Environmental Impact Assessment: Part 2

Project Number: 44914
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PAK: Patrind Hydropower Project

Prepared by Star Hydropower Limited for the Asian Development Bank.

147 MW PATRIND HYDROPOWER PROJECT PAKISTAN

ENVIRONMENTAL IMPACT ASSESSMENT

ADDENDUM

APRIL 2011

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PATRIND HYDROPOWER PROJECT - EIA ADDENDUM

1. INTRODUCTION

This Addendum to the Environmental Impact Assessment (EIA, 2010) prepared by Star Hydro for the 147 MW Patrind Hydropower Project provides additional information and clarification of matters raised by the Asian Development Bank (ADB).

The project was approved by the Private Power and Infrastructure Board (PPIB) of Pakistan in July 2007. The EIA (2006) was subsequently submitted to the Environment Protection Authority (EPA) of Azad Jammu Kashmir (AJK) Province in July 2008 and was not processed at this time. The EIA was subsequently revised in June 2010 and submitted to the EPA AJK and Khyber-Pakhtunkhwa Province that month. EPA AJK issued Environmental Approval in August 2010 following due process in accordance with the laws of AJK, including a Public Hearing held on 5 August 2010. The revised EIA is currently being considered by EPA Khyber-Pakhtunkhwa, with a Public Hearing held at Deedal Meera village on 1 February 2011 as part of this process.

Accordingly, the revised version of the EIA (2010) approved by EPA AJK has not been altered by adding the additional material requested by the ADB, but instead this Addendum has been prepared as a separate supporting report, covering the material requested by the ADB. The Addendum is also supported by the Fish Study (2011), Vegetation Study (2011), and Resettlement Plan (2010) and revised EMP (2010), each of which was prepared at the request of the ADB to provide greater detail on these respective subjects.

2. PROJECT IMPLEMENTATION SCHEDULE

The revised project implementation schedule is provided in the following graph based on the current conditions. Year 1 is expected to commence in July 2011.

Sr. No.	Resettlement Plan Activity	Responsibility		Year 0	Year 1				Year 2				Year 3				Year 4			
		Primary	Secondary	Pre-Project	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Community Consultations	EMU	LAC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	RP Disclosure - Brochure in Urdu	EMU	-	■	■	■														
3	Site Demarcation of Affected Lands	EMU	LAC	■	■	■														
4	Request to LAC for Initiating Process	EMU	LAC	■	■	■														
5	Notification under LAA Section 4	LAC	EMU	■																
6	Inventory - taking of Lands/ Assets	LAC	EMU	■																
7	Compensation Assessment (Revised)	LAC	EMU	■	■	■	■	■												
8	Payment of Compensation	DRO	EMU	■	■	■	■	■												
9	Grievance Redress	GRC	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	Possession of Land/ Assets for Project Works	LAC	EMU	■	■	■	■													
12	Contractor Receives Approval	Contractor	Community		■	■	■	■												
13	Start of Excavation / Construction Works	Contractor	EMU			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

3. DOWNSTREAM RIVER FLOWS

3.1 Kunhar River Flows

Star Hydro proposes to release a minimum of $2m^3/s$ from the project weir to maintain some ecological values in the 13.4 km section of the Kunhar River between the weir and the Jhelum River confluence. This release will be made throughout the year except when the weir is spilling during the monsoon season (an average of 92 days each year from May to early August) and when the full river flow is released when it drops below the minimum flow required to generate power (22.4 m^3/s) for an estimated 39 days on average in December-February. Accordingly, the environmental release of $2.0m^3/s$ will occur for 7.7 months per annum on average, with larger flows occurring for the other 4.3 months (Table 3.1).

The environmental release will be added to by inflows entering the Kunhar River from two relatively large side streams: the Boi-da-Katha that enters 4.6 km below the weir and the Salol Nullah that enters 7.5 km below the weir (Tables 3.2 and 3.3). Four small side streams will also add water to the Kunhar River. It is estimated that the two large streams along with smaller streams will add an average of $1.8m^3/s$ to the Kunhar flow across the year, although these streams will not flow continuously throughout the year every year.

Table.3.1 Kunhar River Average Monthly Flows Rates Below the Weir: Pre- & Post-Project

Month	Mean Natural Flow (m^3/s)	Mean Flow Rate (m^3/s)						
		Total Flow from Weir (Environ. Release + Spill Flow)	Total as Percent of Mean Natural Flow (%)	Boi-da-Katha	Cumulative Flow 4.6 km Below Weir	Salol Nullah	Cumulative Flow 7.5 km Below Weir	Total as Percent of Mean Natural Flow (%)
January	23.6	2.0	**8.5**	0.2	2.2	0.5	2.7	**11.5**
February	25.8	2.0	**7.8**	0.5	2.5	1.1	3.6	**14.0**
March	43.4	2.0	**4.6**	0.8	2.8	1.5	4.3	**9.9**
April	97.2	2.0	**2.1**	0.4	2.4	0.7	3.1	**3.2**
May	184.4	31.4	**17.0**	0.2	31.6	0.3	31.9	**17.3**
June	282.6	129.6	**45.9**	0.2	129.8	0.3	130.1	**46.0**
July	246.6	93.6	**38.0**	2.2	95.8	4.4	100.2	**40.6**
August	149.1	2.0	**1.3**	1.5	3.5	3.0	6.5	**4.4**
September	82.1	2.0	**2.4**	0.7	2.7	1.5	4.2	**5.1**
October	46.6	2.0	**4.3**	0.2	2.2	0.3	2.5	**5.4**
November	33.2	2.0	**6.0**	0.1	2.1	0.3	2.4	**7.2**
December	27.3	2.0	**7.3**	0.3	2.3	0.6	2.9	**10.6**

The volumes of inflows from rainfall runoff in the two main streams have been calculated on the basis of rainfall data and the respective catchment areas, and tabulated in Tables 3.2 and 3.3.

Table.3.2 Estimated Inflow Rate of the Boi-da-Katha (m^3/s)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1981	0.0	0.7	1.6	1.4	0.1	0.0	2.1	0.5	0.2	0.1	0.0	0.0	**0.6**
1982	0.8	0.6	1.0	0.7	0.6	0.0	2.0	3.1	0.0	0.3	0.6	0.5	**0.9**
1983	0.6	0.1	0.8	0.5	0.0	0.0	0.2	4.9	0.4	0.0	0.0	0.0	**0.6**
1984	0.0	1.0	0.9	0.6	0.0	0.3	1.3	2.3	0.4	0.0	0.0	0.1	**0.6**
1985	0.2	0.0	0.1	0.0	0.0	0.0	2.2	0.6	0.0	0.0	0.0	0.5	**0.3**
1986	0.0	0.7	1.1	0.1	0.0	0.0	0.4	3.7	0.5	0.0	1.5	1.0	**0.8**
1987	0.0	0.5	0.5	0.0	0.1	0.0	0.2	0.9	0.0	1.7	0.0	0.0	**0.3**
1988	0.5	0.3	0.8	0.0	0.0	0.2	8.2	0.7	0.0	0.0	0.0	0.7	**0.9**
1989	0.3	0.0	0.2	0.6	0.9	0.0	1.7	0.0	0.0	0.1	0.0	0.0	**0.3**
1990	0.3	1.4	1.4	0.5	0.0	0.0	1.3	4.1	0.6	0.1	0.0	2.3	**1.0**
1991	0.8	1.5	1.6	0.8	0.8	0.3	3.8	0.2	3.6	0.0	0.0	0.0	**1.1**
1992	1.1	0.2	0.9	0.0	0.2	0.0	2.0	1.1	3.7	0.0	0.2	0.0	**0.8**
1993	0.0	0.5	1.3	0.0	0.1	0.0	2.0	0.0	0.6	0.0	0.1	0.0	**0.4**
1994	0.0	0.6	0.4	1.0	0.0	0.0	2.3	1.9	0.0	0.2	0.0	0.9	**0.6**
1995	0.0	0.3	0.6	0.2	0.0	0.2	3.1	0.5	0.0	0.0	0.1	0.0	**0.4**
1996	0.2	0.8	1.5	0.4	0.0	0.4	0.0	2.2	0.2	0.5	0.0	0.0	**0.5**
1997	0.0	0.0	0.3	0.0	0.5	0.0	3.2	2.7	0.0	0.0	0.0	0.0	**0.6**
1998	0.5	1.0	0.8	0.8	0.0	0.1	0.6	1.0	0.1	0.0	0.0	0.0	**0.4**
1999	0.3	0.1	0.6	0.0	0.1	0.6	4.3	0.3	1.4	0.0	0.6	0.0	**0.7**
2000	0.0	0.0	0.2	0.0	0.0	0.0	5.9	0.9	0.6	0.0	0.0	0.2	**0.7**
2001	0.0	0.0	0.1	0.3	0.0	0.2	5.0	0.2	0.6	0.0	0.4	0.0	**0.6**
2002	0.3	0.6	0.1	0.0	0.0	0.9	0.6	2.0	0.4	0.5	0.0	0.0	**0.4**
2003	0.0	2.7	1.4	0.9	0.3	0.7	0.7	1.8	1.7	0.0	0.0	0.4	**0.9**
2004	0.0	0.0	0.0	0.1	0.1	0.2	0.6	0.6	2.6	0.3	0.0	0.0	**0.4**
AVERAGE	**0.2**	**0.5**	**0.8**	**0.4**	**0.2**	**0.2**	**2.2**	**1.5**	**0.7**	**0.2**	**0.1**	**0.3**	**0.6**

Table.3.3 Estimated Inflow Rate of the Salol Nullah (m^3/s)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1981	0.0	1.3	3.1	2.9	0.2	0.0	4.1	0.9	0.5	0.2	0.0	0.0	**1.1**
1982	1.6	1.1	2.1	1.4	1.3	0.0	4.0	6.3	0.0	0.6	1.2	0.9	**1.7**
1983	1.3	0.1	1.7	1.1	0.0	0.0	0.4	9.7	0.9	0.0	0.0	0.0	**1.3**
1984	0.0	2.1	1.8	1.2	0.0	0.5	2.5	4.6	0.7	0.0	0.0	0.2	**1.1**
1985	0.3	0.0	0.2	0.0	0.0	0.0	4.3	1.2	0.0	0.0	0.0	1.1	**0.6**
1986	0.0	1.4	2.3	0.3	0.0	0.0	0.8	7.5	1.0	0.0	3.0	2.0	**1.5**
1987	0.0	1.0	1.0	0.0	0.2	0.0	0.3	1.7	0.0	3.4	0.0	0.0	**0.6**
1988	0.9	0.5	1.6	0.0	0.0	0.4	16.3	1.3	0.1	0.0	0.0	1.5	**1.9**
1989	0.6	0.0	0.4	1.2	1.8	0.0	3.4	0.1	0.0	0.3	0.0	0.0	**0.6**
1990	0.6	2.7	2.7	1.0	0.0	0.0	2.5	8.1	1.3	0.1	0.0	4.6	**2.0**
1991	1.6	2.9	3.3	1.5	1.5	0.6	7.6	0.4	7.1	0.0	0.0	0.0	**2.2**
1992	2.2	0.5	1.8	0.0	0.5	0.0	3.9	2.2	7.3	0.0	0.4	0.0	**1.6**
1993	0.0	0.9	2.7	0.0	0.1	0.0	4.1	0.0	1.2	0.0	0.3	0.0	**0.8**
1994	0.0	1.2	0.7	2.0	0.0	0.0	4.7	3.7	0.0	0.4	0.0	1.7	**1.2**
1995	0.0	0.6	1.1	0.3	0.0	0.3	6.1	1.0	0.0	0.0	0.2	0.0	**0.8**
1996	0.3	1.5	3.0	0.7	0.0	0.7	0.0	4.4	0.4	0.9	0.0	0.0	**1.0**
1997	0.0	0.0	0.7	0.0	1.0	0.0	6.4	5.3	0.0	0.0	0.0	0.0	**1.1**
1998	0.9	1.9	1.6	1.5	0.0	0.3	1.1	2.0	0.3	0.0	0.0	0.0	**0.8**
1999	0.7	0.1	1.3	0.0	0.2	1.1	8.5	0.7	2.8	0.0	1.2	0.0	**1.4**
2000	0.0	0.0	0.4	0.0	0.0	0.1	11.7	1.8	1.3	0.0	0.0	0.5	**1.3**
2001	0.0	0.0	0.2	0.6	0.0	0.5	9.9	0.4	1.2	0.0	0.7	0.0	**1.1**
2002	0.6	1.1	0.2	0.0	0.0	1.7	1.2	4.0	0.8	0.9	0.0	0.0	**0.9**
2003	0.0	5.3	2.9	1.8	0.5	1.4	1.3	3.6	3.3	0.0	0.0	0.8	**1.7**
2004	0.1	0.0	0.0	0.2	0.1	0.3	1.2	1.1	5.1	0.6	0.0	0.0	**0.7**
AVERAGE	**0.5**	**1.1**	**1.5**	**0.7**	**0.3**	**0.3**	**4.4**	**3.0**	**1.5**	**0.3**	**0.3**	**0.6**	**1.2**

Methods of calculating an appropriate environmental flow are discussed in Appendix A, with context to this project.

Impacts

Hydrology - when the full river flow is released from the weir over an average of 39 days in December-February, there will be no change to natural river flows. When the weir spills for an estimated 92 days a year on average from May to early August (monsoon), large downstream flows will occur (natural flow minus plant design discharge of 153 m^3/s), averaging between 17-38% of natural flows from May-July (Table 1).

The 2 m^3/s environmental release is between 1.3-6.0% of the mean monthly flow rate during the non-monsoon months of August-November and March-April (Table 1).

Water quality **–** the quality of the environmental flow will change as water flows downstream, but this deterioration is not expected to be marked given it only flows 13.4 km before entering the much larger and generally warmer Jhelum River.

Water quality is unlikely to significantly decline due to the environmental release of water temporarily stored in the weir as the average detention time in the pond is short (e.g. average water residence time is 10.7 hours when the plant is generating at full load throughout the day).

The release of the full river flow for almost half the days in December-February and spill flows from May-early August will flush the river, helping to maintain water quality that may deteriorate in the 4-4.5 month low flow period between these larger flows.

Water use **–** the EIA (2010) reported that people do not use the Kunhar between the weir and Jhelum River confluence for domestic water supply or as a source of irrigation water. Domestic water is sourced from side streams and springs on slopes above the Kunhar River, while irrigation water is diverted from side streams and gravity fed to fields. The 2 m^3/s minimum river flow will be adequate for stock and wildlife water supply.

Aquatic ecology and fishing **–** the Fish Study (2011) conducted by Star Hydro indicated that that there are limited fish species and numbers of fish in the Kunhar River between the weir and Jhelum River. This finding was supported by additional information provided by Star Hydro showing a marked difference in water temperature between the Kunhar River and much larger Jhelum River (Table 3.4). This amounted to 4.8^{o}C+ difference for eight months of the year and 3^{o}C+ for another two months. Given that fish are sensitive to water temperature it explains why fish do not move into the Kunhar from the Jhelum in numbers.

The study also stated that the change in downstream hydrology "*will affect the composition and abundance of planktonic and benthic communities, thus affecting the food supply of fish*". Fish numbers will be reduced when the downstream flow is reduced to 1.3-6.0% of average natural flows, but the loss of total number of fish in this section of the Kunhar will not be large primarily as a function of low fish numbers currently present.

It is important to note that the environmental flow is not attempting to create a water-body for upstream fish migration as the weir step and gates will prevent the movement of fish upstream past this structure.

Table.3.4 Water Temperature at the Weir Site and Jhelum River

Month	Temperature (°C)	
	Garhi Habibullah	Jhelum
January	6.1	8.5
February	7.2	10.4
March	10.2	13.6
April	11.4	16.8
May	12.0	19.9
June	12.3	22.4
July	14.9	25.1
August	17.9	25.0
September	16.5	23.3
October	13.6	19.2
November	9.8	14.6
December	7.0	9.4

Occasional, non-commercial fishing is undertaken between the weir and Jhelum River confluence, a function of the limited number of fish in this river stretch, as reported in the EIA and Fish Study, thus the reduction in fish numbers that will occur at some times of the year will have a limited impact on fishing.

Economic **–** the release of 2.0m^3/s over an average of 7.7 months each year (totaling 39.9 million m^3) is worth an estimated US$1.7 million in foregone generation revenue per annum.

Conclusion

The design of an environmental release from a hydro power project is usually based on the consideration of ecological, social and economic factors, trading off different values to design the optimum flow.

Whilst the proposed environmental release of 2m^3/s for 7.7 months of the year is a relatively small flow compared to the mean annual flow rate of 104 m^3/s, the key factor to consider is the adequacy of this flow in maintaining and protecting existing river values and uses over this period.

The reduced flow will reduce the area of aquatic habitat and reduce fish numbers along 13.4 km of the Kunhar, but given that fish numbers are naturally low and the weir will prevent upstream fish migration, the release of 2m^3/s is considered adequate.

Given the limited use of this section of the river, generally limited to occasional fishing, the release of 2m^3/s will not maintain fish levels at current numbers, but this is viewed as a secondary impact due to the limited amount of non-commercial fishing practiced and the close availability of a much greater fishing resource (Jhelum River).

3.2 Jhelum River Flows

Existing and proposed flows in the Jhelum River immediately below the tailrace outlet are summarized in Table 3.5. The project will increase Jhelum River monthly flows along the 9 km stretch of river between the tailrace outlet and Kunhar confluence by between is 6.2-16.5%, with natural flow rates occurring below the Kunhar confluence. This flow rate increase is not considered to be a significant impact as the increase is relatively minor and only a short section of river will be affected.

Table.3.5 Jhelum River Average Monthly Flow rates below the Tailrace Outlet: Pre- and Post-Project

Month	Pre-Project Flow in Jhelum River below Tailrace (Powerhouse Site)	Post-Project Flow in Jhelum River below Tailrace (Powerhouse Site)	Post-Project Flow in Jhelum River below Tailrace (Powerhouse Site)	Percentage Increase in Flow (%)
January	184.49	21.56	206.50	**11.7**
February	259.25	23.76	283.01	**9.2**
March	664.23	41.37	705.60	**6.2**
April	1,181.93	95.22	1,277.15	**8.1**
May	1,594.23	153.00	1,747.23	**9.6**
June	1,482.79	153.00	1,635.79	**10.3**
July	1,259.97	153.00	1,412.97	**12.1**
August	892.43	147.14	1,039.57	**16.5**
September	541.38	80.11	621.49	**14.8**
October	294.59	44.57	339.16	**15.1**
November	194.34	31.22	225.56	**16.1**
December	186.64	25.30	211.94	**13.6**

4. GREENHOUSE GAS EMISSIONS AVOIDANCE

The volume of CO_2 emissions that will be avoided per annum by the generation of 633 GWh of renewable energy from the project compared to the volume of CO_2 that would be emitted by the generation of an equivalent amount of power from the current mix of generation supplying the Pakistan grid is estimated as follows:

Baseline factor	=	0.445
Total energy per year	=	632,628 MWh
CO_2 emissions avoided	=	**281,519 t CO_2/year**

The Clean Development Mechanism (CDM) crediting period for the project will be 21 years (seven years plus 2 x seven years renewal), but CO_2 emissions savings will occur over the minimum expected project life of 70 years. The net saving of CO_2 emissions over the project lifetime is a significant environmental benefit. See the draft PDD shared with the ADB CDM team on 2 Feb 2011, Section B-6 for additional information.

5. DAM SAFETY

The Lenders' Independent Engineer, Mott MacDonald, has been engaged for the review of the project design. The basic design shared with the Independent Engineer to date covers all details regarding the structural safety. The Independent Engineer has agreed with the seismic design of the Project.

6. CUMULATIVE RIVER BASIN IMPACTS

The Jhelum River basin, comprising the Jhelum, Kunhar and Neelum rivers down to the basin discharge point into the Chenab River, is predominantly an agricultural area with little industrial development and one major urban area (Muzaffarabad). The main form of development occurring in the basin is the harnessing of river flows for power generation, while the existing Mangla Dam in the lower basin is used for both power generation and irrigation. Existing and proposed hydropower projects in the Jhelum River basin are listed in Table 6.1 below and illustrated in Figure 6.1 (Jhelum River system on the lower right side). As indicated in Table 6.1, only Mangla Dam is currently operating, while the Neelum-Jhelum HPP is under construction and a further five projects have been approved.

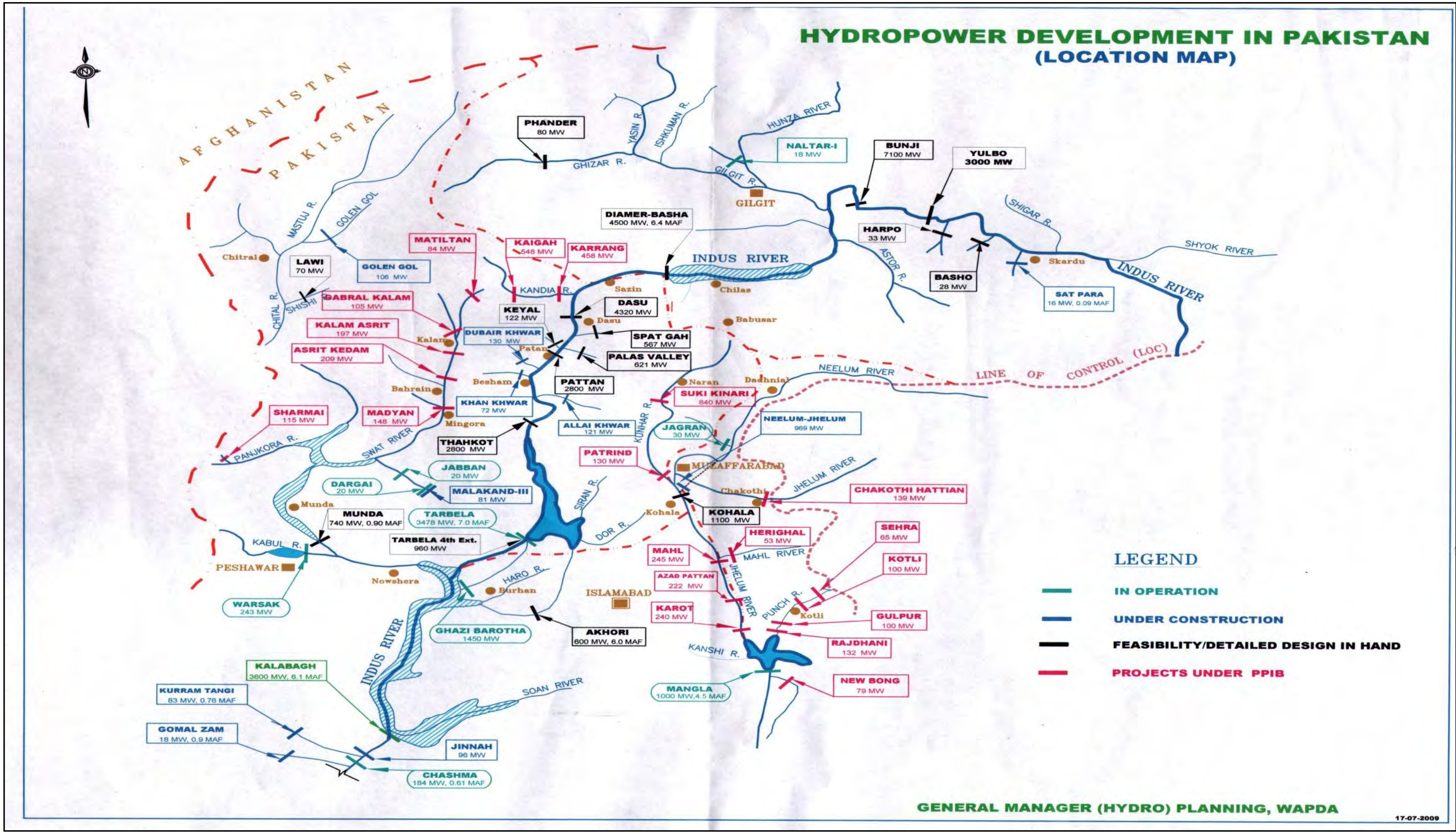
The Patrind Hydropower Project may contribute to two types of cumulative impact in the Jhelum River basin, namely: (i) the alteration of river flows (primarily on the Jhelum River); and (ii) the alteration of aquatic ecology in the basin as a result of altered flows.

At present there are no hydropower projects operating on the Kunhar River, however the Suki Kinari Hydropower Project is proposed 73 km upstream of the Patrind weir. Both Patrind and Suki Kinari are run-of-river projects with very small reservoirs. The impacts of Suki Kinari project will not be accentuated or mitigated by the Patrind Project. In essence, the impacts of the both projects are mutually exclusive and hence there is no multiplier effect.

Table 6.1. : Existing and Proposed Hydropower Projects in the Jhelum River Basin

Project	River	Capacity (MW)	Type	River Distance to Chenab Confluence (km)	Completed/ Expected Completion Date
Mangla Dam	Jhelum (Punjab)	1,100	Storage	311	Operating
Karot Hydel Project	Jhelum (AJK)	720	Run-of-river	359	Approved. feasibility/ detailed design completed for commencement of project construction
Azad Pattan Hydel Project	Jhelum (AJK)	222	Run-of-river	408	Approved. feasibility/ detailed design completed for commencement of project construction
Kohala Hydropower Project	Jhelum (AJK)	312	Run-of-river	474	Feasibility and detailed engineering design completed. Approved by PPIB
Neelum-Jhelum Hydropower Project	Jhelum (AJK)	969	Run-of-river	482	Under Construction
Patrind HPP	Kunhar KPK/AJK	147	Run-of-river (Inter basin transfer into Jhelum River)	504	Approved. Project construction to commence before end of 2011
Suki Kinari HPP	Kunhar (AJK)	840	Run-of-River	577	Feasibility completed and approved by PPIB

Figure 6.1



HYDROPOWER DEVELOPMENT IN PAKISTAN
(LOCATION MAP)
AFGHANISTAN
PAKISTAN
PHANDER 80 MW
NALTAR-I 18 MW
BUNJI 7100 MW
YULBO 3000 MW
DIAMER-BASHA 4500 MW, 6.4 MAF
HARPO 33 MW
BASHO 28 MW
SAT PARA 16 MW, 0.09 MAF
MATILTAN 84 MW
KAIGAH 548 MW
KARRANG 458 MW
LAWI 70 MW
GOLEN GOL 106 MW
GABRAL KALAM 105 MW
KALAM ASRIT 197 MW
ASRIT KEDAM 209 MW
KEYAL 122 MW
DASU 4320 MW
DUBAIR KHWAR 130 MW
SPAT GAH 567 MW
PALAS VALLEY 621 MW
PATTAN 2800 MW
KHAN KHWAR 72 MW
SUKI KINARI 840 MW
SHARMAI 115 MW
MADYAN 148 MW
THAHKOT 2800 MW
ALLAI KHWAR 121 MW
JAGRAN 30 MW
NEELUM-JHELUM 969 MW
PATRIND 130 MW
JABBAN 20 MW
DARGAI 20 MW
MALAKAND-III 81 MW
CHAKOTHI HATTIAN 139 MW
MUNDA 740 MW, 0.90 MAF
TARBELA 3478 MW, 7.0 MAF
KOHALA 1100 MW
TARBELA 4th Ext. 960 MW
HERIGHAL 53 MW
SEHRA 65 MW
MAHL 245 MW
KOTLI 100 MW
AZAD PATTAN 222 MW
WARSAK 243 MW
KAROT 240 MW
GULPUR 100 MW
GHAZI BAROTHA 1450 MW
AKHORI 600 MW, 6.0 MAF
RAJDHANI 132 MW
KALABAGH 3600 MW, 6.1 MAF
MANGLA 1000 MW, 4.5 MAF
NEW BONG 79 MW
KURRAM TANGI 83 MW, 0.76 MAF
GOMAL ZAM 18 MW, 0.9 MAF
JINNAH 96 MW
CHASHMA 184 MW, 0.61 MAF
INDUS RIVER
HUNZA RIVER
GHIZAR R.
YASIN R.
ISHKUMAN R.
GILGIT R.
GILGIT
SHIGAR R.
SHYOK RIVER
ASTOR R.
Skardu
Chilas
Babusar
Sazin
Dasu
Patan
Besham
Kalam
Bahrain
Mingora
Chitral
MASTUJ R.
GOLEN GOL
SHISHI
CHITAL R.
KANDIA R.
NEELUM RIVER
LINE OF CONTROL (LOC)
Naran
Dudhnial
KUNHAR R.
MUZAFFARABAD
Chakothi
JHELUM RIVER
Kohala
SIRAN R.
DOR R.
PANJKORA R.
SWAT RIVER
Munda
KABUL R.
PESHAWAR
Nowshera
HARO R.
Burhan
ISLAMABAD
MAHL RIVER
PUNCH R.
Kotli
KANSHI R.
SOAN RIVER
LEGEND
IN OPERATION
UNDER CONSTRUCTION
FEASIBILITY/DETAILED DESIGN IN HAND
PROJECTS UNDER PPIB
GENERAL MANAGER (HYDRO) PLANNING, WAPDA
17-07-2009

The salient features of projects located upstream of the Kunhar-Jhelum confluence are described below.

Suki Kinari (detailed design stage) – the proposed project is located on the Kunhar River around 73 km upstream of the Patrind weir site. The project is an 840 MW run-of-river type with a 21.4 km long diversion tunnel. The dam is a concrete gravity structure approximately 40-50 m high.

Kohala HPP (detailed design stage) - the proposed project is located on the Jhelum River upstream of the Patrind HPP tailrace. It will have a capacity of 1100 MW, consisting of a 57 m high RCC type dam and a 17.7 km long diversion tunnel.

Neelum-Jhelum HPP (under construction) - the project is being developed under public sector. The 969 MW project is a run-of-river type, diverting Neelum River flows through a 30 km long tunnel. A 47 m high concrete gravity dam.

The salient features of the projects located downstream of the Kunhar-Jhelum confluence are described below.

Azad Patan HPP (detailed design stage) - located downstream of the Kunhar-Jhelum confluence. The proposed project will have a dam of about 70m height diverting the flow on a very small reach of Jhelum River of about 950 m to produce capacity of about 222 MW.

Karot HPP (detailed design stage) – a 720 MW project located downstream of Azad Patan on the Jhelum River. The proposed project has a 91 m high concrete gravity and will divert flows through a 450 m long tunnel.

One of the largest dams in the world, Mangla Dam, is located approximately 155 km downstream of the Patrind Hydropower Project site on the Jhelum River. The dam, completed in 1967 for irrigation and hydropower generation, is 138 m high and has a 253 Km^2 reservoir. The dam alters the downstream seasonal flow of water by impounding monsoon season flows and releasing part of this stored water in the dry season for irrigation and power generation purposes. Approximately 23.0 % of the annual river flow is diverted for irrigation annually, with the remainder flowing down the Jhelum. This dam prevents the movement of migratory fish past this point given its height, thus isolating fish in the upstream basin.

6.1 Cumulative Impact on River Flows

The hydro projects in the Jhelum River basin that will directly affect the Jhelum River flow adjacent to the Patrind tailrace are the 969 MW Neelum-Jhelum Project (under construction) and 1,100 MW Kohala Project (at feasibility stage). The Neelum-Jhelum project will divert the Neelum River (a tributary of Jhelum River), and the Kohala project will divert the Jhelum River, with both diversions located upstream of Muzaffarabad and the Patrind tailrace outlet. These diversions will release diverted flows back into the Jhelum River near the Jhelum-Kunhar confluence 8 km downstream of the Patrind outlet. Based on information received from EPA AJ&K, the combined environmental flow from these two projects (though in practice both will operate independently) will be in the range of 30-40 m^3/s, therefore the natural Jhelum River flow past Muzaffarabad will be reduced considerably from its present levels. However, Patrind HEP will have beneficial

impact on this stretch of the Jhelum as this diversion from the Kunhar will help to offset losses created by the Neelum-Jhelum and Kohala HEPs. This release will positively benefit the water supplies of the city of Muzaffarabad and the 8 km stretch between the tailrace and the Jhelum-Kunhar confluence.

The altered river hydrology in the Jhelum River will not compromise water supply to Muzaffarabad township as the river flow rate will be more than sufficient to supply the town.

The Suki Kinari does not involve an interbasin transfer of water, therefore it will not affect seasonal Kunhar River flows between the tailrace outlet and the Patrind headpond, and therefore it will have no direct impact on Jhelum River flows.

6.2 Cumulative Impact on Aquatic Ecology

Fish migration will be restricted and fish biodiversity may be altered by the combined effects of the Suki Kinari and Patrind HPPs due to river compartmentalization. The Suki Kinari HPP diversion of a large percentage of natural Kunhar river flows around a 35 km stretch of the Kunhar is likely to have a negative impact on fisheries both downstream and upstream of this stretch. Fish migration will be restricted and fish biodiversity may be altered. Changes in turbidity created by reservoir impoundment, combined with an increase in primary productivity, are also known to alter the composition of fish species.

The 35 km Kunhar reach between Suki Kinari dam and powerhouse will have significantly reduced flows and thus impact on aquatic life. The accessibility of local people to the river bed for extraction of sand and gravel etc. will further cause the loss of aquatic organisms existing in riffles, pools and their requirements. The population of fish (especially trout) that is already low will be reduced significantly. Accordingly, the potential impact on fisheries is considered to be negative and of moderate magnitude.

To mitigate the losses/reduction in fish numbers due to the project, a fish hatchery would be established at Kaghan and species adaptable to local conditions could be introduced into the reservoir and river downstream of the dam.

Inundation by Suki Kinari Lake will result in a loss of river habitat of 3 km, which will be replaced by a reservoir (lake) with large water level fluctuations (10m). Fluctuations in water level may cause foreshore erosion, depositing sediments on the reservoir bottom and reducing the nutritional value of sediments for bottom dwelling animals. Fish productivity in the early years following reservoir creation could increase as a result of food and nutrients from inundated terrestrial land. However, over time, as these nutrients disappear, fish productivity may be reduced. Not all fish species will be able to adapt to reservoir (lake) ecology and therefore a potential impact will be the reduction of existing fish biodiversity in the river.

Trout in the Kunhar River upstream and downstream Suki Kinari live in water with temperature lower than 12°C and further increase in temperature reduces the population of this species. The temperature on the reservoir may increase above 12°C and will alter the population of trout in the reservoir. However, a larger water body will be created as a result of dam construction. This reservoir would be used for fisheries development (especially of China Carp) which will enhance the protein availability in the area. This will exert a positive impact. The decay of

organic material such as leaves, twigs, bushes etc. in the bottom of reservoir may encourage the growth of benthic organisms and it will increase the fish production.

7. GRIEVANCE REDRESS MECHANISM

Regardless of its scale, involuntary resettlement inevitably gives rise to grievances among the affected population over issues ranging from entitlements, rates of compensation, eligibility criteria or and other social issues. In addition, grievances may also arise in relation to environmental issues, raised by local people or organizations. Timely redress of such grievances is vital to the satisfactory implementation of resettlement and to the completion of the project on schedule. The Project therefore must ensure that affected persons have access to grievance redress procedures and that such procedures are in place to allow them to lodge a complaint or a claim.

The local community shall be informed about project grievance handling procedures through village discussions. This will occur in all villages within 200 m of construction sites.

All complaints and resolutions will be properly documented by the concerned Grievance Redress Committee (GRC) and be available for review for monitoring purposes. As part of the post-evaluation and monitoring, the grievances will be available for review for Supervisory Consultant and decision regarding grievances shall be consistent with approved policies and entitlements.

Two GRC, one each for weir side and powerhouse, required in order to resolve disputes amicably through consultants. The GRCs are very important as it is expected that most cases, if not all would be resolved by the GRCs. The committee will hear complaints and facilities solutions and the process, as a whole will promote dispute settlement through mediation to reduce litigation.

Grievances are best redressed through project management, local civil administration, or other channels of mediation acceptable to all parties. Such channels of mediation may involve customary and traditional institutions of dispute resolution. The project management should make every effort to resolve grievances at the community level. Recourse to the legal system should be avoided except as a last resort.

7.1 Grievance Redress Committee (GRC)

In the case of Patrind Hydropower Project, major grievances that might require mitigation include the following:

- AP’s not enlisted
- Compensation inadequate
- Dispute about ownership
- Delay in disbursement of compensation
- Environmental issues

This requires that a Grievance Redress Committee (GRC) is constituted to resolve such issues and provide AP’s a public forum to address and resolve such issues adequately. The GRC may be comprised of the following members.

- District Revenue Officer, as the Chairman

- Union Council Nazim, as Principal Member
- Three Affected Community Representatives, as Members
- SHPL

It shall deliver its decision within two to four weeks of registration of the case.

7.2 Functions of the Grievance Redress Committee

The GRC will meet whenever grievances have been forwarded to them. The decision of the GRC will not be binding and APs can take recourse to the civil court if he/she so desires.

The functions and tasks of the GRC are to:

1. Record the grievances of APs, categorize and prioritize them and provide solution to their grievances arising out of land and property acquisition and eligibility for compensation and to raise environmental issues including proof or substantiation of potential damages or concern;
2. Undertake site visits and request relevant information as required to perform its functions;
3. Fix a time frame for resolving the grievance, subject to a maximum of 14 days;
4. Inform aggrieved parties directly about the status/development of their case; and
5. Inform aggrieved parties in writing of the decision.

7.3 Grievances Redress Procedures

This grievance redress procedure along with specific time frame and mechanism for resolutions of complaints will be adopted. This procedure states that any AP who has a complaint or is not satisfied with the compensation provided can complain in writing to the GRC. The GRC will deal with the grievance within seven working days of receipt of any complaint.

The AP's and local stakeholders will be briefed on the function and responsibilities of the grievance redress committees and the grievance redress procedures. Grievance redress mechanism will start from July 2011 i.e. year one and continue till the all grievances are not redressed (June 2014).

8. TRANSMISSION LINE DEVELOPMENT

The transmission line connection from the project to the existing electricity grid will be built by the National Transmission and Despatch Company Limited (NTDC), the agency responsible for transmission line construction and operation.

8.1 Route Options

The proposed route for the transmission line connection is under consideration by NTDC. NTDC has confirmed that the line will not terminate at Muzaffarabad Grid Station as previously considered as there is no space to accommodate additional line bays. The two line options now being considered are:

1. 132 kV line to Garhi Habibullah Grid Station (in the planning stage with land being acquired); or
2. 132 kV or 220 kV transmission line to Mansehra Grid Stations.

The Garhi Habibullah grid connection involves a short transmission line of 20-25 km length, most likely running along Muzaffarabad-Garhi Habibullah Road (left bank of Kunhar), along the existing 132 kV Mansehra-Muzaffarabad transmission line. The Mansehra connection requires a 50-60 km line. The route to Mansehra would be the same as the 132 kV Mansehra-Muzaffarabad transmission line.

8.2 Safeguard Compliance

NTDC compliance with environmental and social safeguards is managed by the Deputy Manager responsible for environment and social issues. NTDC follows national standards for locally-funded projects, and follows both local and donor/funding agency standards for projects funded wholly or partially by outside donors/funding agencies. Over the last few years, NTDC has undertaken extensive transmission projects funded by ADB, adhering to ADB standards for these developments.

An EIA is mandatory for a transmissions line above 11 kV under the National Environmental Protection Agency Regulations, 2000. Accordingly, NTDC will prepare an EIA for the proposed transmission line and obtain approval through the standard process.

No protected areas such as national parks, wildlife sanctuaries or game reserves are crossed by either of the two route options currently being considered. The approximate distances to the nearest protected areas to either transmission line route option are:

- Machiara National Park - 15 km east of the weir site;
- Ayubia National Park - 40 km southwest of the weir site; and
- Manshi Wildlife Reserve - 20 km northeast of Balakot.

Both transmission line route options cross mountainous terrain with sparse population up to Garhi Habibullah (20-25 km). Land cover includes scattered trees, but no dense forests are traversed. The final section of the second route option, from Garhi Habibullah to Mansehra (30-35 km), crosses the Kunhar River near Garhi Habibullah. This route also crosses mountainous terrain with a sparse population, however part of the route has relatively larger tree cover. The route passes near the populated area of Garhi Habibullah, but it avoids built features where possible.

APPENDIX A

ENVIRONMENTAL FLOW ASSESSMENT

1. INTRODUCTION

The protection of aquatic environment is an important consideration in developing schemes for utilization of water resources. Where schemes involve altering the natural flow regime of a surface water system (river or stream etc), it is important to allow a certain share of water, generally referred to as environmental flows, through the existing course of the water so that biological life in the affected stretch can be maintained. While in principle the concept of environmental flows is accepted uniformly, the methodologies for establishing the levels of environmental flows vary considerably amongst experts, environmental agencies or countries. In Pakistan, there is not any specific legislation or ruling or instruction from relevant governments or statutory bodies or regulatory agencies which establish a specific framework or methodology for determining environmental flow. Consequently, in water resource development schemes, where the level of environmental flows has to be established, consultants rely on existing precedents or use their own experience and understanding to propose such flow requirements. In this note, the environmental flow adopted for Patrind Hydropower Project, which is being developed on river Kunhar in Pakistan, is discussed for further clarity and understanding.

2. ENVIRONMENTAL FLOW ASSESSMENT METHODOLOGIES

There are many formulas for the calculation of environmental flow. At present the number of formulas worldwide is 207 [2]. This number is tending to increase day by day. This demonstrates that no good universally valid solution for environmental flow determination exists at the moment and probably will never exist.

The various groups of formulas available for Environmental Flow Assessment (EFA) are based the following aspects [1].

i) Methods based on hydrologic or statistic values;
ii) Methods based on physiographic principles;
iii) Formulas based on velocity and depth of water; and
iv) Methods based on multi-objective planning taking into consideration ecological parameters.

2.1 Methods Based on Hydrologic or Statistical Values

Within these methods, a first subgroup refers to the average flow rate (MQ) of the river at a given cross section. These methods give values between 5 and 60 % of MQ; the latter one in case of high economic importance of fishery.

A second subgroup of methods refers to the minimum mean flow (MNQ) in the river. The values calculated can vary from 33 to 100 % of MNQ.

A third subgroup of methods refers to the prefixed values on the Flow Duration Curve (FDC). In this group there are a wide variety of methods:

from a reserved flow equal to 20% of Q_{300} (flow rate exceeding 300 days of duration) to complex interpolating formulas.

2.2 Methods Based on Physiographic Principles

These methods basically refer to a prefixed specific flow rate expressed as $l/s.km^2$ of catchment area. Values can vary from 1.6 to 9 or more $l/s.km^2$ (in cases of abundance of fish).
These methods are easily applicable presuming there is good basic data. However no hydraulic parameters are considered and neither the effect of tributaries nor the length of the diversion reach is taken into account.

2.3 Formulas Based on Velocity and Depth of Water

Also in this group of methods there is a wide range of variation: one says water velocity in case of reserved flow may not fall below a prefixed threshold value of 0.3-0.5 m/s and the minimum depth of water must be greater than a prefixed value of 10 cm. Another suggests 1.2 – 2.4 m/s and 12 - 24 cm water depth and so on.

The great advantage of these formulas is that the shape of the profile is included in the calculation and there is no need for hydrological data. Nevertheless diversion length and tributaries are not considered.

2.4 Methods Based on Multi-Objective Planning Taking Into Consideration Ecological Parameters

These methods are generally very complex in their application and require considerable expertise in doing so. They require site-specific flow observations and take into account hydrological, hydraulic, ecological, and meteorological data, embracing both ecological and economic parameters. Methods are expensive in data collection and mathematical computing, and are suitable only for particular types of rivers. Their transferability is doubtful.

3. COMPARATIVE STUDY OF EFA FORMULAS FOR PATRIND HPP

3.1 Environmental Flow Formula Used in Patrind Hydropower EIA Studies

The Environmental Flow formula for the Project, which gives a value of $3.7m^3/s$, was used in EIA studies for Patrind Hydropower Project (the Project) as part of Feasibility Study. The same formula was used when EIA studies were updated in early 2010. EIA report of the Project has been approved by the Environmental Protection Agency of AJ&K (EPA-AJK). EPA-AJK or any of the participants (which included people living on the banks of river Kunhar) did not express any reservations on the proposed environmental flow or methodology during the process of EIA review, including during the two public hearings conducted in AJ&K for EIA approval and for CDM process. Since the Project is located in the areas of AJ&K and Khyber Pakhtunkhwa (KP) province, updated EIA has been submitted to EPA-KP, where it is being reviewed. A public hearing has been held in KP for CDM process but no participant expressed any reservation on the environmental flow.

The same formula was earlier used by Fichtner Consultants of Germany for 106 MW Golen Gol HPP, Chitral Pakistan which has physiographic characteristics similar to project area of Patrind HPP. Golen Gol HPP is being developed by WAPDA, the state-owned organization for the development of water resources and hydropower. The EIA for Golen Gol HPP has already been approved by EPA-KP and it showed no reservations on the environmental flow calculation method.

3.2 Comparison of Environmental Flow Formula Value With Estimated Flow in Kunhar River

The following table compares the formula value of $3.7m^3/sec$ with the estimated monthly flows in the river Kunhar reach from weir to river Jhelum confluence in a worst case scenario. The estimated monthly flow in the reach includes contribution from major side streams. This contribution consists of two major components as follows:

i) Rainfall-runoff
ii) Flow from springs

It is noteworthy that the three major side streams have perennial flow and this provide year round drinking water supply to human settlements along those streams.

Month	Mean Natural Flow (m^3/s)	Environmental Release (m^3/s)	Spill Flow (m^3/s)	Flow Contribution of Main Nullahs Downstream of Weir (m^3/s)		Environmental Flow	
				Rainfall Runoff	Spring Flow	Downstream of Weir (m^3/s)	Percentage of Mean Natural Flow
1	2	3	4	5	6	7 (3+4+5+6)	8
January	23.6	2.0	-	0.7	0.5	3.2	13.6
February	25.8	2.0	-	1.6	0.5	4.1	15.9
March	43.4	2.0	-	2.3	0.5	4.8	11.1
April	97.2	2.0	-	1.1	0.5	3.6	3.7
May	184.4	2.0	29.4	0.5	0.5	32.4	17.6
June	282.6	2.0	127.6	0.5	0.5	130.6	46.2
July	246.6	2.0	91.6	6.6	0.5	100.7	40.8
August	149.1	2.0	-	4.5	0.5	7.0	4.7
September	82.1	2.0	-	2.2	0.5	4.7	5.7
October	46.6	2.0	-	0.5	0.5	3.0	6.4
November	32.2	2.0	-	0.4	0.5	2.9	9.0
December	27.3	2.0	-	0.9	0.5	3.4	12.5

The table assumes that the spring flows would be 0.5m^3/s year round in the worst case, although spring flows may have seasonal variation. It can be seen that flow requirement of 3.7 m^3/s, as calculated by Environmental Flow formula, is largely met throughout the year for this river reach in worst case scenario. The effect on fish during four months (Oct to Jan) when the flow is slightly below 3.7m^3/s is not considered significant when viewed from the fact that substantial fish culture does not exist in the river reach under consideration.

Based on the visual observations, however, it can be safely said that the spring flows would normally be in the range of 1.5 – 2.5 m^3/s. If such value is used in the above table, we find that all year round the environmental flow downstream of the weir would remain greater than 3.9 – 4.9 m^3/s. The Project Company is in the process of installing gauges on three major streams to measure their flows into river Kunhar downstream of the weir. The first readings would be available by the end of December or early January.

3.3 Hydrological Methods for EFA

Hydrology based methodologies constitute the highest proportion of the overall number of methodologies on record [2]. Examples of the use of specific percentages of MAF (mean annual flow) to set environmental flows include 10% MAF in Spain, for river catchments for which information is available and routine application of 2.5 – 5% MAF in Portugal.

The following table using 2.5% MAF for Patrind HPP has been prepared.

Comparison of 2.5% mean annual flow with the environmental flow allowed in Kunhar river reach

Month	Environmental Flow (m^3/s) 2.5% of Mean Annual Flow	Estimated Flow allowed (m^3/s) in Kunhar River Reach (worst case)	Estimated Flow allowed (m^3/s) in Kunhar River Reach (normal case)
Jan	2.6	3.2	4.2 – 5.2
Feb	2.6	4.1	5.1 – 6.1
Mar	2.6	4.8	5.8 – 6.8
Apr	2.6	3.6	4.6 – 5.6
May	2.6	32.4	33.6 – 34.6
Jun	2.6	130.6	131.6 – 132.6
July	2.6	100.7	101.7 – 102.7
Aug	2.6	7.0	8.0 – 9.0
Sept	2.6	4.7	5.7 – 6.7
Oct	2.6	3.0	4.0 - 5.0
Nov	2.6	2.9	3.9 – 4.9
Dec	2.6	3.4	4.4 – 5.4

In the above case, the flow in Kunhar river reach under consideration fully meets the requirement of environmental flow according to this methodology.

4. CONCLUSION

Downstream of the weir there is no common utilization of river Kunhar for human consumption. The studies carried out for aquatic ecology also do not provide any indication of extensive river resources having commercial or high ecological value. It is evident that the reduced flow downstream of the weir shall have no major impact on biological environment. It can be stated that a flow of $3.7m^3/s$ can be adopted as environmental flow for the Project. While the streams downstream of the weir would be contributing more than $1.7m^3/s$ to the river flow, a minimum discharge of $2m^3/s$ from the weir should be maintained while the rest of the inflows of river Kunhar can be diverted for power generation.

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