzing the daily data for the Kurram River at Thal and at K.G Headworks, the Design Consultants concluded that the discharge measurements at K.G Headworks were more accurate being done at a hydraulic structure, whereas potential flow measurement errors were observed by SWH at Thal. It is estimated that flow at Thal varies between 40% and 80% of the flow at K.G Headworks. The catchment area of Thal is approximately 43% of the catchment area at K.G Headworks. The Design Consultants concluded that flow measurement at K.G Headworks were more reliable.

The Kurram River flow at Thal was edited as under the following situations:

$$\text{If} \quad QTL < 0.4 * QKH \quad \text{Then } QTL = 0.4 * QKH$$

If QTL > 0.8 * QKH Then QTL = 0.8 * QKH

Where,

QTL = Kurram River flow at Thal

QKH = Kurram River flow at K.G Headworks

3.2.2 Kaitu River at Spinwam

During a field visit, the Design Consultants observed that the gauge reader had recorded some of the flow data arbitrarily, without observing the gauge.

In the light of the data quality concerns, the Design Consultants estimated the flows of Kaitu River at Spinwam by using following relationship:

QSP = QKH – QTL – QKT-TL – QSC – QKH-KT – QKT-LU

Where,

QSP = Kaitu River flow at Spinwam
QKH = Kurram River flow at K.G Headworks
QTL = Kurram River flow at Thal
QKT-TL = Runoff between Thal and Kurram Tangi Dam (Kurram River basin)
QKH-KT = Runoff between Kurram Tangi Dam and K.G Headworks (Kurram River basin)
QSC = Runoff between Spinwam and the confluence of Kaitu and Kurram River (Kaitu River basin)
QKT-LU = Local use of Kurram River flows between Thal and Kurram Tangi Dam for irrigation purposes

The runoff contributions were determined from the weighted average computed rainfall, and runoff factor. The Design Consultants used a runoff factor of 0.1 to 0.2 based on their site visit and engineering judgment.

QRunoff = Average Rainfall of Area * Runoff Factor

3.2.3 Kurram Tangi Dam Inflows

As there are no flow measurements taken at the Kurram Tangi Dam site on the Kurram River, the flow was estimated by the Design Consultants using the following equation, on a 10-day time step as described in the feasibility report. The flows were synthesized for the period (1971-2001).

QKT = QTL + RKT + QKK – LU

Where,

QKT = Kurram River flow at Kurram Tangi Dam
QTL = Kurram River flow at Thal
RKT = Runoff between Thal and Kurram Tangi Dam in the Kurram River catchment
QKK = Inflows from Kaitu Power Feeder
LU = Local use between Thal and Kurram Tangi Dam for irrigation purposes.

As part of the studies for the Detailed Design Report, the annual inflows were revised by updating hydrologic data up to 2005. A correlation was developed between the revised 10-daily inflows into the Kurram Tangi Dam for the period 1971-1980 and flows at K.G Headworks; a second degree polynomial curve was fitted, as follows.

$$Q_{KT\ Revised} = -\ 0.00196\ (Q_{KH})^2 + 0.87914\ (Q_{KH}) + 1.48055;\ (R^2 = 0.81)$$

This equation was used to estimate the 10-daily inflows into Kurram Tangi Dam from flows at K.G Headworks. The annual flows were determined by summation of 10-daily flows. The extended 10-daily and annual inflows to Kurram Tangi Dam for the period 2002-2005 are given in Annex-3 of Detailed Design Report.

3.3 Analyses Performed by the Review Consultants

The Review Consultants first checked for the flow data consistency and homogeneity based on Kolmogorov–Smirnov test, mass curve analysis and double mass curve analyses. Data reviewed by the Review Consultants are summarized in Figure 3-2. The data include more recent flow data through 2011 or 2012.

Table 3-2: Hydrologic Data Reviewed for Kurram Tangi Dam

Sr. No	Station	River	Agency	Type of Data	Period of Record	Data used for Analysis (Review consultants)
Recorded Flows						
1	Thal	Kurram	SWHP, WAPDA	Daily Average	1968-2011	1971-2011
2	K.G Headworks	Kurram	PID, KPK	Daily Average	1971-2012	1971-2012
3	Spinwam	kaitu	PID, KPK	Daily Average	1980-1981, 1985-2011	-
4	Thal	Kurram	SWHP, WAPDA	Average	1971-2011	1971-2011
5	K.G Headworks	Kurram	PID, KPK	Average	1971-2012	-
6	Spinwam	kaitu	PID, KPK	Average	1980-2011	-
Synthesized Flows						
7	Kurram Tangi Dam	Kurram		Average	1971-2011	1971-2011
8	Thal	Kurram		Average	1971-2011	1971-2011
9	K.G Headworks	Kurram		Average	1971-2001	-
10	Spinwam	kaitu		Average	1971-2001	1971-2001
Revised Synthesized Flows						
11	Kurram Tangi Dam	Kurram		Average	1971-2005	-
12	K.G Headworks	Kurram		Average	1971-2005	-

3.3.1 Kolmogorov–Smirnov Test

The Kolmogorov–Smirnov (K-s) test has been applied to historic discharge data at K.G Headworks and discharge data of Kurram River at Thal. It is a statistical test based on cumulative distributions. The hypothesis being tested is that a set of empirical observations come from a particular, known

and completely specified cumulative distribution. The monthly discharge data (hypothesis) for the period 1971-2011 were used. The following formula has been used for working out the critical value 'Dc' and test value 'D_{max}'.

$$Dc = \frac{\alpha}{\sqrt{n}}$$

$$D_{max} = [Sx - Px]$$

Where,

Dc = Critical Value
D_{max} = Maximum value of [Sx – Px]
α = Significance Level
n = No. of total observation in a sample
Sx = Sample cumulative density function based on 'n' observations
Px = Completely specified theoretical cumulative distribution function under null hypothesis

If D_{max} is less than Dc, then the series are consistent. The results of K-S test for various significance levels are given in Table 3-3 and Table 3-4.

Table 3-3: K-S test Statistics for K.G Headworks at Various Significance Levels

n	490				
D_{max}	0.058				
α	0.2	0.1	0.05	0.02	0.01
Dc	0.048	0.055	0.061	0.068	0.073
Consistent?	No	No	Yes	Yes	Yes

Table 3-4: K-S test statistics for Thal at Various Significance Levels

n	490				
D_{max}	0.05				
α	0.2	0.1	0.05	0.02	0.01
Dc	0.048	0.055	0.061	0.068	0.073
Consistent?	No	Yes	Yes	Yes	Yes

Results of K-S test for K.G Headworks in Table 3-3 show D_{max} as less than Dc at three significance levels out of five; therefore, the K-S test implies that the K.G Headworks data are consistent.

Results of K-S test for Thal in Table 3-4 show D_{max} as less than Dc at four significance levels out of five; therefore, the K-S test implies that the Thal data are a bit more consistent.

3.3.2 Mass Curve Analysis

A mass curve analysis was used for checking internal consistency by plotting the cumulative sum of the annual stream flow against time. The results are presented in Figure 3-2 through Figure 3-5 showing clearly that there is no abrupt change in mass curves for the Kurram River at Thal and K.G

Headworks. Hence, these are consistent internally. Mass curve for Spinwam shows abrupt changes in year 1981, (1987-1991) which is not consistent with Thal and K.G Headworks, hence it is not consistent internally.

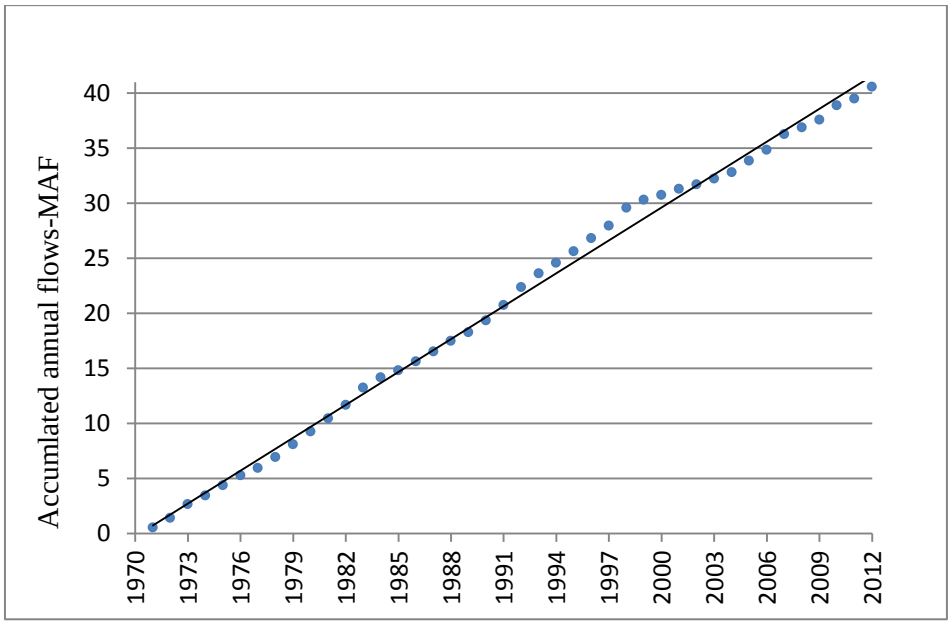

Figure 3-2: Mass Curve for K.G Headworks

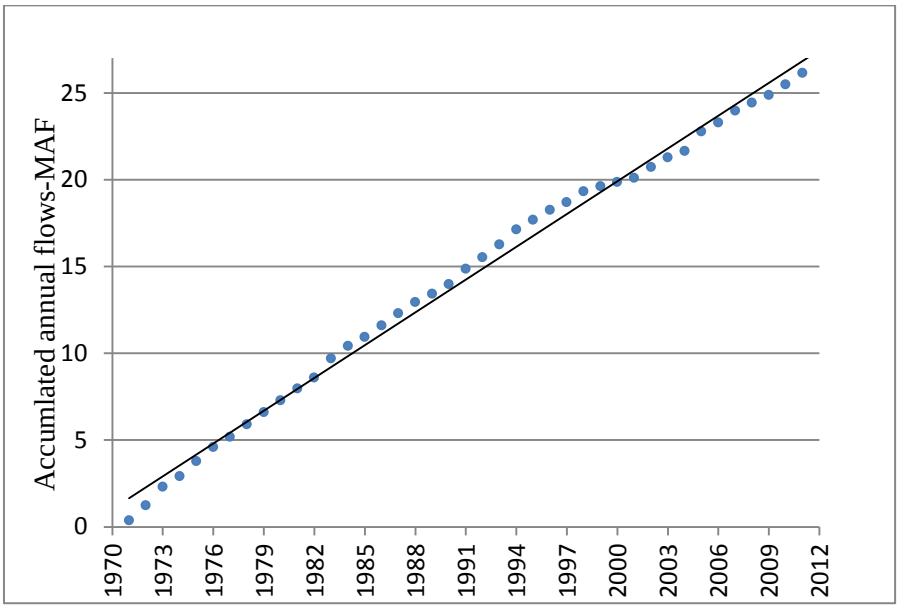

Figure 3-3: Mass Curve for Kurram River at Thal

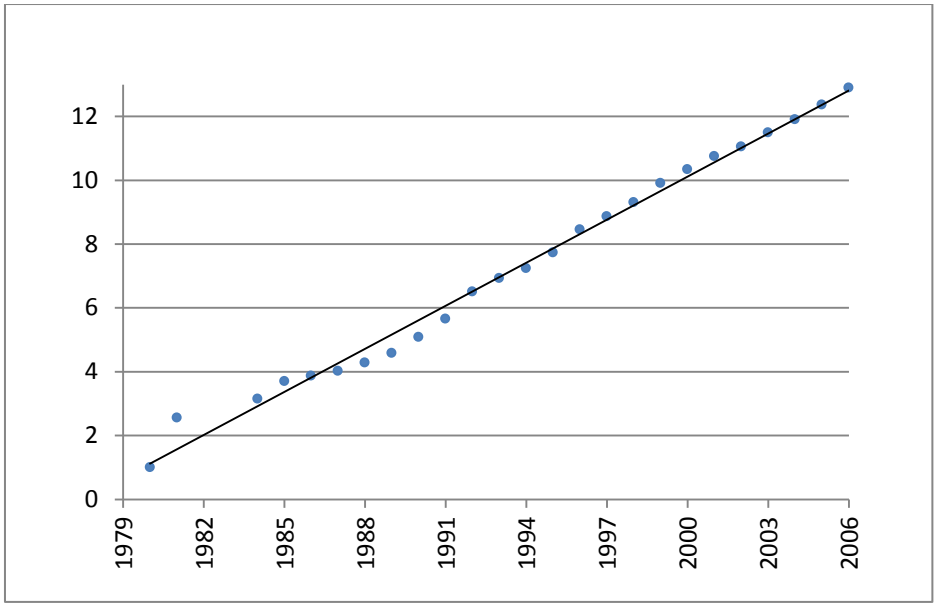

Figure 3-4: Mass Curve For Kaitu River at Spinwam

3.3.3 Double Mass Analysis

A double-mass curve can be used to check for consistency between flow records by comparing one station's flow with a group of other stations in the same area. The annual flow volume (in millions of acre-feet, MAF) for the Kurram River at Thal is plotted against the annual flow volume at K.G Headworks for the years 1971- 2011. The resulting double mass curve is shown in Figure 3-6 and Figure 3-7. The curve is not straight line, indicating that there is some inconsistency in the data.

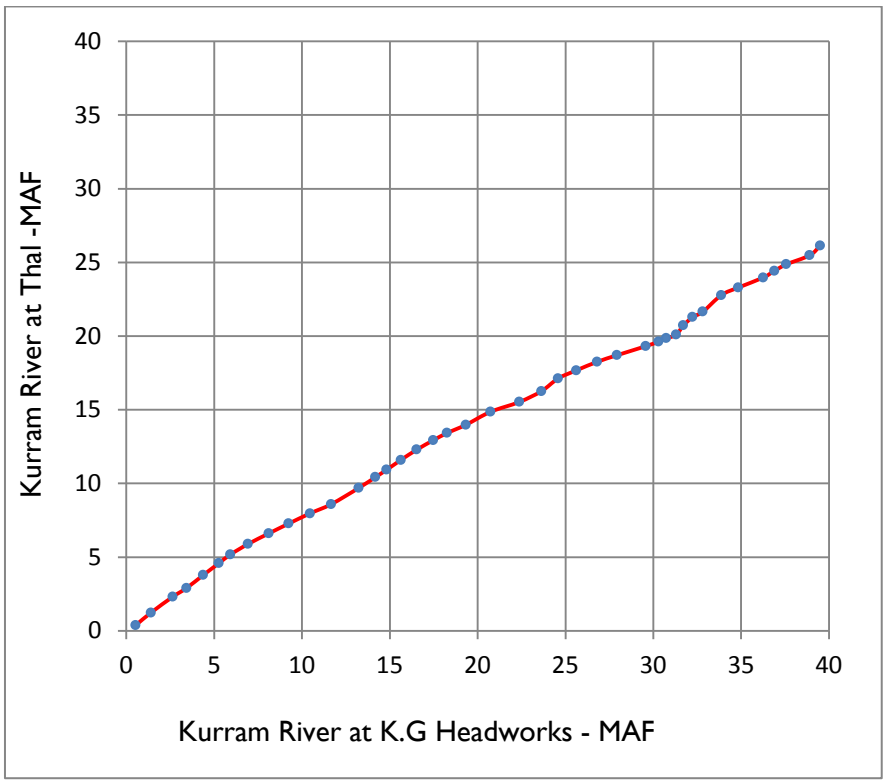

Figure 3-5: Double Mass Curve between Thal and K.G Headworks

The Kaitu River at Spinwam was also plotted against the K.G Headworks for the period 1980 through 2006 (excluding 1982 and 1983). The double mass curve is shown in Figure 3-7, below. The deviations from a straight line indicate that there is inconsistency between the datasets.

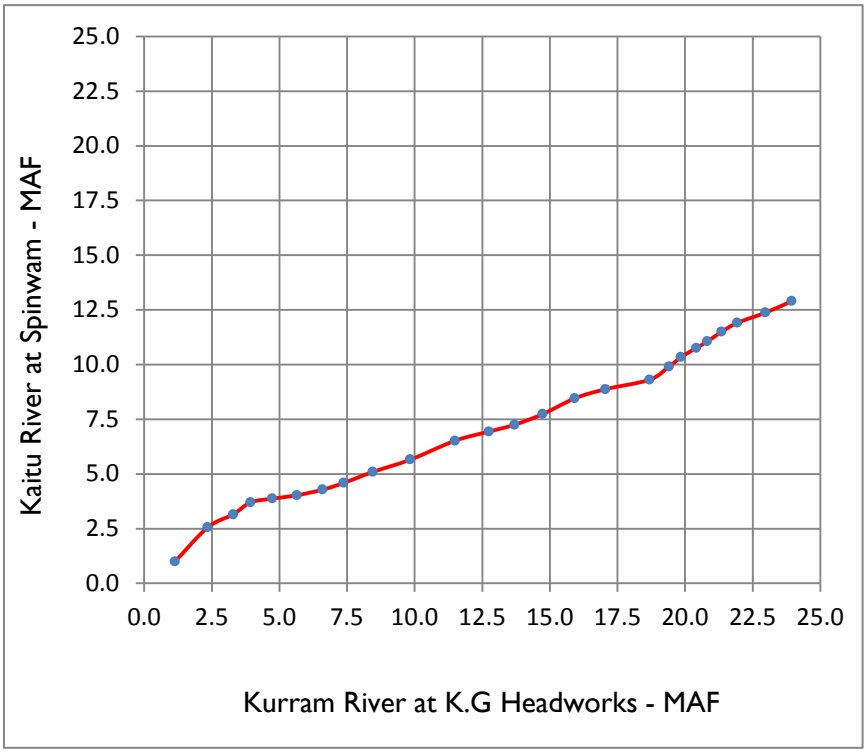

Figure 3-6: Double Mass Curve between Spinwam and K.G Headworks

3.3.4 Inferences

On the basis of above statistical and numerical tests, it is concluded that:

- The result of K-S test indicates that the discharge data of Kurram River at Thal and K.G Headworks are consistent individually.
- Kurram River at Thal and K.G Headworks mass curves does not show abrupt changes and also comparable, therefore these are consistent internally. Spinwam mass curve shows abrupt changes and not comparable with Thal and K.G Headworks.
- The double mass analysis for the Kurram River (Thal and K.G Headworks) results a curve that does not conform to a straight line; this indicates that the flows measured at K.G Headworks are somewhat inconsistent with the flows at Thal.
- The double mass analysis between K.G Headworks and Kaitu River at Spinwam shows fluctuation (Figure 3-7), which indicates that flows estimated at Spinwam are not consistent with the flows estimated at K.G Headworks.

3.3.5 Flow Synthesis at Kurram Tangi Dam (by Review Consultants)

Based on the review described above, the discharge data of Kurram River at Thal was found to be more consistent, and its application to develop flow synthesis scenarios is more reliable than discharge data of Kurram River at K.G Headworks.

The 10-daily discharge data of Kurram River at Thal for the period 1971 through 2011 was used by the Review Consultants to estimate the flows at Kurram Tangi Dam site, using the catchment area ratio method. Additional power inflows from the Kaitu River as determined by the Design Consultants were added to the Kurram River inflows.

Table 3-5 below compares the estimated flows at Kurram Tangi Dam by Design Consultants using the K.G Headworks flows and by the Review Consultant using the Thal flow data.

Table 3-5: Percentage Difference between 10-daily Synthesized Flows at Kurram Tangi Dam presented in Feasibility Report and Flows Synthesized by the Review Consultants using Catchment Area Ratio Method

Month & 10-d period	Synthesized in KTDFR (Th.AF)	Synthesized from Thal (Th.AF)	%age Difference	Month & 10-d period	Synthesized in KTDFR (Th.AF)	Synthesized from Thal (Th.AF)	%age Difference
Jan 01-10	13.29	17.65	32.8	Jul 01-10	26.45	31.26	18.2
Jan 11-20	13.75	16.78	22.1	Jul 11-20	29.31	35.52	21.2
Jan 21-31	15.93	18.72	17.6	Jul 21-31	43.72	44.54	9.9
Feb 01-10	12.61	17.09	35.5	Aug 01-10	40.48	42.94	18.0
Feb 11-20	13.98	16.26	16.3	Aug 11-20	31.57	38.36	11.5
Feb 21-28	12.75	13.84	8.6	Aug 21-31	30.41	35.04	15.2
Mar 01-10	17.98	19.22	6.9	Sep 01-10	20.29	27.68	36.5
Mar 11-20	27.96	27.98	0.1	Sep 11-20	18.02	25.49	41.5
Mar 21-31	37.67	36.40	3.4	Sep 21-30	17.95	21.23	18.3
Apr 01-10	40.59	39.23	3.3	Oct 01-10	16.05	19.68	22.6
Apr 11-20	37.15	41.59	12.0	Oct 11-20	15.95	19.88	24.6
Apr 21-30	38.63	42.13	9.1	Oct 21-31	13.29	18.74	41.1
May 01-10	39.92	44.53	11.6	Nov 01-10	10.75	16.17	50.4
May 11-20	33.91	43.33	27.8	Nov 11-20	10.38	15.65	50.8
May 21-31	33.61	43.49	29.4	Nov 21-30	11.67	16.06	37.6
Jun 01-10	23.63	30.71	29.9	Dec 01-10	13.22	17.06	29.1
Jun 11-20	22.14	28.89	30.5	Dec 11-20	13.04	17.16	31.6
Jun 21-30	19.81	28.17	42.2	Dec 21-31	14.96	18.46	23.4

The synthesized average annual flow volume computed by Design Consultant was 908,000 acre-feet. The average annual flow calculated by the Review Consultants using the updated discharge data of Kurram River at Thal is 987,000 acre-feet.

Table 3-6 below summarizes the monthly and annual average, minimum and maximum flow data for the Kaitu River at Spinwam and the Kurram River at Thal and K.G. Headworks.

Table 3-6: Summary of Flow (Average, Minimum, and Maximum) on a Monthly and Annual Basis

	Kaitu River at Spinwam (1980 – 2011, excluding 1982 and 1983)			**Kurram River at Thal (1971 - 2011)**			**K.G Headworks (1971 - 2012)**		
	Avg.	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**
Jan	456	58	738	598	95	1,117	725	324	1,279
Feb	531	53	1,455	604	110	1,674	817	285	2,490
Mar	714	258	2,838	856	124	2,861	1,604	292	5,659
Apr	755	83	2,476	1,200	122	2,918	2,210	312	7,090

May	777	115	2,772	1,338	125	4,769	1,836	330	5,742
Jun	647	83	1,725	987	171	4,875	1,212	318	4,136
Jul	1,440	265	10,383	1,146	307	2,944	2,018	607	7,130
Aug	1,193	353	2,624	1,184	242	4,233	2,283	725	9,820
Sep	772	118	3,689	844	144	2,520	1,159	545	2,999
Oct	458	53	908	624	123	1,537	825	356	1,695
Nov	399	66	738	574	92	1,076	631	326	1,012
Dec	442	40	797	582	95	948	682	289	965
Annual	715	40	10,383	878	92	4,875	1,334	285	9,820

Figure 3-7 shows the synthesized chronological monthly flow data at the proposed Kurram Tangi dam site.

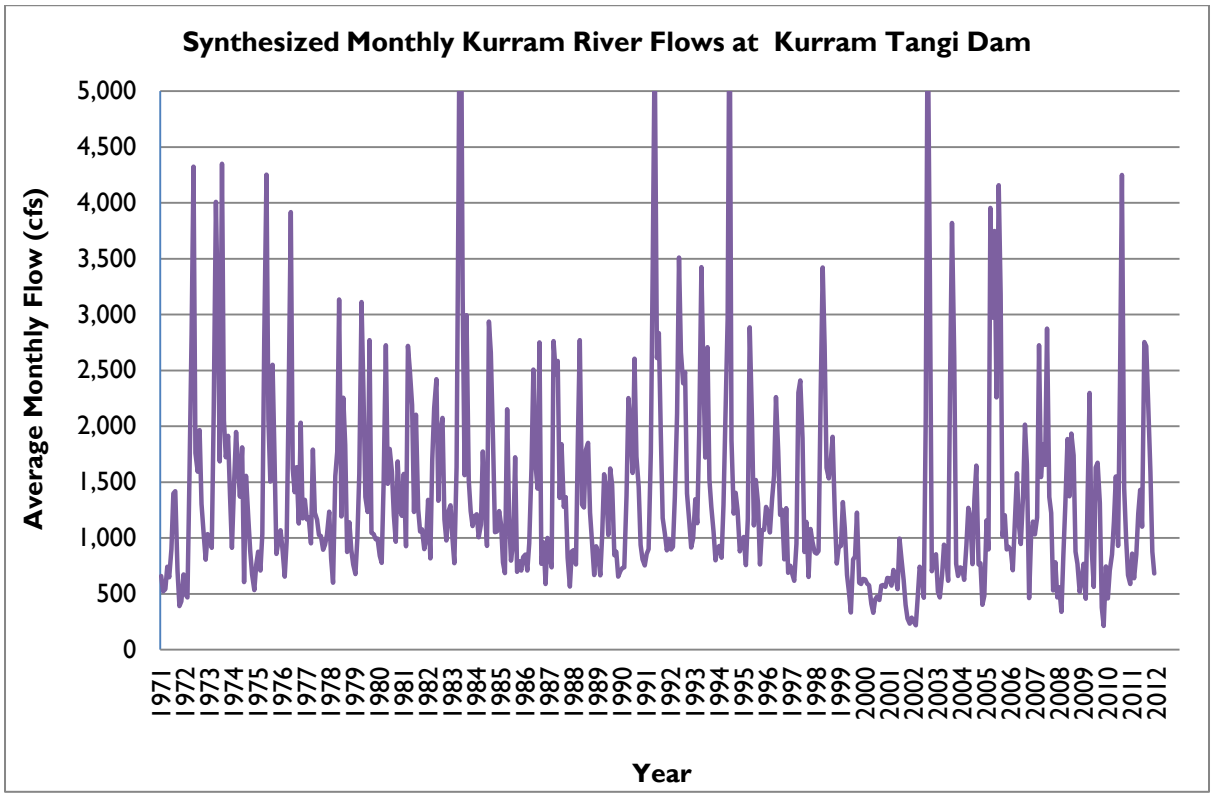

Figure 3-7: Synthesized Monthly Kurram River Flows at the Kurram Tangi Dam

Since the Spinwam gauge is very close to the proposed Kaitu weir, the flows can be considered similar. Figure 3-8 shows the chronological monthly flow data at the proposed Kaitu weir site.

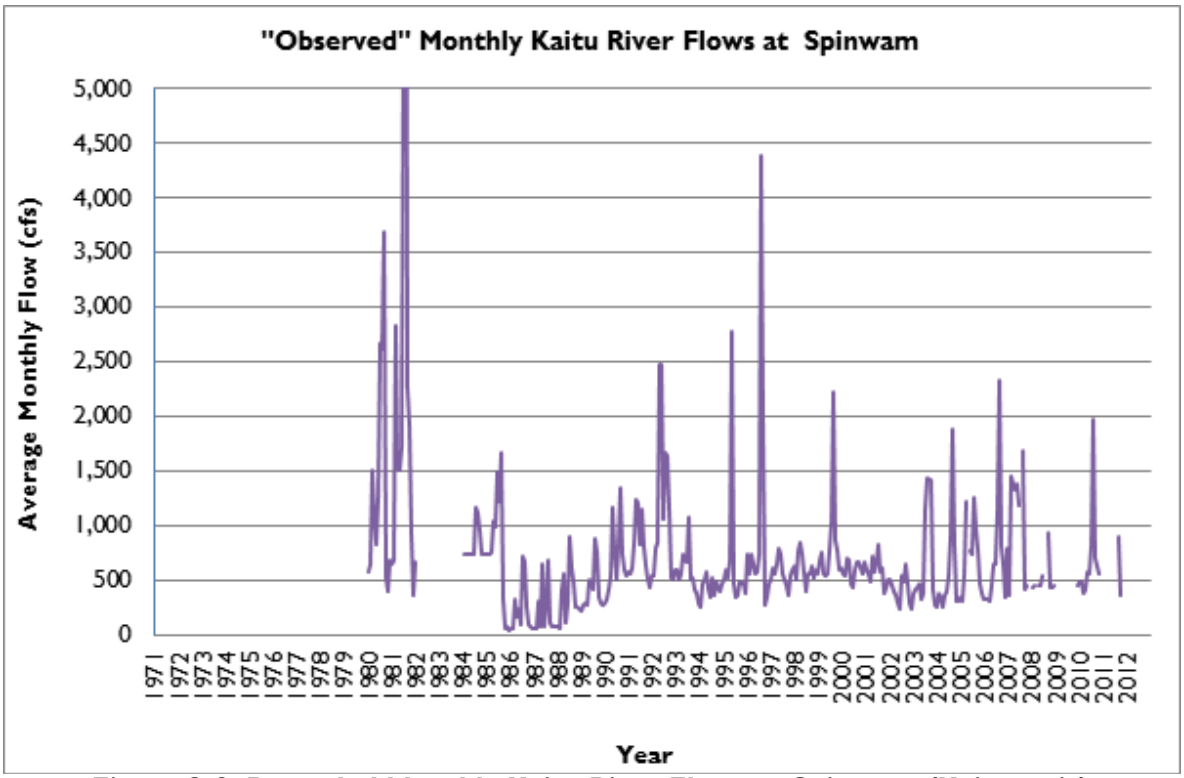

Figure 3-8: Recorded Monthly Kaitu River Flows at Spinwam (Kaitu weir)

3.3.6 Flow Duration Curves

Flow duration curves have been developed for the Kurram River at Thal and K.G Headworks by the Review Consultants. Daily discharge records for K.G Headworks (for the period 1971 through 2012) and Thal (for the period 1971 through 2011) have been used for this analysis. The flow duration is presented in in tabular form in Table 3-6 and Table 3-7.

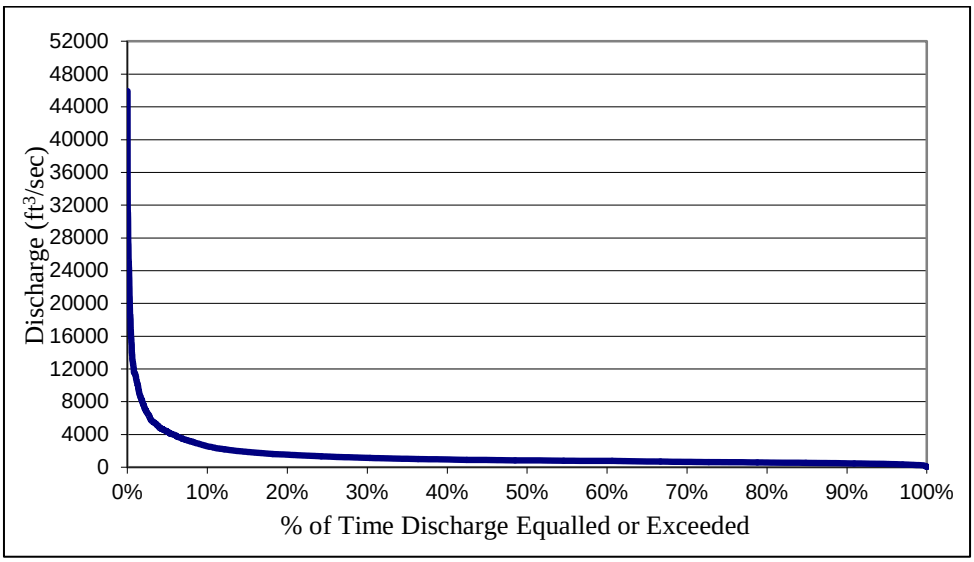

Figure 3-9: Flow Duration Curve at K.G Headworks

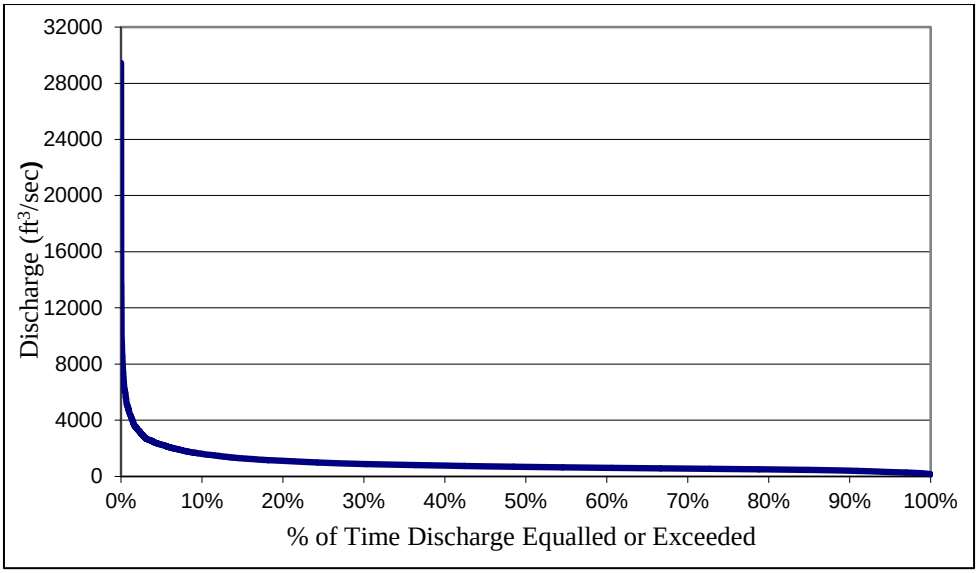

Figure 3-10: Flow Duration Curve at Thal

Table 3-7: Flow-Duration Scenario of Kurram River at K.G Headworks

% of Time	5	10	20	30	40	50	60	70	80	90	100
Flows (cfs)	4080	2329	1397	1039	862	774	665	572	505	376	74

Table 3-8: Flow-Duration Scenario of Kurram River at Thal

% of Time	5	10	20	30	40	50	60	70	80	90	100
Flows (cfs)	2237	1609	1079	848	727	638	570	506	440	308	25

3.3.7 Conclusions and Recommendations

It is concluded from various tests and comparisons of data analysis that:

- The discharge data of Kurram River at Thal is consistent and representative of the catchment area up to Kurram Tangi Dam site.
- In Detailed Design Report, the average annual water availability at Kurram Tangi Dam is estimated at 908,000 acre-feet, while it is estimated at 987,000 acre-feet , using the Thal discharge data.
- The accuracy of the histogram Spinwam gauge flow data needs to be further investigated as it has a major impact on total inflows available at the Kaitu weir and their distribution between minimum downstream flow releases and flows for irrigation and power purposes.
- Discrepancies between the sum of flow gauge data at the Thal and at Spinwam should be resolved.

It is recommended that a site visit of all three stream gauging stations be carried out by flow measurement Specialists to check the accuracy of discharge measurement procedures and rating curves. Recommendations on proper procedures to estimate daily flows should be developed with the Surface Water Hydrology (SWH) Department of WAPDA as well as with the Provincial Irrigation Department (PID) to have consistency and accuracy in recordings and estimates over the entire range of low, medium and high flows,

The need for additional gauges and monitoring facilities for rainfall data, water measurements and water quality should be assessed.

Missing flow data from the Spinwam gauge should be synthesized from other flow and rainfall data.

Once historical flow data for the Kaitu weir and Kurram Tangi reservoir have been confirmed, weir and reservoir operation studies should be updated. Reservoir monthly rule curves and operating procedures for minimum downstream ecological flow releases as well as irrigation and power releases should be developed to maximize water utilization and project benefits. The impacts of climate change, discussed in the supplemental report on Climate Change, should also be integrated into this analysis.

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4. DIVERSION DESIGN FLOOD

Looking at floods with recurrence intervals of 5, 10, and 25 years ("5-year, 10-year and 25-year floods") is helpful in estimating the requirements for stream diversion during the construction period for a dam and its appurtenant features. The magnitude of a greater event—such as a 50- or 100-year flood, or greater—may be required to establish the sill design of emergency spillways, diversion dams, etc.

4.1 Flood Frequency Analysis

In the Detailed Design Report (Ref 2), the 30-year flood—estimated by using the Log-Pearson Type III distribution—was adopted for the design of diversion tunnel.

Frequency analysis has been carried out by the Review Consultants using the Gumbel (extreme value type 1) distribution and Log-Pearson Type III distribution for Kurram River at Thal (1971-2011). The results of both frequency analyses, and that of the frequency analysis carried out during detailed engineering design stage, are given in Table 4-1, below.

Table 4-1: Flood Frequency Analyses for Kurram River at Thal

Return Period (Years)	Estimated Discharge (cfs)		
	Gumbel (EV1)	Log-Pearson Type III	Log-Pearson Type III (KTDFR)
2.33	28,403	24,963	27,358
5	46,539	45,248	53,815
10	61,310	63,556	68,650
20	75,478	78,212	79,979
30	83,629	89,023	85,279
50	93,818	99,107	90,798
100	107,561	114,695	96,581

Plotting position and fitted lines are shown in Figures 4-1 and 4-2.

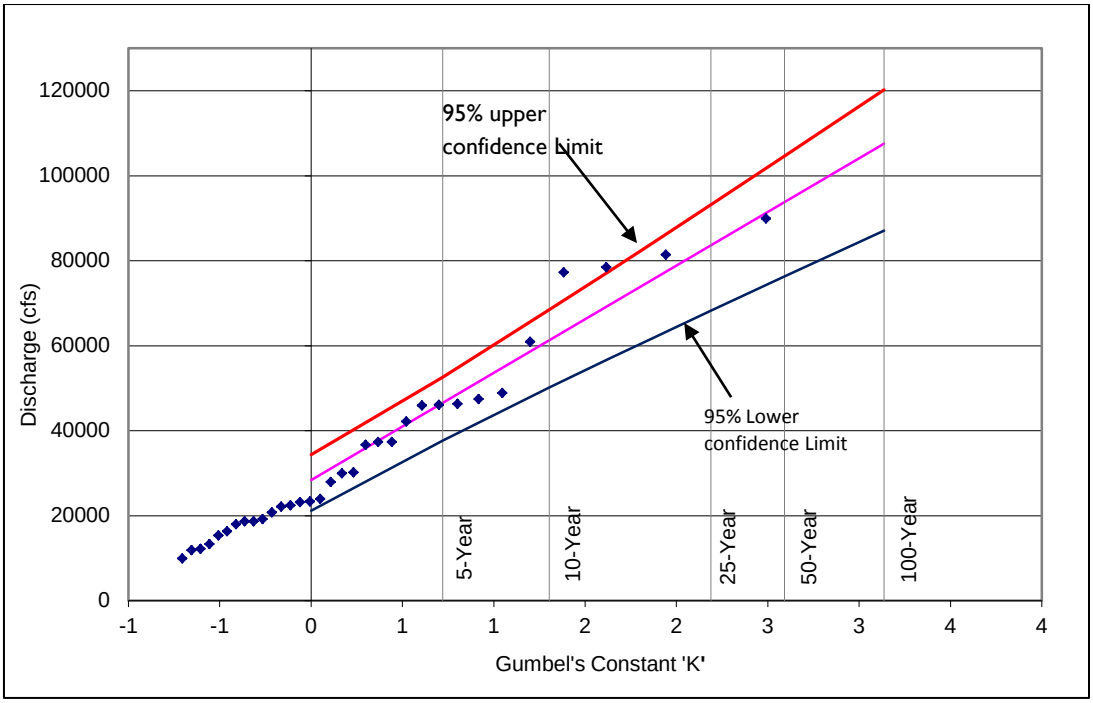

Figure 4-1: Plotting Positions and fitted line with Gumbel EV1 Distribution

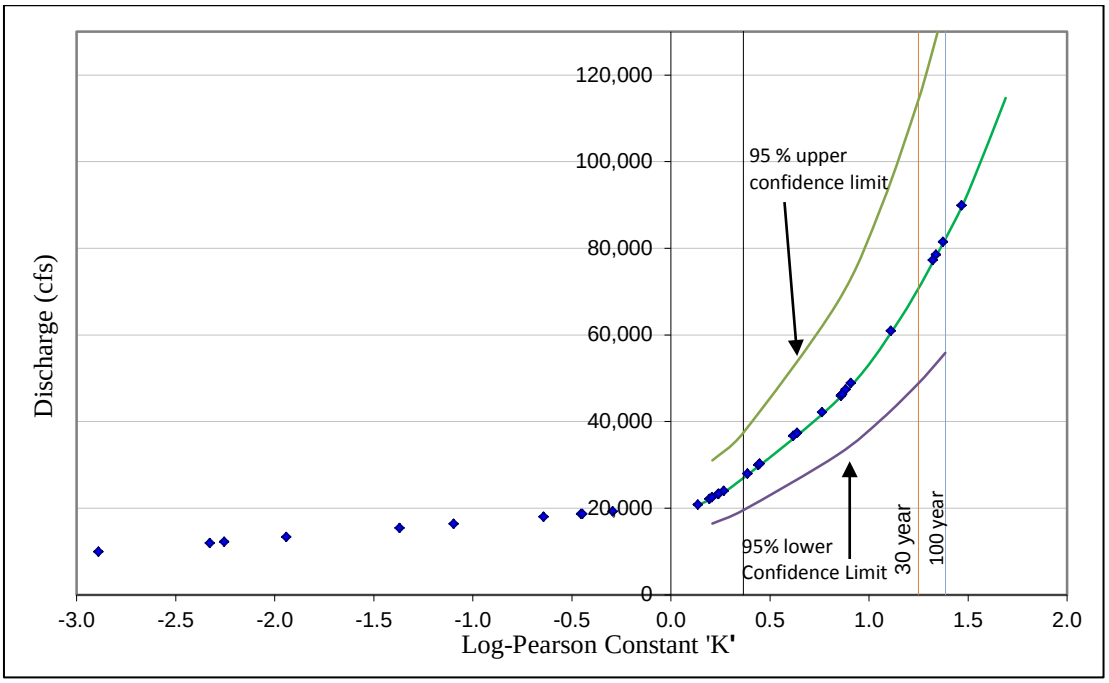

Figure 4-2: Plotting Positions and fitted line with Log-Pearson Type III Distribution

4.2 Conclusions

On the basis of frequency analysis for Thal peak discharge using two techniques, it is concluded that the two set of results obtained in this review are similar. The current results using the same technique as the Feasibility Report (Log-Pearson Type III Distribution) produce different results due to increased data availability for this analysis.

On the basis of frequency analysis results, it is recommended that the 50-year flood should be taken as diversion design flood.

5. CATCHMENT AREAS

Delineating the catchment area is essential to estimating the design flood, sedimentation, and water availability. In the detailed engineering design, the catchment areas were delineated using the Survey of Pakistan (SOP) maps. The SOP maps are available on a minimum scale of 1:50,000.

Digital Elevation Model (DEM) data is also available from the Shuttle Radar Topography Mission (SRTM). The Review Consultant completed a catchment delineation using the DEM data; a comparison of results is given in Table 5-1, below.

Table 5-1: Catchment Areas at Various Locations with SOP and DEM

Catchment	SOP By Design Consultants Sq. miles	DEM By Review Consultants Sq. miles
Kurram River at Thal	2,006	2,101
Kurram River at confluence of Kaitu River	2,600	2,695
Kaitu River at Spinwam	1,962	1,965
Kaitu River at outfall into Kurram River	1,994	1,997
Kurram River including Kaitu River (at Zarwam)	4,594	4,692
Kurram River at Kurram Garhi Headworks	4,632	4,731

The difference in catchment areas at Spinwam and Kaitu River at outfall into Kurram River are tolerable. The remaining four catchment areas are approximately 100 square miles larger when using the DEM data to delineate catchments; this additional area can significantly impact flood magnitudes, water availability and catchment sediment yield.

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6. PMP AND PMF STUDIES

The Probable Maximum Precipitation (PMP) for Kurram Tangi Dam was studied by Pakistan Meteorological Service (PMS) for Kurram River basin in 1968 at the behest of WAPDA. The study was based on rainfall data for 74 years (1891 to 1965), and PMP was determined as 4.3 inches for 60 hours on the basis of a major storm of 7th to 9th July 1910 after following necessary maximization procedures. The PMP rainfall was enhanced 20% due to the 1978 storm recorded at Bannu (5.36 inches in 60 hours), as the dam site is located 20 miles north of Bannu.

Recent PMP studies were reviewed as part of this study. For the studies carried out for the Bara River Dam, the PMP rainfall for Bara River and Mastura River was estimated as 11.3 inches and 13.6 inches, respectively, in 30 hours; this was done considering the flood of 1967, which was the most severee for the area. During the 1978 storm, 5.36 inches of rainfall was recorded for one day at Bannu, per Pakistan Meteorological Department records.

The isohytel map of Pakistan for one-day maximum rainfall (1940-1970) issued by the Pakistan Meteorological department is shown for the project area in Figure 6-1, below. The map shows the 8-inches isohyet passing near Thal.

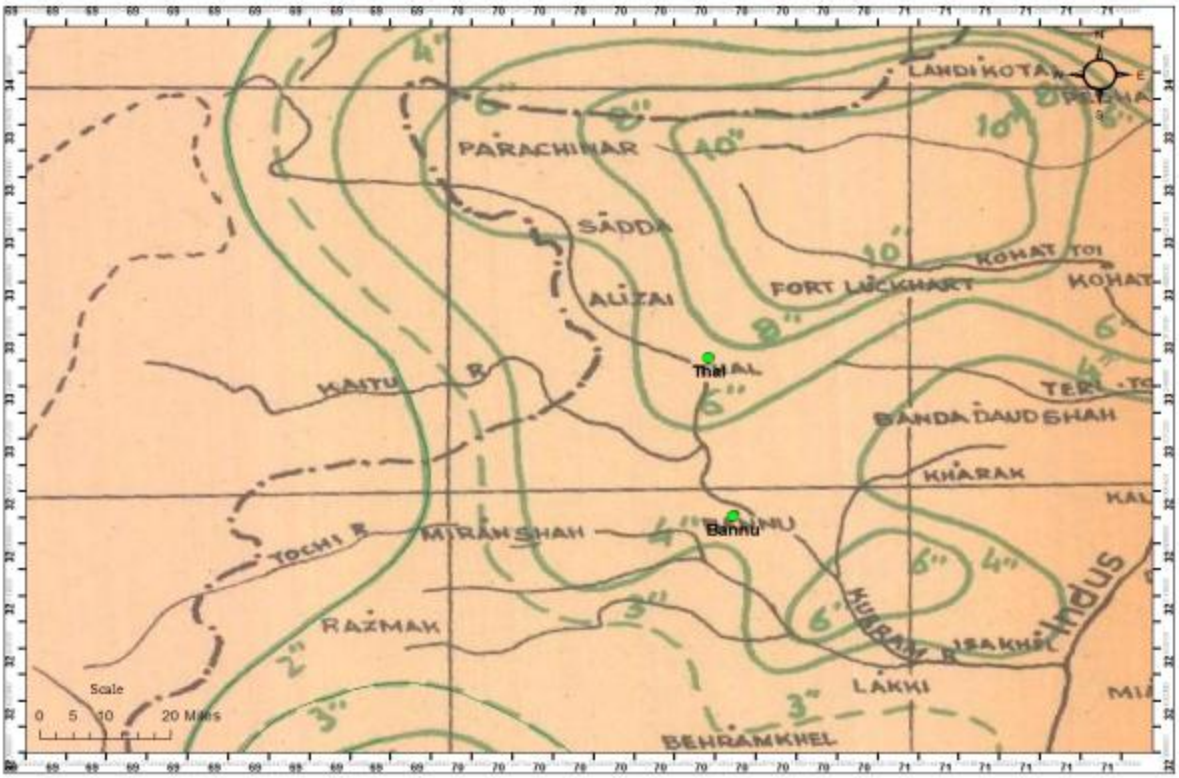

Figure 6-1: One-Day Maximum Isohytel Map of the Study Area (1940-1970)

The PMP magnitudes for rivers in close vicinity, the 8-inch isohyet passing near Thal indicate that the design report PMP for Kurram Tangi Dam was grossly underestimated, and needs to be revised by the Design Consultants.

The PMF was computed using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), developed by the United States Army Corps of Engineers. Input to the program included PMP data (taken from the precipitation hyetograph), unit hydrograph, infiltration loss during the storm and base flow prior to the flood. The PMF, as compared by the Design Consultants, has a peak of 180,753 cfs and a total volume of 0.458 MAF.

The peak and volume of the PMF should be reviewed and recalculated after revising the PMP. Once a new PMP and PMF are calculated, the adequacy of the proposed spillway should be re-evaluated and revised.

7. SEDIMENT STUDY

Sedimentation studies carried out at the feasibility and detailed engineering design stages of the KTMD have been reviewed as part of the Environmental Assessment (EA) studies. The fundamental parameters used by the Design Consultants during the sediment studies and the conclusions drawn thereof are summarized below:

- Average annual sediment yield of Kurram River at Thal: 1.48 acre-feet/sq-mile
- Total sediment load entering into Kurram-Tangi reservoir: 5.93 Million Ton per year. This total load includes suspended and bed loads of Kurram River and only suspended load of Kaitu river; bed load transport through Kaitu-Kurram feeder has been assumed zero as the crest level of Kaitu weir has been set significantly higher than the river bed level.
- Particle size distribution of sand, silt and clay likely to enter into Kurram Tangi reservoir

  Sand 14.4%
  Silt 63.3%
  Clay 22.2%
- Reservoir effective life estimated as 225 years
- Sediment storage or Dead Storage fixed as 200,000 acre-feet, based on a Dead Storage Level (DSL) fixed at El. 1975 feet above sea level (asl)

To validate the parameters used by the Design Consultants, the sediment and discharge data as well as the methodology for estimating reservoir life have been reviewed; a summary of this review is presented below.

7.1 Data Review

In Section 2.11.1 of the Detailed Engineering Design Report, the Design Consultants referred to SWH's observed sediment yield of Kurram River at Thal as 1.48 acre-feet per square mile per annum. It has been further stated that SWH's observed sediment yield of Kurram River has been used for estimation of the Kurram Tangi reservoir life. It is important to mention here that SWH's publication 'Sediment Appraisal of Pakistan Rivers 1960-2005' provides an annual sediment yield of Kurram River at Thal as 1.56 acre-feet per square mile, slightly higher than the Design Consultants' stated value of 1.46 acre-feet per square mile. No reason concerning this discrepancy could be found in both the Feasibility or Detailed Engineering Design report.

It is interesting to note that the Design Consultants had questioned SWH's observed flow discharges of Kurram River at Thal whereas they accepted the sediment yield. The observation made by the Design Consultants was that the observed flow discharge data of Kurram River at Thal were faulty as low flows were underestimated and high flows were overestimated. With the above situation, it became necessary to check the reliability of the sediment yield estimated from the instantaneous samples of suspended sediment concentrations collected by SWH.

To gain confidence in the SWH's catchment sediment yield estimate, published data of long-term annual water availability and sediment yields at several gauging stations located in the same or adjoining basins to the Kurram basin has been obtained from SWH's Sediment Appraisal of Pakistan Rivers 1960-2005. These data have been reviewed and used to find correlation between mean annual runoff and mean annual sediment yield per unit catchment area.

In addition to the SWH gauging station data, the provincial irrigation department has been contacted to obtain information on sediment sampling at Kurram Garhi headworks and sediment deposition records in the existing reservoirs/ponds in the area. We were informed by the provincial irrigation department that a structured and systematic arrangement for sediment sampling at Kurram Garhi

headworks does not exist. With regards to the record of sediment deposition in the pond of Kurram Garhi headworks, the provincial irrigation department stated that the pond is very small and cannot allow sediments to deposit over the year. In other words, sediments that enter the pond get flushed past the headworks during the high flow season of the same year.

With this explanation SWH's published records become the only data source to be analysed to determine the consistency of the published value of sediment yield of Kurram catchment at Thal. SWH's observed data of runoff and sediment yields along with the available period of record considered for developing the correlations are given in Table 7-1. Locations of these gauging stations have been shown in Figure 7-1.

Table 7-1: Runoff and Sediment Data of Kurram River Adjoining Basins

River	Station	Catchment area (sq-mile)	Data record years	Mean annual runoff per unit catchment area (acre-ft/sq-mile)	Mean Annual sediment yield per unit catchment area (acre-ft/sq-mile)
Tochi	Tangi post	1,980	23	93	2.18
Tank Zam	Jandola	840	23	321	14.2
Zhob	Sharik Weir	4,090	10	44	2.52
Gomal	KhajuriKach	11,200	19	76	2.35
DarabanZam	ZamTower	410	13	139	3.06
Gomal	KotMurtaza	13,900	39	6	1.91
Kurram	Thal	2,140	38	303	1.56

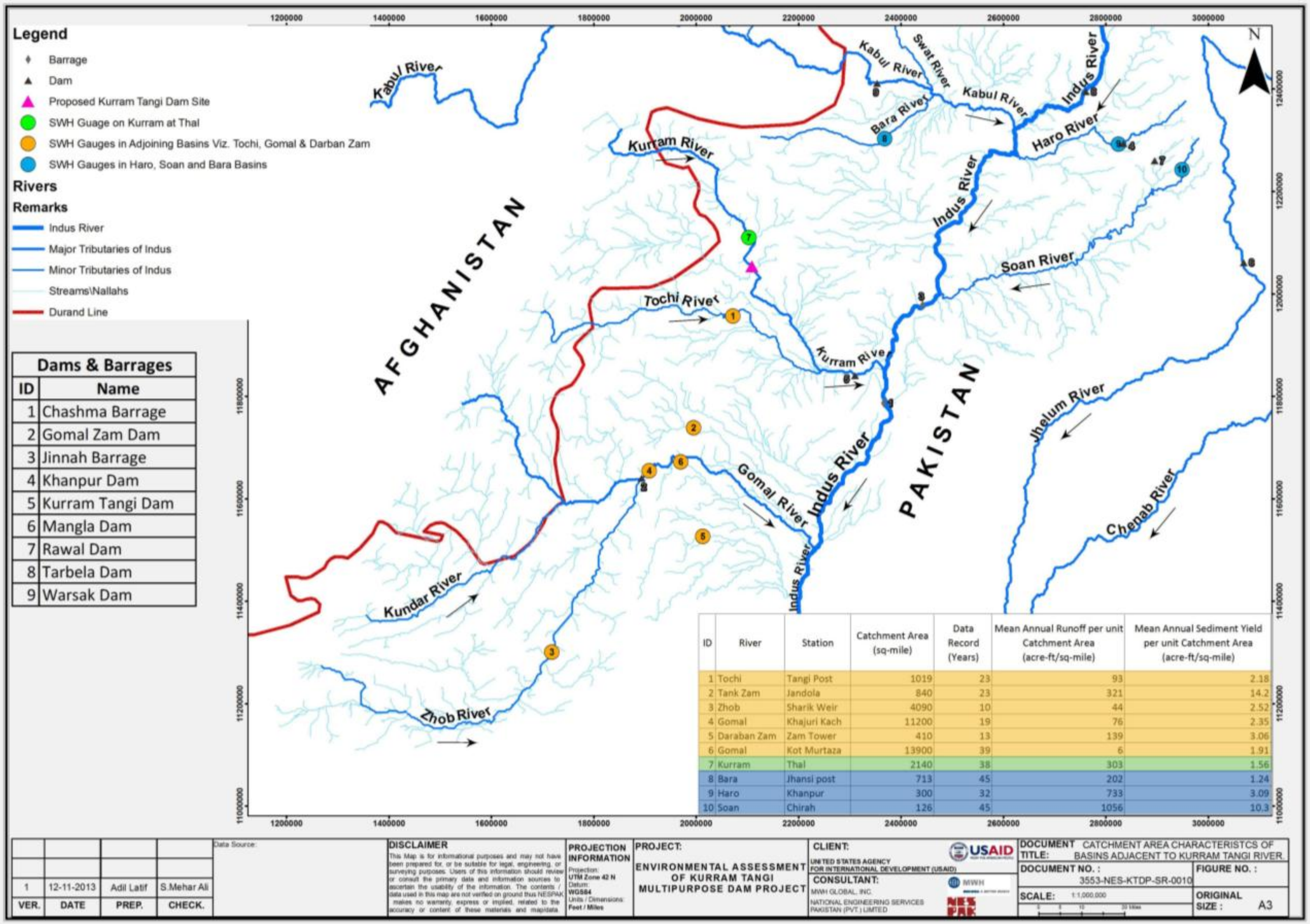

Figure 7-1: Location of the gauging stations used in analysis

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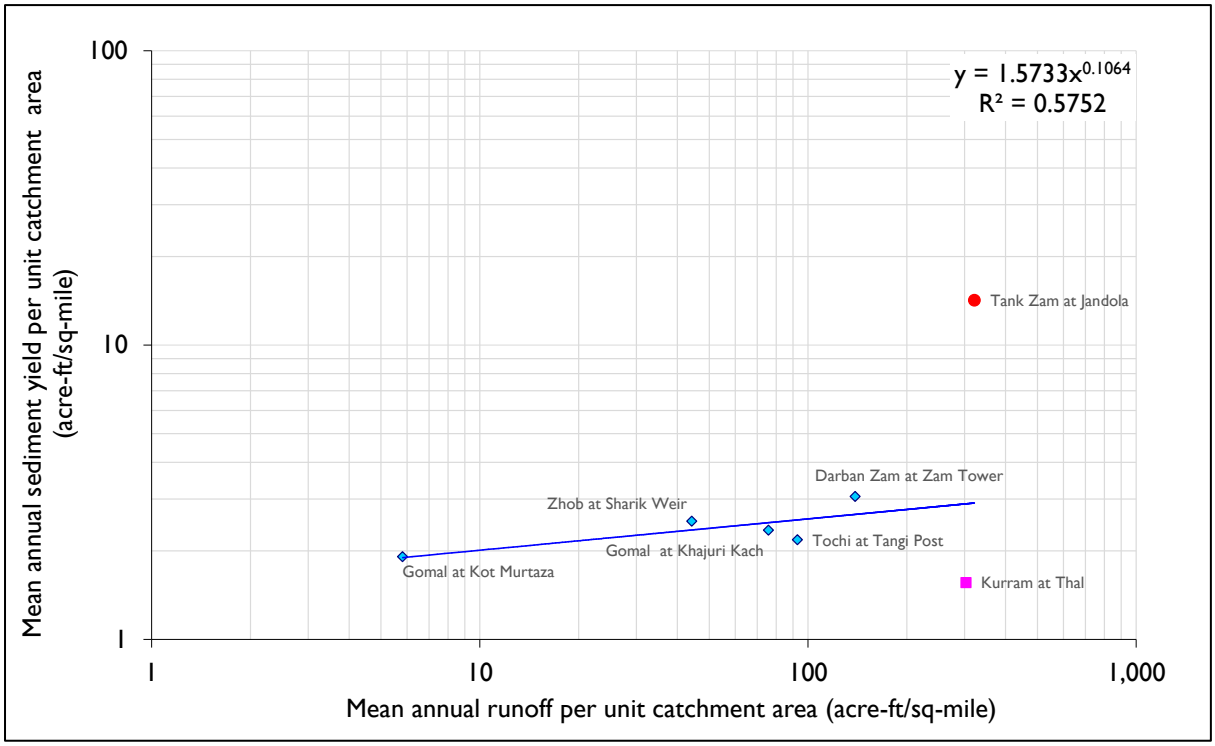

Figure 7-2: Specific runoff versus specific sediment yields of Kurram and adjoining river basins

Figure 7-2 shows a plot of specific runoff vs. specific sediment yield of seven different gauging stations in and around the Kurram basin. The data have been plotted in three distinct colours i.e. blue, red and pink. The pink point represents Kurram River at Thal, the red shows Tank Zam at Jandola whereas all the blue points are for the remaining stations listed in Table 7-1.

The scatter plot depicts that the sediment yield of Tochi, Gomal, DarbanZam, and Zhob Rivers in the adjoining basins of Kurram River basin is in the range of 2 to 3 acre-feet per square mile, corresponding to a range of mean annual runoff of 6 to 150 acre-feet per square mile. Tank Zam at Jandola, however, indicates exceptionally high sediment yield on the order of 14 acre-feet per square mile, with a 321 acre-feet per square mile of mean annual runoff.

To determine the consistency of sediment yield of Kurram River observed at Thal with respect to the sediment yields observed in the adjoining basins, a trend line has been fit while considering the sediment yield of Tank Zam at Jandola as an outlier. This trend line shows a slight increase of sediment yield per unit catchment area with increase in unit runoff. This phenomenon can be explained as supply-limited catchment conditions to generate and deliver the sediments into the streams. The best fit trend line indicates that SWH's observed sediment yield of 1.56 acre-feet per square mile for Kurram River at Thal is underestimated. According to the regression equation shown in Figure 11, the correct estimate would be in the order of 2.89 acre-feet per square mile, based on a mean annual runoff of 303 acre-feet per square mile for the Kurram River at Thal.

7.2 Reservoir Sedimentation

As discussed in the previous section, the mean annual sediment yield of Kurram River at Thal seems underestimated; this would underestimate reservoir sedimentation and overestimate reservoir life.

Furthermore, given the host of uncertainties present in the previous and current sedimentation studies, a vigilant discharge and sediment measurement program at Thal should be implemented as soon as possible. The collected sediment samples should be used to develop a sediment rating curve. The sediment curve developed from the latest samples of sediment concentrations should be compared to the sediment rating curves developed from historic concentration data. This would provide a better understanding of variation in discharge and sediment. This would help verify the estimates made at the feasibility and detailed design stages as well as the determination made in this report. Understanding the best estimate of sediment yield is critical to the final design of the dam, and the sediment estimate should be verified through a more rigorous sediment measurement program.

Moreover, it has been noted in the available project documents prepared at both the feasibility and detailed engineering design stages that reservoir sedimentation has been estimated by using Brune's curve and empirical area-reduction methods instead of carrying out an industry-accepted detailed numerical modeling study. The numerical modeling tools not only help in predicting the long-term sediment deposition patterns but also provide further basis for studying and recommending the potentially effective sediment management measures.

Given the importance of loss of reservoir storage due to sedimentation and the size of investment envisaged for KTMD, it is suggested that a detailed numerical modeling study should be undertaken duly based on a more authentic and valid estimate of annual sediment influx into the reservoir.

Without contradicting the above recommendation to undertake detailed numerical modeling, the reservoir life and sediment distribution pattern estimated at the detailed engineering design stage was reviewed and revised, taking into account the revised estimate of sediment yield for the Kurram catchment at Thal. Review of reservoir life and sediment distribution at various reservoir depths determined at the detailed engineering design stage indicates that the dead storage of 200,000 acre-feet will be filled with sediments in 85 years (Ref: Figure 2.14 of Detailed Engineering Design Report) whereas reservoir's effective life would be 225 years. This estimated time of filling of the reservoir dead storage was determined by using average annual sediment load of 5.93 Million Tons.

To check the Design Consultants' calculated time to fill dead storage, the same Brune's curve was used with the same average annual sediment load as an input (5.93 MST). Based on this, it would take about 55 years to fill the dead storage of 200,000 acre-feet. The new zero-capacity elevation after 55 years of operation is El. 1893 ft ASL, which is about 81 feet lower than the DSL fixed by the design consultants; no reason for fixing the DSL at El. 1974 has been provided in the detailed design report.

After reviewing the estimates of reservoir life and distribution of sediment deposits in the reservoir, the revised annual sediment load of 3 acre-feet per square mile (it was rounded up from the 2.89 calculation) was used to estimate the resulting reservoir sedimentation. The sediment influx into the Kurram Tangi reservoir has been estimated by adding the sediment contribution downstream of Thal up to the Kurram Tangi dam and the suspended sediments from the Kaitu-Kurram power feeder - estimated on the basis of runoff proportion from the respective catchments. It is important to mention that sediment transport through Kaitu-Kurram feeder into the Kurram Tangi reservoir has been assumed as only the suspended sediment portion as the feeder tunnel would draw water from upper layers of the proposed Kaitu weir pond whereas the bed load fraction would be sluiced past the weir through the under-sluices proposed in the weir. In the detailed engineering design bed load fraction of Kurram River has been considered as 15% of suspended sediment; the same percentage has been accepted as being a general characteristic of gravel-sand bed streams. Revised estimates of sediment influx into the Kurram Tangi reservoir is summarized in Table 7-2 below.

Table 7-2: Revised Estimates of Sediment Influx into Kurram Tangi Reservoir

Kurram at Thal (Review Consultants' Estimate)	3.00	acre-feet/square mile/year
Kurram River at Thal (based on Review Consultants Estimate)	7.64	Million Ton/year
Kurram River suspended sediments at KT dam site = 7.64* (628/574)	9.39	Million Ton/year
Kurram River bed load @ 15%	1.41	Million Ton/year
Total sediment load of Kurram River at dam site	10.78	Million Ton/year
Kaitu-Kurram Feeder suspended load = 7.64* (205/636) * 0.70	1.72	Million Ton/year
Total sediment load entering Kurram Tangi Dam = 10.78 + 1.72	12.52	Million Ton/year

Based on the revised estimate of sediment influx of 12.52 Million Ton/year into the Kurram Tangi reservoir, the sediment deposition pattern has been calculated by Brune's median curve. The deposited sediments have been distributed in the reservoir by using Type Curves for Determining the New Zero-Capacity elevation at the Dam based on dimensionless 'F' function (Strand and Pemberton, 1987). The sediment deposition estimates and the New Zero-Capacity elevation at the dam have been presented at 10 years intervals in Table 7-3.

Table 7-3: Revised Estimate of Reservoir Life and Sediment Distribution

Maximum Conservation Level	2127.00	ft ASL			
Gross Storage	1.20	Million acre-feet (MAF)			
Live Storage	1.00	MAF			
Dead Storage	0.20	MAF			
Time	Sediment	Residual	Storage	New 'Zero-Capacity'	Remarks
Period	Deposits	Storage	Lost	Elevation	
(years)	(acre-ft)	(acre-ft)	(%)	(ft asl)	
10	90,707	1,114,429	8%	1864	
15	130,978	1,074,157	11%	1867	
20	171,249	1,033,886	14%	1870	
25	211,233	993,902	18%	1896	Loss of sediment storage; Revised DSL at El. 1900 ft asl
30	251,063	954,072	21%	1910	

35	290,732	914,403	24%	1923	
40	330,400	874,735	28%	1936	
45	369,907	835,228	31%	1949	
50	409,414	795,721	34%	1962	
55	448,730	756,405	37%	1977	Detailed design DSL at El. 1974 ft asl
60	488,046	717,089	41%	1992	
65	527,194	677,941	44%	2001	
70	566,343	638,792	47%	2011	
75	605,337	599,798	50%	2019	
80	644,330	560,805	54%	2028	
85	683,014	522,121	57%	2037	
90	721,697	483,438	60%	2047	
95	760,116	445,019	63%	2054	
100	798,535	406,600	67%	2060	
105	836,508	368,628	70%	2068	
110	874,480	330,655	73%	2075	
115	911,708	293,427	76%	2078	
120	948,935	256,200	79%	2082	
125	985,362	219,773	82%	2090	
130	1,021,788	183,347	85%	2098	
135	1,057,091	148,044	88%	2100	
140	1,092,393	112,742	91%	2103	
145	1,125,403	79,732	94%	2108	
150	1,158,413	46,722	97%	2113	
155	1,180,507	24,628	98%	2114	
160	1,202,602	2,534	100%	2116	Complete loss of storage

Distribution of sediment deposits - determined on the basis of revised sediment influx - indicates that the dead storage of 200,000 acre-feet would be filled with sediments in initial 25 years of reservoir operation. In subsequent years, sediments would start depositing in the live reservoir storage resulting into decreased releases for irrigation and hydropower operations planned at feasibility and detailed engineering design stages. Moreover, after 25 years of operation reservoir water storage capacity would be zero at El. 1900 ft asl which would require to adopt the Dead Storage Level (DSL) at El. 1900 ft asl instead of El. 1974 ft asl being fixed at detailed engineering design.

To retain the DSL at El. 1974 ft asl and keep the live storage fixed as 1,000,000 acre-feet there would be a requirement to raise the Normal Conservation Level (NCL) by 22 ft and fix it at El. 2149 ft asl; this would require raising the height of dam to increase the full effective life of the project from 25 to 55 years. Another option can be to reduce the live storage from 1,000,000 acre-ft to 760,000 acre-ft and increase the dead storage from 200,000 acre-ft to 440,000 acre-ft in which case the Normal Conservation Level, the dam height and the DSL would remain the same as fixed in the detailed engineering design. However, reduction in live storage would reduce the amount of regulated water for irrigation and hydropower.

With no sediment management measures the gross capacity of the reservoir would be completely filled with sediments in about 160 years.

Again, given the importance reservoir storage and investment required for KTDP, a detailed numerical modeling study should be undertaken, using a more authentic and valid estimate of annual sediment influx into the reservoir.

7.3 Channel Degradation Downstream of the Dam

Review of feasibility and detailed engineering design reports indicates that channel degradation downstream of the dam has not been studied. Since almost all of the sediments would be trapped in the reservoir, the water spilled past the dam would be sediment hungry and would cause channel erosion starting from downstream of the dam. Such channel degradation would extend depending upon the channel bed gradation and the magnitude of flow flowing past the dam.

The potential channel degradation due to dam commissioning could detriment the aquatic ecology, e.g. by disturbing the fish habitats, such a detailed study should be performed in the next round of design studies to further assess impacts on the overall environmental assessment of the project. The numerical model discussed earlier would provide estimates of channel degradation under various operational scenarios.

7.4 Other Sediment Related Issues

Beside channel degradation below the dam, other important considerations related to sedimentation phenomenon are;

- Coarse sediment ingress into power tunnels, causing abrasion and
- Optimization of sediment flushing operations

Although both considerations are not directly relevant for undertaking EA studies, these may impact the overall sediment integrity of the system. Based on the review of the feasibility and detailed engineering design studies, no attention has been given to these two considerations. The previously recommended numerical model would be capable of considering these two items.

7.5 Conclusions

Based on the above analyses and discussions, the following conclusions have been drawn:

- SWH's measured mean annual sediment yield of 1.56 acre-feet per square mile of Kurram River at Thal is underestimated on the basis of correlation of long-term published mean-annual specific runoff and sediment yield of Gomal, Darban Zam and Tochi rivers at various gauging stations.
- Based on the regression analysis of long-term observed mean annual sediment yields of the river basins contiguous to the Kurram catchment, an estimate of mean annual sediment yield for Kurram River at Thal was calculated.
- Sediment studies carried out at feasibility and detailed engineering design stages lacks detailed numerical modelling exercises for estimating temporal and spatial distribution of sediments in the Kurram Tangi reservoir.
- Sediment deposition and distribution of deposited sediments in the Kurram Tangi reservoir have been estimated at detailed engineering design stage by employing the empirical methods of Brune's curve and empirical area-reduction methods. The estimated sediment deposition and the corresponding distribution at various reservoir depths have been determined by the design consultants according to which the sediment dead/storage fixed as 200,000 acre-ft would be lost by sediment deposition in about 85 years. The overall effective life of the reservoir would be of the order of 225 years. These estimates have been made by considering average annual sediment influx of 5.93 MST into the Kurram Tangi reservoir.
- To verify the Design Consultant's estimates of reservoir sedimentation, the same annual sediment load of 5.93 MST has been used and Brune's curve has been used to determine the time to fill the reservoir storage capacity. The analyses indicates that the time to deposit 200,000 acre-feet of sediments - as being equivalent to the dead/sediment storage fixed at detailed engineering design – is 55 years.
- By using a revised sediment influx of 12.52 million Tons per annum into the Kurram Tangi reservoir, the dead/sediment storage of 200,000 acre-feet would be filled with sediments within 25 years of project operation.

- To retain the detailed engineering design's DSL (El. 1974 ft asl) and a live storage of 1,000,000 acre-feet, the Normal Conservation Level (NCL) would be required to be raised by 22 feet. This would require raising the height of dam, resulting in an increase of the effective life of the project from 25 to 55 years.
- If the dam height, NCL and DSL are unchanged, the live storage would be reduced to 760,000 acre-feet which would reduce the amount of water for irrigation and hydropower.
- By not employing sediment management measures, it is expected that the capacity of the reservoir would be filled with sediments in about 170 years of operation.
- Given a host of uncertainties in the measured runoff and particularly sediments, it is recommended to undertake a detailed sediment measurement program so that the sediment yield may be verified.
- There is a need to carry out numerical modelling of reservoir sedimentation to determine the effectiveness of drawdown flushing or pressure sluicing (the best known sediment removal methods).
- Channel degradation in the river stretch downstream of the dam needs to be studied to determine the potential change in river regime and its effect on aquatic ecology.
- Besides the channel degradation, sediment ingress into the power tunnel should also be studied to better manage the potential threats of turbine abrasion associated with reservoir sedimentation.

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List of Annexes

Table A-1: Monthly Average Flows Of Krram River at K.G Headworks (cfs)

Year/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	548	500	391	596	475	659	1838	1804	545	386	453	632
1972	431	475	921	2001	3331	1374	1370	1196	1187	567	596	847
1973	708	824	1517	2187	1439	763	7130	2737	1138	909	561	570
1974	626	655	647	1017	2638	541	2141	2077	987	562	453	632
1975	580	638	960	1530	1740	1712	941	3859	1932	576	536	673
1976	661	839	1062	2782	1860	867	1241	1956	1082	975	592	711
1977	683	637	495	1751	966	585	2072	1091	740	717	556	653
1978	584	578	4458	1447	906	973	1370	3441	643	764	760	621
1979	641	1052	1906	2398	1880	1000	1665	5093	1139	1004	794	744
1980	772	850	1902	2181	1279	4136	1889	1570	1309	1070	1012	919
1981	1279	889	3226	2804	2410	1048	2831	1764	1076	960	799	829
1982	1279	889	3226	2804	2410	1048	2831	1764	1076	960	799	829
1983	866	763	1903	6398	5111	1850	1397	3169	1614	1107	893	905
1984	890	868	952	1282	687	721	2838	2803	2027	755	856	861
1985	872	721	685	1699	506	506	1159	1838	695	706	520	733
1986	717	684	1074	1694	1563	910	1619	2177	700	716	597	851
1987	711	648	2870	1307	2582	1223	1748	968	908	778	565	611
1988	623	615	2161	1554	848	1167	2313	3096	1310	638	473	826
1989	774	527	1226	1633	1205	817	1996	2129	727	660	496	632
1990	679	761	2082	2628	1704	1124	3313	2054	1147	836	738	674
1991	782	914	2041	4270	4594	2014	2216	2208	1449	925	783	828
1992	926	1117	1613	5218	5742	2451	2259	3297	1655	1076	905	965
1993	954	812	3102	2683	2177	1658	3588	1526	1634	1020	763	801
1994	849	1074	1410	1818	1510	692	2864	1178	1362	1219	799	910
1995	899	721	1504	4124	2249	1060	1968	1439	820	1029	624	771
1996	789	801	1308	1236	2580	4070	2115	3310	782	1393	592	590
1997	613	633	914	3282	4046	2567	1108	1466	605	1695	921	835
1998	947	1868	4496	7090	2999	1091	1914	1706	2266	1172	785	837
1999	1175	1570	1104	627	562	366	1383	1910	1184	753	702	590
2000	767	728	619	429	438	846	607	807	845	500	336	473
2001	507	397	589	700	330	1251	2192	1384	958	356	326	341
2002	324	502	559	550	340	547	764	798	786	412	392	383
2003	383	507	753	2113	820	444	1201	1603	817	448		
2004	460	519	292	312	359	393	1428	3608	1321	380	424	289
2005	1218	2490	2955	1617	3073	794	1656	1395	807	595	399	375
2006	543	511	1055	625	1901	318	3701	3070	940	1368	968	935
2007	669	1571	5659	4191	1530	3845	1305	1490	1392	648	593	782
2008	786	722	601	1966	1904	734	716	725	620	1073	448	411
2009	479	881	794	2531	977	659	1075	735	1493	596	485	542
2010	597	285	1050	640	1013	727	4866	9820	970	774	505	505
2011	414	817	710	1559	819	696	978	1512	1008	826	563	384
2012	439	479	568	3535	1590	667	1146	4318	2999	765	516	680

Table A-2: Monthly Average Flows Of Kurram River at Thal (cfs)

Year/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	463	439	399	531	484	671	935	862	520	300	267	302
1972	375	375	1152	2161	2920	1302	1136	1435	1012	780	634	800
1973	732	774	1550	2918	2254	1301	2773	1094	1317	1397	1076	659
1974	1117	1674	1268	1024	774	467	889	580	688	486	399	571
1975	614	604	795	2129	3127	1500	1125	1449	1030	628	754	741
1976	612	510	597	1052	2859	1216	1041	1032	841	1537	899	948
1977	860	966	723	1229	862	911	594	624	693	719	816	904
1978	616	501	821	1279	2323	879	1689	1003	663	820	685	482
1979	493	731	1064	2059	1561	984	659	1396	755	629	748	709
1980	513	516	966	1748	999	1133	838	678	718	1235	937	858
1981	1068	789	1747	1208	841	926	1274	784	708	763	641	643
1982	612	606	759	915	1141	809	900	1360	737	632	956	926
1983	718	632	886	2365	4769	2276	1124	1997	1031	827	782	790
1984	815	784	837	1354	925	649	1708	1486	1093	744	785	859
1985	796	592	491	1446	891	592	438	927	455	552	535	616
1986	565	576	730	959	1706	1298	836	2021	540	683	441	613
1987	551	547	1734	1786	1593	872	1202	846	1017	459	351	578
1988	647	599	1267	1997	894	696	1053	898	745	733	512	628
1989	639	537	562	705	911	767	919	760	568	626	501	511
1990	525	603	599	745	979	1106	1204	812	1023	623	559	532
1991	584	654	776	1617	3414	1637	1958	1159	590	703	687	683
1992	603	629	715	696	1589	1547	1470	1366	823	539	511	573
1993	957	918	921	2376	1458	826	1746	840	564	545	510	500
1994	518	514	756	1327	2130	4875	880	684	741	599	605	644
1995	653	651	659	1430	687	613	947	634	596	589	811	883
1996	873	856	1001	1062	1356	885	670	611	577	647	505	504
1997	469	467	514	861	1036	726	472	677	526	506	590	618
1998	577	582	787	1571	1448	1154	716	995	997	511	417	397
1999	542	502	795	414	335	246	329	341	796	229	229	278
2000	329	299	281	208	167	241	307	266	334	444	454	459
2001	460	452	548	449	425	635	376	242	144	123	94	95
2002	95	110	124	122	125	171	1312	4233	2520	407	589	557
2003	304	317	276	279	269	283	1546	2652	1953	459	454	465
2004	467	476	486	570	543	420	729	943	457	463	253	264
2005	807	754	2861	2004	2549	1665	2944	2150	673	801	667	610
2006	594	573	625	825	483	582	755	1230	1199	217	758	788
2007	707	1026	1894	794	1049	1181	1936	722	832	271	573	253
2008	336	234	416	577	1086	915	1196	1015	556	457	345	376
2009	500	337	853	1414	333	246	956	963	920	151	92	472
2010	257	544	420	469	820	546	1560	2990	1021	641	474	348
2011	572	506	422	517	726	700	1840	1783	1651	1107	645	423

Table A-3: Monthly Average Flows Of Kaitu River at Spinwam (cfs)

Year/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	571	649	1502	1083	833	1256	2672	2624	3689	530	402	680
1981	656	691	2838	1527	1501	1725	10383	2259	1923	908	369	660
1984	738	738	738	738	738	738	1161	1112	947	738	738	738
1985	738	738	762	1033	982	1485	1223	1661	326	53	66	40
1986	61	62	333	160	229	94	720	668	246	101	73	56
1987	58	53	305	83	639	83	265	688	118	71	66	83
1988	71	65	411	554	115	293	896	617	481	262	257	215
1989	269	284	270	502	492	414	875	748	349	282	269	287
1990	333	406	544	1161	773	501	827	1339	734	596	540	572
1991	552	613	836	1247	1206	820	1153	806	634	509	424	533
1992	533	789	849	2476	2470	1051	1666	1631	1155	521	509	591
1993	591	509	554	745	685	661	1071	506	515	422	381	295
1994	254	463	509	573	422	339	513	353	482	426	398	468
1995	509	591	529	678	2772	477	336	353	479	460	466	381
1996	734	554	734	551	570	735	4394	1933	275	340	466	509
1997	616	554	640	788	732	551	505	447	368	534	594	628
1998	509	777	845	738	550	402	550	552	636	529	594	550
1999	681	749	550	547	550	776	1035	2216	860	771	594	616
2000	550	545	693	683	464	428	589	672	671	620	551	665
2001	591	554	480	725	575	674	825	584	616	381	432	509
2002	509	450	389	356	291	237	533	483	655	460	292	240
2003	385	423	426	476	320	370	1141	1429	1414	410	274	251
2004	385	346	258	353	396	545	890	1883	816	299	314	351
2005	304	550	1220		772	737	1254	961	764	463	375	322
2006	318	328	305	444	641	650	1129	2335	805	629	335	797
2007	353	1455	1387	1323	1390	1193		1684	416	443		
2008	434	449		444	442	532			941	427	437	443
2009					394					486		444
2010	478	482	371	406	579	560	827	1974	695	621	561	
2011						425		891	365			

Table A-4: 10-Daily Average Flows of Kurram River at Thal (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	1st	473	453	425	389	568	517	920	561	493	318	267	285
	2nd	463	430	387	439	636	1002	537	1376	817	303	266	305
	3rd	502	346	428	767	297	499	1445	739	255	312	269	348
1972	1st	314	371	370	1616	3698	1382	969	1677	474	994	563	767
	2nd	329	373	1723	2339	2935	857	1215	1780	1689	743	607	800
	3rd	522	346	1485	2538	2436	1673	1343	1000	879	685	737	918
1973	1st	804	685	1353	3178	2482	1451	2326	1611	924	1680	1157	733
	2nd	730	608	1536	2852	2670	1282	3200	845	774	1278	1109	645
	3rd	737	878	1923	2741	1848	1176	3085	940	2261	1379	968	668
1974	1st	731	1554	1649	1492	973	436	932	812	636	596	297	519
	2nd	897	1479	1179	941	842	452	731	461	424	471	430	549
	3rd	1840	1662	1110	643	590	516	1098	529	1006	444	472	704
1975	1st	661	636	733	1866	2142	2099	1567	749	1191	463	820	724
	2nd	592	607	672	1657	4067	1291	1100	1717	748	590	752	808
	3rd	653	450	1062	2876	3501	1119	826	2035	1158	895	695	769
1976	1st	678	528	523	779	2151	1891	647	718	753	2140	1219	975
	2nd	592	543	620	825	2521	1131	1197	1677	866	1319	684	959
	3rd	631	409	712	1557	4206	633	1389	809	909	1314	799	1008
1977	1st	1123	1492	799	1327	1237	911	670	769	683	679	874	887
	2nd	690	644	722	1789	648	861	671	560	840	865	744	928
	3rd	858	572	723	578	791	967	504	610	560	687	834	993
1978	1st	670	575	665	642	2763	1022	3611	635	476	898	924	384
	2nd	596	456	900	1430	2274	665	768	902	772	866	551	553
	3rd	647	374	984	1774	2177	954	866	1577	744	782	583	559
1979	1st	470	685	893	1402	2050	1196	528	1505	696	474	889	688
	2nd	498	719	941	2501	1422	1084	627	1538	893	631	693	727
	3rd	562	647	1470	2284	1374	677	891	1292	679	849	666	786
1980	1st	635	457	647	1668	831	780	752	647	722	987	1153	755
	2nd	480	537	913	2053	1249	973	786	778	828	1535	894	717
	3rd	477	505	1441	1534	1022	1651	1062	681	607	1311	770	1191
1981	1st	1061	831	1178	2020	1045	947	1232	914	679	830	655	653
	2nd	1129	650	1519	1073	1022	970	826	802	619	742	635	651
	3rd	1127	731	2729	536	545	867	1898	720	829	797	638	694
1982	1st	625	594	706	764	1741	498	1044	1900	571	646	572	1132
	2nd	608	606	686	931	991	1271	802	939	470	602	1168	892
	3rd	666	499	964	1056	811	661	948	1385	1173	713	1133	851
1983	1st	743	674	695	1776	5268	2897	1317	2982	628	837	781	785
	2nd	716	591	837	2502	5233	2328	950	1655	1632	850	781	790
	3rd	771	506	1220	2828	4310	1614	1225	1567	839	882	788	879
1984	1st	818	803	752	1510	983	705	1117	2023	1052	780	687	862
	2nd	821	772	805	1382	988	633	1966	1245	1350	743	742	867

Table A-4: 10-Daily Average Flows of Kurram River at Thal (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	3rd	891	703	1042	1178	901	613	2220	1345	882	787	931	938
1985	1st	833	679	413	1343	971	631	351	1605	562	550	471	642
	2nd	808	586	353	1816	917	763	622	718	409	570	517	619
	3rd	830	396	759	1187	879	385	387	557	397	593	619	653
1986	1st	605	561	510	866	1895	1478	686	3379	609	533	400	548
	2nd	541	594	852	851	1762	1260	1342	1202	485	953	425	576
	3rd	608	459	905	1165	1641	1163	569	1696	528	634	500	779
1987	1st	624	521	1147	1929	1900	1265	443	822	1868	500	341	366
	2nd	552	614	1520	1716	1300	875	1376	745	507	495	338	801
	3rd	535	398	2719	1722	1748	481	1912	1059	682	432	375	628
1988	1st	650	614	807	2084	1153	719	636	819	630	815	525	592
	2nd	653	574	1088	2070	943	619	704	867	1051	551	486	633
	3rd	707	552	2041	1848	679	753	1929	1102	558	910	528	726
1989	1st	657	544	515	707	1077	833	593	616	440	637	530	534
	2nd	632	533	557	625	915	775	924	671	573	748	481	480
	3rd	696	430	674	788	837	697	1337	1074	695	559	494	574
1990	1st	502	602	518	756	1163	1106	648	1190	943	620	650	511
	2nd	516	587	556	711	928	1036	954	450	1125	622	528	507
	3rd	613	503	786	772	949	1181	2138	880	1007	692	501	635
1991	1st	573	837	702	1152	2513	2670	898	906	630	728	711	701
	2nd	573	549	703	2447	4188	1123	4267	628	582	726	672	669
	3rd	668	449	1006	1262	3901	1127	916	2066	562	729	682	751
1992	1st	591	757	544	630	975	2065	1417	1559	659	577	509	617
	2nd	578	599	674	628	1101	1332	1086	1074	1220	543	502	591
	3rd	705	472	1001	834	2859	1253	2061	1608	594	555	523	573
1993	1st	852	931	831	1489	1367	924	869	494	577	588	511	515
	2nd	1026	829	917	3654	1838	833	1786	1391	553	543	515	502
	3rd	1093	816	1113	1998	1324	724	2768	723	564	563	507	536
1994	1st	517	501	626	1412	1711	2451	851	523	620	628	553	698
	2nd	518	511	606	1116	2304	4608	820	550	582	589	605	638
	3rd	573	430	1116	1460	2599	7590	1063	1051	1025	645	661	665
1995	1st	656	658	666	833	719	683	479	569	613	458	730	864
	2nd	665	650	633	810	651	580	633	703	570	623	855	914
	3rd	706	518	750	2653	764	578	1830	698	609	748	852	965
1996	1st	883	885	993	997	1273	770	759	633	617	623	499	531
	2nd	920	828	1029	1044	1155	1091	601	507	577	707	506	540
	3rd	908	772	1086	1152	1783	798	722	756	541	677	513	495
1997	1st	461	429	509	718	1142	983	425	763	513	392	584	527
	2nd	459	509	477	932	1021	689	432	589	533	440	661	676
	3rd	537	370	611	938	1053	508	609	751	535	738	527	715
1998	1st	582	583	476	1641	1261	1194	877	1040	1144	612	455	421

Table A-4: 10-Daily Average Flows of Kurram River at Thal (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2nd	587	552	691	1546	1741	1141	585	1026	1099	491	355	367
	3rd	621	498	1277	1534	1494	1133	761	1024	753	484	444	443
1999	1st	472	521	838	416	367	264	241	335	623	252	244	281
	2nd	443	493	983	431	343	239	324	288	1494	220	212	287
	3rd	767	394	648	398	330	234	458	434	277	240	231	296
2000	1st	285	308	283	241	174	249	206	265	299	418	468	455
	2nd	312	288	265	199	165	243	274	282	295	462	443	456
	3rd	425	274	324	185	180	232	474	280	409	497	452	514
2001	1st	482	474	410	439	458	365	240	321	134	145	100	94
	2nd	447	420	443	465	398	1103	252	261	152	119	96	101
	3rd	500	375	849	445	465	440	676	169	146	118	88	101
2002	1st	93	104	123	127	143	98	297	3763	4744	352	576	591
	2nd	94	109	120	120	122	103	2358	6529	2264	433	626	568
	3rd	109	70	141	109	122	283	1418	2855	513	478	518	572
2003	1st	283	382	289	290	259	267	985	4250	3921	490	462	461
	2nd	258	293	244	288	266	282	2987	2470	1310	450	438	462
	3rd	403	214	324	259	312	302	828	1515	638	486	463	522
2004	1st	415	514	600	500	510	469	498	630	459	482	243	311
	2nd	455	466	497	452	589	293	959	615	443	479	222	256
	3rd	581	294	412	691	588	453	807	1684	430	475	268	255
2005	1st	1519	530	1120	1818	3019	1746	4941	2217	394	785	691	635
	2nd	564	930	5019	1745	2484	1722	1717	2357	818	843	664	582
	3rd	422	476	2747	2236	2411	1396	2485	2103	737	859	592	676
2006	1st	601	590	557	702	463	368	712	1830	675	220	729	785
	2nd	600	572	684	937	522	405	930	932	2157	216	789	781
	3rd	642	324	700	763	514	887	702	1059	701	237	692	880
2007	1st	701	750	1007	1082	681	829	3657	714	1212	234	494	373
	2nd	719	1241	1577	509	723	929	1743	601	864	341	603	217
	3rd	775	646	3298	723	1855	1628	612	926	385	266	568	196
2008	1st	218	138	511	637	562	1387	629	1621	484	442	398	267
	2nd	528	166	443	588	1045	837	1114	954	591	497	349	392
	3rd	298	274	337	464	1764	479	1970	579	541	480	263	508
2009	1st	473	296	518	1733	203	372	558	635	646	260	118	270
	2nd	558	337	775	1536	331	189	904	1314	1165	143	73	785
	3rd	520	226	1355	891	501	161	1508	1042	868	65	77	412
2010	1st	186	650	282	206	833	607	336	3725	1400	667	487	439
	2nd	201	691	657	518	884	784	1010	3677	939	700	518	350
	3rd	411	134	366	622	830	229	3498	1882	662	625	381	290
2011	1st	535	541	321	480	916	598	1186	1833	1722	1108	755	470
	2nd	789	484	449	677	765	773	2039	2501	2101	1549	692	396
	3rd	452	287	542	360	575	666	2489	1202	1036	779	447	447

Table A-5: 10-Daily Average Flows of Kurram River at K.G Headworks (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	1st	561	504	501	346	404	809	1384	2851	823	361	429	612
	2nd	561	487	332	434	503	806	948	1344	540	430	439	632
	3rd	581	411	380	1011	567	366	3378	1407	273	406	494	718
1972	1st	370	460	517	1478	6691	1025	1982	1296	330	560	484	968
	2nd	415	498	911	1433	2015	697	720	1343	2338	535	451	801
	3rd	553	422	1433	3103	1639	2408	1553	1075	901	665	855	861
1973	1st	767	671	1872	2509	1387	806	9203	4913	1117	1116	573	573
	2nd	740	595	1104	2544	1759	552	3756	1616	649	934	531	573
	3rd	690	1045	1736	1519	1321	935	9184	1972	1654	771	582	625
1974	1st	553	620	639	1596	732	545	1023	4065	1020	675	429	612
	2nd	579	633	472	904	5525	477	2338	1047	471	525	439	632
	3rd	813	584	897	556	1934	651	3287	1338	1476	546	494	718
1975	1st	653	648	720	1589	1953	918	864	2107	2617	602	501	718
	2nd	561	714	696	1204	2308	2395	1100	5258	850	647	501	653
	3rd	587	427	1566	1804	1141	1830	959	4619	2341	539	609	719
1976	1st	580	766	780	2152	1991	1162	464	540	1219	1502	591	662
	2nd	586	944	1261	1537	1816	887	1396	4078	1504	728	536	817
	3rd	886	726	1257	4672	1967	557	1996	1455	529	798	653	728
1977	1st	662	662	560	2475	909	566	714	2032	1385	741	413	657
	2nd	662	677	441	1764	969	492	3103	438	330	938	569	625
	3rd	795	448	535	1025	1122	701	2617	918	509	549	690	747
1978	1st	606	550	1020	1187	1242	530	1899	1797	391	1196	949	640
	2nd	604	584	11561	1586	813	1298	1136	6151	512	593	666	604
	3rd	605	495	1263	1576	758	1096	1219	2738	1031	583	669	683
1979	1st	608	616	1045	2363	2150	1129	753	7956	957	570	886	733
	2nd	697	1591	920	3331	1896	1271	2080	4411	1702	1323	762	696
	3rd	687	758	3953	1512	1791	606	2337	3448	763	1225	739	880
1980	1st	928	883	1373	2550	1569	822	1226	2087	2092	878	1342	786
	2nd	681	686	1730	2144	1253	907	1098	1743	1123	1399	854	698
	3rd	788	900	2804	1861	1149	10701	3543	1045	720	1045	846	1370
1981	1st	1140	953	1109	4057	3602	1223	2114	2084	1010	977	822	822
	2nd	1221	828	1827	2083	2508	859	1022	2487	863	925	789	834
	3rd	1609	712	7081	2286	1376	1068	5657	907	1360	1079	789	918
1982	1st	1140	953	1109	4057	3602	1223	2114	2084	1010	977	822	822
	2nd	1221	828	1827	2083	2508	859	1022	2487	863	925	789	834
	3rd	1609	712	7081	2286	1376	1068	5657	907	1360	1079	789	918
	1st	840	707	1541	6012	4344	2574	1888	5046	888	1283	900	892

Table A-5: 10-Daily Average Flows of Kurram River at K.G Headworks (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983	2nd	834	645	1451	9182	5959	1926	1322	2448	2945	1088	892	939
	3rd	1016	787	2918	4034	5570	1059	1129	2347	1019	1067	892	981
1984	1st	892	881	797	1494	808	564	1967	3934	3098	833	646	864
	2nd	892	860	951	1086	721	502	3270	1907	1544	780	810	898
	3rd	981	781	1209	1272	606	1101	3575	2864	1450	731	1116	911
1985	1st	825	846	547	2851	482	482	419	3429	946	1009	462	647
	2nd	875	679	539	1336	617	617	1792	739	535	622	521	613
	3rd	1008	498	1041	918	422	422	1388	1541	609	561	581	1015
1986	1st	756	567	668	971	2116	1133	1406	4448	674	549	473	724
	2nd	714	832	1370	1466	1408	515	1393	1220	757	1074	572	1054
	3rd	756	520	1297	2655	1328	1088	2228	1094	741	600	748	864
1987	1st	746	586	2381	1593	2780	1883	365	887	1307	884	536	612
	2nd	747	552	2734	1154	1266	1148	1355	1230	653	838	550	612
	3rd	714	679	3799	1181	3974	643	3708	889	768	693	612	673
1988	1st	616	615	1018	1719	1257	1646	1292	2884	1179	788	466	598
	2nd	616	582	1657	1437	656	400	1028	1396	2101	639	427	698
	3rd	702	590	4036	1515	719	1461	4862	5335	658	554	529	1268
1989	1st	775	520	612	2159	1426	1055	1096	1589	505	521	500	555
	2nd	775	500	923	1271	1182	793	2873	836	301	946	457	610
	3rd	853	457	2272	1479	1133	607	2230	4185	1378	583	535	798
1990	1st	594	682	753	3263	2263	783	4076	4530	1660	786	951	611
	2nd	638	666	3672	2490	1985	1606	990	995	643	1052	622	611
	3rd	878	785	2035	2146	1045	990	5222	1338	1142	760	646	872
1991	1st	801	874	1225	4564	3687	2407	1040	1949	821	1033	787	775
	2nd	775	1004	1713	5173	4067	2143	3827	872	2110	955	792	775
	3rd	853	685	3401	3094	6512	1503	2016	4038	1423	884	775	1022
1992	1st	834	1214	828	3608	6697	2675	1512	6460	2278	1242	867	939
	2nd	837	1181	1022	2825	3496	2300	3592	2818	1842	1045	881	1041
	3rd	1203	738	3158	9248	7636	2391	1910	961	854	1055	971	1018
1993	1st	984	775	1210	1597	2177	2044	2993	2252	2284	1429	753	798
	2nd	928	757	4509	3364	1729	1327	1262	1255	1177	867	764	788
	3rd	1050	746	3914	3101	2856	1612	6886	1231	1449	872	775	902
1994	1st	806	879	1105	2542	1691	775	4262	679	1639	1092	796	882
	2nd	882	1030	1856	1581	1651	684	1916	1193	1419	939	793	857
	3rd	949	1103	1419	1341	1347	621	2716	1787	1037	1753	813	1088
1995	1st	938	586	741	2993	3197	1248	566	945	774	972	701	766
	2nd	941	821	589	3952	2026	926	661	1672	797	1300	549	775
	3rd	912	615	3340	5448	1761	1011	4886	1852	892	924	624	853
1996	1st	778	700	1052	938	995	860	1088	1794	1040	1375	547	623
	2nd	795	863	1557	1238	880	7017	4829	5570	616	2031	552	605
	3rd	877	764	1452	1540	6138	4354	649	2913	695	920	678	604

Table A-5: 10-Daily Average Flows of Kurram River at K.G Headworks (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	1st	574	695	675	2990	7598	2794	809	826	542	1421	1123	775
	2nd	629	638	931	3408	3362	3372	1007	2024	580	2496	848	905
	3rd	701	443	1234	3465	1604	1549	1626	1702	698	1345	795	912
1998	1st	776	878	3635	11587	4940	1353	1902	2551	3631	1532	633	891
	2nd	1065	1728	5106	5186	2640	1237	2139	1181	1871	1168	836	790
	3rd	1099	2632	5221	4534	1734	688	1903	1564	1309	938	892	918
1999	1st	888	1284	1421	625	501	281	730	2326	1666	1054	601	688
	2nd	1020	1776	1119	715	626	268	1632	1757	539	721	734	583
	3rd	1742	1345	887	546	617	551	1932	1847	1355	563	775	561
2000	1st	596	822	660	583	260	454	541	839	834	661	281	410
	2nd	839	708	460	327	399	483	581	954	390	483	329	457
	3rd	947	584	803	381	699	1605	764	714	1317	408	401	601
2001	1st	506	443	331	493	414	225	1295	1271	584	437	327	327
	2nd	507	346	326	867	287	3310	1235	2668	1649	372	327	354
	3rd	562	324	1173	744	323	225	4277	359	647	297	327	377
2002	1st	326	347	495	509	341	238	1919	575	1212	396	323	331
	2nd	326	413	512	652	415	287	602	615	497	410	465	365
	3rd	238	843	625	564	234	1026	879	1275	676	424	388	438
2003	1st	404	368	757	1224	651	410	1935	3628	1121	448		
	2nd	373	557	584	3817	409	300	743	497	547			
	3rd	372	618	902	1297	1347	622	950	768	783			
2004	1st		523	287	108	403	408	1322	7223	279	394	267	350
	2nd	417	646	388	108	230	307	2344	3269	3087	379	234	260
	3rd	480	373	210	721	435	463	692	629	598	368	770	260
2005	1st	2516	1370	944	1296	5502	1078	3958	937	1192	444	426	375
	2nd	508	4011	4145	996	1915	830	571	2447	745	821	396	375
	3rd	685	1988	3701	2558	1917	475	551	854	484	526	375	375
2006	1st	610	504	594	729	507	424	5422	5241	1921	387	586	1272
	2nd	519	504	1766	624	636	112	719	1007	272	610	1550	708
	3rd	504	530	827	522	4318	419	4847	2971	629	2951	767	835
2007	1st	702	699	2059	7389	2074	1441	2566	2855	939	750	599	787
	2nd	702	2440	7332	3224	1196	1492	638	706	695	615	615	841
	3rd	608	1575	7412	1960	1338	8602	764	961	2543	585	566	723
2008	1st	806	751	708	2411	758	861	639	777	824	1755	497	396
	2nd	800	736	584	2652	757	692	476	865	429	922	430	383
	3rd	755	673	519	836	3988	651	1003	550	608	590	417	449
2009	1st	461	505	646	2100	1167	767	1413	912	3775	820	480	505
	2nd	461	1179	561	4043	972	844	945	546	417	520	488	566
	3rd	511	980	1140	1449	809	366	887	745	286	461	487	554
	1st	505	578	1551	570	1440	1001	534	19255	807	1026	505	505
	2nd	503	138	939	542	939	569	2488	4113	1146	799	505	505

Table A-5: 10-Daily Average Flows of Kurram River at K.G Headworks (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	3rd	767	122	661	809	661	611	10965	6430	956	521	505	505
2011	1st	414	614	754	651	1010	904	584	687	786	994	681	388
	2nd	414	1086	714	2839	801	829	537	1605	1699	608	561	375
	3rd	414	733	666	1188	662	354	1736	2178	539	871	448	390
2012	1st	383	513	482	1755	1762	766	2114	1578	2176	605	515	554
	2nd	404	470	576	1477	1838	712	788	988	5758	854	474	767
	3rd	521	451	637	7374	1209	524	592	9835	1062	829	560	715

Table A-6: 10 Daily Flows of Kaitu River at Spinwam (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1st	667	691	1850	554	1405	679	7607	1770	2551	1479	370	679
	2nd	605	679	2963	1257	961	1294	7759	3617	1749	924	370	665
	3rd	765	567	4002	2778	2297	3212	16878	1626	1479	417	370	705
1984	1st	739	739	739	739	739	739	785	1090	1221	739	739	739
	2nd	739	739	739	739	739	739	1032	1257	776	739	739	739
	3rd	813	591	813	739	813	739	1788	1106	848	813	739	813
1985	1st	739	739	739	961	1166	1443	567	4749	563	53	65	55
	2nd	739	739	739	998	1199	1315	1694	195	196	53	66	31
	3rd	813	591	887	1146	684	1705	1537	216	222	59	67	38
1986	1st	61	63	53	68	272	64	825	1166	191	97	69	54
	2nd	62	62	420	68	129	64	681	611	341	86	75	57
	3rd	67	48	561	344	310	153	730	298	206	130	76	64
1987	1st	58	51	94	82	568	96	64	635	141	66	67	83
	2nd	58	51	186	82	816	85	67	733	160	72	66	84
	3rd	64	47	665	86	602	68	693	768	53	81	66	92
1988	1st	71	69	208	299	132	146	433	331	411	212	205	196
	2nd	72	65	281	306	111	154	752	328	707	276	274	212
	3rd	79	48	747	1060	115	581	1596	1259	327	325	294	260
1989	1st	265	280	265	539	444	503	501	673	457	296	265	280
	2nd	265	280	265	518	496	396	1545	338	296	282	265	285
	3rd	304	235	307	451	588	347	671	1313	296	300	276	325
1990	1st	296	369	444	916	1036	541	592	2386	678	666	541	541
	2nd	333	414	562	1420	769	522	972	925	522	591	541	541
	3rd	407	355	683	1154	595	444	1005	848	1006	595	541	695
1991	1st	579	574	636	1274	1147	930	739	694	561	510	510	446
	2nd	541	637	636	1300	1300	771	1663	714	733	510	382	510
	3rd	595	510	1323	1172	1299	764	1179	1096	612	561	382	701
1992	1st	446	841	764	1019	3721	1121	1019	1937	904	548	510	510
	2nd	510	764	764	1427	2294	1019	2791	1612	1618	510	510	624
	3rd	701	611	1108	4996	1656	1019	1363	1517	949	561	510	701
1993	1st	510	510	637	764	764	510	624	694	541	510	382	382
	2nd	624	510	523	737	663	713	707	382	471	382	382	254
	3rd	701	408	561	737	701	764	1994	496	535	420	382	280
1994	1st	254	382	510	510	510	382	700	267	452	382	433	382
	2nd	254	510	510	637	382	382	420	344	578	382	382	510
	3rd	280	408	561	574	420	254	471	484	420	561	382	561
1995	1st	510	510	574	510	2835	407	191	13470	573	357	510	382
	2nd	510	637	510	764	2835	656	127	17333	554	510	510	382
	3rd	561	510	561	764	2939	369	726	22181	312	561	382	420
1996	1st	1209	637	1209	637	510	382	4467	4491	267	254	382	510
	2nd	650	510	650	510	510	598	4478	1208	267	382	510	510
	3rd	420	408	420	510	752	1229	4700	305	293	420	510	561
1997	1st	574	637	510	764	828	637	471	407	369	510	510	752
	2nd	637	510	637	764	714	510	541	465	401	586	510	637
	3rd	701	408	841	841	731	510	554	516	337	561	764	561
1998	1st	510	637	892	764	637	446	611	592	701	574	510	637

Table A-6: 10 Daily Flows of Kaitu River at Spinwam (cfs)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2nd	510	828	892	764	510	382	510	561	637	510	637	510
	3rd	561	713	841	688	561	382	586	561	574	561	637	561
1999	1st	637	764	637	510	637	46874	382	2803	892	930	637	574
	2nd	637	764	510	510	510	38535	998	2487	764	764	637	637
	3rd	841	573	561	624	561	32121	1834	1593	930	701	510	701
2000	1st	637	510	637	828	510	382	420	584	675	701	510	637
	2nd	510	510	637	637	510	382	747	811	599	637	510	675
	3rd	561	510	879	586	420	522	663	692	743	586	637	752
2001	1st	637	637	510	701	663	446	707	701	669	382	382	510
	2nd	637	510	382	637	510	1069	915	733	601	382	407	510
	3rd	561	408	598	841	612	510	941	382	580	420	510	561
2002	1st	510	420	446	420	254	167	387	364	873	415	329	167
	2nd	510	433	382	382	369	167	539	416	524	572	294	218
	3rd	561	408	382	267	280	376	729	720	572	442	256	359
2003	1st	365	404	405	530	365	226	906	1642	1922	530	293	167
	2nd	384.5	424.5	329	505	328	435	435	723	1093	405	271	230
	3rd	404	445	532	392	272	447	1466	1878	1226	306	257	351
2004	1st	365	365	293	239	539	547	692	2934	919	365	365	361
	2nd	384.5	342.8	257	293	328	492	492	1129	931	279	314	314
	3rd	404	328	226	525	328	596	756	1613	600	257	264	384
2005	1st	365	317.5	519		608	1062	1814	787	659	467	458	365
	2nd	328	941.1	2018		696	457	457	888	1119	563	369	328
	3rd	226	350	1131		992	692	1053	1186	515	368	296	275
2006	1st	365	384.5	380	530	504	425	1264	3494	1219	479	401	462
	2nd	321	317.5	296	417	397	480	480	2026	503	1010	332	827
	3rd	273.4	270.5	246	385	986	1046	1209	1562	694	420	271	1016
2007	1st	424.5	1453	1881	1065	1557	756		2117	437	531		
	2nd	346.5	1601	1007	1278	1570	877	877	1671	354	433		
	3rd	292.7	1275	1284	1627	1075	1946		1301	457	372		
2008	1st	504.2	508.5		504	509	509			768	417	369	509
	2nd	424.5	441		437	445	529	529		853	387	467	441
	3rd	379.2	391		392	379	560			1204	472	476	385
2009	1st					466					530		444
	2nd					388					488		444
	3rd					335					445		444
2010	1st	444	621	385	365	530	669	365	3455	745	621	621	
	2nd	444	404	365	365	530	530	530	1205	718	621	530	
	3rd	540.5	404	365	489	669	481	1668	1326	621	621	530	
2011	1st						530		435				
	2nd						395	395	1087	365			
	3rd						351		1127	365			

Table A-7: 10-Daily Inflows Of Kurram Tangi Dam (Th.AF)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	1st	13.22	11.12	11.10	11.26	14.86	15.76	24.69	25.18	15.52	7.88	8.08	12.62
	2nd	13.07	11.47	10.16	12.41	16.01	25.11	15.24	35.39	20.24	7.47	8.34	13.10
	3rd	12.97	8.44	11.00	20.55	7.79	12.81	43.34	23.92	6.21	7.86	9.35	14.44
1972	1st	8.40	9.83	9.43	41.06	110.46	36.20	29.01	45.31	11.61	25.25	14.63	19.08
	2nd	8.27	9.08	42.49	59.51	80.52	23.00	31.23	45.33	42.23	18.18	15.44	20.07
	3rd	12.72	8.90	37.01	67.58	66.36	45.51	34.58	26.36	23.80	17.60	17.99	22.50
1973	1st	22.25	16.69	33.65	86.43	66.38	38.01	79.02	61.91	25.66	44.75	29.48	19.88
	2nd	17.79	16.22	41.23	78.98	65.66	32.84	84.76	28.59	19.32	33.65	28.07	15.92
	3rd	20.28	21.41	50.43	73.19	48.30	29.51	95.03	31.64	57.46	35.51	24.79	18.48
1974	1st	19.48	37.83	40.91	38.05	25.31	10.95	25.08	33.48	15.80	16.18	8.37	14.58
	2nd	22.48	37.70	29.46	26.21	50.26	11.79	31.92	17.83	10.49	12.33	11.07	13.59
	3rd	47.81	40.48	27.64	17.37	32.28	13.32	35.67	19.57	26.57	11.70	12.28	17.26
1975	1st	18.26	15.49	18.29	48.24	60.56	51.85	39.68	25.69	44.54	12.59	20.99	20.15
	2nd	16.20	14.77	16.88	45.23	104.73	37.45	28.44	61.44	19.52	15.58	19.22	22.12
	3rd	17.78	11.99	26.51	71.75	87.84	33.45	21.48	64.66	39.71	22.85	18.28	21.36
1976	1st	18.32	12.86	14.66	32.71	61.22	50.42	17.36	19.31	23.42	53.29	31.14	26.13
	2nd	16.32	13.23	19.50	33.00	61.81	29.07	30.72	56.30	21.42	33.67	17.73	26.56
	3rd	19.03	12.85	23.53	64.05	110.13	17.07	35.94	21.72	22.45	34.05	21.03	27.19
1977	1st	29.43	38.09	20.67	40.41	30.53	22.91	17.99	26.90	18.79	17.00	21.28	24.04
	2nd	19.10	17.53	18.16	47.27	20.05	21.88	22.26	15.46	20.51	22.13	18.24	24.82
	3rd	20.92	14.86	17.85	18.86	22.40	24.53	20.92	18.29	13.94	16.81	21.76	24.63
1978	1st	18.24	14.75	16.61	17.34	72.54	26.08	89.45	22.97	11.77	25.52	22.67	13.62
	2nd	14.58	11.82	51.67	40.00	58.56	19.07	21.86	37.35	18.86	22.29	14.89	15.65
	3rd	15.75	9.10	24.16	48.12	55.51	25.79	22.98	48.90	21.38	20.03	15.74	16.08
1979	1st	13.38	18.27	22.17	49.36	58.28	33.54	14.77	56.03	19.51	12.70	21.64	19.58
	2nd	12.22	22.87	23.34	73.87	40.44	29.62	23.54	57.42	24.60	22.71	19.08	20.33
	3rd	14.69	18.35	48.10	61.88	38.71	18.28	35.08	51.47	18.24	26.18	18.21	19.29
1980	1st	21.70	13.36	23.48	52.36	24.23	27.24	28.95	21.29	21.01	26.23	28.40	21.39
	2nd	15.22	17.29	27.60	64.30	35.53	29.34	26.29	32.11	20.51	41.98	24.48	20.09
	3rd	13.14	15.55	37.45	45.57	28.64	50.42	39.38	18.09	16.04	32.02	21.37	29.82
1981	1st	29.45	20.24	32.01	71.23	51.80	23.86	32.66	28.98	19.28	23.14	18.54	19.08
	2nd	32.50	17.03	37.78	44.74	49.91	25.82	21.64	26.82	17.76	18.07	17.33	19.19
	3rd	31.79	17.80	92.11	32.77	28.66	23.77	70.94	19.14	25.97	22.88	17.80	20.55

Table A-7: 10-Daily Inflows Of Kurram Tangi Dam (Th.AF)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1982	1st	23.27	18.59	17.64	44.90	66.69	25.10	42.16	48.15	19.49	17.21	15.62	27.77
	2nd	25.96	14.77	32.67	39.30	49.73	31.46	22.28	39.93	17.10	18.25	28.45	25.07
	3rd	30.68	15.28	51.01	44.66	27.67	22.72	50.94	35.34	32.85	22.80	29.75	24.08
1983	1st	20.32	18.46	22.15	66.24	148.54	81.19	33.69	88.52	17.41	24.91	21.99	22.73
	2nd	20.22	15.22	26.51	90.69	143.73	63.73	26.63	42.27	49.64	24.00	21.87	23.11
	3rd	19.27	12.50	48.54	88.46	121.59	43.55	32.75	47.42	23.29	24.95	21.95	25.27
1984	1st	23.25	22.40	20.68	39.82	27.08	17.68	39.65	62.61	41.94	21.44	18.42	24.46
	2nd	23.41	18.81	20.14	35.37	26.29	16.26	63.96	41.65	37.87	20.23	18.08	23.15
	3rd	25.56	18.72	25.66	30.39	24.00	21.38	71.13	53.95	30.65	20.99	26.45	26.33
1985	1st	22.84	19.15	11.21	48.18	24.05	16.41	10.11	56.14	19.14	17.22	12.29	15.85
	2nd	19.73	16.21	10.53	47.69	24.53	20.50	27.42	19.35	10.50	14.58	13.60	17.31
	3rd	24.20	11.05	19.09	32.30	22.67	10.54	19.67	26.95	11.78	15.39	16.29	16.13
1986	1st	17.41	15.01	13.05	23.33	54.74	38.86	23.06	89.61	16.26	14.04	10.62	16.14
	2nd	15.72	14.50	21.24	26.93	49.05	32.12	36.63	31.19	15.14	26.46	11.67	21.06
	3rd	17.54	12.70	22.32	46.39	45.38	29.12	26.20	42.96	14.34	16.59	12.80	22.37
1987	1st	17.83	14.13	40.01	53.88	55.90	41.75	12.31	22.49	49.70	17.96	10.69	12.98
	2nd	16.32	16.27	46.05	46.35	32.78	25.68	36.82	25.51	13.52	17.10	10.86	21.75
	3rd	15.57	13.54	78.38	46.62	65.09	13.44	60.42	28.05	17.96	13.89	12.17	17.74
1988	1st	17.82	16.53	20.55	58.30	32.75	31.36	23.71	36.01	23.48	19.97	13.61	16.57
	2nd	17.97	15.37	27.49	55.88	25.40	15.66	20.13	29.49	34.81	14.83	12.39	15.63
	3rd	17.22	13.55	63.85	50.70	19.16	28.73	62.63	44.72	14.79	23.09	13.82	23.01
1989	1st	16.49	14.37	13.81	36.08	31.46	22.27	18.14	25.53	11.16	16.43	13.61	14.71
	2nd	15.86	13.65	15.66	26.91	27.27	21.29	37.20	18.80	13.94	21.17	12.41	11.89
	3rd	19.42	11.64	31.80	30.41	25.30	17.54	41.27	43.47	25.22	14.69	12.98	15.40
1990	1st	12.42	15.46	14.55	48.16	49.23	29.64	45.53	58.75	30.37	15.09	20.07	14.68
	2nd	14.64	16.10	29.38	42.67	42.68	35.19	24.75	17.16	28.35	21.92	14.34	14.58
	3rd	16.44	12.27	37.96	43.22	27.33	29.29	84.79	26.90	28.10	18.82	13.75	15.62
1991	1st	17.33	20.38	20.05	57.81	82.60	75.77	23.40	31.53	16.34	21.65	17.31	19.72
	2nd	16.78	19.36	33.95	89.36	115.98	45.72	112.30	17.18	27.96	20.11	16.98	18.31
	3rd	16.99	13.86	51.07	59.75	125.12	33.87	32.96	67.53	25.91	19.82	18.55	21.06
1992	1st	18.14	24.67	17.32	36.26	53.49	62.06	38.08	60.22	30.23	25.41	17.96	20.33
	2nd	17.98	14.58	17.57	39.37	56.45	49.18	47.73	46.67	35.51	21.43	16.57	17.18
	3rd	17.23	15.56	46.28	50.06	99.00	47.18	56.03	41.05	17.54	21.61	19.96	21.73
1993	1st	24.36	25.06	26.09	41.82	48.26	42.42	29.56	28.27	29.15	26.83	15.75	17.36

Table A-7: 10-Daily Inflows Of Kurram Tangi Dam (Th.AF)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2nd	24.99	22.52	45.19	92.73	52.47	27.68	45.03	37.70	23.46	17.90	15.91	17.11
	3rd	30.81	19.87	43.25	69.23	48.51	32.17	86.52	24.73	23.48	18.03	16.01	19.41
1994	1st	17.24	17.98	20.67	48.20	48.05	62.36	38.68	15.10	30.41	22.81	16.81	17.22
	2nd	17.68	15.75	28.98	34.10	59.24	112.75	34.37	22.49	25.50	19.54	17.08	18.59
	3rd	20.39	15.25	27.48	41.11	68.83	185.97	38.46	34.94	27.72	31.92	18.47	21.76
1995	1st	20.45	16.57	17.43	39.33	47.19	26.64	13.43	18.28	15.12	19.66	19.79	23.93
	2nd	18.89	15.83	16.65	38.07	38.70	19.85	16.94	31.54	15.19	23.08	21.98	25.26
	3rd	20.70	12.66	35.61	94.37	36.66	19.66	60.12	27.91	15.09	20.99	22.03	26.83
1996	1st	24.29	23.56	24.61	27.61	35.02	21.25	21.99	17.31	19.45	25.67	13.40	15.23
	2nd	23.50	20.17	25.49	30.50	30.75	52.06	30.96	28.82	14.73	30.24	13.48	15.34
	3rd	24.90	18.80	30.47	34.66	68.76	32.53	18.85	28.51	13.95	19.51	14.19	14.17
1997	1st	13.00	12.51	14.18	38.19	57.56	48.65	12.85	20.49	12.76	12.63	22.80	16.95
	2nd	13.07	14.15	18.62	50.25	50.88	35.58	15.18	22.78	13.00	26.12	18.39	17.37
	3rd	14.30	10.07	23.67	48.47	34.93	28.41	24.12	24.91	13.06	25.58	16.34	17.53
1998	1st	14.18	17.70	29.48	69.12	59.91	34.58	31.77	46.54	50.56	30.26	11.38	18.75
	2nd	16.11	13.77	46.31	67.39	57.97	32.80	31.60	26.86	35.96	22.39	16.60	16.52
	3rd	20.95	21.10	63.42	67.10	44.04	29.48	27.96	26.71	26.83	18.78	18.02	19.31
1999	1st	15.65	24.85	21.02	13.30	10.73	6.95	8.19	23.42	25.44	13.24	10.14	14.10
	2nd	20.99	29.57	27.89	14.92	10.78	6.36	15.30	13.08	36.87	12.07	11.92	12.06
	3rd	18.71	24.22	15.99	11.54	9.20	6.62	24.61	13.06	10.73	10.43	13.04	11.57
2000	1st	12.02	12.14	11.50	11.62	5.09	6.61	6.81	8.46	8.15	10.30	11.40	12.30
	2nd	7.60	11.94	8.18	6.57	4.74	9.00	8.50	8.90	7.35	11.91	10.87	11.32
	3rd	17.76	11.06	14.73	6.22	9.92	11.21	13.06	9.21	18.63	12.37	11.23	14.61
2001	1st	13.16	12.27	10.40	12.41	11.57	9.66	11.05	14.11	3.82	7.05	4.84	5.36
	2nd	12.40	10.52	11.24	13.17	10.11	38.00	11.39	17.21	10.99	5.27	4.66	5.87
	3rd	12.59	11.41	20.96	14.19	10.60	11.48	26.24	5.68	9.19	4.33	4.36	5.83
2002	1st	5.04	4.62	5.88	15.20	14.97	8.07	13.52	102.17	121.16	12.54	15.88	17.42
	2nd	4.73	4.64	9.36	14.13	12.51	7.98	64.37	167.55	58.54	14.63	17.10	16.53
	3rd	5.37	3.80	13.03	14.87	12.16	11.67	46.02	77.25	16.41	14.71	14.97	16.87
2003	1st	9.65	11.41	9.91	19.18	17.78	12.20	30.27	114.05	101.13	15.91	13.11	14.25
	2nd	8.73	9.13	12.40	18.23	16.02	12.34	79.69	68.72	35.30	15.04	12.52	13.96
	3rd	12.54	7.30	17.51	18.53	16.79	12.13	31.63	44.62	19.45	14.89	13.65	15.66
2004	1st	12.87	14.61	17.48	24.29	23.90	17.09	18.41	25.89	16.81	15.71	7.77	10.58
	2nd	13.53	13.34	18.54	22.22	23.89	12.61	30.30	23.52	14.18	15.76	7.26	8.94

Table A-7: 10-Daily Inflows Of Kurram Tangi Dam (Th.AF)

Year	10-Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	3rd	16.87	9.25	19.63	29.05	23.52	15.82	31.14	48.72	14.37	14.64	8.89	9.15
2005	1st	39.75	15.01	30.15	56.39	85.01	48.22	126.63	64.54	15.22	23.08	18.68	18.49
	2nd	16.19	24.65	128.69	53.72	70.03	47.41	48.74	65.96	23.33	24.61	18.01	16.87
	3rd	12.99	13.68	76.51	66.68	67.93	38.78	72.00	58.94	21.84	23.99	16.79	19.42
2006	1st	17.41	16.46	16.45	29.22	22.75	14.65	23.63	55.10	22.07	9.33	19.62	22.14
	2nd	17.06	15.94	23.11	34.04	22.24	15.32	29.59	31.24	55.93	9.35	21.08	21.73
	3rd	18.34	9.98	26.66	30.80	21.71	26.39	28.56	33.52	20.97	8.85	19.21	24.38
2007	1st	19.85	20.36	27.41	38.46	28.05	25.87	95.35	27.93	35.16	9.68	13.89	12.09
	2nd	19.95	32.21	44.86	23.61	27.13	28.10	49.39	23.20	24.44	12.39	16.54	7.99
	3rd	21.60	17.82	89.92	29.82	54.37	44.42	26.39	30.26	13.27	9.53	16.21	7.72
2008	1st	8.06	5.46	15.32	27.62	25.16	39.46	21.60	50.01	17.43	14.73	11.54	9.51
	2nd	15.29	6.03	17.23	25.53	34.98	25.85	34.08	31.77	17.80	16.18	10.36	12.25
	3rd	9.98	8.77	17.81	23.53	52.17	16.44	59.46	21.82	17.08	14.77	8.78	15.32
2009	1st	14.30	9.30	15.50	54.31	16.42	14.76	19.87	26.00	21.36	10.30	4.73	9.60
	2nd	16.05	10.21	25.32	48.62	17.59	10.06	28.95	40.56	31.78	7.58	3.63	21.83
	3rd	15.38	7.61	42.60	33.91	21.40	8.70	48.19	33.09	25.03	4.64	4.24	12.98
2010	1st	7.30	17.94	9.75	17.13	31.77	20.46	14.47	101.26	39.73	20.21	13.72	13.71
	2nd	7.34	18.83	22.45	23.84	31.07	24.56	31.53	98.11	26.28	21.13	14.48	11.24
	3rd	12.72	5.37	18.53	27.36	29.40	10.35	96.67	53.56	20.03	18.30	11.63	10.01
2011	1st	15.78	15.26	10.69	23.80	33.78	20.26	35.18	55.17	47.58	30.96	20.24	14.47
	2nd	21.66	13.77	17.39	27.71	28.17	24.29	56.58	69.46	54.56	41.81	18.71	12.36
	3rd	13.74	9.09	22.81	20.98	23.19	20.99	72.09	37.00	29.13	22.04	13.25	13.84
Monthly Average (1971-2011)		17.72	15.73	27.87	40.98	43.78	29.26	37.11	38.78	24.80	19.43	15.96	17.56