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Environmental Assessment

Strategic Environmental Assessment of

# Hydropower Development in Azad Jammu and Kashmir

National Impact Assessment Programme

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# Table of Contents

**Appendices:**

# Exhibits

# Executive Summary

**Introduction**

The Government of Pakistan (GoP) and the International Union for Conservation of Nature (IUCN) have jointly implemented the National Impact Assessment Program (NIAP), which aims to contribute to sustainable development in Pakistan through strengthening the Environmental Impact Assessment (EIA) process and introducing Strategic Environmental Assessment (SEA) in national development planning.

To facilitate the SEA activities under NIAP, a SEA Task Force has been established at the Planning Commission to oversee the introduction of SEA in the country, including supervision of SEA pilot studies. As a result of the discussions held in the State of Azad Jammu and Kashmir (AJK), the Government of AJK agreed to volunteer its hydropower plan (the 'Plan') for SEA piloting.

This final report brings together all of the background, analysis, and recommendations made in the three phases of the SEA pilot study.

**Establishing the Context**

Before the environmental and social implications of the Plan can be determined, it is necessary to establish the context behind it by identifying its objectives, and investigating the organizational responsibility for the overall plan.

The focus of this SEA is the hydropower development plan for AJK. Initial consultations with Government agencies led to the conclusion that no overall, coordinating strategic plan exists. The closest approximation to such a plan is the collection of individual project proposals of the Water and Power Development Authority (WAPDA), the Private Power and Infrastructure Board (PPIB), the Hydroelectric Board (HEB), and the Private Power Cell (PPC). For the purposes of this pilot SEA, this combined collection of proposals is taken to be "the Plan".

According to the latest information available from the four government agencies involved in hydropower development in AJK, there are currently 12 operational hydropower projects in the state. An additional 13 are under construction while 37 more sites have been identified for detailed feasibility studies, (which, for some sites, may be under progress).

As is generally understood, SEA can take one of two forms. It can be applied to a policy, plan, or programme (PPP), after the initiative in question has already been designed or even undertaken. This form of SEA is known as “ex post” or “after the fact”. When SEA is applied in this fashion, it is akin to the approach taken by environmental impact assessment (EIA), when it is applied to site–specific development projects. In its other conception, SEA can be applied as a method for incorporating environmental concerns or issues into the development of a PPP. In this “ex ante” or “before the fact” form, SEA influences the actual design of a PPP before it is completed and executed.

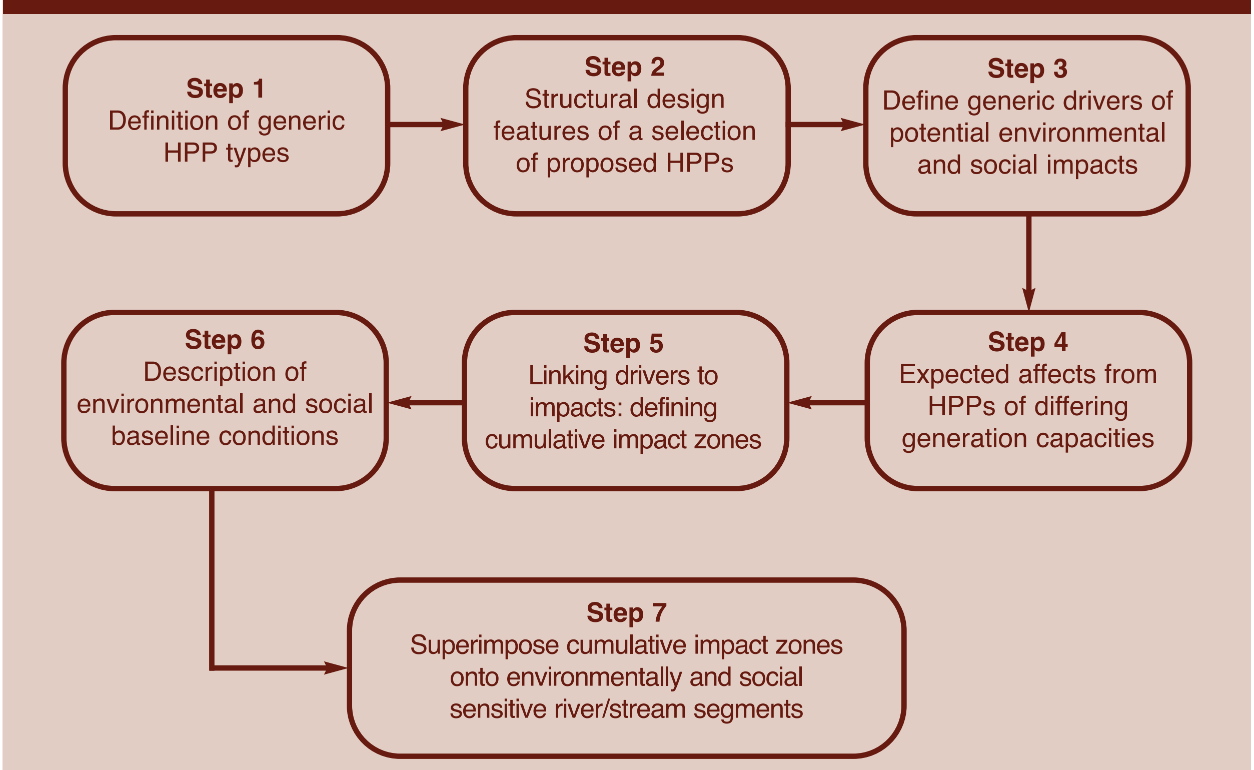
In this case study, the SEA took the form of an ex post assessment based on the collection of 62 existing or proposed projects that make up the de facto Plan.

**Cumulative Impacts of Hydropower Projects Methodological Steps**

As is always the case with any kind of impact assessment work, it helps to have a methodological “map” to guide the study process. Exhibit I outlines the methodological approach that was undertaken.

The approach consists of seven distinct steps that were followed in chronological order. By way of brief introduction, Step 1 should define and categorize the proposed hydropower projects (HPPs) as listed in the hydropower plan that is the focus of attention. Step 2 is used to outline the structural design features of a selection of proposed HPPs of differing generation capacity. This background material allows, in Step 3, for the definition of the generic drivers of potential environmental and social impacts. Categorizing HPPs into different types based on the drivers of impacts helps identify the key issues that are to become the focus of the SEA study and the recommendations that will result from it.

**Exhibit I: SEA Study Methodology: Connection between HPP Design, Drivers, and Cumulative Impacts**



In Step 4 links are investigated between drivers and actual potential impacts by outlining the expected effects from HPPs of different generation capacities. Step 5 extends this analysis to examine the environmental and social risks associated with planned HPP development on specific stretches of rivers and streams. Based on the geographical locations and potential cumulative impacts expected from hydropower development, river and stream sections are delineated into Cumulative Impact Zones. Based on the possible extent and severity of cumulative impacts, these zones are categorized into Moderately Critical, Highly Critical, or Extremely Critical.

With this background analysis in hand, Step 6 involves the careful examination of the environmental and social “baseline” conditions existing along the river and stream stretches that will likely see HPP development taking place. Finally, in Step 7 the Cumulative Impact Zones identified in Step 5 are superimposed on the ecologically and socioeconomically sensitive segments identified in Step 6. This allows the HPPs contained in the hydropower development plan to be ranked according to their overall cumulative impact potential.

**Outcomes of the Cumulative Impact Assessment**

The ranking of an HPP enables the proponents of the project, environmental consultants, and government agencies to identify, at a glance:

- the overall existing ecological and socioeconomic picture of the area where a HPP is being planned for development or currently in the process of being constructed and the regions where more detailed studies need to be prioritized;
- the scale of the impact an HPP will have on the ecology and socioeconomic condition of the area where it will be located;
- the contribution of each HPP to the overall impacts from the development of all the HPPs included in the Plan;
- the potential need for a change of qualifying conditions for either EIA or IEE studies for different HPPs and the level of detail in which the ecological and socioeconomic impact assessment studies need to be conducted for targeted projects;
- the role and significance of coordination between the different government agencies responsible for the development and implementation of the hydropower plan;
- an opportunity for revising the Plan as a whole or revising the type, size, layout and structural components of a HPP to utilize any benefit from other HPPs being built in the vicinity; and,
- specific regions where public awareness campaigns need to be organized by the government to help monitor HPPs during the construction and operation phases.

Exhibit II presents the outcome of the cumulative ecological assessment, and Exhibit III presents a similar analysis, but for socio–economic impacts. A clear outcome is that the area of most concern, both from ecological and socio–economic perspectives, is the Poonch River and its feed–in nullahs from the Line of Control down to the Mangla Dam. The nine proposed HPPs all rank highest for potential ecological and social impact. As indicated in Exhibits 2 and 3, however, it should be noted that the Poonch River segment only accounts for 7% of the total AJK hydropower generation potential.

**Exhibit II: A Map of HPPs in the Hydropower Development Plan of AJK and their Ranking based on their Cumulative Ecological Impact**

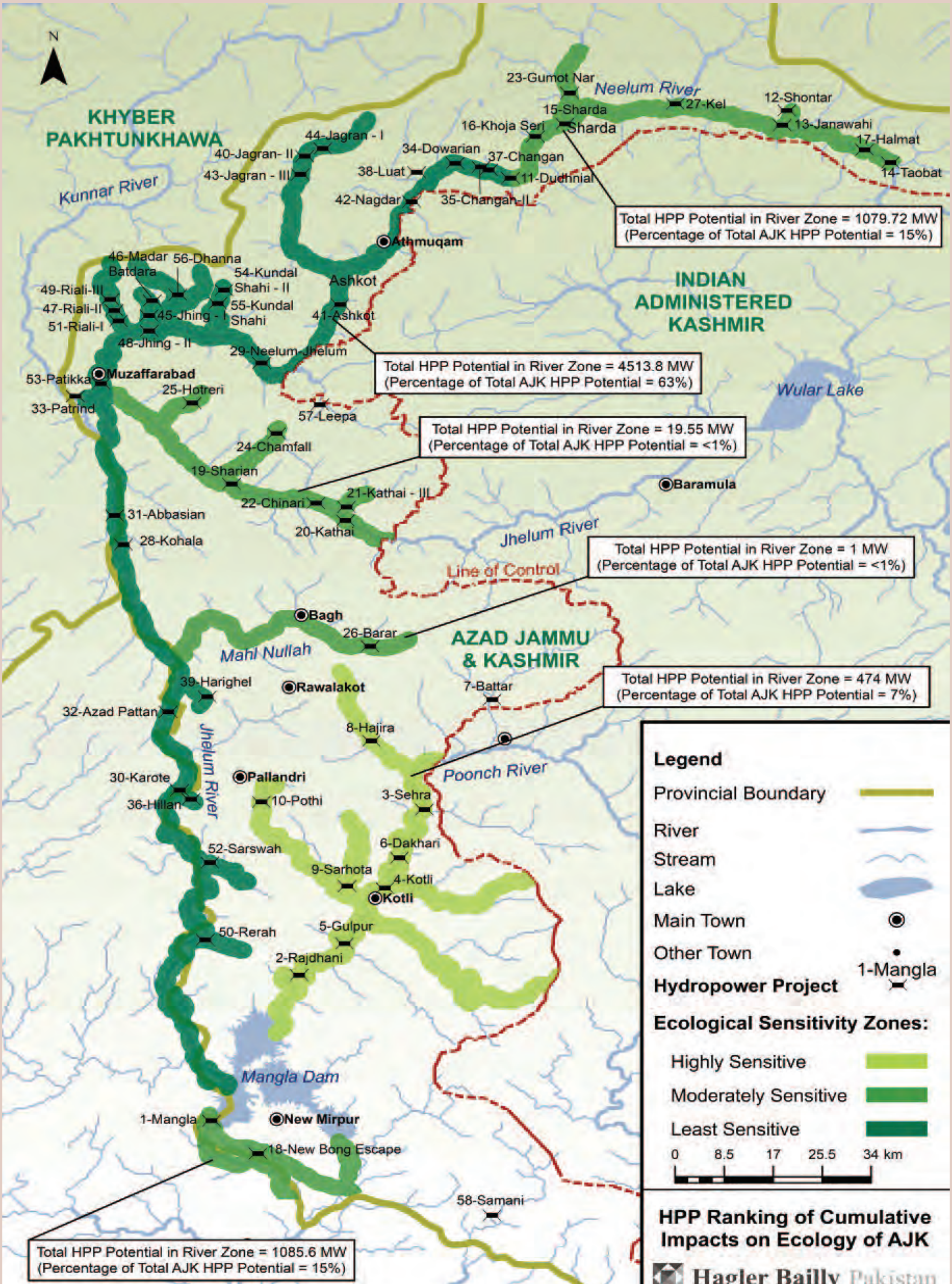
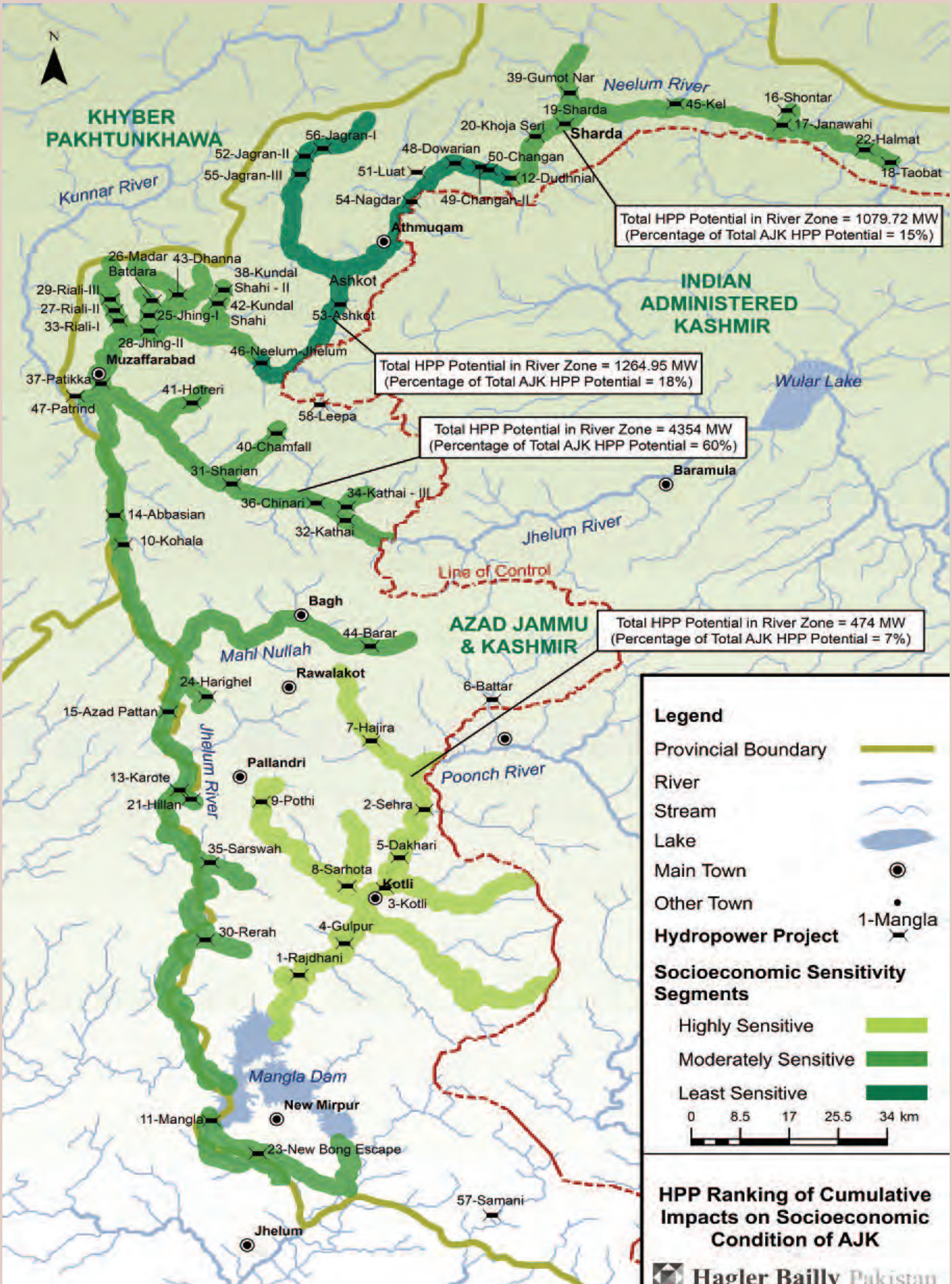


**Exhibit III: A Map of HPPs in the Hydropower Development Plan of AJK and their Ranking based on their Cumulative Socio–Economic Impact**



**Informing Decision–making**
The analyses undertaken during the "establishing the context" and "cumulative impact assessment" components of the SEA pilot study resulted in a number of recommendations for institutional reform that will allow overall hydropower planning for AJK to be improved. The following recommendations focus on: clarifying responsibilities for hydropower plan ownership; improving project development planning; guidelines for environmental impact assessment; and, proposing minor regulatory amendments.

***Recommendation 1: Establishment of an AJK Hydropower Planning Committee***
An AJK Hydropower Planning Committee should be established. It should be made up of senior managers from WAPDA, HEB, PPIB, and PPC, along with other relevant AJK government representatives from the wildlife, fisheries, and tourism sectors. The purpose of the Committee should be to develop and regularly update an overall hydropower plan for AJK. Establishment and management of the Hydropower Planning Committee should be the responsibility of the AJK P&DD[1].

***Recommendation 2: Development of a Coordinated Hydropower Development Plan***
A comprehensive hydropower plan or basin development plan needs to be developed and "owned" by all four agencies as members of the Hydropower Development Organization. This plan should be updated on a regular (perhaps 6–monthly) basis.

***Recommendation 3: Promoting Synergistic Project Development***
Where there are HPPs in close proximity to each other, either on a main river, or on tributary nullahs, proponents should be required to consult about project design to enable synergistic development. Such consultation should be required even if project initiation schedules are not synchronized.

***Recommendation 4: Terms of Reference***
Terms of Reference for full EIA studies associated with relevant HPPs should include cumulative assessment requirements.

***Recommendation 5: Indicator Species and Monitoring***
The AJKEPA should select fish species in different ecological stretches of AJK rivers as indicators of river–health. The number of these indicator–fish species should be monitored regularly throughout the life of the hydropower plan.

***Recommendation 6: Ecological Flow***
Keeping in view the high ecologically sensitivity of the Poonch River and its tributaries, it is recommended that all the hydropower projects planned on the Poonch River should use holistic approaches for determination of downstream environmental flow.

***Recommendation 7: Regulatory Amendment***
The 50 MW benchmark should not be the main screening criterion used to determine the required level of environmental assessment. AJK EPA should use ecological and social sensitivity ranking tables and maps to determine whether a HPP should require an IEE or EIA.

The Azad Jammu & Kashmir Environmental Protection Agency Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations 2009, Schedule I and Schedule II should be rewritten as follows:
Schedule I: List of Projects Requiring an IEE

***B. Energy***
Additional sentence to add to point 1:
Projects under 50MW qualify for an IEE, unless they are located on a "highly sensitive" ecological and/or social segment, in which case they must undergo a full EIA.
Schedule II: List of Projects Requiring an EIA
***A. Energy***
No changes required to this Schedule.

1. At a workshop held in Muzaffarabad on February 14, 2014 to present the results of Phase 3, senior officials indicated that a Hydropower Development Organization had been recently established, and that it absorbed the planning responsibilities of HEB, PPIB, and HEC.

# 1. Introduction

## 1.1 The Pilot Strategic Environmental Assessment Study

The Government of Pakistan (GoP) and the International Union for Conservation of Nature (IUCN) have jointly implemented the National Impact Assessment Program (NIAP), which aims to contribute to sustainable development in Pakistan through strengthening the Environmental Impact Assessment (EIA) process and introducing Strategic Environmental Assessment (SEA) in national development planning. The Program has four implementation partners: Pakistan Environmental Protection Agency (PakEPA), Environment Wing (EW) of the Ministry of Climate Change (MoCC), Planning Commission of Pakistan (PC), and IUCN Pakistan. Additionally, the Netherlands Commission for Environmental Assessment (NCEA) has an advisory role in the Project and provides technical advice. The total duration of the Program is four and a half years.

To facilitate the SEA activities under NIAP, a SEA Task Force has been established at the Planning Commission to oversee the introduction of SEA in the country, including supervision of SEA pilot studies. In its second and third meetings, the Task Force decided that SEA pilots would be selected from the urban land–use planning and energy sectors, with the latter having a specific focus on power generation. As a result of the discussions held in the State of Azad Jammu and Kashmir (AJK), the Government of AJK agreed to volunteer its hydropower plan (the ‘Plan’) for SEA piloting.

The objectives of the pilot SEA of the hydropower plan were to:

- develop an understanding of the state of hydropower planning in AJK;
- assess the potential environmental and social risks associated with the hydropower plan;
- assess the potential environmental and social benefits associated with the hydropower plan;
- if necessary, suggest alternative plan options that better optimize economic, environmental, and social outcomes; and,

- assess the institutional and policy constraints to mainstreaming environmental and social considerations into AJK hydropower planning and development, and provide recommendations on how these constrains might be addressed.

## 1.2 Outline of the Development of the SEA Pilot Study

The SEA pilot study was undertaken in three phases, over a 12–month period from February 2012, to February 2013. The first phase began with a 3–day preparatory training workshop in Muzaffarabad for approximately 80 participants, followed by a second mixed training and validation workshop in Mirpur in April, 2013.

The output report from the first phase helped to establish the context behind the Plan by identifying its objectives; investigating the organizational responsibility for the overall Plan; and, conducting an institutional and stakeholder analysis to ascertain the relationship between the Plan and the plans and strategies of other public and private sectors in AJK. It also detailed relevant government policies and mapped hydropower projects (HPPs) in different stages of development, illustrating their locations, installed power generating capacities, and the government institutions in charge of their development. Phase 1 work was presented in a report titled "Establishing the Context", and dated June 17th, 2013.

The objective of Phase 2 was to assist the AJK authorities to identify the scale, diversity, magnitude and complexity of the potential environmental and social impacts emanating from the development of the Plan, and to identify the areas and river sections most sensitive to those impacts. This component was the most technically–complex part of the SEA study, and was published in a report titled, "Cumulative Impacts of Hydropower Projects", and dated November 20, 2013.

The objective of Phase 3 of the SEA pilot was to present recommendations for institutional reform that would allow the majority of recommendations made in Phase 2 to be implemented, and overall hydropower planning for AJK to be improved. The focus of Phase 3 was on: clarifying responsibilities for hydropower plan ownership; improving project development planning; guidelines for environmental impact assessment; and, proposing minor regulatory amendments. The work undertaken in Phase 3 was published on January 28th, 2014 in a report titled, "Informing Decision–making".

## 1.3 Outline of the Final Report

This final report brings together all of the background, analysis, and recommendations made in the three phases of the SEA pilot study. Section 2 establishes the context for the SEA study by focusing on the hydropower plan, its objectives, and the institutions and stakeholders that have an interest in hydropower development. Section 3 presents the results from Phase 2 of the pilot. It focuses entirely on examining the cumulative impacts of the projects proposed in the short–and–medium term. Section 4 concludes with recommendations that relate to informing future decision–making.

# 2. Phase 1: Establishing the Context

## 2.1 Introduction

This section of the final report establishes the context behind the Government of AJK's hydropower development plan, by identifying its objectives; investigating the organizational responsibility for the overall plan; and conducting an institutional and stakeholder analysis to ascertain the relationship between the plan, and the strategies and plans of other public and private proponents in AJK.

## 2.2 Mapping Hydropower Development in AJK

Over the last decade, the development of hydropower resources in AJK has become a priority for the government as a result of Pakistan's significant shortfall in energy production, which is estimated to rise to over 8,500 MW.[2] This shortfall has resulted in prolonged power cuts and is adversely affected economic growth and development, thereby becoming one of the top challenges facing the political leadership of the country.

AJK's hydropower development would be a significant contribution to Pakistan's energy demands as electricity produced by power plants in the former – and in the four Pakistani provinces – is sold to the latter's National Transmission and Distribution Company (NTDC) which redistributes it across Pakistan and AJK through the national grid.

Given the challenge of meeting the energy demands of the country, while also keeping energy costs affordable for consumers, the Government of Pakistan (GoP) has prioritized hydropower development across all territories in its control. AJK, with its estimated hydropower potential of over 5,000 MW, figures significantly in this plan. The AJK government is committed to fast–tracking hydropower projects to raise the installed hydropower capacity from its current levels, of approximately 120 MW to 400 MW by the year 2015.[3] The road map for achieving this goal is a result of the combined effect of Pakistan's Policy for Power Generation 2002 and WAPDA's Vision 2025 – Hydro Development Plan.

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2. Dawn. (2012, June 17). Electricity Shortfall in the Country Reaches 8,500 MW. Retrieved May 2013, 20, from Pakistan: http://dawn.com/2012/06/17/residents–protest–prolonged–loadshedding–in–lahore
3. Hydro Electric Board. (n.d.). Objectives. Retrieved May 18, 2013, from AJK Hydro Electric Board: http://www.ajkheb.org/ObjectivesPolicies

### 2.2.1 Policy for Power Generation Projects 2002

Hydropower development in the State of AJK is governed in the main by the Policy for Power Generation Projects (2002) formulated by Pakistan's Ministry of Water and Power (MW&P). With a view to addressing projected power shortages, the policy includes several "investor–friendly" changes in the methodology and approach to implementing new power projects across the country. It provided a clear set of incentives, along with a regulatory regime that effectively gives a roadmap to attract private investment in power generation at competitive prices.[4]

Through the power generation policy of 2002, the GoP promotes solicited bids for hydropower projects and indigenous fuel–based projects where feasibility studies are already available or, where feasibility study work is to be initiated on raw–sites for exploiting indigenous as well as renewable resources.[5]

Salient Features of Power Policy 2002
The salient features of the Power Policy of 2002 are as follows:[6]

- The scope of the policy covers private, public–private and public sector projects.
- Aims to enhance share of renewable energy resources especially hydropower.
- Encourages exploration of indigenous resources including hydel, coal gas and renewable resources through active involvement of local engineering, design and manufacturing capabilities.
- Includes invitation of bids on tariff through international competitive bidding (ICB);
- Encourages unsolicited bids to develop raw sites where feasibility studies are not available.
- Projects above 50 MW are to be handled at the federal level while projects below 50MW are to be supported, facilitated and handled by the respective provincial and AJK departments they are geographically located in.
- MW&P, through the Private Power and Infrastructure Board (PPIB) remains the focal point at federal level.

The 2002 power policy has been adopted by the GoAJK, providing guidelines for private sector investment in the development of hydropower projects in the state. The policy was formulated to promote private investment and public–private partnerships across Pakistan and the State of AJK allowing the provinces and AJK to manage investments for power projects up to 50 MW while those above 50 MW would be handled at the federal level.

**Salient Features of the 2002 Power Policy as Adopted by the GoAJK**

The salient features of the 2002 power policy as adopted by the GoAJK are as follows:[7v]

- Raw sites are to be awarded on first–come–first–serve basis to interested investors who establish their financial soundness in meeting the equity component of the investment.
- Sites where feasibility studies have already been conducted can be made part of solicited competitive bidding if the interested investors reimburse the cost of the feasibility study.
- State–owned land would be leased on concessional rates for project development to investors and developers without provision for escalation of lease rates.

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4. Government of Khyber Pukhtunkhawa. (2006). Policy for Hydropower Generation Projects . Peshawar, KPK.
5. In the context of hydropower development, Pakistan's Water and Power Development Authority (WAPDA) and respective hydropower development departments of the provinces and states within Pakistan, including AJK, conduct topographical and hydrological studies of locations with a potential for further developed as a hydropower site. After preliminary tests, such sites are designated 'raw–sites', if they are deemed fit for a full and detailed feasibility study for development into a hydropower project
6. Pakistan Water and Power Development Authority. (2012). Hydro Potential in Pakistan. WAPDA House, Lahore – Pakistan: Public Relations Division (WAPDA).
7. Hydro Electric Board. (n.d.). Objectives. Retrieved May 18, 2013, from AJK Hydro Electric Board: http://www.ajkheb.org/ObjectivesPolicies

- Support is to be provided for acquisition, leasing and purchase of privately owned land through the relevant land revenue department.

- Support is also provided for setting up of regional Receipt and Dispatch grid for optimal utilization of capacity.

- A generous package for Build–Operate–Transfer (BOT) implementation including 5 years grace period for extension of operation is available.

- Generous tax/levies and incentives are included to promote cottage industrial and agricultural units running on hydropower projects on the concept of captive generation.

**2.2.2 WAPDA's Vision 2025 Hydro Development Plan**

In 2008, Pakistan's Water and Power Development Authority (WAPDA) announced its Vision 2025–National Water Resource and Hydropower Development Program designed to organize and prioritize the development of hydropower projects in the short, medium and long term to meet the power deficits facing the country.[8] It is revised and updated according to WAPDA's annual report submitted to the GoP, and details the current and future development of hydropower resources across Pakistan and AJK.

Vision 2025 details all of the hydropower development related activities in Pakistan and AJK being undertaken along with their status and progress. Identified projects are designated, either to the public or private sector, or to a public–private partnership for construction and commissioning depending upon the urgency to complete a project while keeping in view the resources available from the government or private funders.[9] The Water and Power Development Authority (WAPDA) is carrying out feasibility studies and engineering designs for various hydropower projects with a cumulative generation capacity of more than 25,000 MW, with a view to increasing the installed hydropower capacity across Pakistan to around 42,000 MW by the end of the year 2020.[10]

Taking into account the objectives of the power generation policy of 2008 and the lack of available funds in the national exchequer, WAPDA's Vision 2025 is heavily oriented towards the private sector for the development of the different projects. The projects compiled in the program are categorized in one of the following forms:

- Raw–sites for hydropower projects identified and ready for feasibility studies by the private sector;[11]

- Hydropower sites complete with feasibility studies conducted by the private or public sector, ready to be developed further by the private sector or under Public Private Partnerships (PPP) and;

- Private hydropower projects undertaken by provincial governments, Gilgit Baltistan and AJ&K, where the power purchaser is the federal entity; where the transmission or distribution network of the federal government is used; and where the tariff determined or approved by National Electric Power Regulatory Authority (NEPRA) or GoP guarantee is required.

## 2.3 Proposed Hydropower Projects in AJK

According to the latest information available from all the government agencies involved in hydropower development in AJK, there are currently 12 operational hydropower projects in the state. An additional 13 are under construction

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8. Siddiqui, R. H. (2008, September 24). Wapda 'Vision 2025' to help solve power crisis. Retrieved May 24, 2013, from The Nation: http://www.nation.com.pk/pakistan–news–newspaper–daily–english–online/Business/24–Sep–2008/Wapda–Vision–2025–to–help–solve–power–crisis.
9. Pakistan Water and Power Development Authority. (2011). Annual Report 2010 – 2011. WAPDA House, Lahore – Pakistan: Public Relations Division (WAPDA).
10. Pakistan Water and Power Development Authority. (2012). Hydro Potential in Pakistan. WAPDA House, Lahore – Pakistan: Public Relations Division (WAPDA).
11. Raw sites are those identified by WAPDA as potentially suited for hydropower development due to suitable hydrology and topography. Raw sites undergo feasibility studies after which hydropower development on the site commences.

while 37 more sites have been identified for detailed feasibility studies, (which, for some sites, may be under progress).

Exhibit 2.1 shows a list of all the projects in different stages of completion with the government agency responsible for the project stated alongside each. In the late eighties, WAPDA conducted comprehensive hydel potential reports on the three main rivers of AJK, namely, the River Jhelum, River Poonch and River Neelum. Various sites with an estimated total capacity of about 4,635 MW of hydel potential have been identified in AJK and been included in WAPDA's Vision 2025 program.

In order to exploit the hydel resources of AJK, the Government of AJK (GoAJK) established the AJK Hydro Electric Board (HEB) in 1989 to plan and undertake development of identified hydro potential and implement public sector hydropower projects. Subsequently, with the intention of providing a 'one-window' facility and to encourage the development of hydel potential in the private sector, the GoAJK created the AJK Private Power Cell (PPC) in 1995. More details on the structure, functions, and project plans of the four agencies is presented in the full Phase 1 report.

HEB and PPC are the two government agencies in AJK that are responsible for the implementation of hydropower projects in AJK with capacities up to 50 MW. This is in accordance with the power policy of 2002 which made provinces and the State of AJK responsible for managing the development and implementation of power projects with capacities up to 50 MW, leaving the federal agencies, namely WAPDA - for public sector projects, and PPIB - for private sector projects - to manage hydropower projects in AJK with capacities greater than 50 MW. Exhibit 2.2 shows the relationship between the four agencies and hydropower development, whereas Exhibit 2.3 displays their locations.

The exercise of mapping and identifying hydropower projects in different stages of development in AJK made use of information from public and private resources readily available to the public. Information on hydropower projects already in operation is available in detail; however, the latest information on projects under construction or in various stages of a feasibility study is limited to their locations, generating capacities and stages of development.

The four government agencies responsible for hydropower development in AJK; the federal agencies – WAPDA and PPIB; and AJK agencies – HEB and PPC; present inconsistent information with varying levels of detail. The federal agencies have made recent updates to the information available online while the information on the AJK agencies website contains outdated information.

Among the different sources of information on hydropower development in the AJK provided by the four agencies, some include detailed information covering location, capacity, progress status, energy generation, nature of project and other relevant information. Others, however, simply state names and power generating potential. The general trend revealed was that the federal agencies provided more information than their AJK counterparts and within the agencies there was more information on projects already in operation with only minimal information on projects under construction or in the feasibility stage.

This report has included only those pieces of information which were commonly available for all the hydropower projects in different stages of progress across all the concerned agencies. At this stage only the locations, potential capacities in MW and statuses of the projects have been mapped.

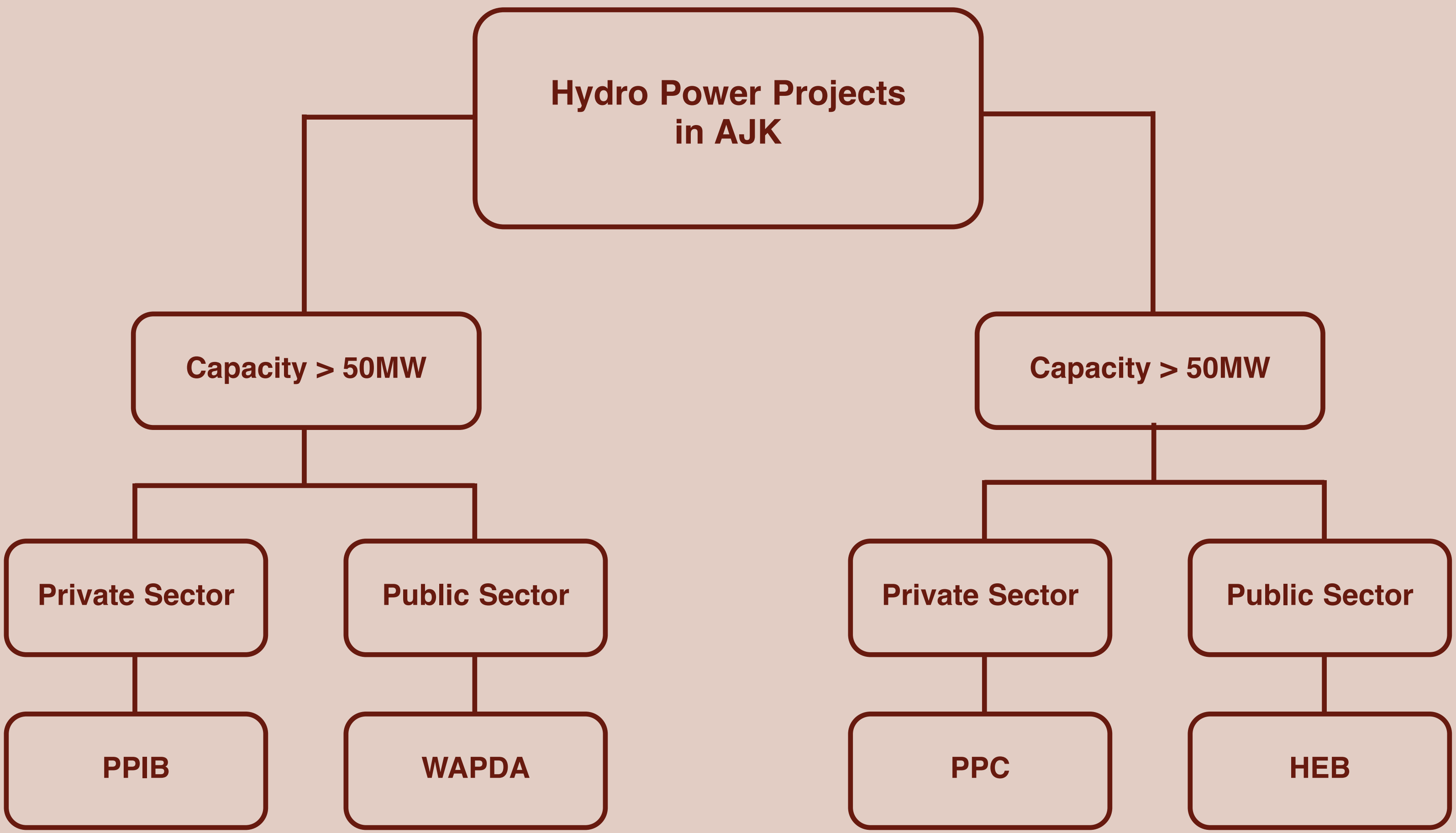
Similarly, the exact locations of the projects that are operational or under construction were easy to obtain, while locations of projects under different feasibility stages were limited to mentioning the river and closest town or village the hydropower project was to be located in. Therefore, the coordinates of the different projects being planned or in different stages of feasibility studies were the closest approximation according to the limited information available.

## Exhibit 2.1: List of Hydropower Projects in AJK in Various Stages of Development under Different Agencies

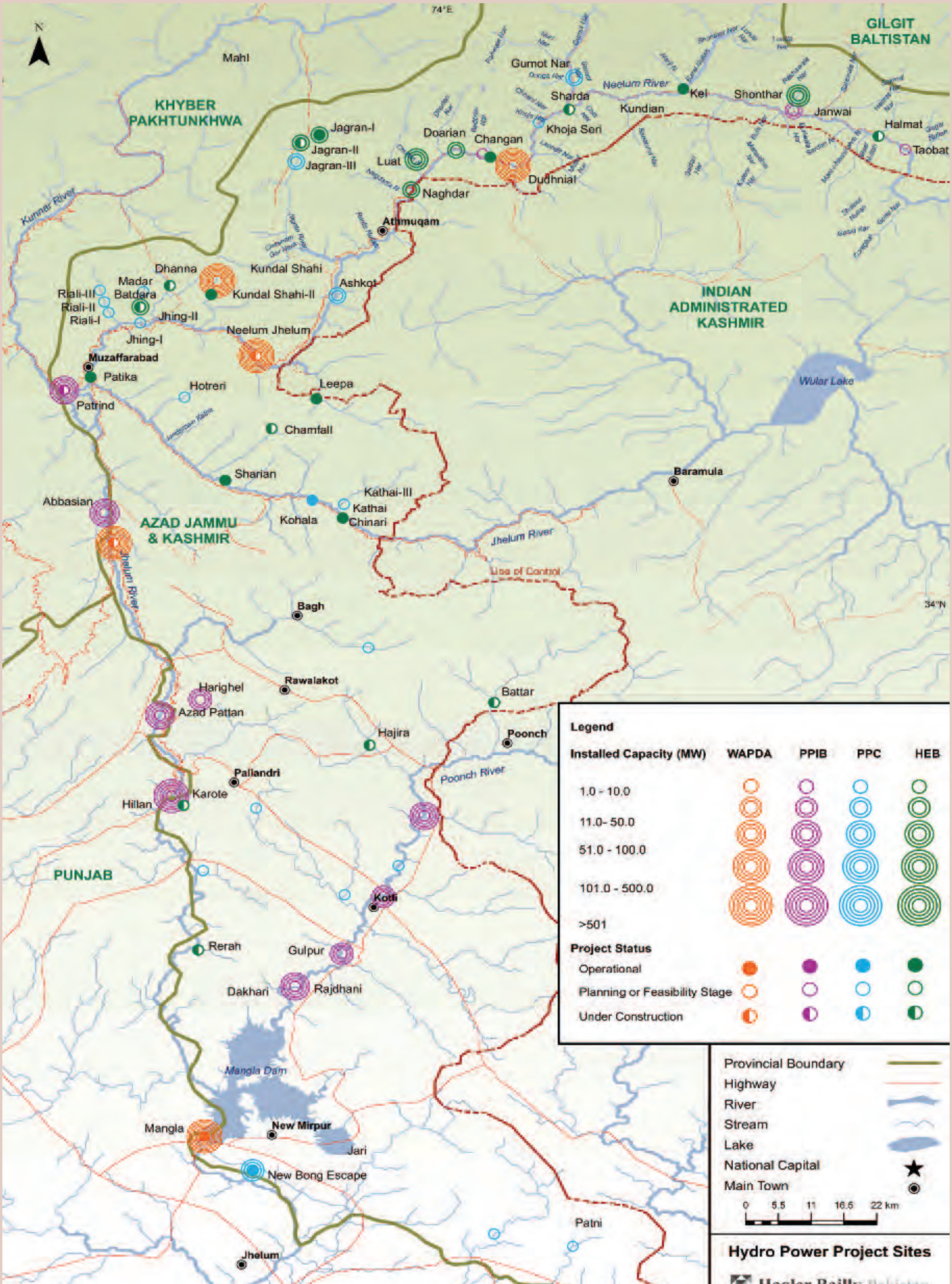
| Sr. No | Project | Installed Capacity (MW) | Executing Agency | Project Status |
|---|---|---|---|---|
| 1. | Patikka | 0.05 | HEB | Operational |
| 2. | Changan | 0.05 | HEB | Operational |
| 3. | Kel | 0.4 | HEB | Operational |
| 4. | Kathai | 1.6 | HEB | Operational |
| 5. | Leepa | 1.6 | HEB | Operational |
| 6. | Kundal Shahi | 2 | HEB | Operational |
| 7. | Sharian | 3.2 | HEB | Operational |
| 8. | Jagran - I | 30.4 | HEB | Operational |
| 9. | New Bong Escape | 84 | PPC | Operational |
| 10. | Jari | 1 | PPC | Operational |
| 11. | Chinari | 0.2 | PPC | Operational |
| 12. | Mangla (incl. Dam Raising) | 1,000 | WAPDA | Operational |
| 13. | Halmat | 0.32 | HEB | Under Construction |
| 14. | Hillan | 0.6 | HEB | Under Construction |
| 15. | Dhanna | 1.5 | HEB | Under Construction |
| 16. | Hajira | 3 | HEB | Under Construction |
| 17. | Sharda | 3 | HEB | Under Construction |
| 18. | Rerah | 3.2 | HEB | Under Construction |
| 19. | Battar | 4.8 | HEB | Under Construction |
| 20. | Chamfall | 6.4 | HEB | Under Construction |
| 21. | Jhing - I | 14.4 | HEB | Under Construction |
| 22. | Jagran- II | 43.5 | HEB | Under Construction |
| 23. | Patrind | 147 | PPIB | Under Construction |
| 24. | Kohala | 1,100 | WAPDA | Under Construction |
| 25. | Neelum-Jhelum | 969 | WAPDA | Under Construction |
| 26. | Naghdar | 39 | HEB | Planning or Feasibility Stage |
| 27. | Doarian | 46 | HEB | Planning or Feasibility Stage |
| 28. | Shontar | 52 | HEB | Planning or Feasibility Stage |
| 29. | Luat | 63 | HEB | Planning or Feasibility Stage |
| 30. | Jari II | 2.5 | PPC | Planning or Feasibility Stage |
| 31. | Dakhari | 2.2 | PPC | Planning or Feasibility Stage |
| 32. | Kathai - III | 1 | PPC | Planning or Feasibility Stage |

| *Sr. No* | *Project* | *Installed Capacity (MW)* | *Executing Agency* | *Project Status* |
|---|---|---|---|---|
| 33. | Hotreri | 5.4 | PPC | Planning or Feasibility Stage |
| 34. | Jhing - II | 4 | PPC | Planning or Feasibility Stage |
| 35. | Riali - III | 3.7 | PPC | Planning or Feasibility Stage |
| 36. | Riali-II | 4.9 | PPC | Planning or Feasibility Stage |
| 37. | Riali-I | 1.6 | PPC | Planning or Feasibility Stage |
| 38. | Ashkot | 40 | PPC | Planning or Feasibility Stage |
| 39. | Jagran-III | 35 | PPC | Planning or Feasibility Stage |
| 40. | Khoja Seri | 2 | PPC | Planning or Feasibility Stage |
| 41. | Kundian | 48 | PPC | Planning or Feasibility Stage |
| 42. | Madar Batdara | 10.2 | PPC | Planning or Feasibility Stage |
| 43. | Samani | 1.6 | PPC | Planning or Feasibility Stage |
| 44. | Sarhota | 1 | PPC | Planning or Feasibility Stage |
| 45. | Sarswah | 0.7 | PPC | Planning or Feasibility Stage |
| 46. | Pothi | 1 | PPC | Planning or Feasibility Stage |
| 47. | Barar | 1 | PPC | Planning or Feasibility Stage |
| 48. | Gumot Nar | 40 | PPC | Planning or Feasibility Stage |
| 49. | Rajdhani | 132 | PPIB | Planning or Feasibility Stage |
| 50. | Gulpur | 100 | PPIB | Planning or Feasibility Stage |
| 51. | Kotli | 100 | PPIB | Planning or Feasibility Stage |
| 52. | Karote | 720 | PPIB | Planning or Feasibility Stage |
| 53. | Azad Pattan | 222 | PPIB | Planning or Feasibility Stage |
| 54. | Kohala | 1,100 | PPIB | Planning or Feasibility Stage |
| 55. | Changan-II | 9 | PPIB | Planning or Feasibility Stage |
| 56. | Taobat | 10 | PPIB | Planning or Feasibility Stage |
| 57. | Janawahi | 12 | PPIB | Planning or Feasibility Stage |
| 58. | Mahl | 511 | PPIB | Planning or Feasibility Stage |
| 59. | Harighel | 53 | PPIB | Planning or Feasibility Stage |
| 60. | Abbasian | 360 | PPIB | Planning or Feasibility Stage |
| 61. | Kundal Shahi - II | 600 | WAPDA | Planning or Feasibility Stage |
| 62. | Dudhnial | 960 | WAPDA | Planning or Feasibility Stage |

**Exhibit 2.2: Institutional Relationships between WAPDA, PPIB, HEB and PPC for Hydropower Development in AJK**



## Exhibit 2.3: Locations, Capacities, Progress Status and Executing Agencies of Hydropower Projects in AJK



### 2.3.1 Proposed Hydropower Projects above 50 MW

According to the Policy for Power Generation Projects 2002, both public- and private-sector hydropower projects with capacities greater than 50 MW will be implemented by WAPDA and PPIB respectively. However, in the case of private-sector projects, the GoAJK would be the main driver and catalyst for marketing and coordinating projects located within its territory, along with the PPIB.

#### Water and Power Development Authority (WAPDA)

According to Exhibit 2.4, other than Mangla Dam which was completed in 1967, WAPDA is executing four public-sector projects in AJK with a total capacity of 3,629 MW. Of these, two are under construction with the remaining two in feasibility stages. Exhibit 2.5 indicates the location, capacities and progress status of the hydropower Projects.

**Exhibit 2.4: List of Public-Sector Projects being executed by WAPDA in AJK**

| *No* | *Project* | *Installed Capacity (MW)* | *Project Status* |
|---|---|---|---|
| 1 | Mangla (incl. Dam Raising) | 1,000 | Operational |
| 2 | Kohala | 1,100 | Under Construction |
| 3 | Neelum-Jhelum | 969 | Under Construction |
| 4 | Kundal Shahi - II | 600 | Planning or Feasibility Stage |
| 5 | Dudhnial | 960 | Planning or Feasibility Stage |
| | **Total** | **4,629** | |

## Exhibit 2.5: Locations, Capacities and Progress Status of Hydropower Projects in AJK being executed by WAPDA

**Private Power and Infrastructure Board (PPIB)**
According to Exhibit 2.6 the PPIB is in the process of implementing 13 projects in AJK, which in total will add 3,476 MW of hydropower in the state. Out of these, one project is under construction while the rest are all either ready for feasibility studies or their feasibility studies are already in progress. Exhibit 2.7 indicates the location, capacities and progress status of the hydropower projects.

Although having capacities below 50 MW, the feasibility studies for Changan-II, Taobat and Janawahi will be completed under PPIB, after which overseeing of the further processing of the site will come under PPC.

**Exhibit 2.6: List of Private-Sector Projects being executed by PPIB in AJK**

| *No* | *Project* | *Installed Capacity (MW)* | *Project Status* |
|---|---|---|---|
| 1 | Patrind | 147 | Under Construction |
| 2 | Rajdhani | 132 | Planning or Feasibility Stage |
| 3 | Gulpur | 100 | Planning or Feasibility Stage |
| 4 | Kotli Hydropower Project | 100 | Planning or Feasibility Stage |
| 5 | Karote | 720 | Planning or Feasibility Stage |
| 6 | Azad Pattan | 222 | Planning or Feasibility Stage |
| 7 | Kohala | 1,100 | Planning or Feasibility Stage |
| 8 | Changan-II | 9 | Planning or Feasibility Stage |
| 9 | Taobat | 10 | Planning or Feasibility Stage |
| 10 | Janawahi | 12 | Planning or Feasibility Stage |
| 11 | Mahl | 511 | Planning or Feasibility Stage |
| 12 | Harighel | 53 | Planning or Feasibility Stage |
| 13 | Abbasian | 360 | Planning or Feasibility Stage |
| | **Total** | **3,476** | |

**Exhibit 2.7: Locations, Capacities and Progress Status of Hydropower Projects in AJK being executed by PPIB**

### 2.3.2 Proposed Hydropower Projects up to 50 MW

According to the power policy of 2002, the GoAJK will manage hydropower development of projects with up to 50 MW capacities in the state. Public-sector projects will be executed by HEB while private-sector projects will be implemented by PPC.

**Hydro Electric Board (HEB)**

Public sector projects are implemented by HEB and it has so far completed eight projects with total installed capacity of 39.3 MW. Another 14 projects with a combined capacity of 280.72 MW are either under construction or in the feasibility-study stage. Exhibit 2.8 and Exhibit 2.9 list the hydropower projects and indicate their locations in AJK.

**Exhibit 2.8: List of Public-Sector Projects being executed by HEB in AJK**

| *No* | *Project* | *Installed Capacity (MW)* | *Project Status* |
|---|---|---|---|
| 1 | Patikka | 0.05 | Operational |
| 2 | Changan | 0.05 | Operational |
| 3 | Kel | 0.4 | Operational |
| 4 | Kathai | 1.6 | Operational |
| 5 | Leepa | 1.6 | Operational |
| 6 | Kundal Shahi | 2 | Operational |
| 7 | Sharian | 3.2 | Operational |
| 8 | Jagran – I | 30.4 | Operational |
| 9 | Halmat | 0.32 | Under Construction |
| 10 | Hillan | 0.6 | Under Construction |
| 11 | Dhanna | 1.5 | Under Construction |
| 12 | Hajira | 3 | Under Construction |
| 13 | Sharda | 3 | Under Construction |
| 14 | Rerah | 3.2 | Under Construction |
| 15 | Battar | 4.8 | Under Construction |
| 16 | Chamfall | 6.4 | Under Construction |
| 17 | Jhing - I | 14.4 | Under Construction |
| 18 | Jagran- II | 43.5 | Under Construction |
| 19 | Naghdar | 39 | Planning or Feasibility Stage |
| 20 | Doarian | 46 | Planning or Feasibility Stage |
| 21 | Shontar | 52 | Planning or Feasibility Stage |
| 22 | Luat | 63 | Planning or Feasibility Stage |
| | **Total** | **320.02** | |

## Exhibit 2.9: Locations, Capacities and Progress Status of Hydropower Projects in AJK being executed by HEB

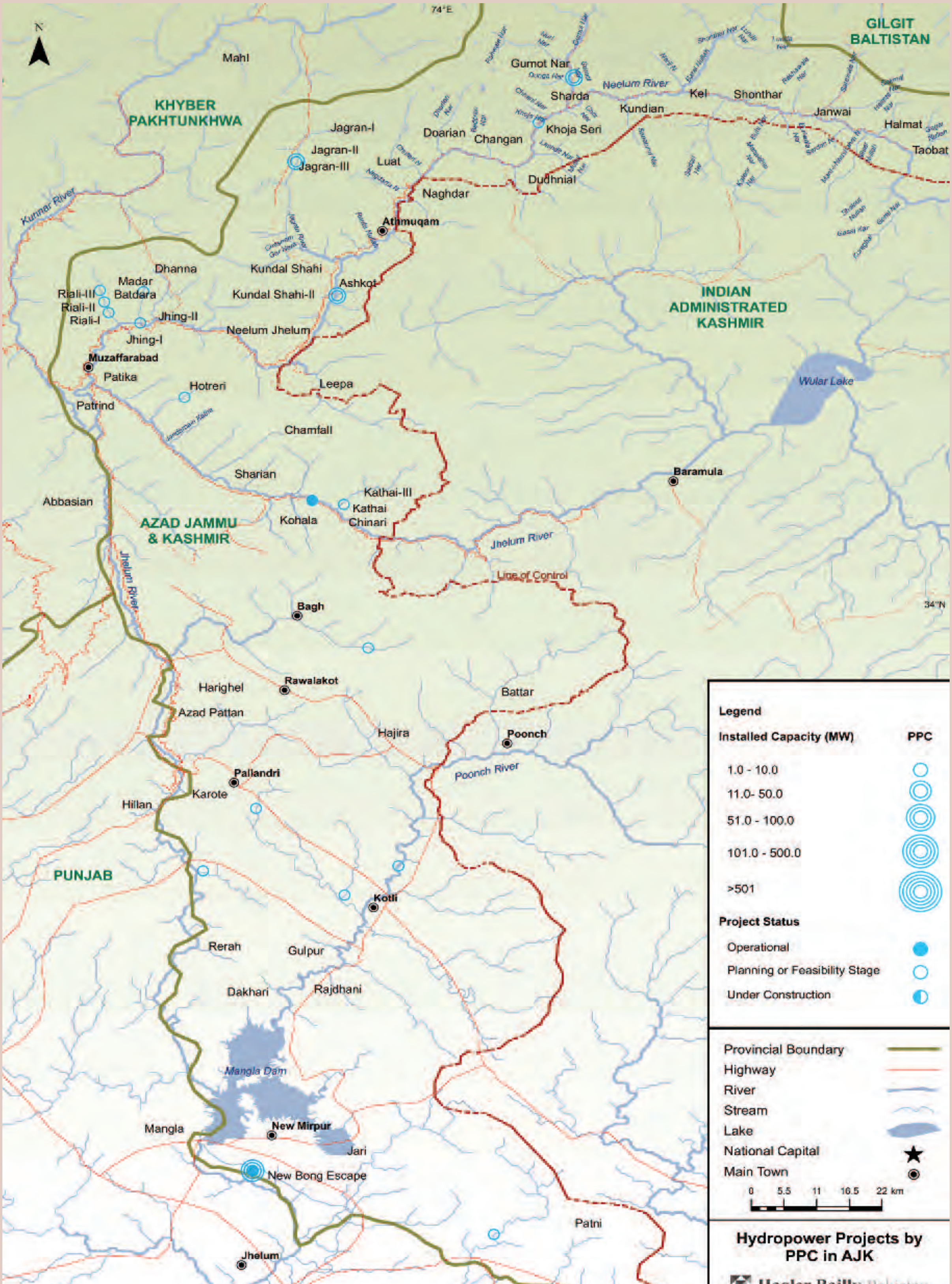
**Private Power Cell (PPC)**

Exhibit 2.10 lists the private-sector hydropower projects being executed by PPC. Among its accomplishments is Pakistan's first private-sector hydropower project, namely, the 84 MW New Bong Escape Hydropower Project on upper Jhelum canal. Two other projects are also operational with another 19 projects with a combined capacity of 205.8 MW being planned or in the feasibility stage. Exhibit 2.11 indicates the location, capacities and progress status of the hydropower projects.

**Exhibit 2.10: List of Private-Sector Projects being executed by PPC in AJK**

| *No* | *Project* | *Installed Capacity (MW)* | *Project Status* |
|---|---|---|---|
| 1 | New Bong Escape | 84 | Operational |
| 2 | Jari Kas | 1 | Operational |
| 3 | Chinari | 0.2 | Operational |
| 4 | Jari II | 2.5 | Planning or Feasibility Stage |
| 5 | Dakhari | 2.2 | Planning or Feasibility Stage |
| 6 | Kathai - III | 1 | Planning or Feasibility Stage |
| 7 | Hotreri | 5.4 | Planning or Feasibility Stage |
| 8 | Jhing - II | 4 | Planning or Feasibility Stage |
| 9 | Riali - III | 3.7 | Planning or Feasibility Stage |
| 10 | Riali-II | 4.9 | Planning or Feasibility Stage |
| 11 | Riali-I | 1.6 | Planning or Feasibility Stage |
| 12 | Ashkot | 40 | Planning or Feasibility Stage |
| 13 | Jagran-III | 35 | Planning or Feasibility Stage |
| 14 | Khoja Seri | 2 | Planning or Feasibility Stage |
| 15 | Kundian | 48 | Planning or Feasibility Stage |
| 16 | Madar Batdara | 10.2 | Planning or Feasibility Stage |
| 17 | Samani | 1.6 | Planning or Feasibility Stage |
| 18 | Sarhota | 1 | Planning or Feasibility Stage |
| 19 | Sarswah | 0.7 | Planning or Feasibility Stage |
| 20 | Pothi | 1 | Planning or Feasibility Stage |
| 21 | Barar | 1 | Planning or Feasibility Stage |
| 22 | Gumot Nar | 40 | Planning or Feasibility Stage |
| | **Total** | **291** | |

**Exhibit 2.11: Locations, Capacities and Progress Status of Hydropower Projects in AJK being executed by PPC**



### 2.4 The Hydropower Plan and the Focus of the SEA

The focus of this SEA is the hydropower development plan for AJK. Initial consultations with Government agencies led to the conclusion that no overall, coordinating strategic plan exists. The closest approximation to such a plan is the collection of individual project proposals of WAPDA, the PPIB, the HEB, and the PPC that were listed and described in Section 2.3. For the purposes of this pilot SEA, this combined collection of proposals is taken to be “the plan”.

As is generally understood, SEA can take one of two forms. It can be applied to a policy, plan, or programme (PPP), after the initiative in question has already been designed or even undertaken. This form of SEA is known as “ex post” or “after the fact”. When SEA is applied in this fashion, it is akin to the approach taken by environmental impact assessment (EIA), when it is applied to site–specific development projects. In its other conception, SEA can be applied as a method for incorporating environmental concerns or issues into the development of a PPP. In this “ex ante” or “before the fact” form, SEA influences the actual design of a PPP before it is completed and executed.

In this case study, the SEA took the form of an ex post assessment based on the collection of 62 existing or proposed projects that were listed in Exhibit 2.1.

### 2.5 The Hydropower Plan and the Focus of the SEA

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In this case study, the SEA took the form of an ex post assessment based on the collection of 62 existing or proposed projects that were listed in Exhibit 2.1.

### 2.6 Stakeholder Identification and Mapping

Section 2.3 provided an understanding of the intensity of proposed hydropower development in AJK. Building 62 dams in a relatively small area will likely affect the interests and livelihoods of many stakeholders. Phase 1 of the SEA undertook a detailed stakeholder analysis. The outcomes of that work are presented in full in the Phase 1 report.

#### 2.6.1 Stakeholder Analysis Methodology

The following methodology was adopted for identification and analysis of potential stakeholders in hydropower development in AJK:

- A web–based search was conducted to identify all the government departments, NGOs and civil society organizations that were considered relevant to hydropower development in AJK.
- A matrix was developed to measure the level of interest and influence of the stakeholders in hydropower planning and development in AJK, with the help of information available on the websites of these institutions.
- The scores from stakeholder influence and interest analyses were mapped.

**2.6.2 Outcomes of the Stakeholder Analysis**
A list of the identified stakeholders is provided in Exhibit 2.12. "Interest" and "influence" were determined by applying a questionnaire–based scoring system. The outcomes of this analysis are presented in Exhibit 2.13, where a simple x–y grid measures increasing levels of influence and interest as we move away from the bottom–left corner of the grid.

The top–right quadrant maps stakeholders deemed to be the most influential, interested, or affected by hydropower development in AJK. Stakeholders falling into this quadrant should be kept close during hydropower planning due to their mandates and objectives. Stakeholders positioned in the top–left quadrant are those with more influence but little interest in – or with little impact on them – from hydropower planning and development. These entities only need to be consulted on an ongoing basis.

Stakeholders positioned in the bottom–right quadrant are those with significant interest in the hydropower planning and development process, but hold almost no influence over it. These organizations should be consulted and kept informed of the planning and development process.

The bottom–left corner contains all of the remaining stakeholders that were included in the stakeholder mapping exercise. These entities have almost no influence in affecting hydropower planning and development in AJK and no interest in it either. These entities should be simply monitored for developing levels of interest and for collection of data from them if pertinent to the hydropower development process.

**Exhibit 2.12: List of Identified Institutional Stakeholders**

| *No* | *Institutional Stakeholder* | *Abbreviation* | *State* | *Type* |
|---|---|---|---|---|
| 1 | Environmental Protection Agency | AJKEPA | AJK | Government |
| 2 | Electricity Department | ED | AJK | Government |
| 3 | Planning Commission of Pakistan | PCP | Pakistan | Government |
| 4 | Local government and Rural Development Department | LG&RDD | AJK | Government |
| 5 | Forest Department | FD | AJK | Government |
| 6 | Wildlife and Fisheries Department | WFD | AJK | Government |
| 7 | Agriculture and Animal Husbandry Department | AAHD | AJK | Government |
| 8 | Planning and Development Department | AJKP&DD | AJK | Government |
| 9 | Ministry of Climate Change | MoCC | Pakistan | Government |
| 10 | National Electric Power Regulatory Authority | NEPRA | Pakistan | Government |
| 11 | Board of Revenue | BoR | AJK | Government |
| 12 | Environmental Protection Agency | Pak–EPA | Pakistan | Government |
| 13 | AJK University | UAJK | AJK | Academic |
| 14 | Mirpur University of Science and Technology | MUST | AJK | Academic |
| 15 | Industries, Commerce, Mineral Resources and Labour Department | ICML | AJK | Government |
| 16 | Health Department | HD | AJK | Government |
| 17 | Police Department | PD | AJK | Government |
| 18 | AJK Technical Education and Vocational Training Authority | AJKTEVTA | AJK | Government |
| 19 | Public Works Department | PWD | AJK | Government |
| 20 | Finance Department | FD | AJK | Government |
| 21 | Social Welfare and Women Affairs Department | SWWD | AJK | Government |
| 22 | Tourism and Archeology Department | TAD | AJK | Government |

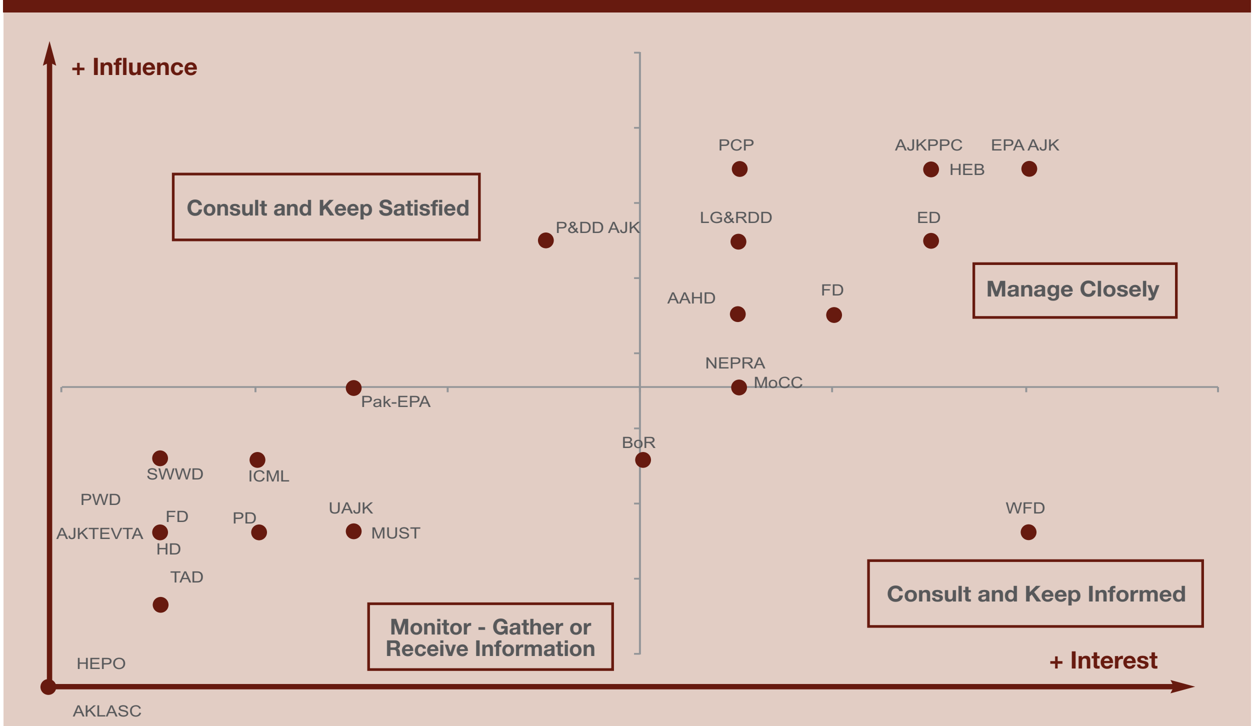
## 2.7 Establishing the Context: Conclusion

Both the exercise of mapping the plan and the identification of major institutional players, are necessary prerequisites for conducting an effective SEA of the hydropower plan in AJK, where recommendations will not be limited to addressing the physical environmental impacts of plan implementation, but will also cover institutional recommendations for improving the integration of environmental factors at the planning stage.

This section of the final report has summarized the work undertaken during Phase 1 of the SEA pilot. Two significant conclusions can be reached from this analysis. First, no overall hydropower plan exists for the State of AJK. In its place are sets of project proposals developed by four separate institutions … WAPDA, HEB, PPIB, and PPC. Phase 1 collated these sets of project proposals for the first time. When mapped, the 62 proposed hydropower projects make up a “de facto” hydropower plan for AJK. It is this collection of projects that the main body of the SEA pilot focuses on in Phase 2.

Second, the stakeholder analysis indicated that there are many groups and organizations with interests in how hydropower projects develop in the State. Some of these could significantly influence hydropower development, and so should be kept closely involved in all stages of planning, design, and construction.

**Exhibit 2.13: Stakeholders of AJK Hydropower Development Mapped According to Interest and Influence**



# 3. Phase 2: Cumulative Impacts of Hydropower Projects

## 3.1 Introduction

The purpose of SEA is to examine the environmental and social impacts that may emanate as a result of the introduction of a new policy, plan, or programme. Section 2 showed that the current hydropower plan may result in approximately 60 new HPPs being developed in AJK in the medium term. Depending on their size and siting, these projects may not necessarily result in significant adverse impacts when they are assessed individually. However, when looked at as a whole, their cumulative impact could be significant. Because we do not know exactly where each of the HPPs will be sited, nor are we sure of the specifics of their design, this SEA pilot focuses on the overall cumulative impacts that may result from implementation of the hydropower plan as a whole.

This section of the final report summarizes the work that was undertaken during Phase 2 of the SEA pilot study. The objective was to assist the AJK authorities to identify the scale, diversity, magnitude and complexity of the potential environmental and social impacts emanating from the development of the de facto Plan, and to identify the areas and river sections most sensitive to those impacts. Phase 2 also aimed to provide the authorities with a guide to help direct the focus of further detailed EIA studies that may need to be undertaken as part of the design of specific projects.

## 3.2 Cumulative Assessment Methodology

Exhibit 3.1 outlines the methodological approach taken in this study. In Step 1, we define and categorize the proposed HPPs as listed in Exhibit 2.1. We present this discussion in Section 3.3.1 of this report. In Step 2, we outline the structural design features of a selection of proposed HPPs of differing generation capacity. This information is presented in Section 3.3.2 and Section 3.3.3.

This background material allows us, in Step 3, to define the generic drivers of potential environmental and social impacts. Categorizing HPPs into different types based on the drivers of impacts helps identify the key issues that are to become the focus of the study and the recommendations that will result from it. The results of this exercise are shown in Section 3.3.4.

In Step 4 we begin to make the link between drivers and actual potential impacts by outlining the expected effects from HPPs of different generation capacities. We present this analysis in Section 3.3.5. In Step 5 we extend this analysis to examine the environmental and social risks associated with planned HPP development on specific stretches of rivers and streams (Section 3.3.6 and Section 3.3.7). Based on the geographical locations and potential cumulative impacts expected from hydropower development in AJK, river and stream sections are delineated into Cumulative Impact Zones. Based on the possible extent and severity of cumulative impacts, these zones are categorized into Moderately Critical, Highly Critical, or Extremely Critical.

With this background analysis in hand, in Step 6 we then carefully examine the environmental and social "baseline" conditions existing along the river and stream stretches that will likely see HPP development taking place.

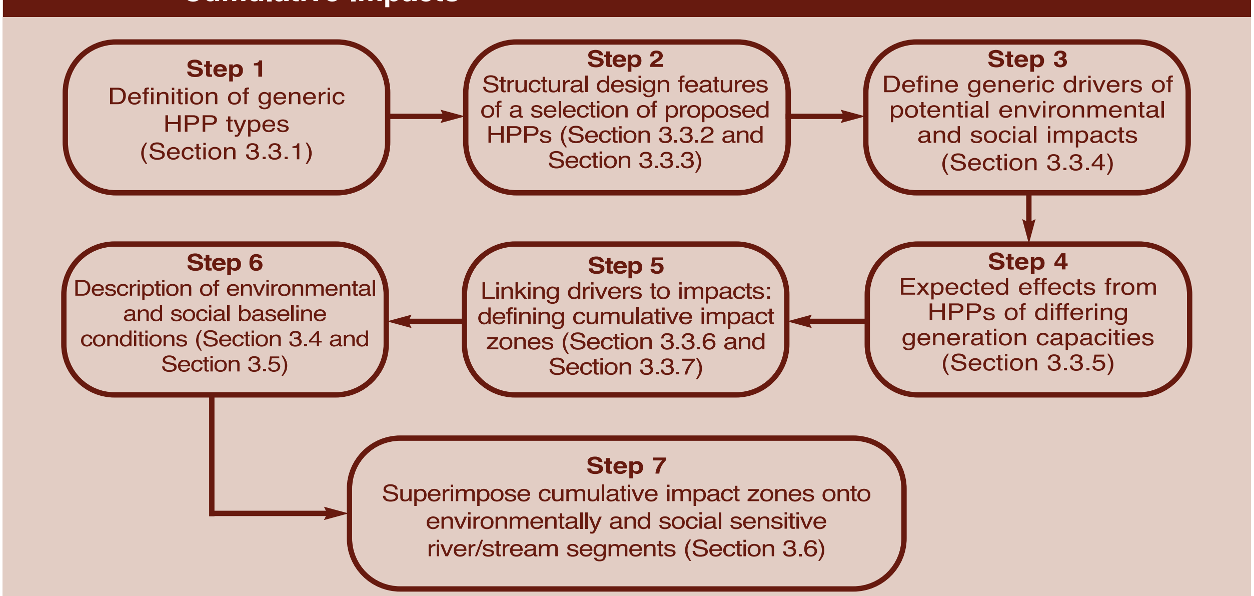
Section 3.4 describes the aquatic and terrestrial ecological resources of AJK as well as the regulatory and institutional framework that are in place for conserving these resources. Based on ecological contiguity, the rivers and streams of AJK are divided into nine zones. The ecological sensitivity of each river zone is assessed and discussed followed by a determination of the sensitivity of river sections to the development of HPPs. Section 3.5 presents the outcome of a similar analysis of socio–economic conditions. The socio–economic sensitivity of river/stream segments is determined and rated as Least, Moderate or Highly sensitive to HPP development.

Finally, in Step 7 (presented in Section 3.6 of the report), the Cumulative Impact Zones identified earlier are superimposed on the ecologically and socioeconomically sensitive segments of AJK identified in Section 3.4 and Section 3.5 respectively. This allows the HPPs contained in the hydropower development plan to be ranked according to their overall cumulative impact potential.

The ranking of an HPP will enable the proponents of the project, environmental consultants, state agencies and AJKEPA to identify, at a glance:

- the overall existing ecological and socioeconomic picture of the area where a HPP is being planned for development or currently in the process of being constructed and the regions where more detailed studies need to be prioritized;

**Exhibit 3.1: SEA Study Methodology: Connection between HPP Design, Drivers, and Cumulative Impacts**



- the scale of the impact an HPP will have on the ecology and socioeconomic condition of the area where it will be located;

- the contribution of each HPP to the overall impacts from the development of all the HPPs included in the Plan;

- the potential need for a change of qualifying conditions for either EIA or IEE studies for different HPPs and the level of detail in which the ecological and socioeconomic impact assessment studies need to be conducted for targeted projects;

- the role and significance of coordination between HEB, PPC, WAPDA, PPIB and AJKEPA in developing the hydropower plan in a manner which minimizes impacts;

- an opportunity for revising the Plan as a whole or revising the type, size, layout and structural components of a HPP to utilize any benefit from other HPPs being built in the vicinity; and,

- the regions in AJK where public awareness campaigns need to be organized by the government to help monitor HPPs during the construction and operation phase.

## 3.3 Categorizing Hydroelectric Power Projects and Defining Impact Drivers

This section of the report focuses on the characteristics of impacts emanating from proposed HPPs. It outlines the design features of different types of hydropower projects, and delineates the nature of likely construction activities. It then attempts to categorize impact drivers. Understanding the nature and scale of the drivers can help in the assessment of the severity and extent of different impacts.

Impacts that could arise from the development of the Plan will vary in severity and magnitude. After the categorization of the drivers of impacts, the section examines the indicators of environmental and social impacts of individual HPPs in general; identifies those relevant to the geographic, topographic and socioeconomic context of AJK; and categorizes them based on the likelihood of the impact arising, the magnitude of the effect, and the scale of mitigation and monitoring that will be required to control them.

The locations of the projects and their individual impacts then allow for different river zones to be identified based on the cluster of HPPs of different sizes within close geographic proximity. The zones help to indicate the regions in AJK that are environmentally and socioeconomically prone to the impacts of the development of the Plan and require greater intervention in the planning process.

The section concludes by focusing on the cumulative impacts of the HPPs.

### 3.3.1 Step 1: Categorizing Proposed HPPs

Exhibit 3.2 indicates the number of HPPs in different stages of development in AJK. Out of a total of 62 HPPs in the Plan, 12 are currently in operation; 13 are under construction, and the remaining 37 projects are in the planning or feasibility stage at the time of drafting this report. According to Exhibit 3.3, out of an estimated total installed capacity of 8,716 MW available from the Plan, 1,124 MW or 13 % of the available capacity is already online; 2,297 MW or 26 % is under construction; and 5,295 MW or 61 % of the remaining capacity is currently in the feasibility or planning stage.

In terms of installed capacities, the largest HPP is the online and operational 1,100 MW Mangla Dam, while the smallest HPP, currently in the planning phase, has a proposed installed capacity of 0.05 MW. To illustrate the spread of the HPPs in terms of their installed capacities, the following analysis splits them into four categories:

- less than 10 MW,

- between 10 and 20 MW,

- between 20 and 50 MW,

- between 50 and 200 MW, and,

- greater than 200 MW.

This breakdown serves to illustrate the variety of sizes of the HPPs in the Plan. According to Exhibit 3.4, the bulk of the HPPs—33 out of 62—are below 10 MW in size. Three projects are between 10 and 20 MW; eight are between 20 and 50 MW; another eight are between 50 and 200 MW; and the remaining 10 projects are between 200 and 1,100 MW.

Out of the 12 HPPs that are currently in operation, only one—the 1,100 MW Mangla Dam—has an installed capacity over 200 MW. Out of the 13 dams currently under construction only two; Kohala and Neelum–Jhelum, will have installed capacities over 200 MW. Only seven out of 37 HPPs currently in the planning stage have an installed capacity over 200 MW. 84 % of all the HPPs in the Plan, in all stages of development, are below 200 MW in size. These HPPs will provide only 1,174 MW out of 8,716 MW, or 13 %, of the total installed capacity planned for exploitation in the Plan. The remaining 16 % of HPPs will contribute 7,542 MW, or 87 %, of all the installed capacity available in the Plan. Exhibit 3.5 provides a summary.

According to the Constitution of Pakistan, the development of HPPs in AJK with an installed capacity greater than 50 MW is the responsibility of federal agencies such as the Private Power Infrastructure Board (PPIB) and Water and Power Development Authority (WAPDA). AJK's Hydroelectric Board (HEB) and Private Power Cell (PPC) are responsible for the development of HPPs with installed capacities less than 50 MW.

It is expected that the federal government, in an effort to overcome the issue of acute power shortage in the country, will prioritize the development of the large HPPs that make up 87 % of the total estimated hydropower potential in the Plan. Though these are only 10 in number—out of which only Mangla dam is currently in operation—the scale and extent of the environmental and social impacts of these HPPs will be much larger than those with installed capacities less than 200 MW. This will primarily be due to larger storage and/or diversion structures; greater extent and volume of river water diverted; and, the larger scale of construction activities involved. However, regardless of the agency responsible for developing the HPPs, the ambit for environmental protection in AJK falls under the sole responsibility of the Environmental Protection Agency of AJK (AJKEPA).

Impacts from smaller HPPs, less than 200 MW in size, should not be underestimated. Although they may only be responsible for 13 % of the total installed capacity of the Plan, there are 52 in total. Individually these may be considered to have little environmental and social impacts. A number of them concentrated on the same river systems within a limited geographical spread could, however, result in greater environmental and social impacts.

There is limited information available on the design of HPPs being planned in AJK, particularly with regards to the size and types of diversion and storage or pondage sections. However, interactions with AJKEPA officials have revealed that in principle there are no storage dams in the Plan, with Mangla being the only one of its type in the State.

All of the different types of HPPs with different installed capacities in the Plan will be run–of–river (RoR) projects. These make use of the potential of a natural river course, usually by diverting it from its original path and releasing it back in a section

**Exhibit 3.2: The Number of HPPs in AJK in Different Phases of Development**

| *HPPs in Different Phases of Development* | *Number of HPPs* |
|---|---|
| Operational | 12 (19 %) |
| Under Construction | 13 (21 %) |
| Planning or Feasibility Stage | 37 (60 %) |

**Exhibit 3.3: A Breakdown of the Plan in terms of Power Generating Capacities and Stage of Development of the Projects**

| *Size of HPP* | *Number of HPPs* | *Total Power Capacity (MW)* | *Total Power Capacity of HPPs in Operation1 (MW)* | *Total Power Capacity of HPPs Under Construction (MW)* | *Total Power Capacity of HPPs in the Planning or Feasibility Stage (MW)* |
|---|---|---|---|---|---|
| ≤ 10 MW | 33 | 85 | 10.1 (0.1 %) | 22.8 (0.3 %) | 51.6 (0.6 %) |
| 10 < MW ≤ 20 | 3 | 37 | 0.0 (0 %) | 14.4 (0.2 %) | 22.2 (0.3 %) |
| 20 < MW ≤ 50 | 8 | 322 | 30.4 (0.3 %) | 43.5 (0.5 %) | 248.0 (2.8 %) |
| 50 < MW ≤ 200 | 8 | 731 | 84.0 (1 %) | 147.0 (1.7 %) | 500.0 (5.7 %) |
| 200 < MW ≤ 1100 | 10 | 7542 | 1000.0 (11.5 %) | 2069.0 (23.7 %) | 4473.0 (51.3 %) |
| **Total** | **62** | **8716** | **1124.5 (13 %)** | **2296.7 (26 %)** | **5294.8 (61 %)** |

**Exhibit 3.4: Proportion of Different Sizes of HPPs in the Plan**

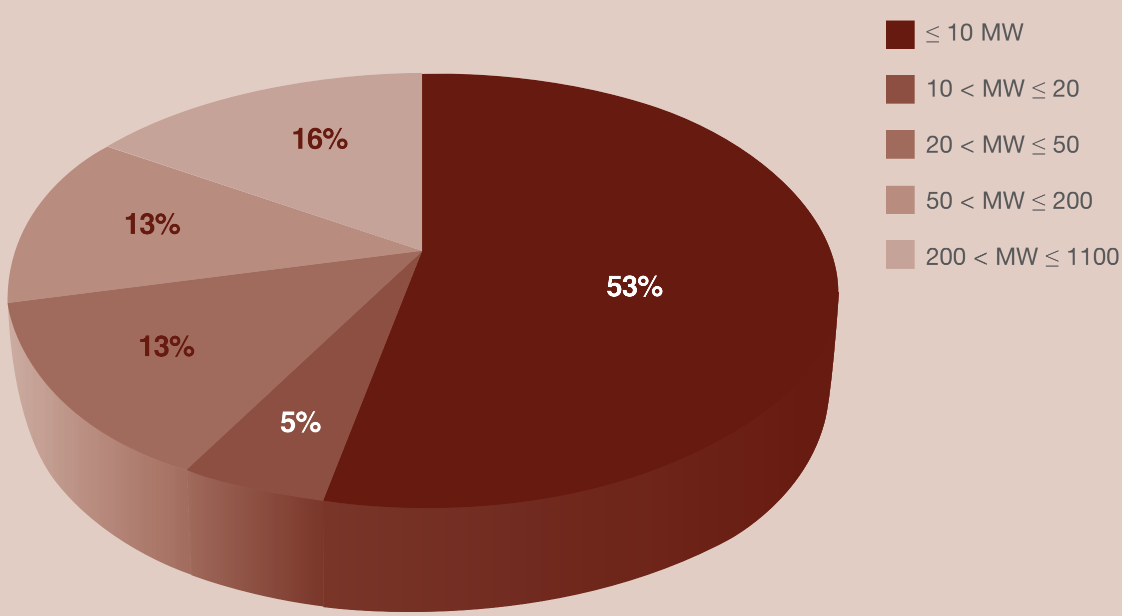



**Exhibit 3.5: A Comparison of HPPs in the AJK Hydropower Plan with an Installed Capacity of less than or greater than 200 MW**

| | | |
|---|---|---|
| Installed Capacity < 200 MW | 52 HPPs (84 %) | Total Installed Capacity = 1,174 MW (13 %) |
| Installed Capacity > 200 MW | 10 HPPs (16 %) | Total Installed Capacity = 7,542 MW (87 %) |

of the same or different river further downstream. Storage dams such as Mangla are different, because they store water to create an artificial head. However, in order to ensure that larger RoR projects run at their design capacities, different degrees of storage or pondage of water for short periods is required to shield the project from the natural daily, weekly and monthly fluctuations of river flow.

This implies a categorization of the environmental and social impacts of different RoRs based on their installed capacities. Investigations of the design of six RoR projects in AJK in different stages of development reveal that RoRs with installed capacities close to 100 MW and above have temporary water storage/pondage components and significant flow diversion volumes and extents as compared to smaller RoR projects. This will be discussed further in the next section.

**3.3.2 Step 2: Generic Design Features of HPPs**

HPPs currently in operation in AJK are based on either the conventional storage of water impounded by a dam; or utilize the potential in coursing rivers by building a diversion facility. The latter are often termed run–of–river (RoR) projects. Both harness the energy in flowing water to generate electricity. In RoR systems, running water is diverted from a river and guided down a channel, or penstock, which leads to a generating house. Here, the force of the moving water spins a turbine, which then drives a generator. Used water is fed back into the main river further downstream.

The difference between RoR and large, conventional storage HPPs is usually the absence of a dam or reservoir, and projects tend to be on a smaller scale. RoRs need to be built on a river with a consistent and steady flow. Most of the large RoR facilities do use a dam, or weir, to ensure enough water enters the penstock. Pondage is also used at some facilities to store small amounts of water. RoR plants with pondage tend to be more reliable, as they assuage the effects of daily and seasonal flow infrequencies.[12] The size of the dam and the volume of pondage, however, begin to skew the boundaries between the two project types and thereby complicate the discussion of relative environmental and social impacts.

Exhibit 3.6 illustrates the main components of a RoR project, which also contribute significantly to project construction costs.[13] The main structural features include:

- Intake weir – constructed to draw water from the river, thereby creating a small 'headpond' of water.

- Penstocks – these pipes deliver water from the headpond to the turbines in the power station downstream. They are normally placed at the bottom of the headpond, in order to maximize the intake of the water flow, and are typically 3–8 km long. Penstocks are made of different materials (from plastic to high quality steel) on different sections of the pipe, depending on the pressure and the economic viability. For example, in the final part of the penstocks where the steepest drop occurs, high quality steel is required because of the high pressure inside the pipe. Penstocks can make up around 50% of a project's cost.

- Powerhouse containing turbines and generators – these turbines and generators are the core of a project. Each turbine and generator is uniquely designed for the site, which is determined by the head[14], flow and volume of water of each site. They also need to be compatible. As technology improves, the turbines associated with RoR hydroelectricity generation are getting better in design and efficiency, leading to a reduction of overall maintenance costs. Turbines and generators will normally take up

12. Energy BC: Run of River Power. (2012). Retrieved October 8, 2013, from http://www.energybc.ca/
13. Chen, Y., & Hardman, R. (n.d.). The Renewable Hydro Electricity Market in British Columbia. Retrieved October 8, 2013, from Cleantech Magazine: http://www.cleantechinvestor.com/
14. Head is defined as the difference in the elevation of water at the penstock and the elevation of the turbine inlet located in the powerhouse.

to around 15% of a project's cost.

- Tailrace – a channel through which the diverted water is returned to its natural flow.

- Access roads – construction may be required depending on the existing infrastructure and remoteness of the project site. This sometimes can have a significant impact on the cost of developing a site.

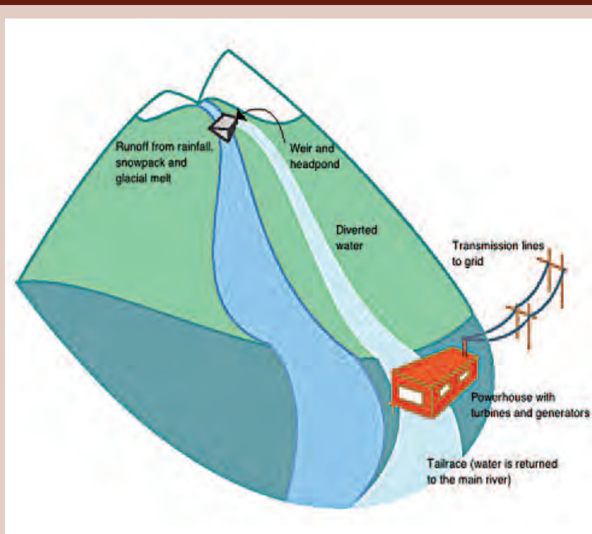
- Transmission lines – transmission lines from the powerhouse to the local transmission grid can have a significant impact on project costs. A remote site may require significant investment in transmission infrastructure to connect the project to the local grid. However, with strategic planning, this cost can be shared over several projects if several RoR projects are developed in close proximity.

HPPs that rely on the conventional storage of a body of water behind a dam wall to create an artificial head utilize one of three main types of dam design: embankment, gravity and arch dams. The selection of dam type is mainly according to dam–site topography and geology. Earth and rock embankments, which are usually the cheapest to build, make up more than 80 per cent of all large dams in the world. Embankments are generally built across broad valleys near sites where the large amounts of construction material required can be quarried. The Tarbela dam in Pakistan is the world's most voluminous dam containing 106 million cubic meters of earth and rock, more than 40 times the volume of the Great Pyramid.[15]

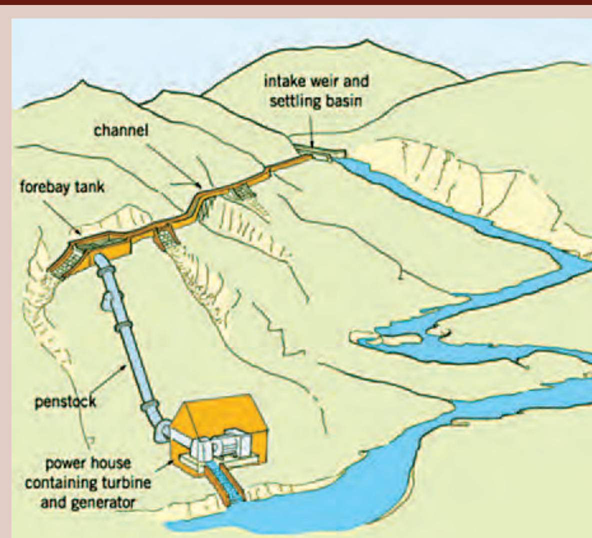
Gravity dams are thick, straight walls of concrete built across relatively narrow valleys with firm bedrock. Arch structures, also made from concrete, are limited to narrow canyons with strong rock walls and make up only around four per cent of large dams in the world. The inherent strength of the shape enables the thin wall of an arch dam to hold back a reservoir with only a fraction of the concrete needed for a gravity dam of similar height.[16]

Other than the main wall itself, spillways are used to discharge water from the reservoir. Dams built across broad plains may include long lengths of ancillary dams and dykes as is the case with Mangla dam which has a reservoir, a main embankment, and an intake embankment.

**Exhibit 3.6: The Layout of Run–of–River Projects with the Main Components Illustrated. (courtesy: Charlotte Helston, www.energybc.ca and Practical Action, www.sswm.info)**




Typical run–of–river scheme




Components of a run–of–river scheme.

15. McCully, P. (2001). Silenced Rivers: The Ecology and Politics of Large Dams. London: Zed Books.
16. Ibid.

### 3.3.3 Step 2: Specific Design Features of Proposed HPPs in AJK

This section summarizes the main features of different types of HPPs in AJK's hydropower development plan. A combination of time constraints and the difficulty in obtaining public records from government agencies limited the number of HPPs considered in this section to the following seven:

- 1.15 MW Kathai–III,
- 4.8 MW Rialli–II,
- 35 MW Nagdar,
- 40 MW Dowarian,
- 100 MW Gulpur,
- 900 MW Neelum–Jhelum, and,
- 1,100 MW Mangla.

Information for the Kathai, Rialli, Nagdar and Dowarian HPPs was extracted from Initial Environmental Examination (IEE) reports collected from AJKEPA. Information for Gulpur and Neelum–Jhelum HPPs was available in–house at HBP due to previous project experience with the two. Extensive information on Mangla is available on the internet.

Despite the paucity of information, an analysis of the structural features of the seven HPPs listed above—which cover a range of installed capacities from 1.15 MW to 1,100 MW— is sufficient in providing an accurate representation of the main structural features and components for HPPs of different sizes in the Plan.

Out of the seven, Mangla is the only HPP based on conventional storage of water behind a dam wall. The remaining six are all RoRs with different types and sizes of diversion structures; and, different extents of river sections and water volumes diverted. The next section describes their main features and Exhibit 3.7 illustrates their location.

***Kathai–III 1.15 MW***

The 1.15 MW Kathai–III is a RoR located on the Qazi Nag Nullah , a tributary of the Jhelum River.[17] A 166.74 m long inundation canal diverts river water through silt excluders into a 562 m long power channel. The channel ends into a forebay with a storage capacity of 328 m3. A 78 m long penstock with an outside diameter of 1.5 m takes the water into a Francis turbine (Exhibit 3.8) with a shaft power capacity of 385 kW. While the cost of the project is unknown, estimates from projects of similar sizes in the AJK shown in Exhibit 3.9 place the approximate costs in the range of Rs.300 million (US$ 2.8 million). Construction time is expected to be around three years.

17. The term 'nullah' describes a stream. The two words, stream and nullah, will be used interchangeably in this report.

## Exhibit 3.7: Locations of Kathai–III, Rialli–II, Nagdar, Dowarian, Gulpur, Neelum–Jhelum and Mangla HPPs in AJK

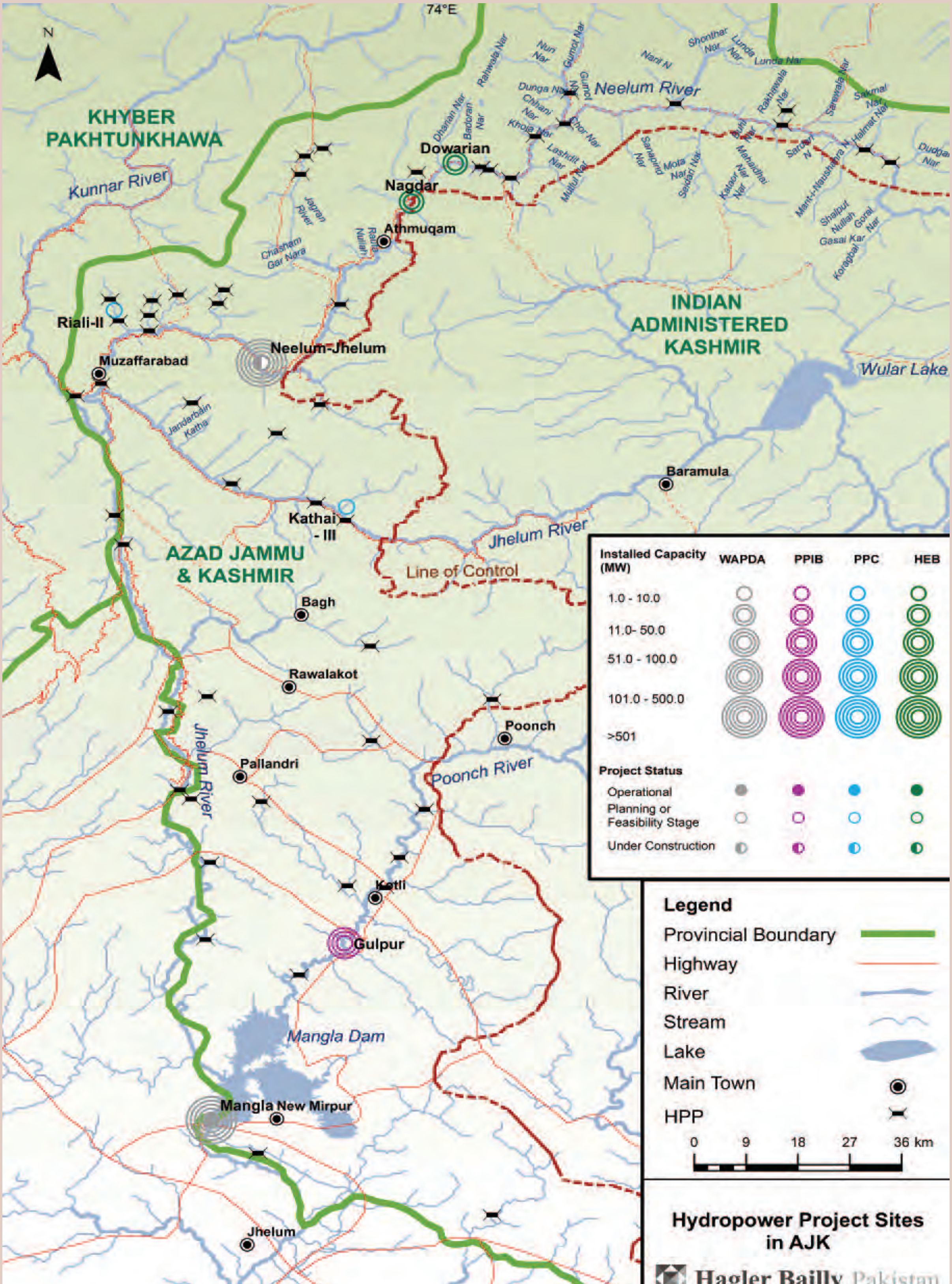


**Exhibit 3.8: A Francis Turbine. (courtesy: http://hydropower.shop.co)**

**Exhibit 3.9: Cost in Rs. Million of HPPs in AJK with Installed Capacities between 0.3 and 3.2 MW. (courtesy: http://electricity.ajk.gov.pk/)**

| | *HPP (MW)* | *Installed Capacity. (Rs. million)* | *Cost* |
|---|---|---|---|
| 1 | Sharian | 3.2 | 464.00 |
| 2 | Hillan | 0.600 | 68.00 |
| 3 | Rangar–I | 0.600 | 60.990 |
| 4 | Halmat | 0.32 | 52.00 |
| 5 | Ranger–II | 0.45 | 30.722 |
| 6 | Sharda | 3.0 | 359.900 |
| 7 | Qadirabad | 3.00 | 398.00 |
| 8 | Rehra | 3.20 | 344.00 |
| 9 | Battar | 4.8 | 760.403 |
| 10 | Dhannan | 1.7 | 297.456 |
| | **Total** | **20.87** | **2835.471** |

***Rialli–II 4.8 MW***

The 4.8 MW Rialli–II is a RoR located on the Ghoriwala Nullah which flows into the Neelum River. The main structural features include a 27 m long Tyrolean weir[18] (Exhibit 10 and Exhibit 3.11) built in the nullah which laterally diverts river flow into an approach channel with a 33 m long silt excluder. A settling basin is built in the channel to remove sand and silt from the water. The silt excluder provides a passage for sediments at the bottom of the water channel back into the river while the remaining water goes into a 4,000 m long power channel.

The power channel directs the water into a 40 m long forebay with a storage capacity of 1,415 m3. From the forebay, a 150 m high spillway takes the water into a 655 m long penstock where takes up the form of a single jet of water and ends by turning a Pelton Wheel turbine (Exhibit 3.12). The turbine has a capacity of 2,510 kW and can generate up to 3,300 V. While the cost of the project is unknown, estimates from projects of similar sizes in the AJK place the approximate costs in the range of Rs.500 million (US$ 4.7 million). It is expected to take approximately three years to construct.

**Exhibit 3.10: Man checking the grid at a Tyrolean Weir. Tanzania. (Photo: D. Bourman, Aqua for All, courtesy: www.akvopedia.org)**

**Exhibit 3.11: The Elements of the Intake Structure with a Tyrolean Weir (courtesy: www.nzdl.org)**

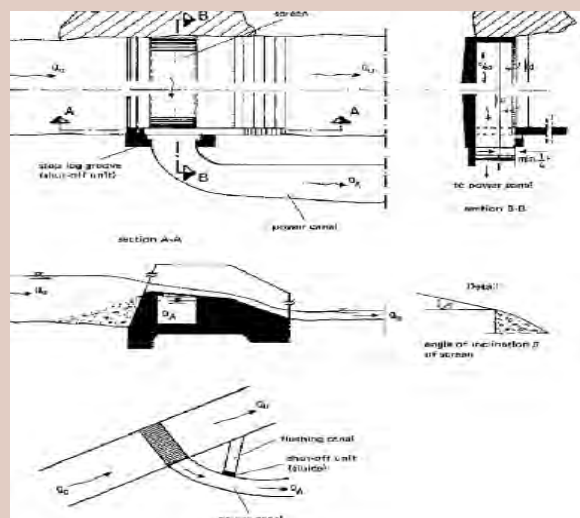
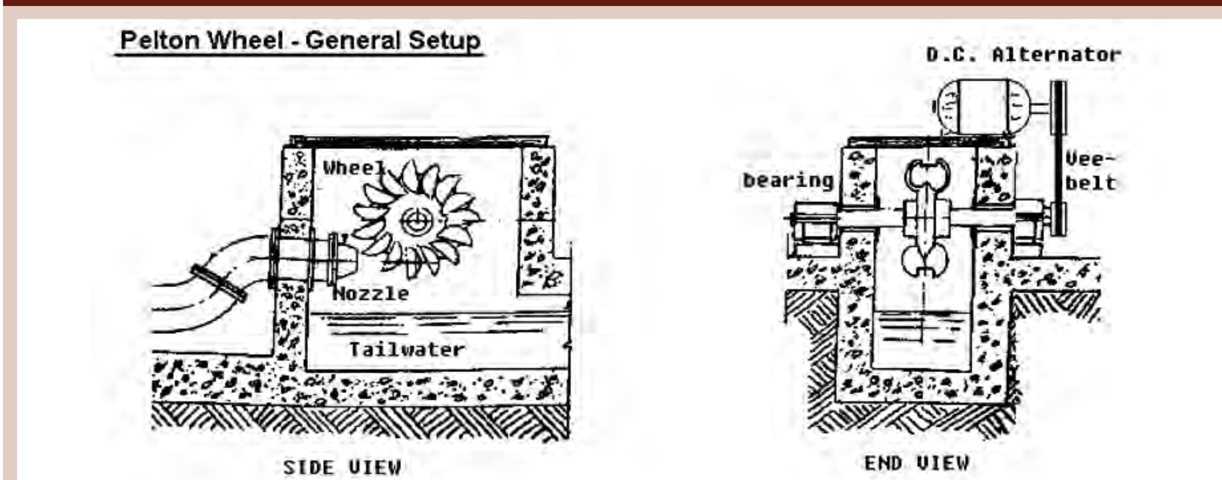


**Exhibit 3.12: General Setup of a Pelton Wheel. (courtesy: Ron Shannon http://permaculturewest.org.au/)**




18. A Tyrolean weir is a water inlet structure in which water is abstracted from the main flow through a screen over a gutter. The bars of the screen are laid in the direction of the current and inclined in the direction of the tail water so that coarse bed load is kept out of the collection canal and transported further downstream. The gutter is usually made of concrete and built into the river bed. From the gutter, water enters a pipeline, which drains into a sedimentation tank and then flows by gravity into the rest of the system. Tyrolean Weir. (2010, October). Retrieved August 8, 2013, from akvopedia: http://akvopedia.org/wiki/Tyrolean_weir and Lauterjung, H., & Schmidt, G. (1989). Planning of intake structures. Brauschweig: Friedr. Vieweg & Sohn.

***Nagdar 35 MW***

The 35 MW Nagdar is a RoR HPP planned on the perennial flows of the Nagdar Nullah, a right bank tributary of the Neelum River. The project layout utilizes a head of 470 m and a design discharge of 9 m3/s. A concrete weir with a height of 6 m above the nullah bed will divert water into a power intake with a gross intake area of 12 m2. A connecting channel between the weir and the power intake flows at a slope of 1 in 500 along the right side of the nullah. The open channel has a maximum capacity of 9 m3/s and a length of 40 m up to the silt excluder. Upon reaching the silt excluders, suspended particles with a diameter above 0.22 mm are discharged into two chambers each with a width of 4 m and a length of 54 m. Downstream of the excluder, water enters the power intake tunnel with an approximate length of 3,840 m from the inlet to the surge tank. The tunnel has a design capacity of 9 m3/s and acts as a low pressure tunnel. From the surge tank to the inlet of the turbine, pressure shaft of 2.1 m diameter would be excavated with a 420 m concrete lined vertical drop followed by a steel lined 260 m horizontal section. Water then enters a power house carrying 4 Pelton wheel turbines. The estimated cost of Nagdar is Rs. 6 billion (US$ 52 million). It is expected to take approximately four years to construct.

***Dowarian 40 MW***

The 40 MW Dowarian HPP is a RoR on the Dowarian nullah, a right bank tributary of the Neelum River. A concrete weir with a height of 8 m from the nullah bed and a length of 24 m across will divert water to a turbine through a head of 497 m. The weir directs water into a power intake with a gross area of 12.0 m2 at a maximum rate of 11.60 m3/s. Water then goes through a 158 m long connecting channel with a width of 2.8 m and a depth of 1.8 m. The connecting channel has a silt excluder which removes suspended particles with a diameter above 0.22 mm.

Water flowing out of the silt excluder then enters a 2,200 m long power tunnel with a design capacity of 9.6 m3/s. This tunnel ends at a surge tank which helps accommodate fluctuations in water levels and maintains the design water level in the headrace tunnel. Water from the surge tank ends up at the turbines through a 1,180 m long penstock with a diameter of 1.7 m and a design capacity of 9.60 m3/s. The penstock is placed as an embedded pipe laid over terraces of the Dowarian village with varying angles of 20 to 45°. Water finally enters a powerhouse hosting four Pelton turbines each with a capacity of 10 MW. The outflow from the powerhouse is discharged into the Neelum River through a 50 m tailrace channel. The estimated cost of Dowarian is Rs 4 billion[19] (US$ 40 million). It is expected to take approximately four years to construct.

***Gulpur 100 MW***

Gulpur HPP, with a 100 MW power generation capacity and annual generation capability of 465 gigawatt–hour (GWh), is also a RoR project. The project site is in the Kotli District of AJK and located about 5 km south of Kotli town on the Poonch River, a tributary of Jhelum River.

Unlike Kathai, Rialli, Nagdar and Dowarian RoRs which rely on diversion structures such as weirs and inundation canals, this project will require the construction of a 32 m dam on the Poonch River downstream of its confluence with Ban Nullah. The dam will create a reservoir with a volume of 21.9 million m3. The water from the reservoir will be diverted to a 3.1 km head race tunnel with a diameter of 7.75 m. The intake of the tunnel will be located in the Ban Nullah about 2 km upstream of the confluence of the Ban Nullah with the Poonch River. A powerhouse with three Francis turbines will be constructed on the left bank of Poonch River about 6 km downstream of the dam and then discharged back into the Poonch River. According to the feasibility study of the Gulpur project, the total expected cost is Rs. 17 billion[20]

19. Government of Azad Jammu and Kashmir. (n.d.). Development Projects. Retrieved October 5, 2013, from Electricity Department: http://electricity.ajk.gov.pk/
20. Staff Report. (2013, September 10). Agreement for 100 MW Gulpur Hydropower Project signed. Retrieved October 5, 2013, from Daily Times: http://www.dailytimes.com.pk/

(US$ 159 million). It is expected to take approximately three years to construct.

***Neelum–Jhelum 900 MW***

The 900 MW Neelum–Jhelum HPP will generate power by the water diverted from River Neelum through a tunnel to River Jhelum; hence, it is also a RoR project. Like Gulpur, this project also utilizes a dam wall as a diversion structure. However, this wall will be a 47 m tall and 125 m long gravity dam. It will withhold a reservoir with an 8,000,000m3 (6,486 acre·ft) capacity of which 2,800,000m3 (2,270 acre·ft) is peak storage. The dam at Nauseri diverts up to 280 m3/s (9,888 cu ft/s) of the Neelum southeast into a 28.5 km (18 mi) long head–race tunnel; the first 15.1 km (9 mi) of the head–race is two tunnels which later meet into one. The tunnel passes 380 m (1,247ft) below the Jhelum River and through its bend. At the terminus of the tunnel, the water reaches the surge chamber which contains a 341m (1,119ft) tall surge shaft and an 820 m (2,690ft) long surge tunnel. From the surge chamber, the water is split into four different penstocks which feed each of the four 242 MW Francis turbine–generators in the underground power house 22 km south of Muzaffarabad. After being used to generate electricity, the water is discharged southeast back into the Jhelum River through a 3.5 km (2 mi) long tail–race tunnel. The drop in elevation between the dam and power station afford an average hydraulic head of 420m (1,378 ft).[21] The estimated cost of the project is Rs. 307 billion[22] (US$ 2.89 billion). It is expected to take approximately eight years to construct.

**Exhibit 3.13: Gravity Dam of the Neelum–Jhelum HPP under Construction at Nauseri in AJK**

21. Water and Power Development Authority. (n.d.). Nhelum Jhelum Hydropower Project. Retrieved October 10, 2013, from http://www.wapda.gov.pk/
22. Yasin, A. (2011, November 2). PM displeased with delay in Neelum–Jhelum project. Retrieved November 5, 2013, from The News International: http://www.thenews.com.pk/

***Mangla 1,100 MW***

Mangla HPP was constructed between 1961 to 1967 across the Jhelum River, about 108 km southeast of Islamabad in Mirpur District of AJK. The Mangla Dam components include a reservoir, main embankment, intake embankment, main spillway, emergency spillway, intake structures, 5 tunnels and a power station. Besides the main dam, a dyke called Sukian – 17,000 feet in length, and a small dam called Jari Dam to block the Jari Nala, had to be constructed. There was a total of 120 x 106 cubic yards (cu yds) of excavation for the reservoir whereas the total fill amounted to 142 x 106 cu yds and concrete to 1.96 x 106 cu yds respectively. The main embankment is earthfill with clay as the core material. Gravel and A–type sandstone are applied on the shoulders. The maximum height of embankment above the core trench is 454 feet and the length is 8,400 feet. The intake embankment is earthfill type with B–type sandstone as the core material. Gravel is applied on the shoulders. The maximum height of intake embankment above the core trench is 262 feet and the length is 1,900 feet. The main spillway is a submerged orifice type with 9 radial gates, 36 x 40 feet each; it has a maximum capacity of 1.1 million cusecs. The emergency spillway is weir type with an erodible bund and a maximum capacity of 0.23 million cusecs. The 5 tunnels are steel and concrete lined and 1,560 feet long in bedrock. The internal diameter ranges between 26–31 feet. There are a total of 10 vertical Francis type turbines in the power house. Each of these turbines has an output of 13,800 bhp with a rated head of 295 feet of water. Mangla Dam was constructed at a cost of Rs. 6.6 billion[23] (US$ 1.4 billion). Mangla was constructed in six years.

Exhibit 3.14 summarizes the main features of different types of HPPs in AJK's hydropower development plan.

From the preceding section on the features of HPPs in AJK, the following general observations standout:

- The design of RoR projects is strongly defined by the installed power generating capacities of the projects.
- RoRs with lower design capacities are built taking into account the water flows of nullahs while larger RoRs are designed to utilize the larger river flow volumes provided by the main stem of rivers.
- The lower design capacities of smaller RoRs help make use of flow volumes of the nullahs regardless of the seasonal fluctuations. Larger RoRs, however, need to be shielded from daily, weekly, monthly and seasonal fluctuations of river flow in order to operate at design capacities.
- While smaller RoR projects do not store water, larger ones, on the other hand, utilize dam walls to store some volume of water to ensure consistency of flows into the penstock. However, the volumes stored by the larger RoRs do not compete in scale with the volumes stored behind conventional storage dams such as Mangla.
- Smaller RoRs rely only on diversion weirs and inundation canals to divert river water.
- Due to the difference in the types of diversion structures and the extent of diversion of water in terms of distance and volume, smaller RoRs do not have as extensive a construction area as that of larger RoRs.

### 3.3.4 Step 3: Defining Generic Drivers of Potential Environmental and Social Impacts

Construction activities associated with RoRs tend to be spread from the diversion facility site—such as weirs and dams—to the powerhouse. In the case of 40 MW Dowarian, the distance is 4.7 km. However, for the 900 MW Neelum–Jhelum, the span covers a distance of approximately 30 km. For conventional storage dams, the span of areas where construction activities take place is smaller, since all the power production components are located closer together.

Most of the sites where the HPPs are planned are remote locations with little or no existing infrastructure such as roads, residential buildings,

23. International Union for the Conservation of Nature Pakistan. (n.d.). Mangla Dam. Retrieved October 10, 2013, from www.cms.waterinfo.net.pk

**Exhibit 3.14: Main Features of HPPs with different Installed Capacities in AJK's Hydropower Development Plan**

| HPP | Installed Capacity | Location | Main Structural Features | Estimated Cost of Construction | Estimated Duration of Construction in years |
|---|---|---|---|---|---|
| Kathai–III | 1.15 MW | Qazi Nag Nullah, a tributary of the Jhelum River | • 166 m long inundation canal<br>• silt excluder<br>• 562 m long power channel<br>• forebay with a storage of 328 m3<br>• 78 m long penstock<br>• Francis Turbine with a shaft power of 385 KW | Rs.300 million (US$ 2.8 million) | 3 |
| Rialli–II | 4.8 MW | Ghoriwala Nullah, a tributary of the Neelum River | • 27 m long Tyrolean weir built in the nullah<br>• 33 m long silt excluder<br>• 4,000 m long power channel<br>• 40 m long forebay with a storage capacity of 1,415 m3<br>• 655 m long penstock<br>• Pelton Wheel with a capacity to generate 2,510 kW of power and generate voltage of 3,300 V | Rs.500 million (US$ 4.7 million) | 3 |
| Nagdar | 35 MW | Nagdar Nullah, a right bank tributary of the Neelum River | • head of 470 m and a design discharge of 9 m3/s<br>• concrete weir with a height of 6 m above the nullah bed<br>• power intake with a gross intake area of 12 m2<br>• 40 m long connecting channel<br>• a two–chamber silt excluder with a width of 4 m and a length of 54 m<br>• power tunnel with an approximate length of 3,840 m<br>• power house carrying 4 Pelton wheel turbines | Rs. 6 billion (US$ 52 million) | 4 |
| Dowarian | 40 MW | Dowarian Nullah, a right bank tributary of the Neelum River | • a concrete weir of 8 m height above the nullah bed,<br>• head from the weir to the turbine will be 497 m<br>• power intake with a gross area of 12.0 m2<br>• a 158 m long connecting channel with a maximum capacity of 11.60 m3/s with a 2.8 m width and 1.8 m water depth<br>• a two–chamber silt excluder<br>• 2,200 m long power tunnel which has a design capacity of 9.6 m3/s<br>• 1,180 m long penstock with a diameter of 1.7 m and a design capacity of 9.60 m3/s<br>• four Pelton turbines each with a capacity of 10 MW<br>• a 50 m tailrace channel | Rs 4 billion (US$ 40 million) | 4 |

| HPP | Installed Capacity | Location | Main Structural Features | Estimated Cost of Construction | Estimated Duration of Construction in years |
|---|---|---|---|---|---|
| Gulpur | 100 MW | Poonch River, a tributary of Jhelum River | • construction of a 32 m dam on the Poonch River<br>• 3.1 km head race tunnel with a diameter of 7.75 m<br>• 3 Francis Turbines | Rs. 17 billion (US$ 159 million) | 3 |
| Neelum–Jhelum | 900 MW | across the Neelum River | • average hydraulic head of 420 m<br>• 47 m tall and 125 m long gravity dam<br>• a pondage (reservoir) with a 8,000,000 m3<br>• diversion of up to 280 m3/s of the Neelum southeast into a 28.5 km (18 mi) long head–race tunnel<br>• surge chamber which with a 341 m (1,119 ft) tall surge shaft<br>• 820 m (2,690 ft) long surge tunnel<br>• four different penstocks which feed each of the four 242 MW Francis turbine–generators in the underground power house | Rs. 307 billion (US$ 2.89 billion) | 8 |
| Mangla | 1,100 MW | across the Jhelum River | • 3.5 km (2 mi) long tail–race tunnel<br>• a reservoir behind main earthfill embankment 454 feet and the length is 8,400 feet<br>• intake earthfill embankment, height 262 feet and the length is 1,900 feet<br>• main spillway, emergency spillway<br>• 5 tunnels<br>• 10 vertical Francis type turbines in the power house an output of 13,800 bhp with a rated head of 295 feet of water<br>• a dyke called Sukian – 17,000 feet in length, 144 feet and the length is 16,900 feet<br>• a small dam called Jari Dam 274 feet and the length is 6,800 feet | Rs. 6.587 billion (US$ 1.473 billion) | 6 years. |

markets or hospitals. Based on the main features of the different types of HPPs in the Plan summarized in Exhibit 3.14, HPP construction activities in the AJK will generally include:

- Site preparation activities such as clearing;
- Earthworks (dirt, debris pushing and grading);
- Construction of the intake systems;
- Construction of access roads, channel and pipelines;
- Construction of the powerhouse and installation of the turbine and generator;
- Construction of an electrical substation and transmission lines;
- Preparation and use of material and equipment lay down areas;
- Extraction and haulage of sand and aggregate for concrete ingredients from an appropriate borrow area near the site;
- Storage piles, quarry sites, crushing, concrete batching plants;
- Refueling stations with diesel storage tanks will also likely be used during construction;
- Vehicles, machinery and equipment, and movement of such on unpaved land;
- Combustion of fuel; and,
- Night time construction.

Workforce camps are likely to be established at weir and powerhouse sites which serve as project management staff camps during construction. Pre–construction activities will also include taking over of land and houses; the commencement of construction of the access road to diversion tunnel outlets; diversion tunnel portal excavations; weir and powerhouse access bridges and roads; and preparation of camp sites.

### 3.3.5 Step 4: The Link between HPP Generation Capacity and Driver Type

As discussed earlier, interactions with AJKEPA officials revealed that in principle there are no storage dams in the Plan. Mangla is the only conventional storage dam of its type in the State. Therefore, this section will focus on the drivers relevant to RoR projects.

Section 3.3.4 demonstrated that in AJK in general, RoRs as large as the 40 MW Dowarian do not use a dam wall and instead divert water through weirs or inundation channels. The 100 MW Gulpur however, uses a 32 m dam wall to divert water. The 900 MW Neelum–Jhelum also utilizes a 47 m high gravity wall to divert water away from the river. The type of diversion structure and the extent of diversion of water are major drivers of environmental impacts. The diversion and storage of river water can lead to serious water quality deterioration, destroy riparian ecosystems, reduce sediment and nutrient loads downriver, and flood extensive natural habitats. Livelihoods associated with river resources such as fishing are also affected and, as a result, have an impact on the socioeconomic condition of the people living close to the HPPs and the rivers.

The construction of an HPP involves many components such as the intake weir, power canal, tunnel, penstock, spillway, powerhouse, tailrace, residential colony and temporary labour camp. The activities associated with construction have their own environmental impacts such as the production of liquid effluents, gaseous emissions, particulate matter, solid wastes, and noise.

The environmental and social impacts of an HPP[24] cannot be deduced by size alone, even if increasing the physical size may increase the overall impacts of a specific HPP. Generally, the larger the HPP project in terms of size, the greater the drivers of the impacts. However, because each hydropower plant is uniquely designed to fit the specific characteristics of a given geographical site, the relationship between the magnitude of the drivers and the resulting magnitude of impacts is quite complex.

24. Egre, D., Milewski, J.C. (2002). The diversity of hydropower projects, Energy Policy, Vol. 30, No. 14, Nov. 2002, pp 1225–1230.

In most parts of the world, classification according to size has led to concepts such as 'small hydro' and 'large hydro', based on installed capacity measured in Mega–Watts (MW) as the defining criterion.[25] Small–scale hydropower plants (SHP) are more likely to be RoR facilities than are larger hydropower plants. However, there is no worldwide consensus on definitions regarding size categories.[26] Various countries or groups of countries define 'small hydro' differently. Some examples are given in Exhibit 3.15. This broad spectrum in definitions of size categories for hydropower may be motivated in some cases by national licensing rules to determine which authority is responsible for the process as in the case of AJK[27], or in other cases by the need to define eligibility for specific support schemes.[28] Regardless, it clearly illustrates that countries have different legal definitions of size categories that match their local energy and resource management needs. It is therefore not possible to categorize the planned AJK HPPs based on the size of their drivers, as this is not necessarily an accurate indicator of the nature and magnitude of resulting environmental and social impacts. However, it is generally accepted in the literature on hydropower that the larger the hydropower scheme, the greater the adverse effects on riverine wildlife, riverside communities and river ecology.[29]

In Pakistan, there is a demarcation of HPPs above and below 50 MW based on a very broad and general definition of expected environmental impacts from projects on either side of the dividing line. In 1997 the Pakistan EPA issued the Policy and Procedures for Filing, Review and Approval of Environmental Assessment. HPPs over 50 MW were included in Schedule A, and required the undertaking of full EIA before project approval. Those HPPs with generation capacities less than 50 MW were only required to produce initial environmental examinations (IEE)[30]. In 2000, after the devolution of powers in Pakistan, the AJK government promulgated the AJK Environmental Protection Act which follows the policy of 1997.

According to the policy, projects in Schedule A "are generally major projects and have the potential to affect a large number of people. They also include projects in environmentally sensitive areas. The impact of such projects may be irreversible and could lead to significant changes in land use and the social, physical and biological environment". Projects in Schedule B "include those where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. These are projects not generally located in environmentally sensitive areas or smaller proposals in sensitive areas".[31]

Hydropower comes in manifold project types and is a highly site–specific technology, where each project is a tailor–made outcome for a particular location within a given river basin to meet specific needs for energy and water management services. The criteria stated in the two schedules attempt to cover a variety of expected environmental impacts of projects from a broad range of industry sectors which include agriculture and livestock, energy, manufacturing and processing, and water supply and treatment. Therefore, they are not specific to HPPs and cannot be used as a basis for a classification criterion linking installed capacity to general properties common to all HPPs in the Plan above or below a certain MW limit.

25. Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.–M. Devernay, M. Freitas, D. Hall, A. Killingtveit, Z. Liu, 2011: Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs–Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
26. Egre, D., Milewski, J.C. (2002). The diversity of hydropower projects, Energy Policy, Vol. 30, No. 14, Nov. 2002, pp 1225–1230.
27. According to the Constitution of Pakistan, the development of HPPs in AJK with an installed capacity greater than 50 MW is the responsibility of federal agencies such as the Private Power Infrastructure Board (PPIB) and Water and Power Development Authority (WAPDA). AJK's Hydroelectric Board (HEB) and Private Power Cell (PPC) are responsible for the development of HPPs with installed capacities less than 50 MW.
28. Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.–M. Devernay, M. Freitas, D. Hall, A. Killingtveit, Z. Liu, 2011: Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs–Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
29. Williams, A., & Porter, S. (2006). Comparison of hydropower options for developing countries with regard to the environmental, social and economic aspects. Proceedings of the International Conference on Renewable Energy for Developing Countries.
30. Government of Pakistan. (November, 1997). Policy and Procedures for the Filing, Review and Approval of Environmental Assessment.
31. Ibid.

However, considering the major differences between RoRs in AJK up to 40 MW and those with an installed capacity of 100 MW and above, the 50 MW limit may be considered a useful benchmark in attempting some form of categorization of drivers of impacts suitable to the scope of this SEA.

The 50 MW benchmark is sufficient in fulfilling the objectives of this study, especially considering that 44 out of the 62 projects in the Plan are less than 50 MW in size; eight are between 50 MW and 200 MW; and, only the remaining 10 projects are spread over a range of sizes between 200 MW and 1,100 MW.

This report, therefore, will utilize the 50 MW benchmark to categorize the drivers of environmental and social impacts, based on a number of assumptions.

- It will be assumed that for HPPs in AJK less than 50 MW they:
  - have smaller design capacities for power generation and do not require river water stored behind a dam wall;
  - will rely only on diversion weirs and inundation canals which do not store any water;
  - will be built on nullahs and not on major river stems;
  - will divert water from the nullahs into either the same nullah downstream, or the main river; and,
  - will not have an extensive construction area, as the distance between the diversion point and powerhouse will be within 10 km.
- On the other hand, it will be assumed that for HPPs greater than 50 MW they:
  - have large design capacities for power generation and require a certain volume of river water stored behind a dam wall to shield them from seasonal fluctuations;
  - will rely on a dam wall for diversion and pondage of water;
  - will be built on major river stems;
  - will divert water from the one major river stem into a section of the same river further downstream or into another river; and,
  - will have an extensive construction area, as the distance between the diversion point and powerhouse will be greater than 10 km.

These assumptions are summarized in Exhibit 3.16, and the 50 MW capacity benchmark is mapped for all proposed HPPs in Exhibit 3.17.

**Exhibit 3.15: Small–scale hydropower by installed capacity (MW) as defined by various countries[32]**

| *Country* | *Small–scale hydro as defined by installed capacity (MW)* | *Reference Declaration* |
|---|---|---|
| Brazil | ≤30 | Brazil Government Law No. 9648, of May 27, 1998 |
| Canada | <50 | Natural Resources Canada, 2009: canmetenergy–canmetenergie.nrcan–rncan.gc.ca/eng/renewables/small_hydropower.html |
| China | ≤50 | Jinghe (2005); Wang (2010) |
| EU Linking Directive | ≤20 | EU Linking directive, Directive 2004/101/EC, article 11a, (6) |
| India | ≤25 | Ministry of New and Renewable Energy, 2010: www.mnre.gov.in/ |
| Norway | ≤10 | Norwegian Ministry of Petroleum and Energy. Facts 2008. Energy and Water Resources in Norway; p.27 |
| Sweden | ≤1.5 | European Small Hydro Association, 2010: www.esha.be/index.php?id=13 |
| USA | 5–100 | US National Hydropower Association. 2010 Report of State Renewable Portfolio Standard Programs (USRPS) |

32. Ibid.

### 3.3.6 Step 5: Linking Drivers to Impacts: Defining Cumulative Impact Zones

Through application of the 50 MW benchmark, Exhibit 3.17 provides an introduction to the idea that the magnitude of environmental and social impact drivers can be mapped, and that there may be cumulative impacts that should be taken into account when decisions are made about the implementation of the overall hydropower plan. This section of the report attempts to identify and rank river and stream sections according to their susceptibility to cumulative impacts.

***Key indicators of Environmental and Social Impacts of HPPs***

A Sustainable Development Working Paper[33] published by the Environmentally and Socially Sustainable Development Department of the World Bank in 2003 highlights indicators that can be applied when thinking about the environmental and social impacts of HPPs. This discussion relates to dams as well as RoRs.

*Reservoir surface area*

The area flooded by the reservoir is a strong proxy variable for many environmental and social impacts. A large reservoir surface area means that there will be loss of more natural habitat and wildlife and displacement of more people. Very big reservoirs are found normally in lowlands with resultant problems such as tropical diseases and aquatic weeds. They also usually impound large rivers putting many aquatic and fish species at risk.

*Water Retention Time in Reservoir*

Average water retention time in the reservoir during standard operational hours is very useful in estimating the scope of expected water quality problems. The shorter the retention time, the better environmental desirability of the project.

*Biomass Flooded*

Standard convention for calculating biomass flooded is in tons per hectare based on the percent cover of different vegetation types in the reservoir area. Dams should ideally minimize inundation of the forests which have very high biomass content. Flooding native forests also adds to release of greenhouse gases and threatens biodiversity.

*Length of River Impounded*

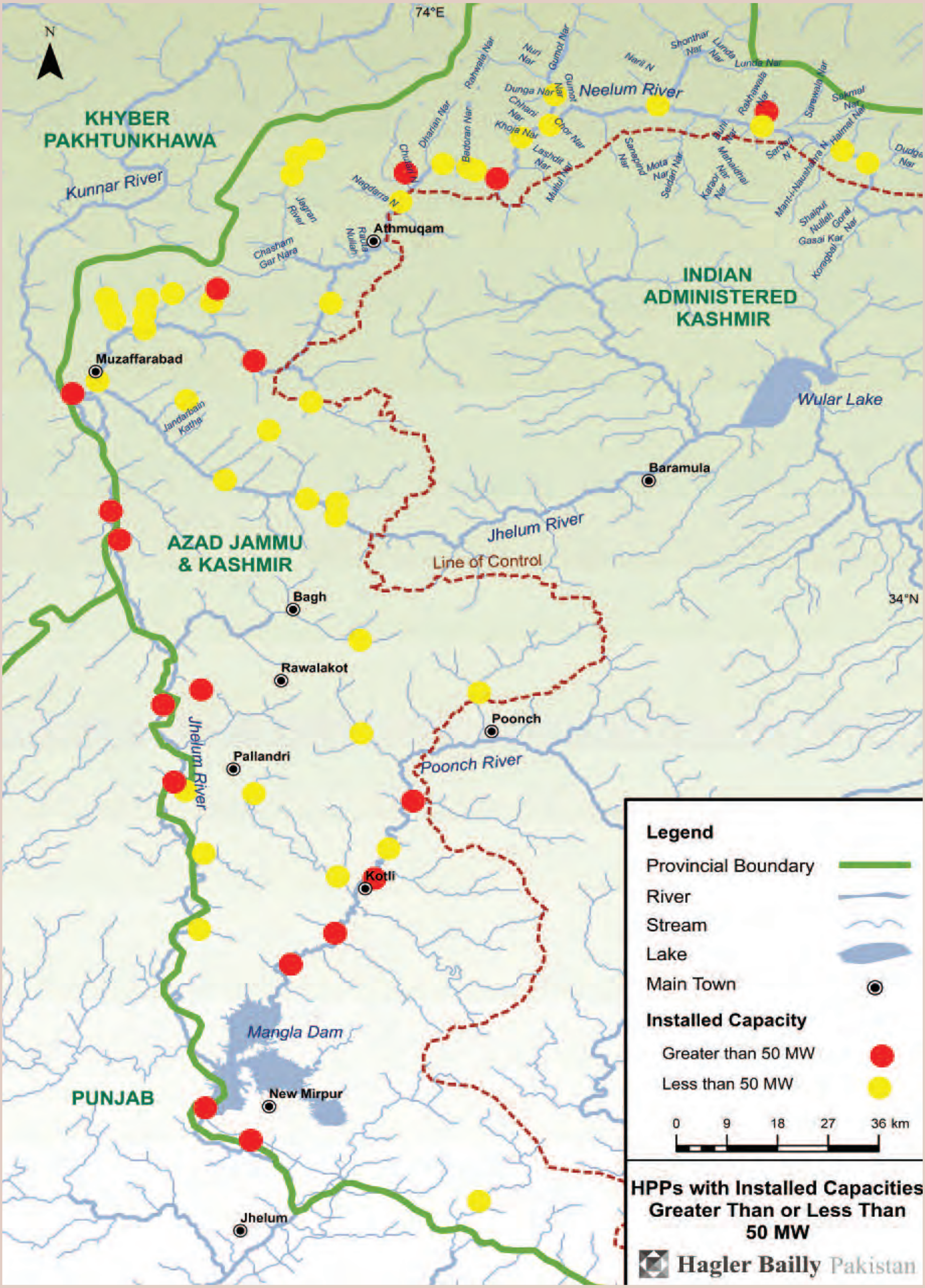
For the conservation of aquatic and riparian biodiversity including riverine forests, hydropower projects should aim to minimize the length of river (main stem plus the tributaries) impounded by the reservoir which is measured during high flow periods.

**Exhibit 3.16: Categorization of Drivers of Environmental and Social Impacts**

| *Categorization of Drivers of Environmental and Social Impacts* | |
|---|---|
| *Less than 50 MW* | *Greater than 50 MW* |
| • have smaller design capacities for power generation and do not require river water stored behind a dam wall.<br>• will rely only on diversion weirs and inundation canals which do not store any water.<br>• will be built on nullahs and not on major river stems.<br>• will divert water from the nullahs into either the same nullah downstream, or the main river.<br>• will not have an extensive construction area, as the distance between the diversion point and powerhouse will be within 10 km. | • have large design capacities for power generation and require a certain volume of river water stored behind a dam wall to shield it from seasonal fluctuations.<br>• will rely on a dam wall for diversion and pondage of water.<br>• will be built on major river stems.<br>• will divert water from the one major river stem into a section of the same river further downstream or into another river.<br>• will have an extensive construction area, as the distance between the diversion point and powerhouse will be greater than 10 km. |

33. Quintero, Juan David; Ledec, George. 2003. Good dams and bad dams: environmental criteria for site selection of hydroelectric projects. LCSES Sustainable Development working paper series ; no. 16. Washington D.C. – The Worldbank. http://documents.worldbank.org/curated/en/2003/11/5256830/good–dams–bad–dams–environmental–criteria–site–selection–hydroelectric–projects

## Exhibit 3.17: Comparison of Proposed HPPs against Installed Capacity Size of 50 MW



*Length of River Dried Out*

This indicator measures the length in kilometers of the river which is left dry (with less than 50 percent of dry season mean flow) below the dam or diversion weir as a result of water diversion. This value should be minimized due to the loss of fish and other aquatic life, damage to riparian ecosystems, and disruption of human water supplies and agricultural activities.

*Number of Downriver Tributaries*

This indicator relates to the number of major undammed tributaries downstream of the project site. A higher number of tributaries are desirable for maintaining accessible habitat for migratory fish, the natural flooding regime for riverine ecosystems, and nutrient or sediment inputs needed for the high biological activities of the estuaries.

Likelihood of Reservoir Stratification

Stratification in a reservoir takes place when the upper zone of the lake is thermally segmented from the deeper zone; the latter becoming stagnant and lacking in dissolved oxygen therefore making the region unsuitable for most aquatic life.

*Reservoir life*

Useful reservoir life is the number of years before the dead storage of a reservoir is completely filled, when further sedimentation decreases the live storage and inhibits power generation. Dead storage refers to the part of the reservoir water beneath the level of the intakes for the dam turbines; and the water above this intake is referred to as live storage. Useful reservoir life depends on dead storage and river borne sediment loads. This indicator is useful in determining relative sustainability of electric power generation. This indicator normally varies from less than ten years before dead storage is filled to potentially thousands of years. Reservoirs which are deep and situated on low–sediment–load rivers have the longest useful reservoir lives.

*Access Roads through Forests*

Where the risks of induced deforestation are high, project siting should minimize the kilometers of required new or upgraded access roads passing through or near natural forests.

*Human Resettlement*

Hydropower project location should ideally seek to minimize the number of people requiring resettlement from the land area affected by the reservoir and various civil works.

*Effect on Critical Natural Habitats*

The number of sites and hectares of critical natural habitats that are expected to be lost due to inundation, borrow pits or other components need to be assessed. Critical natural habitats such as officially proposed protected areas, as well as unprotected areas of known high importance for biodiversity conservation need to be taken into account. Some hydroelectric projects imply very important conservation opportunities by providing a strong justification (sediment reduction) and financial resources needed for protecting natural habitats in upper catchment areas.

*Fish Species Diversity and Endemism*

Fish species diversity is the number of species known from the project area, including the dam and reservoir site, as well as the downstream zone of project influence. Fish species endemism is the number of native species known only from the project area, or the river system where the project is located, and nowhere else on Earth. Dams are environmentally less objectionable if they affect rivers with a naturally low diversity and endemism of native fish species. In general, large, lowland rivers in warm (tropical or subtropical) climates have a high diversity of native fish and other aquatic organisms, while small rivers in cold (tropical highland or temperate) climates have relatively low diversity. Large, lowland rivers are also more likely to have significant seasonal fish migrations, which are effectively blocked by most dams. However, highland rivers and streams often have relatively high endemism in their fish fauna, especially if they are isolated from other rivers by waterfalls or other natural barriers. River segments with threatened fish species found nowhere else should be classified as critical natural habitats and, ideally, would receive permanent protection from dams or other potentially damaging civil works. However, dams and reservoirs in upper tributary rivers and streams need not threaten the survival of any endemic fish (ormollusks, or other aquatic life) if they affect only an insignificant portion of the river area used by these species. They should also be sited so as not to block important fish migrations.

*Cultural Property Affected*
An indication of the cultural significance of the area to be inundated (or otherwise affected by the project) is the number (by type) of cultural (archaeological, historical, paleontological, or religious) objects or sites. It is important to note whether each type of cultural property at the project site is salvageable (totally, partially, or not at all).

***Indicators Relevant to the AJK Hydropower Plan***
Based on the criteria and assumptions for categorizing drivers of impacts outlined in Section 3.3.5 and the geographic, topographic, hydrological and socioeconomic context of AJK, the following indicators are considered to be the most relevant in predicting the environmental and social impacts from the development of the Plan:

I. Length of river dried out.

II. Number of downriver tributaries.

III. Construction works and access roads through forests.

IV. Human resettlement.

V. Fish habitat, effect on critical natural habitats and fish species diversity and endemism.

VI. Reservoir size.

Exhibit 3.18 applies these indicators as criteria to compare the environmental and social impacts that might be expected from HPPs that are either below, or above, the 50 MW benchmark.

In the exhibit, the severity of possible impacts is categorized using a colour scheme. The categorizations are based on the likelihood of the impacts taking place, the magnitude of the effect and the scale of mitigation and monitoring that may be required. The description of the categories is as follows:

- Low (green):
  - Likelihood of impact occurring is low;
  - If it takes place, the severity and magnitude of the impact on riverine ecology is small; and,
  - There are minimal mitigation measures required and no long–term monitoring.

- Medium (yellow):
  - Likelihood of impact occurring is high;
  - The severity and magnitude of the impact on riverine ecology is high; and,
  - It will require some mitigation measures in the design of the HPP but no monitoring required.

- High (red):
  - Likelihood of impact occurring is high;
  - The severity and magnitude of the impact on riverine ecology and human settlements is high
  - Mitigation measures may include compensation and resettlement of locals and regular monitoring of project during its life.

**Exhibit 3.18: Potential Environmental and Social Impacts of the Hydropower Development Plan in AJK and the Expected difference in Severity of the Impacts between HPPs with Installed Capacities less than 50 MW and those greater than 50 MW**

| *Indicators of Environmental and Social Impacts* | *Potential Environmental and Social Impacts*[34] | *Expected difference in Severity of Environmental and Social Impacts in AJK from HPPs with Installed Capacities less than 50 MW and those greater than 50 MW* | |
|---|---|---|---|
| | | *Less than 50 MW* | *Greater than 50 MW* |
| I. Length of river dried out | • Serious water quality deterioration, due to the reduced oxygenation and dilution of pollutants by relatively stagnant reservoirs (compared to fast–flowing rivers). | • HPPs smaller than 50 MW will mostly have diversion weirs in the nullahs with no impoundment of water. Water is expected to continuously flow even when diverted. Water quality deterioration will however be a serious concern in the part of the river downstream of the diversion structure if all the water is diverted, especially in the dry winter season. However, in terms of scale, the length of river expected to be dried out by smaller HPPs is less than that diverted by larger HPPs. | • For HPPs greater than 50 MW there may be some form of damming involved with the impoundment of water. This can potentially result in serious water quality deterioration, due to the reduced oxygenation and dilution of pollutants by relatively stagnant reservoirs (compared to fast–flowing rivers), flooding of biomass (especially forests) and resulting underwater decay, and/or reservoir stratification (where deeper lake waters lack oxygen). |
| II. Number of downriver tributaries | • Major downriver hydrological changes can destroy riparian ecosystems dependent on periodic natural flooding, exacerbate water pollution during low flow periods, and increase saltwater intrusion near river mouths.<br>• Reduced sediment and nutrient loads downriver of dams can increase river–edge and coastal erosion and damage the biological and economic productivity of rivers and estuaries.<br>• Induced desiccation of rivers below dams (when the water is diverted to another portion of the river, or to a different river) kills fish and other fauna and flora dependent on the river; it can also damage agriculture and human water supplies. | • HPPs smaller than 50 MW will mostly be located on nullahs. The water from these nullahs will eventually reach the main stem of a river either directly or through other nullahs where flow is diverted. Generally, there are a larger number of downriver tributaries from water diversion points in nullahs than HPPs located in the larger main river stems. | • HPPs greater than 50 MW are expected to be built mostly on the main stem of rivers. Therefore, relative to smaller HPPs built on nullahs, they will have less downriver tributaries from the point where water is diverted or temporarily stored. This implies a lack of ecological ecosystem regulation that tributaries provide. Therefore, larger HPPs are expected to harm riparian ecosystems more than HPPs less than 50 MW in size. |
| III. Construction works and access roads through forests | • New access roads to hydroelectric dams can induce major land use changes—particularly deforestation—with resulting loss of biodiversity, accelerated erosion, and other environmental problems.<br>• Power transmission line rights–of–way often reduce and fragment forests; indirectly, they occasionally facilitate further deforestation by improving physical access. Large birds are sometimes killed in collisions with power lines, or by electrocution. Power lines can also be aesthetically objectionable.<br>• Quarries and borrow pits are used to provide material for construction of the dam and | • Due to the mountainous terrain in AJK, the lack of existing infrastructure, and the nature of HPPs, both types of projects; greater than 50 MW and less than 50 MW, are expected to have major road works through forest areas. Power transmission lines will be required for both types of projects and quarrying and borrow pits are expected for both. However, in relative terms, the magnitude of impacts for HPPs with an installed capacity less than 50 MW are expected to be less than for HPPs greater than 50 MW due to the smaller distances between diversion structures and the powerhouses. | • Due to the larger scale on which the projects are laid out, it expected that all impacts from the building of access roads, quarrying activities and borrow pits, transmission lines, will be more for larger projects. |

| *Indicators of Environmental and Social Impacts* | *Potential Environmental and Social Impacts*[34] | *Expected difference in Severity of Environmental and Social Impacts in AJK from HPPs with Installed Capacities less than 50 MW and those greater than 50 MW* | |
|---|---|---|---|
| | | *Less than 50 MW* | *Greater than 50 MW* |
| | complementary works. They can considerably increase the area of natural habitats or agricultural lands that are lost to a hydroelectric project.<br>• Cultural property, including archaeological, historical, paleontological, and religious sites and objects, can be inundated by reservoirs or destroyed by associated quarries, borrow pits, roads, or other works | | |
| IV. Human resettlement | • Involuntary displacement of people is often the main adverse social impact of HPPs.<br>• It can also have important environmental implications such as with the conversion of natural habitats to accommodate resettled rural populations. | • There are no human resettlements expected with these HPPs as they do not require the impoundment of water creating reservoirs.<br>• Construction works and plant sites may, however, require some resettlement. These, however, will be smaller in scale than for larger HPPs. | • Even if there is impoundment of water and reservoirs created, the volume will not be so large as to contribute to human resettlement.<br>• Human resettlements may, however, be triggered in some villages which are affected by the larger scale of construction works covering extensive areas, characteristic of HPPs larger than 50 MW. |
| V. Fish habitat, Effect on critical natural habitats and fish species diversity and endemism | • HPPs often have major effects on fish and other aquatic life. Reservoirs positively affect certain fish species (and fisheries) by increasing the area of available aquatic habitat. However, the net impacts are often negative because (a) the dam blocks upriver fish migrations, while downriver passage through turbines or over spillways is often unsuccessful; (b) many river adapted fish and other aquatic species cannot survive in artificial lakes; (c) changes in downriver flow patterns adversely affect many species, and (d) water quality deterioration in or below reservoirs (usually low oxygen levels sometimes gas super–saturation) kills fish and damages aquatic habitats. Fresh water molluscs, crustaceans, and other benthic organisms are even more sensitive to these changes than most fish species, due to their limited mobility. | • The diversion structures will affect fish in the nullahs by blocking upriver fish migrations and downriver passages.<br>• The fish will become more susceptible especially in the dry season when flows in the river are low. This will also impact downriver aquatic habitats which are dependent on the flow from upstream. | • All of the negative impacts on riverine ecology associated with reservoir and diversion structures and the diversion of river water will also apply to the larger projects. However, the scale and magnitude of the impact will be larger due to the scale and size of diversion.<br>• There is however, an opportunity with the larger reservoirs for fish farming which may not be available in the smaller projects. |

| *Indicators of Environmental and Social Impacts* | *Potential Environmental and Social Impacts*[34] | *Expected difference in Severity of Environmental and Social Impacts in AJK from HPPs with Installed Capacities less than 50 MW and those greater than 50 MW* | |
|---|---|---|---|
| | | *Less than 50 MW* | *Greater than 50 MW* |
| VI. Reservoir size | • Flooding of biomass (especially forests) and resulting underwater decay, and/or reservoir stratification (where deeper lake waters lack oxygen).<br>• Some reservoirs permanently flood extensive natural habitats, with local and even global extinctions of animal and plant species. Particularly hard–hit are riverine forests and other riparian eco systems, which naturally occur only along rivers and streams.<br>• The loss of terrestrial wildlife to drowning during reservoir filling is an inherent consequence of the flooding of terrestrial natural habitats. Some infectious diseases can spread around hydroelectric reservoirs, particularly in warm climates and densely populated areas. Some diseases (such as malaria and schistosomiasis) are borne by water–dependent disease vectors (mosquitoes and aquatic snails); others (such as dysentery, cholera, and hepatitis A) are spread by contaminated water, which frequently becomes worse in stagnant reservoirs than it was in fast–flowing rivers.<br>• Floating aquatic vegetation can rapidly proliferate in eutrophic reservoirs causing problems such as (a) degraded habitat for most species of fish and other aquatic life, (b) improved breeding grounds for mosquitoes and other nuisance species and disease vectors, (c) impeded navigation and swimming, (d) clogging of electro–mechanical equipment at dams, and (e) increased water loss from some reservoirs.<br>• Greenhouse gases (carbon dioxide and methane) are released into the atmosphere from reservoirs that flood forests and other biomass, either slowly (as flooded organic matter decomposes) or rapidly (if the forest is cut and burned before reservoir filling)<br>• Over time, live storage and power generation are reduced by reservoir sedimentation, such that much of some projects' hydroelectric energy might not be renewable over the long term | • It will be unlikely that there will be any reservoirs in these projects. | • Reservoir sizes may be large and may risk flooding parts of riverine forests along the rivers.<br>• The problems associated with longer water retention times may be relevant for larger RoR projects. |

34. Quintero, Juan David; Ledec, George. 2003. Good dams and bad dams: environmental criteria for site selection of hydroelectric projects. LCSES Sustainable Development working paper series ; no. 16. Washington D.C. – The Worldbank. http://documents.worldbank.org/curated/en/2003/11/5256830/good–dams–bad–dams–environmental–criteria–site–selection–hydroelectric–projects

### 3.3.7 Step 5: Potential Cumulative Environmental and Social Impacts from AJK's Hydropower Development Plan

In previous sections, both the drivers of the environmental and social impacts, and the impacts themselves have been analyzed, taking into account individual HPPs of different sizes. However, aquatic biodiversity in rivers does not exist in isolation in different stretches of rivers, but as an integrated process across the basin. When the process is disrupted by a diversion structure such as a dam, weir, canal or tunnel, it has basin–wide impacts. The development of a number of HPPs on the same river basins and systems will result in cumulative environmental and social impacts. One large–scale hydropower project of 2,000 MW located in a remote area of one river basin might have fewer negative impacts than the cumulative impacts of 400 5 MW hydropower projects in many river basins.[35]

In the context of hydropower development, cumulative impacts can result from (i) multiple actions at a given site associated with a single project, or (ii) can be additive or synergistic[36] in nature when potential impacts of multiple dams are taken into account and are concentrated in time or space, for example, the impacts of a series of small dams constructed on a single stream or on streams within a single river basin.[37] Such impacts may occur when the affected system is being perturbed repeatedly and increasingly by the same local agent with sufficient frequency so that it does not have time to recover between events (time–crowding), or the affected system is being perturbed by several similar activities or different activities having similar effects, in an area too small to assimilate the combined impacts (space–crowding).[38]

A strong correlation exists between stream flow and a river's physico–chemical characteristics such as water temperature and habitat diversity. Changes in flow volume and patterns can adversely impact the structure, distribution and composition of fish communities in the region. Dams, or any construction across rivers, are always a barrier for fish which move from one part of stream or river to another as part of their life cycle processes. Changes in the sedimentation flows due to dam or barrier construction, especially in Himalayan rivers, are expected to have an adverse impact on fish habitats. Even a few centimeters of sediment layer over the natural substrata is enough to affect the foraging and spawning fish negatively. Changes in the abundance of fish species found in AJK rivers may affect income generated by locals from commercial fishing activities and from tourists attracted by game–fishing in the State.

In this section, different cumulative impacts are discussed based on the different drivers of impacts of HPPs in the Plan and the nature and magnitude of the impacts. In the process, river sections which are most vulnerable to cumulative impacts will be identified as impact zones and will then be superimposed on the environmentally and socially sensitive river sections of AJK to be identified in Section 3.3.8 and Section 3.3.9.

Exhibit 3.19 describes the mechanics of how cumulative impacts from the construction and operation of HPPs may affect different environmental and social components. Potentially affected components include the following:

- Habitats and Wildlife
  - Flora species
  - Fish species
  - Amphibians
  - Reptiles
  - Birds
  - Mammals

35. Egre, D., Milewski, J.C. (2002). The diversity of hydropower projects, Energy Policy, Vol. 30, No. 14, Nov. 2002, pp 1225–1230. Synergistic or interactive effects are generally the result of interactions between effects of two or more projects that result in combined effects that are greater than the sum of the individual project's effects and typically more complex and difficult to assess than additive effects.
36. Arikan, Esra; Dieterle, Gerhard; Bouzaher, Aziz; Ceribasi, Ibrahim Haluk; Kaya, Dundar Emre; Nishimura, Shinya; Karamullaoglu, Ulker; Kahraman, Bilgen. 2012. Sample guidelines : cumulative environmental impact assessment for hydropower projects in Turkey. Washington DC ; World Bank. http://documents.worldbank.org/curated/en/2012/12/17671936/sample–guidelines–cumulative–environmental–impact–assessment–hydropower–projects–turkey
37. Rajvanshi, Asha; Roshni Arora; Vinod B. Mathur; K. Sivakumar; S. Sathyakumar; G.S. Rawat; J.A. Johnson; K. Ramesh; NandKishor Dimri and Ajay Maletha (2012) Assessment of Cumulative Impacts of Hydroelectric Projects on Aquatic and Terrestrial Biodiversity in Alaknanda and Bhagirathi Basins, Uttarakhand. Wildlife Institute of India, Technical Report. Pp 203 plus Appendices.
38. Ibid.

- Water
  - Public water users
  - Aquatic environment
  - Downstream riverbed

- Sedimentation
  - Riverbed substratum
  - Foraging and spawning areas for fish species
  - Environmental cues.

- Ways of Life, Territorial Organization, Land Use, Protected Areas, Economics
  - Closest residential area/receptor
  - Terrestrial environment
  - Agriculture
  - Grazing
  - Forest
  - National parks
  - Wildlife preservation and development areas
  - Wetlands
  - Cultural heritage sites
  - Mining
  - Fishery
  - Tourism

**Exhibit 3.19: Mechanics of Cumulative Impacts from Hydropower Projects** [39 40]

| *Cumulative Impact Sectors* | *Impact Components* | *Mechanics of Cumulative Impacts* |
|---|---|---|
| Habitats and Wildlife | • Flora species<br>• Fish species<br>• Amphibians<br>• Reptiles<br>• Birds<br>• Mammals | • Cumulative impact on aquatic flora and fauna across the basin<br>• Changes in the hydrological regime. A strong correlation exists between stream flow and a river's physico–chemical characteristics such as water temperature and habitat diversity. Research on the distributional ecology of fishes suggests that fish assemblages form in response to the physico–chemical factors of the environment.<br>• Change in the assemblage structure of stream fishes or species composition is imposed by temporal variation in stream flow, which ultimately affects the entire biodiversity of the river ecosystem.<br>• Changes in the sediment flow<br>• Changes in the quality of water<br>• Interruption in the migratory routes<br>• Interference in strategic biodiversity environment<br>• HPPs with dams and diversion structures effect the nutrient flow either for longer or for a shorter period depending upon structure. Submerged rivers act as nutrient traps. Changes in the nutrient flow would adversely affect the downstream fishes and other aquatic biodiversity.<br>• Cumulative impact on terrestrial flora and fauna across the basin due to multiple projects<br>• Cumulative impact of deforestation due to various projects<br>• Loss, fragmentation or isolation of habitats<br>• Interference or pressure over protected sites<br>• Pressure over endangered species |

39. Arikan, Esra; Dieterle, Gerhard; Bouzaher, Aziz; Ceribasi, Ibrahim Haluk; Kaya, Dundar Emre; Nishimura, Shinya; Karamullaoglu, Ulker; Kahraman, Bilgen. 2012. Sample guidelines: cumulative environmental impact assessment for hydropower projects in Turkey. Washington DC; World Bank. http://documents.worldbank.org/curated/en/2012/12/17671936/sample–guidelines–cumulative–environmental–impact–assessment–hydropower–projects–turkey
40. Rajvanshi, Asha; Roshni Arora; Vinod B. Mathur; K. Sivakumar; S. Sathyakumar; G.S. Rawat; J.A. Johnson; K. Ramesh; NandKishor Dimri and Ajay Maletha (2012) Assessment of Cumulative Impacts of Hydroelectric Projects on Aquatic and Terrestrial Biodiversity in Alaknanda and Bhagirathi Basins, Uttarakhand. Wildlife Institute of India, Technical Report. Pp 203 plus Appendices.

| *Cumulative Impact Sectors* | *Impact Components* | *Mechanics of Cumulative Impacts* |
|---|---|---|
| Water | • Public water users<br>• Aquatic environment<br>• Downstream riverbed | • Impact of differential water flow downstream from power house in dry season months, with sudden release of heavy flows during peaking/ power generation hours and no releases during other times.<br>• Opportunity for the multiple uses of water<br>• Cumulative impact on hydrological flows, at various points within project, at various points within a day, season, year, over the years and cumulatively across the basin and impacts thereof.<br>• This will include impacts on various hydrological elements including springs, tributaries, groundwater aquifers and thus access to drinking water and irrigation |
| Sedimentation | • Riverbed substratum<br>• Foraging and spawning areas for fish species<br>• Environmental cues. | • Changes in sedimentation at various points within project, at various points within a day, season, year, over the years and cumulatively across the basin and impacts thereof.<br>• Release of silt free water into the river downstream from the power house and impact thereof on the geomorphology, erosion, stability of structures.<br>• Release of silt laden water into the river channel downstream from the dam, and its accumulation across the dry season. |
| Ways of Life<br>Territorial Organization<br>Land Use<br>Protected Areas<br>Economics | • Closest residential area/receptor<br>• Terrestrial environment<br>• Agriculture<br>• Grazing<br>• Forest<br>• National parks<br>• Wildlife preservation and development areas<br>• Wetlands<br>• Cultural heritage sites<br>• Mining<br>• Fishery<br>• Tourism | • Cumulative impact of all the project components (dam, tunnels, blasting, power house, muck dumping, mining, road building, township building, deforestation, transmission lines, etc)<br>• Cumulative impact of mining of various materials required for the projects (sand, boulders, coarse and fine granules, etc.)<br>• Cumulative impact of blasting of tunnels on various aspects<br>• Cumulative impact of muck dumping into rivers.<br>• Road Infrastructure Improvements.<br>• Pressure over the ways of life due to people attracted to the area of the project<br>• Changes in the way of life of people depending of the river environmental services<br>• Epidemiological changes<br>• Loss of archaeological, historic and cultural patrimony<br>• Increase of conflicts<br>• Local Labour Market dinamization;<br>• Interference in the territorial organization of local people<br>• Interference in the flow of people, goods and services<br>• Loss of municipalities' territory<br>• Pressure over sociocultural relationships<br>• Pressure over ecological conditions of indigenous area.<br>• Loss of areas with economic productivity<br>• Loss of resources (mining, fishery, touristy, agricultural, among others)<br>• Local Government Revenues Increase; |

***Cumulative Impacts from HPPs in AJK***

Having outlined the different possible cumulative impacts from the construction and operation of HPPs and the mechanics with which different environmental and social sectors could be affected, this section attempts to relate this information to the specific context of AJK. Its purpose is to introduce the concept of impact zones.

The following are the main kinds of impacts on aquatic biodiversity (discussed in detail in Section 3.4) expected because of changes in the natural flow due to HPPs:

- Stagnated water in the submersible zones of HPPs which are not conducive to the health of torrent hill stream/river fish such as snow trout and Himalayan loaches,
- Less or no water flow in the dry zones of HPPs which is also expected to adversely affect aquatic biodiversity,
- Changes in the natural flow which may also fail to provide the natural environmental cues to the aquatic biodiversity to breed or maintain annual life histories.

The main impacts on the socioeconomic conditions of the people (discussed in detail in Section 3.5) are expected to arise from the following:

- Construction of a number of HPPs to increase the pressure on mining and quarrying activities in river beds,
- Adverse impact on native fish diversity and abundance to affect income earned by people from commercial fishing activities,
- The number of tourists to AJK attracted by game–fishing will dwindle, adversely affecting income generated from the tourism sector.

Exhibit 3.20 details all of the potential cumulative impacts on different environmental and social sectors resulting from the AJK Hydropower Development Plan.

**Exhibit 3.20: Potential Cumulative Impacts on different Environmental and Social Sectors from the AJK Hydropower Development Plan**

| *Cumulative Impact Sectors* | *Cumulative Impacts in AJK* |
|---|---|
| Habitats and Wildlife | • The distribution and abundance of riverine species in AJK will be effected by the effects of flow regulation.<br>• Three kinds of adverse impacts on aquatic biodiversity are expected because of changes in the natural flow due to HPPs in AJK: (a) Stagnated water in the submersible zones of HPPs which are not conducive for torrent hill stream/river fishes such as snow trout and Himalayan loaches, (b) Less or no water flow in the dry zones of HPPs which is also expected to adversely affect aquatic biodiversity but it may be mitigated by maintaining minimum environment flow and (c) changes in the natural flow may also fail to provide the natural environmental cues to the aquatic biodiversity to breed or maintain annual life histories, but this can again be mitigated by following minimum environmental flows even though it would help partially to maintain the current status of aquatic ecosystem and its biodiversity<br>• Dam or any construction across rivers in AJK will be barriers for fish which move from one part of stream/river to another as part of their life cycle processes. These structures are always detrimental to the survival of fish especially on migrants which use different habitats for different life history requirements.<br>• Changes in flow volume and patterns can adversely impact the structure, distribution and composition of fish communities in AJK rivers. Therefore, significant areas of the fish habitat may either be modified or lost due to proposed hydro projects in the basin. |

| *Cumulative Impact Sectors* | *Cumulative Impacts in AJK* |
|---|---|
| | • Migratory fish species such as the Mahseer migrate from the main river to smaller streams for spawning, or downstream of river to upstream for the same. Any obstacle such as a dam/barrage across rivers will break this normal migratory behavior which would ultimately affect the breeding cycle.<br>• Nutrient availability is the major environmental factor that determines the fish species composition in Himalayan rivers. Therefore, any changes in the nutrient flow would affect the overall composition of the fish community.<br>• RoR reservoir may provide useful habitats for promoting fisheries but they would be detrimental to the native fish diversity in the region.<br>• In AJK, the terrestrial habitat loss is in the form of forest land taken for the HPP infrastructure and areas submerged under water by reservoirs. |
| Water | • This may result in no flow downstream of power house for an entire day or more.<br>• Or, on the other hand, sudden releases of huge quantity of water in other times.<br>• This may result in injuries, accidents and fatalities of people and cattle and destruction of property in downstream areas. |
| Sedimentation | • Changes in the sedimentation flows due to dam/barrier construction, especially in Himalayan rivers, are expected to have an adverse impact on fish habitat.<br>• Some fish species in AJK rivers prefer substratum that are pebble, cobble, boulders, gravel, sand and occasionally loamy soil. These substrata are considered to be ideal grounds for foraging and spawning of Snow trout and many more Himalayan fishes.<br>• Dam construction and diversion weirs would change the sedimentation flow.<br>• Even a few centimeters of sediment layer over the natural substrata is enough to effect the foraging and spawning fish negatively. |
| Ways of Life<br>Territorial Organization<br>Land Use<br>Protected Areas<br>Economics | • Natural ecosystems (including riverine ecosystems) and their biological components provide a range of services that are of substantial ecological, economic and cultural value to society. The changes in the riverine ecosystem due to impairment of its provisioning, regulating, cultural and supporting functions that are linked to the construction of HPPs often lead to substantial economic and social impacts.<br>• People living in AJK depend on the agriculture that provides major support to the population and with the rise in population; individual landholdings significantly shrink over the years. In addition to the expansion of urban areas and road building activities, HPPs may further marginalize individual landholdings in AJK possibly contributing to the hardship of the local population.<br>• Apart from providing life's basic needs, changes in river flows influence livelihoods, income, and local migration, which in turn may sometimes lead to unrest and even political conflicts.<br>• The consequent impacts on economy and physical security, freedom, choice and social relations have wide–ranging impacts on well–being and health. |

***Identifying Cumulative Impact Zones***

Based on the geographical locations and potential cumulative impacts expected from hydropower development in AJK, river and stream sections across the State that may be prone to the cumulative impacts of HPP development can be delineated into impact zones.

The cumulative impacts relevant to AJK and outlined in Exhibit 3.20 reveal that the nature and magnitude of the potential impacts are linked strongly to the rivers and streams themselves. The extent of potential environmental and social impacts, in terms of geographical area, is also limited to areas close to them. This is due to the topography of AJK, where rivers flow through narrow valleys with steep and high slopes on both sides. Therefore, in terms of the lateral extent of impacts, these are not expected to carry the effect of any cumulative environmental or social impact beyond 500 m from the center of the river on both sides. The main rivers of the AJK are the Neelum, Jhelum and Poonch rivers. HPPs not located on these are assumed to be located on the nullahs or streams that are tributaries of the main rivers.

Therefore, the delineation of impact zones is centered on the nullahs and the main stems of the rivers where the HPPs will be located. The nullahs and river sections will be split based on a continuous stretch up to a confluence point where another nullah or river intersects.

For illustrative purposes, the width of the impact zone on each side of the river is kept at 1.5 km. The lengths of the zones, however, are governed by the effect of RoRs on nullahs and main stems of rivers, not only at the points where diversion structures are located, but also on stretches located downriver. Hence, the longer boundary of the impact zones along the river takes into account the cumulative impacts of the development of a number of HPPs in close proximity on the same river systems.

Based on the predicted extent and severity of the cumulative impacts, the impact zones will be categorized into Moderately Critical Zones, Highly Critical Zones and Extremely Critical Zones.

<u>*Extent of Cumulative Impact*</u>

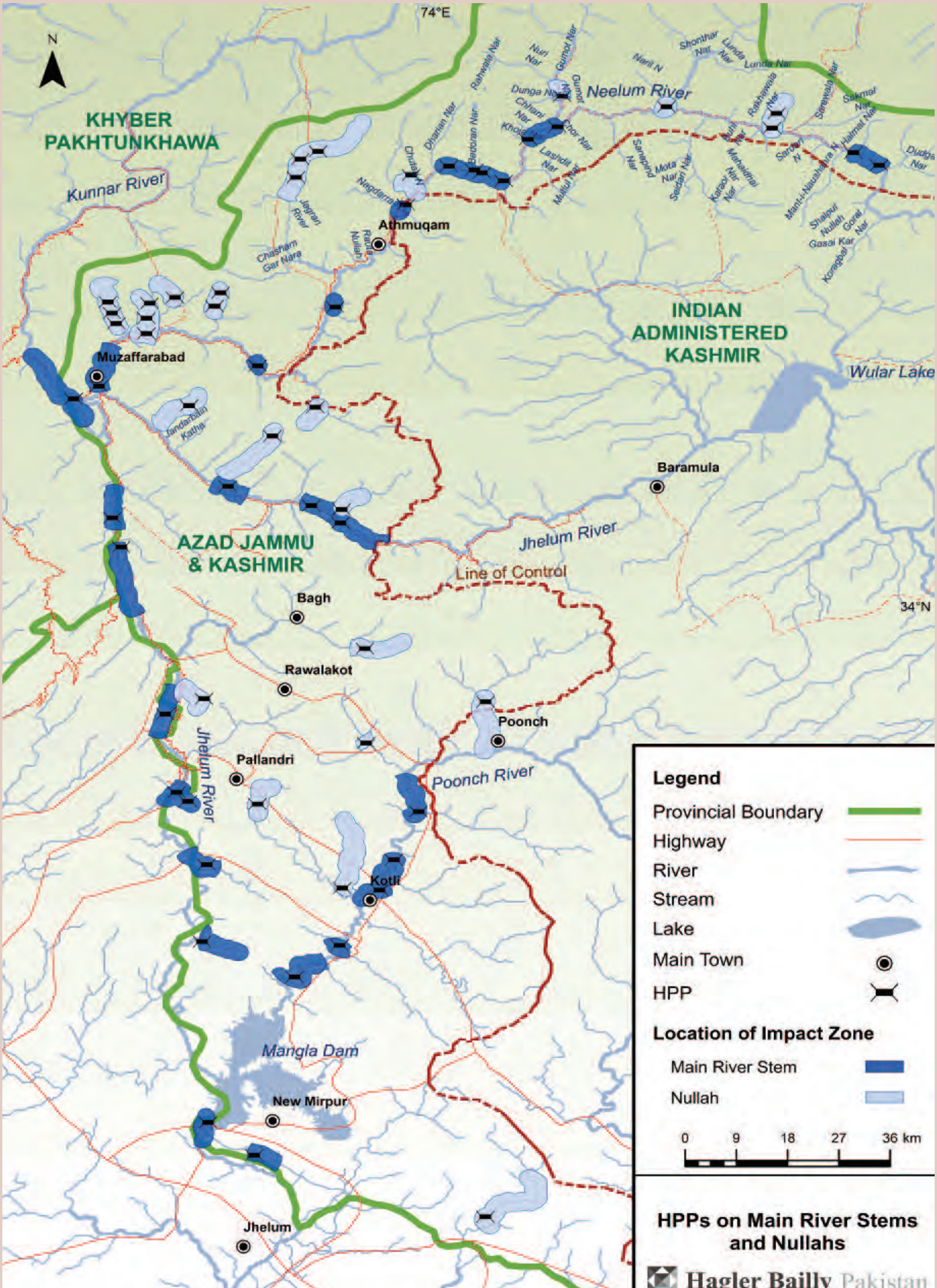
The extent of cumulative impact will be categorized in terms of their location on a nullah or the main stem of a river, and the number of other HPPs located on that same section.

- Nullahs or main river stems — in terms of the length of river dried out and the number of downstream tributaries available to absorb upstream ecological disturbances, nullahs are considered better locations for HPPs than main river stems. Therefore, if a particular zone is located on a nullah it scores '1', while those on a main river stem score '2'. The impact zones on main river stems and nullahs are shown in Exhibit 3.21.

- The number of HPPs — knowing the extent of a river section affected by the diversion of water by specific HPPs would be the most useful indicator of the extent of cumulative impacts. However, the exact locations of the HPPs in the Plan are not available. Considering the scope of this report, the number of HPPs being planned in a particular zone is an adequate substitute to indicate the extent of impact. Zones with one HPP in them score '1', while zones with more than one HPP located on them score '2'.

The scoring system is used to indicate the extent of cumulative impact. In Exhibit 3.22 the location of an impact zone is designated as being either 'restricted', 'medium' or 'wide'. The extent of cumulative impact is expressed graphically in Exhibit 3.23.

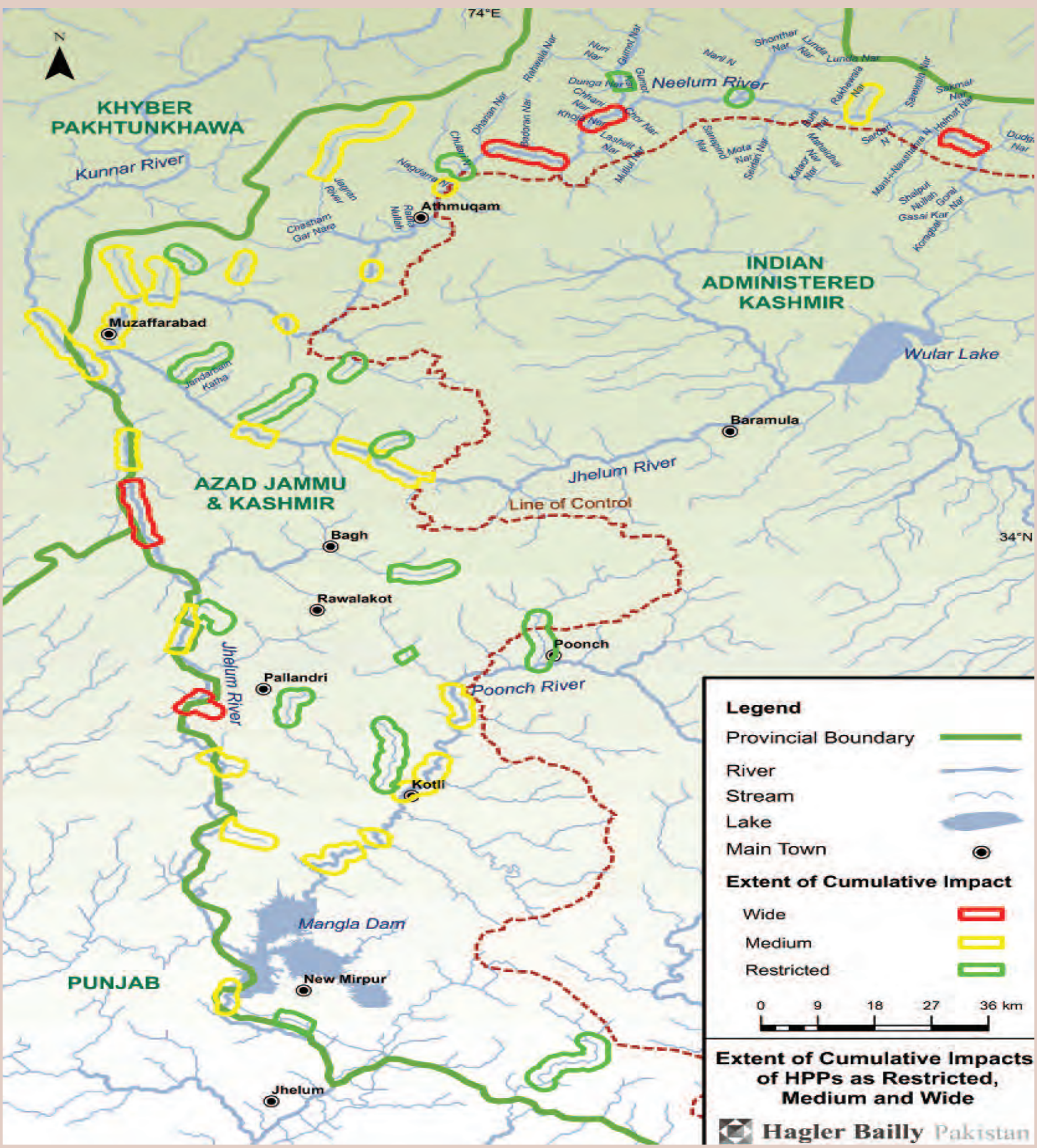
## Exhibit 3.21: Impact Zones on Main River Stems and Nullahs in AJK



## Exhibit 3.22: Matrix indicating the Extent of Cumulative Impacts as 'Restricted', 'Medium' and 'Wide'

| Extent of Cumulative Impacts (Total Score) | | Number of HPPs in a given zone | |
|---|---|---|---|
| | | One (score = 1) | More than one (score = 2) |
| Location of impact zone | Nullah (score = 1) | Restricted (2) | Medium (3) |
| | Main stem of river (score = 2) | Medium (3) | Wide (4) |

## Exhibit 3.23: Extent of Cumulative Impacts on Nullahs and Main River Stems from HPPs in AJK



*Severity of Cumulative Impact*
The severity of cumulative impacts in the identified impact zones can be categorized based on whether the proposed HPPs in the zones are less than, or greater than the 50 MW benchmark.

- The severity of cumulative impacts can be categorized as:

- Moderate; if all the HPPs in an impact zone are smaller than 50 MW, and,
- Severe: if there are HPPs larger than 50 MW in size or there is a mix of both types.

Exhibit 3.24 indicates the location of HPPs with installed capacities greater or less than 50 MW on nullahs and main river stems in AJK.

Exhibit 3.25 illustrates the cumulative impact zones according to the severity of impacts.

**Exhibit 3.24: HPPs with Installed Capacities Greater or Less than 50 MW on Nullahs and Main River Stems in AJK**

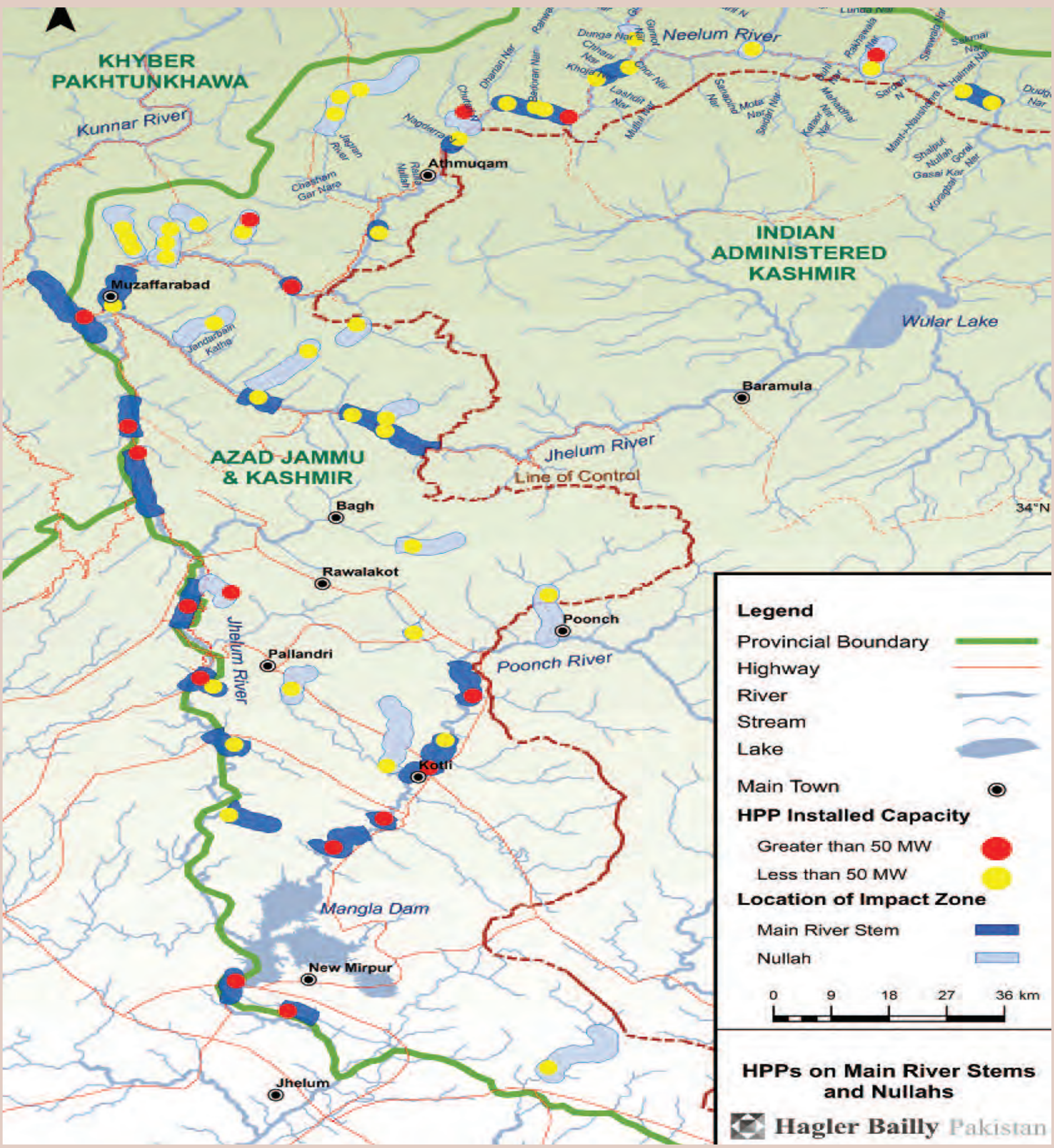


**Exhibit 3.25: Cumulative Impact Zones in AJK categorized according to the Severity of Impacts**

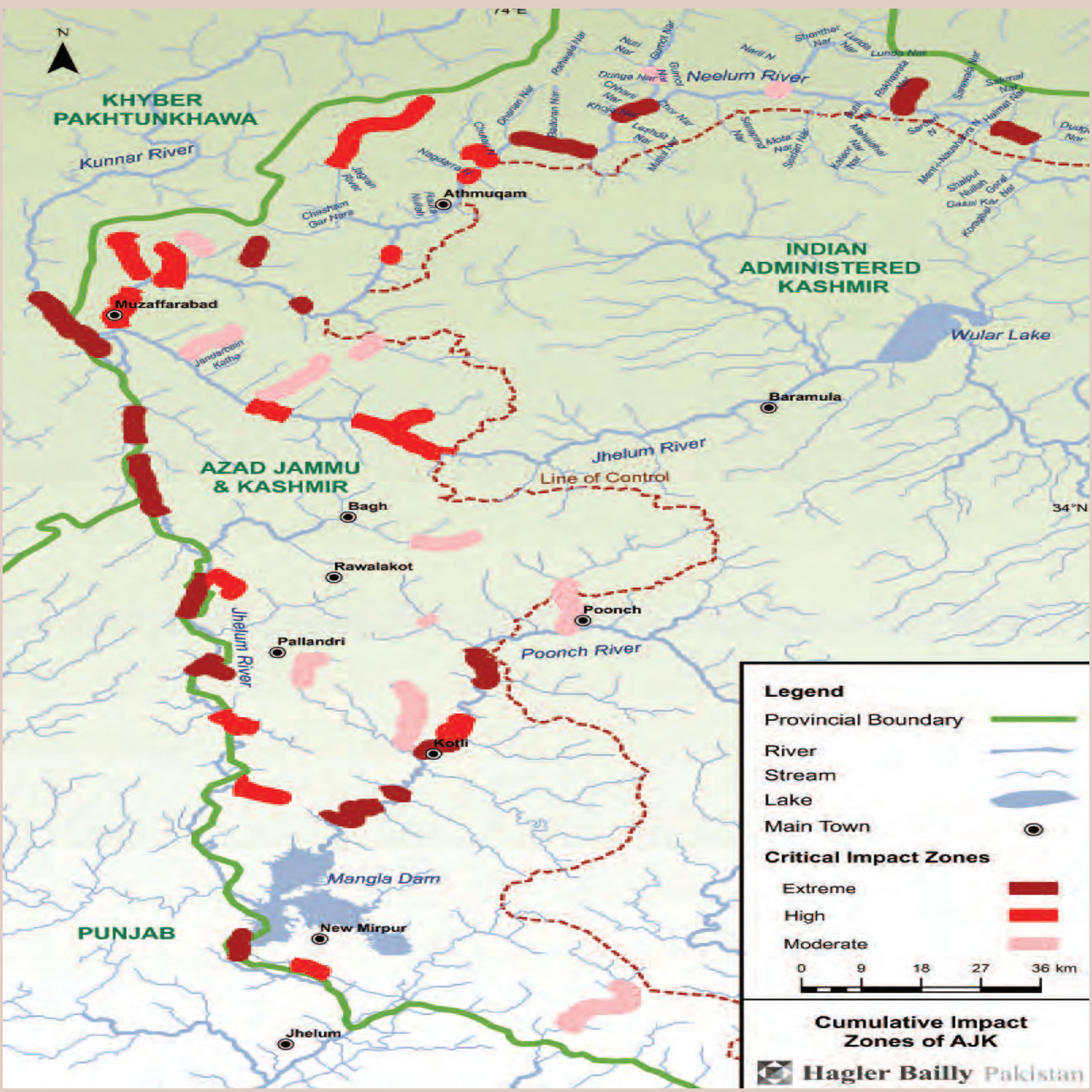
***Categorizing Cumulative Impact Zones***

Based on the predicted extent and severity of cumulative impacts, the impact zones can be categorized into Moderately Critical Zones, Highly Critical Zones and Extremely Critical Zones according to the categories described in the matrix in Exhibit 3.26. Exhibit 3.27 presents these impact zones in mapped format.

**Exhibit 3.26: Matrix showing the Categorization of Cumulative Impact Zones as Moderately Critical, Highly Critical and Extremely Critical based on the Extent and Severity of Cumulative Impacts**

| *Categorization of Cumulative Impact Zones* | | *Extent of Impact* | | |
|---|---|---|---|---|
| | | *Restricted* | *Medium* | *Wide* |
| Severity of Impact | Moderate | Moderately Critical | Highly Critical | Extremely Critical |
| | Severe | Highly Critical | Extremely Critical | Extremely Critical |

**Exhibit 3.27: Moderately Critical, Highly Critical and Extremely Critical Impact Zones in AJK based on the Extent and Severity of Cumulative Impacts**



***Conclusion***

The extent of the river system in AJK which will be affected by the development of HPPs in the hydropower plan can be seen from Exhibit 2.27. All of the main stems of the rivers of AJK are host to Extremely, Highly and Moderately Critical Impact Zones. On the nullahs, the Cumulative Impact Zones are mostly only highly or moderately critical.

It must be remembered that the results of the categorization of the nature of the Cumulative Impact Zones in AJK are—to a degree—arbitrary. The categorization was based on the severity and extent of the cumulative impacts using qualitative predictive methods such as the matrices in Exhibit 3.22 and Exhibit 3.26. In turn, these were based on a brief analysis of the design features of HPPs, and on a limited amount of primary scientific data.

For a fully rigorous study of cumulative impacts, it would be necessary to examine the structural features and components of all the HPPs in the Plan in greater detail. Such a study would look into the exact volumes of water diverted, the remaining downstream flows, the extent of the diversion, the exact volume of planned impoundment of water, the size of the construction works, and the extent and locations of development of new infrastructure associated with each project.

The objective of this report is to assist the AJK authorities identify the scale, diversity, magnitude and complexity of the potential cumulative environmental and social impacts emanating from the development of the Plan, and to identify the areas and river sections most sensitive to those impacts. The report also aims to provide the authorities with a guide to help direct the focus of further detailed EIA studies that may need to be undertaken as part of the design of specific projects. The identification of the critical impact zones in Exhibit 3.27 adequately serves the purpose by providing approximate locations of the areas expected to be affected and the possible severity of impacts.

What remains now is to examine the condition of environmental and social 'baselines' on rivers or nullahs that are likely to be developed. The Cumulative Impact Zones identified in Exhibit 3.27 can then be superimposed on these baselines, and the areas in AJK most prone to cumulative impacts from the development of the Plan will finally be identified.

## 3.4 Step 6: Environmental Baseline

### 3.4.1 Introduction

This section focuses on the aquatic and terrestrial ecological resources of AJK. A considerable amount of background information on river characteristics, aquatic flora and fauna, terrestrial flora, mammals, birds, reptiles, and protected areas is included in Appendix B of this report. A literature review of research articles, previous EIA (Environmental Impact Assessment) reports, relevant books and websites was carried out to gather this information.

For the purposes of this SEA pilot study, the condition of the environmental baseline in relevant rivers and streams is represented by fish. They are the most easily studied aquatic organisms (compared to algal flora and macro–invertebrates), sensitive to physical and chemical variations in the water as well as to changes in river flows and volumes. They are therefore vulnerable to changes caused by the construction and operation of HPPs. Fish fauna are therefore used as an indicator of river biodiversity for the purpose of ecological zoning in this report.[41] The sources used to identify fish ecology in the rivers of AJK in this report are listed in Exhibit 3.28.

Based on ecological contiguity, this report divides the rivers of AJK into nine zones. The features of these river zones as well as the ecological resources they contain are discussed in detail in Section 3.4.2. The ecological sensitivity of each river zone is assessed and discussed followed by a determination of the sensitivity of river sections to the development of HPPs (Section 3.4.3).

41. Mirza, M. R. (1994). Geographical distribution of freshwater fishes in Pakistan: a review. Punjab Univ. J. Zool., 9: 93–108.

**Exhibit 3.28: Sources of Information used in this Report on Fish Ecology in the Rivers of AJK**

| *Name* | *References Used* |
|---|---|
| Neelum River | • Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.<br>• Mirza, M. R. (1994). Geographical distribution of freshwater fishes in Pakistan: a review. Punjab Univ. J. Zool., 9: 93-108.<br>• Rafique, M. (2007). Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae. Ph.D. dissertation, UAAR. Pp 220. |
| Jhelum River | • Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2013. Environmental Assessment of Neelum Jhelum Hydroelectric Project River Diversion. Interim Report prepared for Ministry of Water and Power, Islamabad.<br>• Mirza, M. R. (1994). Geographical distribution of freshwater fishes in Pakistan: a review. Punjab Univ. J. Zool., 9: 93-108.<br>• Rafique, M. (2007). Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae. Ph.D. dissertation, UAAR. Pp 220. |
| Poonch River | • Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation<br>• Mirza, M. R. (1994). Geographical distribution of freshwater fishes in Pakistan: a review. Punjab Univ. J. Zool., 9: 93-108.<br>• Rafique, M. (2007). Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae. Ph.D. dissertation, UAAR. Pp 220. |
| Mangla Reservoir | • Mirza, M. R. (1994). Geographical distribution of freshwater fishes in Pakistan: a review. Punjab Univ. J. Zool., 9: 93-108.<br>• Rafique, M. (2007). Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae. Ph.D. dissertation, UAAR. Pp 220. |

### 3.4.2 Ecological Zoning of AJK Rivers

Fish abundance and diversity is dependent on the nature of the water habitat, water temperature, water quality, conditions of the river–bed, as well as climatic conditions. Thus the physical and chemical characteristics of a water body have a direct relationship with the type of fish that will be found. Based on similarities in physical and chemical characteristics as well as the diversity of fish fauna, the rivers of AJK have been divided into nine ecological zones. These zones are shown on a map in Exhibit 3.29:

- Zone A – Neelum River from Taobat to Dudhnial
- Zone B – Neelum River from Dudhnial to Nauseri
- Zone C – Neelum River from Nauseri to Muzaffarabad
- Zone D – Jhelum River upstream Domel
- Zone E – Jhelum River Downstream Domel
- Zone F – Jhelum River at and below the Confluence of Mahl Nullah
- Zone G – Poonch River and Tributaries
- Zone H – Mangla Reservoir
- Zone I – Downstream Mangla Reservoir

The physical and biological characteristics of each zone are discussed below. A list of the fish species reported from each zone is given in a summary table. The fish species that have a conservation status or that are known to be economically important have been flagged in red colour. This is followed by a discussion in which the ecological importance and sensitivity of each zone is assessed using the following indicators.

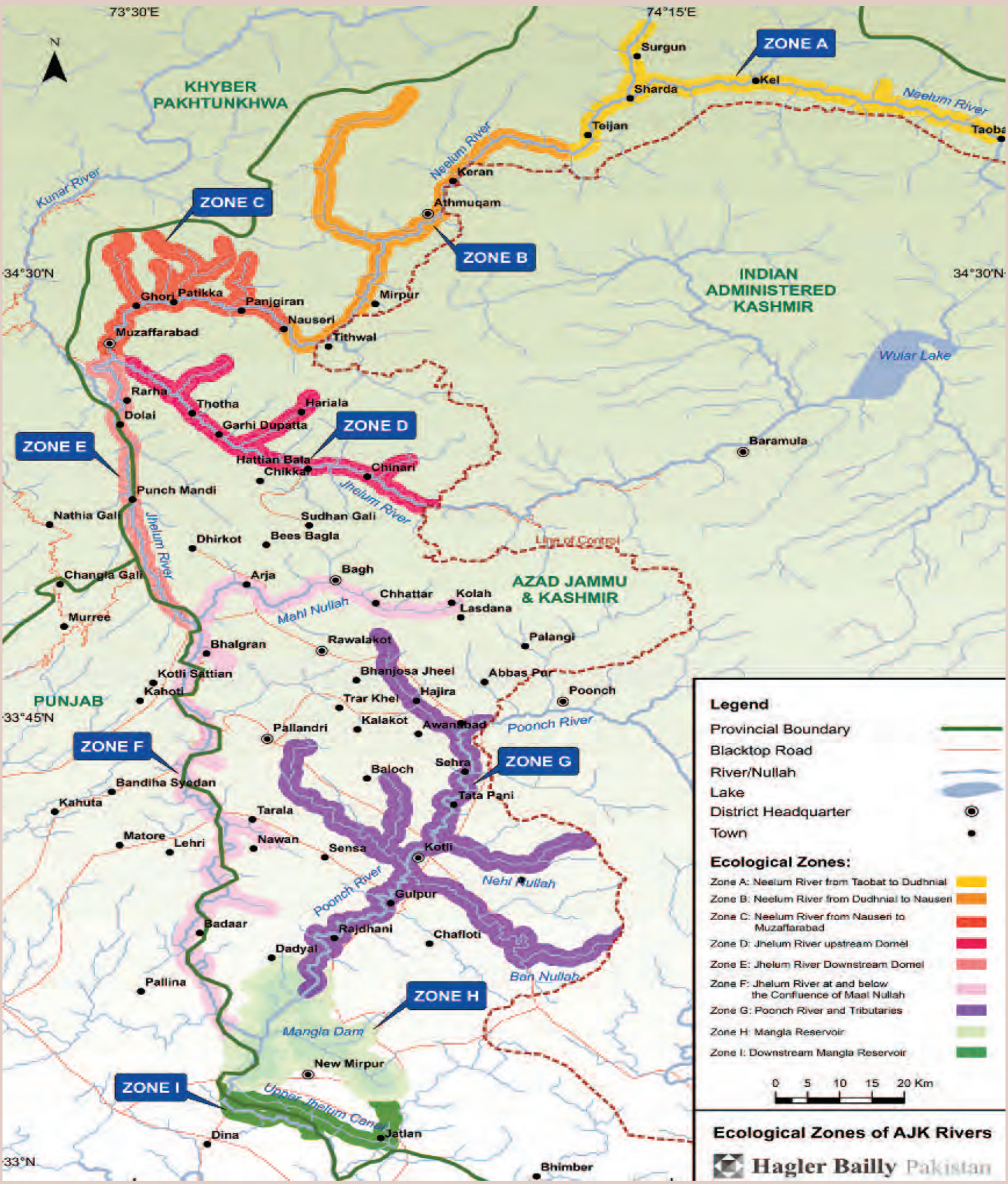
- Fish Diversity – This refers to the type and number of fish species reported. Greater fish diversity is indicative of conditions conducive for fish feeding, breeding and growth.[42]
- Conservation Status of Species – These may include species that are listed in the IUCN Red List 2013[43] or those that are endemic to AJK[44].
- Status as Protected Area – A protected area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values.[45] Protected areas may include wildlife sanctuaries or national parks declared by the local government. Also included are protected areas declared by IUCN Protected Areas Management[46] and those that contain a critical habitat as designated by the International Finance Corporation (IFC) Performance Standards.[47]
- Economic Value of Fish – Fishing not only provides food for local consumption but is also a source of livelihood for individuals involved in commercial fishing as well as for individuals working in the food industry (such as processing and packaging of edible fish species). Fish are also important for recreational and sport fishing and boost tourism.
- Besides, the above indicators, some river ecosystems are important because they provide a breeding ground, or migratory route

42. Rafique, M. (2007). Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae. Ph.D. dissertation, UAAR. Pp 220.
43. The IUCN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on plants and animals that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon–specific conservation programme (i.e., are Near Threatened).
44. Endemism is the ecological state of being unique to a defined geographic location, such as an island, country or other defined zone, or habitat type.
45. Dudley, N. (ed.) (2008) Guidelines for Appling Protected Areas Management Categories. IUCN: Gland, Switzerland.
46. IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation. Available at official website of IUCN: http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/ accessed on 16 September 2012.
47. Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

for other fish species that abound in either upstream or downstream river zones. Therefore, they are important for maintaining the connectivity of fauna of one river zone with another. This aspect has also been considered in assessing the ecological sensitivity of each zone.

- The zones are assessed and ranked on a scale of 'high', 'medium' and 'low' sensitivity for each of the aforementioned indicators. Together these indicators combine to give a picture of the ecological sensitivity of each zone.

## Exhibit 3.29: Ecological Zones of AJK Rivers



**Zone A – Neelum River from Taobat to Dudhnial**

*Physical Characteristics of the Zone:*
Physical characteristics of the river stretch from Taobat to Dudhnial do not vary much and is considered trout zone as maximum number of Brown trout is found in this area. Mean temperature varies from 6–7°C. Dissolved oxygen ranges from 8–10 mg/l and pH ranging from 6–7 and TDS ranging from 50–100 ppm. The river bed is generally gravely, cobbly or rocky. The river is mainly wide and shallow ranging from 1–2 m. The water velocity ranges from 0.5–2m/s. All these physical factors indicate a cold water river inhabiting cold water fish fauna.

*Biological Characteristics of the Zone:*
The fish species observed and reported from this river stretch are listed below in Exhibit 3.30.

The species *Salmo trutta fario*, is mainly restricted in this zone of river. The species *Triplophysa stoliczki* and *Diptychus maculatus* are only found in upper areas of the river and not recorded below the town of Sharda. The species *Schizothorax plagiostomus, Triplophysa kashmirensis* and *Glyptosternum reticulatum*, are found throughout the length of the river Neelum. Brown trout, though an exotic species, is considered an esteemed fish and has high commercial value. Similarly Alwan Snow Trout and Tibetan Snow Trout are locally consumed as food fish. *Triplophysa kashmirensis*, though quite common in the area, is an endemic fish and not recorded outside the Kashmir Valley.

*Discussion*
*Fish Diversity:* Only 6 fish species have been reported from this zone, therefore the overall fish diversity is low due to cold climatic conditions in this zone. These fish are adapted to the cold weather conditions and therefore, sensitive to drastic temperature variations.

*Economic Importance of Fish:* Two of the fish reported from this zone are economically important; the Brown trout *Salmo trutta fario*, has high commercial value and Alwan Snow Trout *Schizothorax plagiostomus* and Tibetan Snow Trout *Diptychus maculatus* are locally consumed as food fish. Because of the high commercial importance of the Brown Trout *Salmo trutta fario*, as well as its restricted distribution, we can rate the economic importance of fish in this zone as High.

*Conservation Importance of Fish Species:*
Although *Schizothorax plagiostomus richardsonii* is widely distributed along the Himalayan foothills and previous studies have indicated that it is abundantly and commonly found, recent observations over the last 5 to 10 years indicate

**Exhibit 3.30: Fish fauna found in Zone A of the Neelum River (Taobat to Dudhnial)**

| *No* | *Scientific name* | *Family* | *Common name* | *Distribution* | *IUCN Status* | *Commercial Importance* | *Abundance in the Zone* |
|---|---|---|---|---|---|---|---|
| 1 | *Salmo trutta fario* | Salmonidae | Brown Trout | Wide/ Exotic | Least Concern (LC) | Very high | Common |
| 2 | *Triplophysa stolkiczki* | Balitoridae | High Altitude Loach | Upper Indus and upper Neelum only | Not Evaluated | No | Rare |
| 3 | *Triplophysa kashmirensis* | Balitoridae | Kashmir Hill stream Loach | Endemic | Not Evaluated | No | Common |
| 4 | *Schizothorax plagiostomus richardsonii* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Rare |
| 5 | *Diptychus maculatus* | Cyprinidae | Tibetan Snow Trout | Wide | Not evaluated | High | Rare |
| 6 | *Glyptosternum reticulatum* | Sisoridae | Himalayan Catfish | Wide | Not evaluated | No | Common |

drastic declines in many areas of its range due to introduction of exotics, damming and overfishing (IUCN Red List 2013). Therefore, it has been listed as Vulnerable in the IUCN Red List. However, no Endangered or Critically Endangered fish species has been reported from the area. The High Altitude Loach *Triplophysa stolkiczki* and Kashmir Hill stream Loach T*riplophysa kashmirensis* have restricted ranges and are endemic. It can, therefore be deduced that the conservation importance of the fish species in Zone A is medium.

*Protected Area:* Some parts of this zone are included in the Musk Deer National Park which is a protected area.

**Zone B – Neelum River from Dudhnial to Nauseri**

*Physical Characteristics of the Zone*

Physical characteristics of the river stretch from Dudhnial to Nauseri vary in many ways as many side streams from comparatively lower altitude join the river. The water volume increases and so is the water speed. River flows in gorge for most of the times. The river bed is mainly devoid of gravel or cobbles and is dominated by rocky bed. Brown trout, though distributed in this zone but its population is very low. Mean temperature varies from 8–10°C. Dissolved oxygen ranges from 8–10 mg/l and pH ranging from 6–7. The river stretch is still dominated by cold water fish fauna but species composition and relative abundance changes in this zone.

*Biological Characteristics of the Zone*

The fish species found in this stretch of river is indicated in Exhibit 3.31 along with associated data.

The Brown Trout *Salmo trutta fario* in this zone is very rare in this zone and only recorded during the winter season. Kashmir Hill Stream Loach *Triplophysa kashmirensis* is very common in this zone and is one of the dominant species. Similarly Alwan Snow Trout *Schizothorax plagiostomus* is common species in this zone. Himalayan Catfish *Glyptosternum reticulatum* is rare due to the reasons that the river runs through gorges and is deep in this zone which is not preferred habitat for this fish. Triplophysa Loach *Triplophysa microps* is a species of lower altitude and stars it appearance in this zone has a very thin population.

*Discussion*

*Fish Diversity:* Only 5 fish species have been reported from this zone, therefore the overall fish diversity is low due to cold climatic conditions in this zone. These fish are adapted to the cold weather conditions and therefore, sensitive to drastic temperature variations.

*Economic Importance of Fish:* Two of the fish reported from this zone are economically important. The Brown Trout *Salmo trutta fario*, has high commercial value but has a low abundance in this zone and is only seen here in the winter

**Exhibit 3.31: Fish Fauna found in Zone B of the Neelum River (Dudhnial to Nauseri)**

| No | Scientific name | Family | Common name | Distribution | IUCN Status | Commercial Importance | Abundance in the Zone |
|---|---|---|---|---|---|---|---|
| 1 | *Salmo trutta fario* | Salmonidae | Brown Trout | Wide/ Exotic | Least Concern (LC) | Very high | Rare |
| 2 | *Triplophysa kashmirensis* | Balitoridae | Kashmir Hill stream Loach | Endemic | Not Evaluated | No | Common |
| 3 | *Triplophysa microps* | Balitoridae | Leh Triplophysa Loach | Wide | LC | No | Rare |
| 4 | *Schizothorax plagiostomus richardsonii* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Common |
| 5 | *Glyptosternum reticulatum* | Sisoridae | Himalayan Catfish | Wide | Not evaluated | No | Rare |

months. Alwan Snow Trout *Schizothorax plagiostomus* is locally consumed as food fish and has high commercial importance. Overall, the economic importance of fish in this zone can be labeled as Low.

*Conservation Importance of Fish Species:* No Endangered or Critically Endangered fish species has been reported from this zone. *Schizothorax plagiostomus richardsonii* is listed as Vulnerable in the IUCN Red List. Even though this fish species is widely distributed along the Himalayan foothills and previous studies have indicated that it is abundantly and commonly found, recent observations over the last 5 to 10 years indicate drastic declines in many areas of its range due to introduction of exotics, damming and overfishing (IUCN Red List 2013).

The Kashmir Hill Stream Loach *Triplophysa kashmirensis* has a restricted range and is endemic to the Kashmir area.
Overall, the conservation importance of fish species in this zone can be ranked as medium.

*Protected Area:* There is no protected area in this zone.

**Zone C – Neelum River from Nauseri to Muzaffarabad**

*Physical Characteristics of the Zone*

The river stretch from Nauseri to Muzaffarabad falls in lower altitude. The side channels joining the river have comparatively warm water which elevate the river water temperature. Discharge rate is at its maximum resulting in an increase in water velocity. The river bed is sandy and cobbly where river widens but is mainly rocky when it flows in gorge. The fish fauna found in upper and middle reaches is mostly not represented in this zone and new fish found in downstream areas are represented here. Mean temperature varies from 12–14˚C during the summer season. Dissolved oxygen ranges from 7–8 mg/l and pH ranging from 6–7.

*Biological Characteristics of the Zone*

The fish species found in this stretch of river are indicated in Exhibit 3.32 along with associated data. Photographs of some of the species are included in Exhibit 3.33.

The fish fauna of this zone is quite diverse and represented by eight species. Only three species viz., *Triplophysa kashmirensis, Schizothorax plagiostomus* and *Glyptosternum reticulatum* found in upper reaches are represented in this zone because all these three species are widely

**Exhibit 3.32: Fish Fauna found in Zone C of the Neelum River (Nauseri to Muzaffarabad)**

| No | Scientific name | Family | Common name | Distribution | IUCN Status | Commercial Importance | Abundance in the Zone |
|---|---|---|---|---|---|---|---|
| 1 | *Triplophysa kashmirensis* | Balitoridae | Kashmir Hill stream Loach | Endemic | Not Evaluated | No | Rare |
| 2 | *Triplophysa microps* | Balitoridae | Leh triplophysaloach | Wide | LC | No | Common |
| 3 | *Schizothorax plagiostomus* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Common |
| 4 | *Glyptosternum reticulatum* | Sisoridae | Himalayan Catfish | Wide | Not evaluated | No | Rare |
| 5 | *Glyptothorax stocki* | Sisoridae | Bhed Catfish | Endemic | Not evaluated | No | Common |
| 6. | *Glyptothorax pectinopterus* | Sisoridae | Sticking Catfish | Wide | Not evaluated | No | Rare |
| 7. | *Crossocheilus latius* | Cyprinidae | Gangetic latia | Wide | LC | No | Common |
| 8. | *Schistura nalbanti* | Balitoridae | Rawlakot loach | Endemic | Not evaluated | No | Common |

distributed in the river Neelum. The species *Glyptothorax stocki, Glyptothorax pectinopterus, Crossocheilus latius,* and *Schistura nalbanti* inhabit this zone by migrating from the downstream areas.

*Discussion*

*Fish Diversity:* Eight (8) fish species have been reported from this zone, therefore the overall fish diversity can be rated as low.

*Economic Importance of Fish:* Alwan Snow Trout *Schizothorax plagiostomus* is the only fish of this zone that has a high commercial importance. However, this fish is found throughout the Neelum River. So the fish fauna of this zone have an overall low economic importance.

*Conservation Importance of Fish Species:* No Endangered or Critically Endangered fish species has been reported from this zone. The only fish found here that has an IUCN status is the *Schizothorax plagiostomus richardsonii*. Although this fish is widely distributed along the Himalayan foothills and previous studies have indicated that it is abundantly and commonly found, recent observations over the last 5 to 10 years indicate drastic declines in many areas of its range due to introduction of exotics, damming and overfishing (IUCN Red List 2013). Therefore, it has been listed as Vulnerable in the IUCN Red List.

The Kashmir Hill Stream Loach T*riplophysa kashmirensis* has a restricted range and is endemic to the Kashmir area. Similarly, the Rawlakot loach *Schistura nalbanti* is endemic to Kashmir. Due to the presence of these endemic species, the overall conservation importance of fish species in this zone can be ranked as medium.

*Protected Area:* There is no protected area in this zone.

**Zone D – Jhelum River upstream Domel**

*Physical Characteristics of the Zone*

River Jhelum has diversity of habitats and also a good diversity of fish fauna. It is considered a cool water river with a wide range of temperature ranging from 6°C during winter and 24°C during the summer seasons. The Dissolved Oxygen ranges from 6–7 mg/l as the river remain turbid throughout monsoon season. River bed varies greatly with patches of sand, gravel but cobbly and rocky habitat predominates in most of the stretches of the river.

*Biological Characteristics of the Zone*

The fish species found in this stretch of river is indicated in Exhibit 3.34 along with associated data.

**Exhibit 3.33: Photographs of Fish Fauna found in Zone A, Zone B and Zone C (Neelum River)**

a. Brown Trout *Salmo trutta fario*

b. Tibetan Snow Trout *Diptychus maculatus*

c. Alwan Snow Trout *Schizothorax plagiostomus*

d. High Altitude Loach *Triplophysa stoliczkae*

Water temperature in the river Jhelum remains around 24°C during the summer season. Due to this warm water regime, the fish fauna from downstream areas migrate in the Jhelum river during summer season. These species include *Barilius pakistanicus, Garra gotyla, Labeo dyocheilus, Labeo dyocheilus,* and *Crossocheilus latius*. Other species are the resident fish fauna of the river Jhelum upstream Domel.

*Discussion*

*Fish Diversity:* A total of 17 fish species have been reported from this zone including members of Family Balitoridae, Cyprinidae and Sisoridae. Therefore the overall fish diversity can be rated as medium.

*Economic Importance of Fish:* At least six to eight fish species found in this zone are commercially important. These include *Cyprinus carpio, Schizothorax plagiostomus, Cyprinus carpio, Labeo dyocheilus, Schizothorax plagiostomus, Schizothorax curvifrons, Racoma labiatus,* and *Schizopyge esocinus*. The economic importance of fish species in this zone is therefore medium.

*Conservation Importance of Fish Species:*
Kashmir Catfish Glyptothorax kashmirensis, recorded from this river zone is listed as Critically Endangered in the IUCN Red List 2013. According to the Assessment Information given in the IUCN Red List,

**Exhibit 3.34: Fish fauna found in Zone D, Jhelum River upstream Domel**

| No | Scientific name | Family | Common name | Distribution | IUCN Status | Commercial Importance | Abundance in the Zone |
|---|---|---|---|---|---|---|---|
| 1 | *Barilius pakistanicus* | Cyprinidae | Pakistani Baril | Endemic | Not evaluated | No | Common |
| 2 | *Cyprinus carpio* | Cyprinidae | Common Carp | Wide | Vulnerable | High | Common |
| 3 | *Garra gotyla* | Cyprinidae | Sucker Head | Wide | LC | No | Common |
| 4 | *Puntius ticto* | Cyprinidae | Scarlet Barb | Wide | LC | No | Common |
| 5 | *Labeo dyocheilus* | Cyprinidae | Thicklip labeo | Wide | LC | High | Common |
| 6 | *Triplophysa microps* | Balitoridae | Leh triplophysaloach | Wide | LC | No | Common |
| 7 | *Schizothorax plagiostomus* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Common |
| 8 | *Schizothorax curvifrons* | Cyprinidae | Sattar Snowtrout | Wide | Not evaluated | High | Common |
| 9 | *Racoma labiatus* | Cyprinidae | Kunar Snowtrout | Wide | Not evaluated | High | Rare |
| 10 | *Schizopyge esocinus* | Cyprinidae | Chirruh Snowtrout | Wide | Not evaluated | High | Common |
| 11 | *Glyptothorax stocki* | Sisoridae | Bhed Catfish | Endemic | Not evaluated | No | Common |
| 12 | *Glyptothorax kashmirensis* | Sisoridae | Kashmir Catfish | Endemic | Critically Endangered | No | Rare |
| 13 | *Glyptothorax pectinopterus* | Sisoridae | Sticking Catfish | Wide | Not evaluated | No | Rare |
| 14 | *Crossocheilus latius* | Cyprinidae | Gangetic Latia | Wide | LC | No | Common |
| 15 | *Schistura nalbanti* | Balitoridae | Rawlakot Loach | Endemic | Not evaluated | No | Common |
| 16 | *Schistura afasciata* | Balitoridae | Havelian Loach | Endemic | Not evaluated | No | Common |
| 17 | *Schistura alepidota* | Balitoridae | Swat Loach | Endemic | Not evaluated | No | Common |

"*Glyptothorax kashmirensis* is known only from the Jhelum River in Kashmir, which is currently being dammed in several locations. This will impact the fast flowing river species specialist due to habitat loss and from potential introduction of exotic invasive fish species into the reservoirs. The species is assessed as Critically Endangered due to a predicted decline of more than 80% over the next five to ten years due to the above severe, irreversible threats."

Two more species are included in the IUCN Red List. These include the species *Cyprinus carpio* and *Schizothorax plagiostomus* that are listed as Vulnerable. In addition, there are six fish species reported from this zone that are endemic to Pakistan. The species *Barilius pakistanicus, Glyptothorax stocki, Glyptothorax kashmirensis, Schistura nalbanti, Schistura afasciata,* and *Schistura alepidota* found in River Jhelum are endemic to Pakistan.

Due to the presence of a Critically Endangered fish as well six endemic fish species, the conservation importance of fish species in this zone is high.

*Protected Area:* There is no protected area in this zone.

*Connectivity:* Due to the warm water regime in this river zone, the fish fauna from downstream areas migrate in the Jhelum River during summer season. These species include *Barilius pakistanicus, Garra gotyla, Labeo dyocheilus, Labeo dyocheilus,* and *Crossocheilus latius*. Thus, this river zone is important for supporting the fish found in downstream sections of the river and thus plays a role in connectivity with downstream ecosystems.

**Zone E – Jhelum River Downstream Domel**

*Physical Characteristics of the Zone*

Water in Neelum and Kunhar rivers remains cold even during the summer season with maximum water temperature of 13°C. Water in the River Jhelum above Domel remains warm during summer season with maximum temperature of

**Exhibit 3.35: Fish Fauna found in Zone E, Jhelum River Downstream Domel**

| No | Scientific name | Family | Common name | Distribution | IUCN Status | Commercial Importance | Abundance in the Zone |
|---|---|---|---|---|---|---|---|
| 1 | *Barilius pakistanicus* | Cyprinidae | Pakistani baril | Endemic | Not evaluated | No | Common |
| 2 | *Garra gotyla* | Cyprinidae | Sucker head | Wide | LC | No | Common |
| 3 | *Puntius ticto* | Cyprinidae | Scarlet barb | Wide | LC | No | Common |
| 4 | *Schizothorax plagiostomus* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Common |
| 5 | *Glyptothorax stocki* | Sisoridae | Bhed Catfish | Endemic | Not evaluated | No | Common |
| 6 | *Glyptothorax pectinopterus* | Sisoridae | Sticking cat fish | Wide | Not evaluated | No | Rare |
| 7 | *Crossocheilus latius* | Cyprinidae | Gangetic latia | Wide | LC | No | Common |
| 8 | *Botia lohachata* | Cobitidae | Reticulate loach | Wide | Not evaluated | Aquarium fish | Rare |
| 9 | *Acanthocobitis botia* | Balitoridae | Mottled loach | Wide | LC | No | Rare |
| 10 | *Schistura nalbanti* | Balitoridae | Rawlakot loach | Endemic | Not evaluated | No | Common |
| 11 | *Schistura afasciata* | Balitoridae | Havelian loach | Endemic | Not evaluated | No | Common |
| 12 | *Schistura alepidota* | Balitoridae | Swat Loach | Endemic | Not evaluated | No | Common |

24°C. Mean monthly flow rate of the River Neelum exceeds that of River Jhelum in the peak summer months and this cold water from Neelum River significantly affects the water temperature of the River Jhelum below Domel after their confluence. Consequently, water temperature of River Jhelum below Domel remains moderate and does not rise beyond 17°C. Three temperature regimes viz., warm water regime in the river Jhelum above Domel, cold water regime in the river Neelum and Kunhar and a cool water regime in the river Jhelum below Domel help the fish fauna to disperse in different parts of the rivers according to their optimal temperature choice.

*Biological Characteristics of the Zone*
The fish species found in this stretch of river is indicated in Exhibit 3.35 along with associated data.

The water in the river downstream of Domel becomes cool as compared to upstream Domel due to confluence of rivers Neelum and Kunhar. It also runs through more gorges as compared to the stretch upstream Domel. The water discharge also increases as a result of confluence of Neelum and Kunhar. These factors reduce the number of fish species in this stretch of river. All the snow trout species found in the Jhelum upstream Domel are not represented in this stretch of river.

*Discussion*
*Fish Diversity:* A total of 12 fish species have been reported from this zone including members of Family Balitoridae, Cyprinidae and Sisoridae. The overall fish diversity can be rated as medium.

*Economic Importance of Fish:* Only the Alwan Snow Trout *Schizothorax plagiostomus* is a commercially important edible fish species found in this zone. Besides this, the Reticulate loach *Botia lohachata* is an aquarium fish but it is rare in this zone. Overall, the fish fauna of this zone have an overall low economic importance.

*Conservation Importance of Fish Species:* No Endangered or Critically Endangered fish species has been reported from this zone. The only fish found here that has an IUCN status is the *Schizothorax plagiostomus richardsonii.*

Endemic fish species found in this zone include *Glyptothorax stocki, Schistura nalbanti, Schistura afasciata, Schistura alepidota* and *Barilius pakistanicus.*

The conservation importance of the fish species in this zone can be labeled as low since Alwan Snow Trout *Schizothorax plagiostomus* as well as the endemic fish are widely distributed and found in the River Jhelum both upstream and downstream Domel.

*Protected Area:* There is no protected area in this zone.

**Zone F – Jhelum River at and below the Confluence of Mahl Nullah**
*Physical Characteristics of the Zone*
Water temperature of this stretch of the river is quite high and reaches up to 28–30˚C during summer months. Owing to high temperature and closeness to the Mangla dam, the area is mainly occupied by the warm water fish fauna with a few species representing the cool water.

*Biological Characteristics of the Zone*
The fish species found in this stretch of river is indicated in Exhibit 3.36 along with associated data. Photographs of some of the species are included in Exhibit 3.37.

This stretch of the river receives the Mahl Nullah draining the Bagh and Arja area. The Mahl Nullah is an open small stream with shallow water having cobbly bed. It forms one of the habitat for breeding of the fish species, Mahseer *Tor putitora*. This river stretch is influenced by the Mangla Reservoir and the species *Tor putitora, Clupisoma garua, Salmophasia punjabensis, Gagata cenia,* and *Securicula gora* represent the reservoir fishes which have inhabited this stretch of the river. The fish *Schizothorax plagiostomus* is just represented in this stretch and forms its southernmost limit.

*Discussion*
*Fish Diversity:* A total of 12 fish species have been reported from this zone including members of Family Balitoridae, Cyprinidae and Sisoridae. The overall fish diversity can be rated as medium.

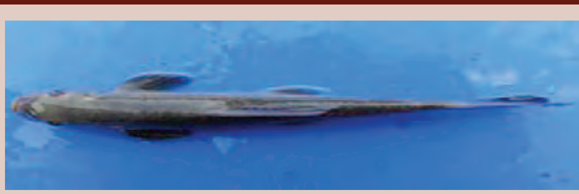
*Economic Importance of Fish:* The commercially important fish fauna of this zone includes the *Tor putitora* and *Clupisoma garua* which have migrated from the reservoir. However, the abundance of the *Tor putitora* in this zone is low. The other fish of commercial importance is the *Schizothorax plagiostomus* which is also very rare in this zone. Therefore, the economic importance of fish in this zone can be labeled as low.

*Conservation Importance of Fish Species:* The fish species Mahseer *Tor putitora* is listed as Endangered in the IUCN Red List 2013. It has been recorded from this zone particularly in the Mahl Nullah that forms a habitat for breeding of this fish. A detailed write–up about this fish species is given in the description of the next zone. The Vulnerable fish species *Schizothorax plagiostomus* is also found in this zone but, is rare in this zone.

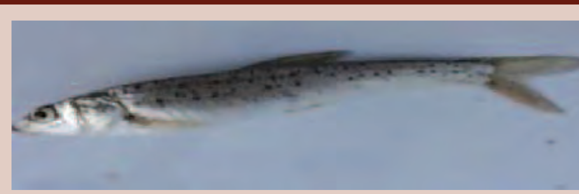
**Exhibit 3.36: Fish Fauna found in Zone F, Jhelum River at and below the Confluence of Mahl Nullah**

| No | Scientific name | Family | Common name | Distribution | IUCN Status | Commercial Importance | Abundance in the Zone |
|---|---|---|---|---|---|---|---|
| 1 | *Barilius pakistanicus* | Cyprinidae | Pakistani baril | Endemic | Not evaluated | No | Common |
| 2 | *Salmophasia punjabensis* | Cyprinidae | Punjab razorbelly minnow | Endemic | Not evaluated | No | Common |
| 3 | *Crossocheilus latius* | Cyprinidae | Gangetic latia | Wide | LC | No | Common |
| 4 | *Securicula gora* | Cyprinidae | Gora chela | Wide | LC | No | Common |
| 5 | *Garra gotyla* | Cyprinidae | Sucker head | Wide | LC | No | Common |
| 6 | *Puntius ticto* | Cyprinidae | Scarlet barb | Wide | LC | No | Common |
| 7 | *Tor putitora* | Cyprinidae | Golden Mahseer | Wide | Endangered | High | Rare |
| 8 | *Schizothorax plagiostomus* | Cyprinidae | Alwan Snow Trout | Wide | Vulnerable | High | Rare |
| 9 | *Glyptothorax pectinopterus* | Sisoridae | Sticking cat fish | Wide | Not evaluated | No | Rare |
| 10 | *Schistura nalbanti* | Balitoridae | Rawlakot loach | Endemic | Not evaluated | No | Common |
| 11 | *Clupisoma garua* | Schilbeidae | Garua bachcha | Wide | LC | Very high | Rare |
| 12 | *Gagata cenia* | Sisoridae | Indian gagata | Wide | LC | No | Common |

**Exhibit 3.37: Photographs of Fish Fauna found in Zone D, Zone E and Zone F (Jhelum River)**



a. The Sucker head *Garra gotyla*



b. The Chirruh snow trout *Schiziopyge esocinus*

c. Alwan Snow Trout *Schizothorax plagiostomus*

d. *Glyptothorax kashmirensis*

Endemic fish species found in this zone include *Schistura nalbanti, Barilius pakistanicus* and *Salmophasia punjabensis.*

The conservation importance of the fish species in this zone can be labeled as low since the abundance of the Mahseer *Tor putitora* is low in this zone. Moreover the Alwan Snow Trout *Schizothorax plagiostomus* as well as the endemic fish are not restricted to this zone and widely distributed in the Jhelum River both upstream and downstream of Domel.

However, since the Mahl Nullah forms a breeding habitat for Endangered Tor putitora, this stretch of Zone F (Mahl Nullah) can be labeled as High for the conservation importance of fish.

*Protected Area:* There is no protected area in this zone.

**Zone G – Poonch River**

*Physical Characteristics of the Zone*

The Poonch is the warm water river and the water temperature approaches to 30˚C during the summer months.

*Biological Characteristics of the Zone*

The fish species found in this river are indicated in Exhibit 3.38 along with associated data.

Out of 29 species found in Poonch River, 13 species viz., *Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio, Botia rostrata, Sperata seenghala, Clupisoma garua, Ompok bimaculatus* and *Mastacembelus armatus* are species of special importance (Exhibit 3.39). Photographs of some of the species are included in Exhibit 3.40.

*Discussion*

*Fish Diversity:* A total of 29 fish species have been reported from this zone. River Poonch is rich in fish diversity as 29 fish species have been recorded from a stretch of about 100 km. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer rivers and have 12 to 32 fish species respectively. The reason is the topography and water temperature of the river Poonch. The Poonch flows gently in a vast and flat valley which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. Thus the fish diversity of the fish in this zone is labeled High.

*Economic Importance of Fish:* Of species bearing IUCN status, *Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio,* and *Ompok bimaculatus* are commercially important. The other commercially important species are *Sperata seenghala, Clupisoma garua, Mastacembelus armatus,* and *Cyprinus carpio*. Some of these species such as *Tor putitora, Sperata seenghala* and *Clupisoma garua* have very high commercial importance. So overall the economic importance of fish in this zone is high.

*Conservation Importance of Fish Species:* The species, *Barilius pakistanicus* and *Schistura punjabensis* are endemic to Pakistan. Five species, *Tor putitora* (Endangered), *Schizothorax plagiostomus (richardsonii)* (Vulnerable), *Cyprinus carpio* (Vulnerable), *Botia rostrata* (Vulnerable), *Ompok bimaculatus* (Vulnerable) and *Ompok bimaculatus* (Near Threatened) have special IUCN status

The fish species Mahseer *Tor putitora* is an important food and sport fish found in this zone. The largest and most stable population of this fish in the country in found in the Poonch River that also forms a breeding ground for this fish. Keeping in view its decling population and threats to survival, it has been declared Endangered in

**Exhibit 3.38: Fish fauna found in Zone G – Poonch River**

| No | Scientific name | Family | English Name | Distributional status | IUCN Status | Commercial Value |
|---|---|---|---|---|---|---|
| 1 | *Chela cachius* | Cyprinidae | Silver hatchet chela | Wide | LC | Low |
| 2 | *Salmophasia bacaila* | Cyprinidae | Large razorbelly minnow | Wide | LC | Low |
| 3 | *Aspidoparia morar* | Cyprinidae | Aspidoparia | Wide | LC | Low |
| 4 | *Barilius pakistanicus* | Cyprinidae | Pakistani baril | Endemic | Not determined (ND) | Low |
| 5 | *Esomus danricus* | Cyprinidae | Flying barb | Wide | LC | Low |
| 6 | *Cirrhinus reba* | Cyprinidae | Reba carp | Wide | LC | Fairly good |
| 7 | *Cyprinion watsoni* | Cyprinidae | Cyprinion | Wide | ND | Low |
| 8 | *Labeo dero* | Cyprinidae | Kalbans | Wide | LC | Fairly good |
| 9 | *Labeo dyocheilus* | Cyprinidae | Pakistani Labeo | Wide | LC | High |
| 10 | *Osteobrama cotio* | Cyprinidae | Cotio | Wide | LC | Low |
| 11 | *Puntius chola* | Cyprinidae | Swamp Barb | Wide | LC | Low |
| 12 | *Puntius sophore* | Cyprinidae | Spotfin Swamp Barb | Wide | LC | Low |
| 13 | *Puntius ticto* | Cyprinidae | Two spot Barb | Wide | LC | Low |
| 14 | *Tor putitora* | Cyprinidae | Mahseer | Wide | Endangered | Very high |
| 15 | *Crossocheilus latius* | Cyprinidae | Gangetic latia | Wide | LC | Low |
| 16 | *Garra gotyla* | Cyprinidae | Sucker head | Wide | LC | Low |
| 17 | *Schizothorax plagiostomus (richardsonii)* | Cyprinidae | Snow carp | Wide | Vulnerable | High |
| 18 | *Cyprinus carpio* | Cyprinidae | Common carp | Exotic | Vulnerable | High |
| 19 | *Acanthocobitis botia* | Noemacheil idae | Mottled Loach | Wide | LC | Low |
| 20 | *Schistura punjabensis* | Noemacheil idae | Hillstream loach | Endemic | ND | Low |
| 21 | *Botia rostrata* | Cobitidae | Twin–banded Loach | Wide | Vulnerable | Low |
| 22 | *Sperata seenghala* | Bagridae | Giant river cat fish | Wide | LC | Very high |
| 23 | *Clupisoma garua* | Schilbeidae | Garua bachwaa | Wide | LC | Very high |
| 24 | *Ompok bimaculatus* | Siluridae | Butter Catfish | Wide | Near Threatened | Low |
| 25 | *Glyptothorax pectinopterus* | Sisoridae | Flat head Catfish | Wide | LC | Low |
| 26 | *Chanda nama* | Channidae | Elongate glass–perchlet | Wide | LC | Low |
| 27 | *Parambasis baculis* | Chandidae | Himalayan glassy perchlet | Wide | LC | |
| 28 | *Parambasis ranga* | Chandidae | Indian glassy fish | Wide | LC | |
| 29 | *Mastacembelus armatus* | Mastacemb elidae | Tire–track spiny eel | Wide | LC | High |

the IUCN Red List 2013. This is explained in the most recent Ecological Baseline Study of the Poonch River[48]

The Mahseer fish, Tor putitora, found in Poonch River is one of the most important food and sport fish of the subcontinent. It is listed as Endangered species by IUCN and is the victim of the habitat degradation due to anthropogenic activities. It has a migratory habit and fish mainly breeds in the upper reaches of the river Poonch in hilly areas with gravely and sandy river bed. The Poonch River has by far the most abundant population of this fish in the country as its population has been depleted in most of the areas of the country due to habitat fragmentation and pollution. Poonch River is the most promising area for Mahseer fisheries in Pakistan. It has the highest and stable population of Mahseer in the country. The reason for the high population of this fish in Poonch River is the geography of the area, water chemistry and physico–chemical factors prevailing in the Poonch River and viability of suitable breeding grounds like Hajira, Naeil, Mendhar, Goin, Rangar, Sarota and Ban Nullahs.

The Assessment Information about the Mahseer *Tor putitora* available in the IUCN Red List 2013[49] is outlined below:
"*Tor putitora* is a widely distributed species in south and southeast Asia, with a restricted area of occupancy. However, the species is under severe threat from overfishing, loss of habitat, decline in quality of habitat resulting in loss of breeding grounds, and from other anthropogenic effects that have directly resulted in declines in harvest in several locations. In addition, with several dams planned for construction in the future in the Himalayan region, they could have a more drastic effect on tor populations blocking their migrations and affecting their breeding. Inferring population declines from observed cases with that of the

**Exhibit 3.39: Species of Special Concern found in the Poonch River, Azad Kashmir**

| No | Scientific name | Distributional status | IUCN Status | Commercial value | Max. Length (cm) | Max. Weight (kg) |
|---|---|---|---|---|---|---|
| 1 | *Barilius pakistanicus* | Endemic | – | – | – | – |
| 2 | *Schistura punjabensis* | Endemic | – | – | – | – |
| 3 | *Cirrhinus reba* | – | – | Fairly good | 30 | 0.3 |
| 4 | *Labeo dero* | – | – | Fairly good | 75 | 0.2 |
| 5 | *Labeo dyocheilus* | – | – | High | 90 | 5 |
| 6 | *Tor putitora* | – | Endangered | Very high | 275 | 54 |
| 7 | *Schizothorax plagiostomus (richardsonii)* | – | Vulnerable | High | 60 | 2.5 |
| 8 | *Cyprinus carpio* | – | Vulnerable | High | 110 | 40.1 |
| 9 | *Botia rostrata* | – | Vulnerable | – | – | – |
| 10 | *Sperata seenghala* | – | – | Very high | 150 | 10 |
| 11 | *Clupisoma garua* | – | – | Very high | 61 | 0.5 |
| 12 | *Ompok bimaculatus* | – | Near threatened | Fairly good | 45 | 0.2 |
| 13 | *Mastacembelus armatus* | – | – | High | 90 | 0.5 g |

48. Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF–P) by Himalayan Wildlife Foundation.
49. Jha, B.R. & Rayamajhi, A. 2010. Tor putitora. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 15 August 2013.

trends across the entire distribution range, the species is estimated to have declined by more than 50% in the past and if the current trends continue and with the new dams being built, the population may decline even up to 80% in the future. The species is therefore assessed as Endangered and is in need of urgent conservation efforts to save it from becoming locally extinct in several locations."

Thus the conservation importance fish in this zone can be summarizes as being High.

*Protected Area:* The entire stretch of the Poonch River and its tributaries has been declared as a National Park. It is also home to an Endangered fish species *Tor putitora*.

*Connectivity:* The Poonch River serves as a breeding ground for the commercially important fish species of the Mangla Reservoir and therefore plays a vital role in supporting fish populations in the downstream ecosystem.

The ecological importance of the Poonch River has been summarized in the Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012. These are listed below. "

1. *Last refuge for Mahseer Fish:* Mahseer has been a widely distributed fish in Pakistan during sixties and seventies. It was flourishing in the five rivers of Punjab and breeding in the Himalayan foothill areas. Due to damming of the water bodies, ecological fragmentation of the water bodies, pollution, water diversion, habitat destruction and indiscriminate hunting, its population has been continuously declining in its natural habitat. Its distribution range in the country, therefore, continued squeezing and presently it is almost non–existent in the rivers of Punjab. Recently (2010), IUCN has declared it as an "Endangered species". The Poonch River, however, is still having a reasonably good population of Mahseer. It is still successfully breeding in its upper and middle reaches. The main centers of Mahseer breeding are the Ban Nullah, Rangar Nullah, Nail Nullah, Hajeera Nullah, Meander Nullah and the Titri Note area where river is widened to its maximum extant. It is the Poonch River where anglers still can catch a fish of 100 cm weighing 10 Kgs.

2. *Breeding ground For the Fish Fauna of Mangla Reservoir:* Poonch River serves as a huge breeding ground for most of the fish fauna of the Mangla reservoir which breeds in flowing water conditions. Most of the commercially important cyprinid and cat fish breed in backwaters of the reservoir in the Poonch River. The side nullahs meeting to Poonch river form the major breeding grounds for these fishes. These Nullahs also serve as nursery grounds for the fishes breeding in these side streams.

**Exhibit 3.40: Photographs of Fish Fauna found in Zone G (Poonch River)**

a. Golden Mahseer *Tor Putitora*

b. Twin–banded Loach *Botia rostrata*

c. Butter Catfish *Ompok bimaculatus*

d. Dhi, *Torki Labeo dyocheilus*

3. *Natural Reserve for Twin–banded Loach, Botia rostrata:* Twin banded loach is a beautiful aquarium fish. It has almost the same story as that of Mahseer. The fish has been quite common in the Himalayan foothill areas but presently its population in the foothill areas is almost depleted or non–existent. The Poonch River has a very good population of this loach and is a hot spot area for this fish.

4. *Supporting Healthy Population of Labeo dyocheilus:* Poonch River holds the largest population of *Labeo dyocheilus* as compared to any other river in the country. This fish has maximum size in this river and a fish weighing 3–4 kg is commonly caught in the nets.

5. *Supporting Healthy Population of Garra gotyla:* The fish Garra gotyla is also a fish of submountanous areas but it is also found in plains. Its population in plain areas has decreased over the last 20 years and hardly one comes across any fish while sampling. Once upon a time it was very common in Potowar areas but it is no more seen in any of these areas except a few localized places. Poonch River has very healthy population of this fish throughout its length in AJK.

6. Supporting High fish diversity as compared to its size: The Poonch is the smallest river in AJK as compared to other two rivers, the Jhelum and the Neelum. It, however, has a very good fish diversity of 29 species as compared to 32 species in Jhelum and 12 species in Neelum. It is due to optimum water temperature, pristine breeding grounds, wide river valley, and network of side nullahs with suitable physic–chemical environment."

**Zone H – Mangla Reservoir**

*Physical Characteristics of the Zone*

The Kunhar and Neelum are cold–water rivers having water temperature less than 15˚C even during the summer months. The Poonch is a warm water river and the water temperature of the rivers approaches 30˚C during the summer months. Water in the Jhelum River has an intermediate temperature which reaches up to 25˚C during the summer months. These variable temperature regimes give the reservoir a unique physico–chemical characteristic and fish fauna of all the water bodies are represented in the reservoir to variable extents in addition to major influence of the downstream areas of the plains.

*Biological Characteristics of the Zone*

The fish species found in this river are indicated in Exhibit 3.41 and Exhibit 3.42 along with associated data.

*Discussion*

*Fish Diversity:* A total of 57 fish species have been reported from this zone and the overall fish diversity can be labeled as Very High.
Economic Importance of Fish: Mangla reservoir is important for supporting several commercially important fish. There are at least 18 commercially important fish present in this zone as indicated in Exhibit 3.41. Therefore the economic importance of this zone is high.

*Conservation Importance of Fish Species:* The fish species Mahseer *Tor putitora* habitat is listed as Endangered in the IUCN Red List 2013. It has been recorded from this zone even though it is rare in this zone. The *Cyprinus carpio* is listed as Vulnerable while the species listed as Near Threatened include *Chitala chitala, Hypophthalmichthys molitrix, Oreochromis mossambicus, Ompok bimaculatus, Ompok pabd, Wallago attu* and *Bagarius bagarius*.

The conservation importance of the fish species in this zone can be labeled as Medium since the endangered fish, *Tor putitora* does not have a high abundance in this zone. The other fish species are either Vulnerable or Near Threatened.

*Protected Area:* There is no protected area in this zone.

**Exhibit 3.41: Fish Fauna found in Zone H (Mangla Reservoir)**

| Nos. | Scientific Name | Family | IUCN status |
|---|---|---|---|
| 1. | *Chitala chitala* | Notopteridae | Near Threatened |
| 2. | *Notopterus notopterus* | Notopteridae | Least Concern |
| 3. | *Gudusia chapra* | Clupeidae | Least Concern |
| 4. | *Chela cachius* | Cyprinidae | Least Concern |
| 5. | *Amblypharyngodon mola* | Cyprinidae | Least Concern |
| 6. | *Securucula gora* | Cyprinidae | Least Concern |
| 7. | *Salmostoma bacaila* | Cyprinidae | Least Concern |
| 8. | *Aspidoparia morar* | Cyprinidae | Least Concern |
| 9. | *Barilius pakistanicus* | Cyprinidae | Not Evaluated |
| 10. | *Barilius vagra* | Cyprinidae | Least Concern |
| 11. | *Esomus danricus* | Cyprinidae | Least Concern |
| 12. | *Catla catla* | Cyprinidae | Least Concern |
| 13. | *Cirrhinus mrigala* | Cyprinidae | Least Concern |
| 14. | *Cirrhinus reba* | Cyprinidae | Least Concern |
| 15. | *Cyprinion watsoni* | Cyprinidae | Not Evaluated |
| 16. | *Labeo boga* | Cyprinidae | Least Concern |
| 17. | *Labeo calbasu* | Cyprinidae | Least Concern |
| 18. | *Labeo dero* | Cyprinidae | Least Concern |
| 19. | *Labeo microthalmus* | Cyprinidae | Least Concern |
| 20. | *Labeo dyocheilus* | Cyprinidae | Least Concern |
| 21. | *Labeo rohita* | Cyprinidae | Least Concern |
| 22. | *Osteobrama cotio* | Cyprinidae | Least Concern |
| 23. | *Puntius chola* | Cyprinidae | Least Concern |
| 24. | *Puntius sarana* | Cyprinidae | Least Concern |
| 25. | *Puntius sophore* | Cyprinidae | Least Concern |
| 26. | *Puntius ticto* | Cyprinidae | Least Concern |
| 27. | *Puntius vittatus* | Cyprinidae | Least Concern |
| 28. | *Tor putitora* | Cyprinidae | Endangered |
| 29. | *Crossocheilus diplocheilus* | Cyprinidae | Not Evaluated |
| 30. | *Garra gotyla* | Cyprinidae | Least Concern |
| 31. | *Cyprinus carpio* | Cyprinidae | Vulnerable |
| 32. | *Ctenopharyngodon idellus* | Cyprinidae | Not Evaluated |
| 33. | *Hypophthalmichthys molitrix* | Cyprinidae | Near Threatened |
| 34. | *Hypophthalmichthys nobilis* | Cyprinidae | Data Deficient |
| 35. | *Acanthocobitis botia* | Noemacheilidae | Least Concern |
| 36. | *Botia lohachata* | Cobitidae | Not Evaluated |
| 37. | *Aorichthys seenghala* | Bagridae | Least Concern |
| 38. | *Mystus bleekeri* | Bagridae | Least Concern |
| 39. | *Mystus cavasius* | Bagridae | Least Concern |

| Nos. | Scientific Name | Family | IUCN status |
|---|---|---|---|
| 40. | *Clupisoma garua* | Schilbeidae | Least Concern |
| 41. | *Clupisoma naziri* | Schilbeidae | Not Evaluated |
| 42. | *Ompok bimaculatus* | Siluridae | Near Threatened |
| 43. | *Ompok pabda* | Siluridae | Near Threatened |
| 44. | *Wallago attu* | Siluridae | Near Threatened |
| 45. | *Bagarius bagarius* | Sisoridae | Near Threatened |
| 46. | *Gagata cenia* | Sisoridae | Least Concern |
| 47. | *Glyptothorax punjabensis* | Sisoridae | Not Evaluated |
| 48. | *Xenentodon cancila* | Belonidae | Least Concern |
| 49. | *Channa orientalis* | Channidae | Not Evaluated |
| 50. | *Channa punctata* | Channidae | Least Concern |
| 51. | *Chanda nama* | Channidae | Least Concern |
| 52. | *Parambasis baculis* | Chandidae | Least Concern |
| 53. | *Parambasis ranga* | Chandidae | Least Concern |
| 54. | *Nandus nandus* | Nandidae | Least Concern |
| 55. | *Glossogobius giuris* | Gobiidae | Least Concern |
| 56. | *Mastacembelus armatus* | Mastacembelidae | Least Concern |
| 57. | *Oreochromis mossambicus* | Cichlidae | Near Threatened |

**Exhibit 3.42: Economically Important Fish Species found in Mangla Reservoir along with their Salient Features**

| No | Species | Commercial Value | Country Status | Status in Zone H |
|---|---|---|---|---|
| 1 | *Chitala chitala* | High | Less common | Less common |
| 2 | *Cirrhinus mrigala* | Very high | Commn | Common |
| 3 | *Cirrhinus reba* | Fairly good | Common | Common |
| 4 | *Gibelion catla* | Very high | Common | Less common |
| 5 | *Labeo calbasu* | High | Common | Common |
| 6 | *Labeo dyocheilus* | Fairly High | Less Common | Less common |
| 7 | *Labeo rohita* | Very high | Common | Common |
| 8 | *Tor putotora* | Very high | Rare | Rare |
| 9 | *Cyprinus carpio* | High | Common | Common |
| 10 | *Hypophthalmichthys molitrix* | High | Less common | Common |
| 11 | *Hypophthalmichthys nobilis* | High | Less common | Less common |
| 12 | *Ctenopharyngodon idella* | High | Less common | Less common |
| 13 | *Sperata sarwari* | High | Less common | Common |
| 14 | *Bagarius bagarius* | High | Common | Common |
| 15 | *Wallago attu* | High | Common | Common |
| 16 | *Clupisoma garua* | Very high | Common | Rare |
| 17 | *Clupisoma naziri* | Very high | Rare | Rare |
| 18 | *Oreochromis mossambicus* | High | Common | Common |

**Zone I (Downstream of Mangla Reservoir)**

*Physical Characteristics of the Zone*

The Zone below the Mangla Reservoir is much disturbed and least studied area from fisheries point of view. The area contains the abandoned original river bed where the dam has been constructed and is devoid of water except which is seeped from the structure. It has a stretch of 6–7 km and has series of pools. Below the power house, water passes through the turbine and flows through a concrete walled channel. The channel is then divided by gates in such a way that much of the water is diverted in the Upper Jhelum Canal and overflow is again diverted towards river channel.

*Biological Characteristics of the Zone*

Little research has been done to study the fish species in this zone downstream Mangla reservoir. The fish species likely to be found in the river zone below Mangla reservoir are indicated in Exhibit 3.43 along with associated data. Photographs of some fish species found in Zone I are given in Exhibit 3.44.

*Discussion*

*Fish Diversity:* A total of 44 fish species have been reported from this zone and the overall fish diversity can be labeled as very high. Most of the fish species are the same as those found in the Mangla reservoir.

*Economic Importance of Fish:* There are commercially important fish species found in this zone. However, the abundance of these fish is small compared to the Mangla reservoir. The overall economic importance of this fish in this zone in can be labeled as medium.

*Conservation Importance of Fish Species:* The fish species Mahseer *Tor putitora* habitat is listed as Endangered in the IUCN Red List 2013. It has been recorded from this zone even though it is very rare in this zone. The Cyprinus carpio is listed as Vulnerable while the species listed as Near Threatened include *Chitala chitala, Hypophthalmichthys molitrix, Oreochromis mossambicus, Ompok bimaculatus, Ompok pabd, Wallago attu* and *Bagarius bagarius*.

The conservation importance of the fish species in this zone can be labeled as Low since the abundance of these fish in this zone is low.

*Protected Area:* There is no protected area in this zone.

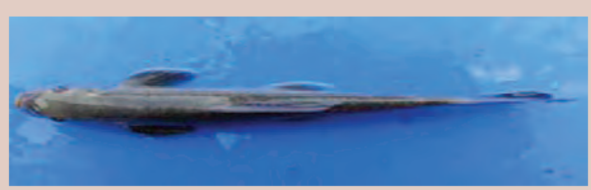
**Exhibit 3.43: Fish Fauna Likely to be found in Zone I – Downstream Mangla Reservoir**

| No | Scientific Name | Family | Commercial importance | IUCN Status |
|---|---|---|---|---|
| 1. | *Notopterus notopterus* | Notopteridae | Yes | Least Concern |
| 2. | *Gudusia chapra* | Clupeidae | No | Least Concern |
| 3. | *Chela cachius* | Cyprinidae | No | Least Concern |
| 4. | *Amblypharyngodon mola* | Cyprinidae | No | Least Concern |
| 5. | *Securucula gora* | Cyprinidae | No | Least Concern |
| 6. | *Salmostoma bacaila* | Cyprinidae | No | Least Concern |
| 7. | *Aspidoparia morar* | Cyprinidae | No | Least Concern |
| 8. | *Barilius pakistanicus* | Cyprinidae | No | Not Evaluated |
| 9. | *Barilius vagra* | Cyprinidae | No | Least Concern |
| 10. | *Esomus danricus* | Cyprinidae | No | Least Concern |
| 11. | *Catla catla* | Cyprinidae | Yes | Least Concern |
| 12. | *Cirrhinus mrigala* | Cyprinidae | Yes | Least Concern |
| 13. | *Cirrhinus reba* | Cyprinidae | Yes | Least Concern |
| 14. | *Labeo calbasu* | Cyprinidae | Yes | Least Concern |
| 15. | *Labeo dero* | Cyprinidae | Yes | Least Concern |

| No | Scientific Name | Family | Commercial importance | IUCN Status |
|---|---|---|---|---|
| 16. | *Labeo dyocheilus* | Cyprinidae | Yes | Least Concern |
| 17. | *Labeo rohita* | Cyprinidae | Yes | Least Concern |
| 18. | *Osteobrama cotio* | Cyprinidae | No | Least Concern |
| 19. | *Puntius sophore* | Cyprinidae | No | Least Concern |
| 20. | *Puntius ticto* | Cyprinidae | No | Least Concern |
| 21. | *Puntius vittatus* | Cyprinidae | No | Least Concern |
| 22. | *Tor putitora* | Cyprinidae | Yes | Endangered |
| 23. | *Crossocheilus latius* | Cyprinidae | No | Least Concern |
| 24. | *Cyprinus carpio* | Cyprinidae | Yes | Vulnerable |
| 25. | *Ctenopharyngodon idellus* | Cyprinidae | Yes | Not Evaluated |
| 26. | *Hypophthalmichthys molitrix* | Cyprinidae | Yes | Near Threatened |
| 27. | *Hypophthalmichthys nobilis* | Cyprinidae | Yes | Data Deficient |
| 28. | *Acanthocobitis botia* | Noemacheilidae | No | Least Concern |
| 29. | *Aorichthys seenghala* | Bagridae | Yes | Least Concern |
| 30. | *Mystus bleekeri* | Bagridae | No | Least Concern |
| 31. | *Mystus cavasius* | Bagridae | No | Least Concern |
| 32. | *Clupisoma garua* | Schilbeidae | Yes | Least Concern |
| 33. | *Ompok bimaculatus* | Siluridae | Yes | Near Threatened |
| 34. | *Wallago attu* | Siluridae | Yes | Near Threatened |
| 35. | *Bagarius bagarius* | Sisoridae | Yes | Near Threatened |
| 36. | *Gagata cenia* | Sisoridae | No | Least Concern |
| 37. | *Xenentodon cancila* | Belonidae | No | Least Concern |
| 38. | *Channa punctata* | Channidae | Yes | Least Concern |
| 39. | *Chanda nama* | Channidae | No | Least Concern |
| 40. | *Parambasis baculis* | Chandidae | No | Least Concern |
| 41. | *Parambasis ranga* | Chandidae | No | Least Concern |
| 42. | *Glossogobius giuris* | Gobiidae | No | Least Concern |
| 43. | *Mastacembelus armatus* | Mastacembelidae | Yes | Least Concern |
| 44. | *Oreochromis mossambicus* | Cichlidae | Yes | Near Threatened |

**Exhibit 3.44: Photographs of Fish Fauna found in Zone H and Zone I (Mangla Reservoir and Downstream of Mangla Reservoir)**

a. The minnow *Securicula gora*



b. The Sucker head *Garra gotyla*

c. Butter Catfish *Ompok bimaculatus*

d. Dhi, *Torki Labeo dyocheilus*

### 3.4.3 Sensitivity Zoning for Hydropower Development

The previous section assessed the ecological importance of each of the nine designated ecological zones of the rivers of AJK by using the diversity of the fish species of each zone as indicators. The following parameters were used:

- Fish Diversity
- Economic Importance of Fish
- Conservation Importance of Fish
- Classification as Protected Area

In addition, the connectivity to upstream and downstream ecosystems was taken into consideration to assess the ecological importance of each zone.

This section assesses the sensitivity of each designated zone to hydropower development keeping in view the ecological importance of each zone based on the above–mentioned parameters.

**Impacts of Dams on River Ecosystems**

There is a constant interchange of materials, energy and nutrients between the water in the river, its banks, its bed and its floodplains. During the course of the water's passage from source to sea sediments are continuously transported, sorted by size, re–sorted, eroded and deposited by the daily, yearly and decadal variations in flow, giving rise to permanent and semi–permanent river–channel features, such as pools, rapids, ox–bow lakes, sandbars and floodplains. The floodplains are areas of fertile soils, replenished by the river during each flood and often highly valued as agricultural land. The dynamic, ever–changing environment creates the physical–chemical template upon which the river's organisms live their lives.[50]

The changing conditions along a river result in an orderly and predictable transition of species. Different plants and animals live in the headwaters than in the lower reaches and different plant communities occur high on banks than lower down near the water. Some fish species need to move onto seasonally inundated floodplains to complete their life cycles whilst others need the conditions provided in–channel throughout their lives. Some animal species need to migrate up and downstream at different times of the year or into and out of tributaries, to find appropriate temperature and other conditions. Some plants and animals live in pools and others in fast–flowing rapids and riffles, some in colder water and some in warmer environments, and so on.

Similarly, species respond to temporal changes in changing flow conditions, with each river's mix of plant and animal species having evolved over millennia to live in synchrony with its unique short and long term cyclical flow patterns. Plant species have evolved to flower and fruit at specific times of the annual flow cycle, fish time their spawning to coincide with the optimal flow and temperature conditions for their young to survive, and insects emerge from the water to mate and release their eggs at specific times of the year when air temperatures, food and other conditions are optimal. Some species thrive in drier years and others in wetter years, and so the balance of species is maintained with none dominating but rather the mix of species changing from year to year. For all of these organisms the river provides breeding sites, a nursery for their young, a highway along which they migrate and a vehicle for dispersing the next generation.

Both the spatial and temporal responses of plants and animals to changing conditions are usually set within quite specific limits—limits that are usually not known or only barely understood by humans. In most cases, we manage river ecosystems without good knowledge of what species they support, even less the needs of those species for survival. In our ignorance, however, we do at least now better understand that any physical or chemical change to an

50. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.

ecosystem outside of its natural range will disrupt relationships between species, probably reduce biological diversity and abundances, and potentially cause community shifts characterized by loss of sensitive, often rare, species and proliferation of robust, often common, species. A discussion on the impacts of dams on river ecosystems and their users is given in Appendix A of this report.

**Sensitivity Rating**

The sensitivity of each ecological zone to the construction and operation of HPPs has been placed in three categories: 'highly sensitive', 'moderately sensitive' and 'least sensitive'. These rankings are based on the Total Biodiversity Assessment Score calculated as explained below. The three fish related indicators i.e. fish diversity, economic importance of fish and conservation importance of fish are given a score of 1, 2 and 3 depending on their rating of low, medium and high respectively. If the entire zone is a protected area it is given a score of 3, if a part of the zone is included in a protected area, it is given a score of 2, and for no protected area present in the zone, a score of 0 is assigned. The Total Biodiversity Assessment Score for each zone is calculated by adding the scores for each of the four indicators and the following criteria are used to make the final assessment regarding the sensitivity of the zone to hydropower development.

Least Sensitivity Zone – Total Assessment Score of 1 – 4.

Moderate Sensitivity Zone – Total Assessment Score of 6 – 8

High Sensitivity Zone – Total Assessment Score of 9 – 12.

The sensitivity rating of each designated river zone to hydropower development is shown in Exhibit 3.45 and a map of this sensitivity zoning is shown in Exhibit 3.46.

**Exhibit 3.45: Ecological Sensitivity Zoning for Hydropower Development**

| *Zone Name* | *Ecological Zone* | *Fish Diversity* | *Economic Importance of Fish* | *Conservation Importance of Fish* | *Protected Area* | *Biodiversity Assessment Score* | *Sensitivity Classification* |
|---|---|---|---|---|---|---|---|
| Zone A | Neelum River from Taobat to Dhudnial | Low | High | Medium | Parts of zone included in Musk Deer National Park | 8 | Moderately Sensitive |
| Zone B | Neelum River from Dhudnial to Nauseri | Low | Low | Medium | No | 4 | Least Sensitive |
| Zone C | Neelum River from Nauseri to Muzaffarabad | Low | Low | Medium | No | 4 | Least Sensitive |
| Zone D | Jhelum River upstream Domel | Medium | Medium | High | No | 7 | Moderately Sensitive |
| Zone E | Jhelum River Downstream Domel | Medium | Low | Low | No | 4 | Least Sensitive |
| Zone F | Mahl Nullah | Medium | Low | High | No | 6 | Moderately Sensitive |
| Zone F | Jhelum River at and below the Confluence of Mahl Nullah | Medium | Low | Low | No | 4 | Least Sensitive |
| Zone G | Poonch River and Tributaries | High | High | High | Protected Area | 12 | Highly Sensitive |
| Zone H | Mangla Reservoir | Very High | Very High | Medium | No | 8 | Not relevant for zoning assessment |
| Zone I | Downstream of Mangla Reservoir | High | Medium | Low | No | 6 | Moderately Sensitive |

## Exhibit 3.46: Ecological Sensitivity Zones for Hydropower Development

**Discussion**

As shown in the summary table in Exhibit 3.45, only one designated river zone has been categorized as Highly Sensitive. This is Zone G that includes Poonch River and tributaries. The zones that have been categorized as Moderately Sensitive include Zone A (Neelum River from Taobat to Dudhnial), Zone D (Jhelum River upstream Dudhnial), one section of Zone F (Mahl Nullah) and Zone I (Downstream Mangla Reservoir). The reasons for these categorizations are discussed below.

**Highly Sensitive Zone**

Only the River Zone G that includes the Poonch River and tributaries has been categorized as Highly Sensitive to the construction and operation of HPPs. This is because this zone has high fish diversity, high economic and commercial importance of fish and is also a designated national park. The salient features of this zone that justify its designation as highly sensitive are outlined below:

- High fish diversity of 29 fish species in a stretch of about 100 km.
- Presence of economically important fish species including the Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio, Ompok bimaculatus Sperata seenghala, Clupisoma garua, Mastacembelus armatus, and Cyprinus carpio. Some of these fish have high commercial importance.
- Presence of endemic fish species including Barilius pakistanicus and Schistura punjabensis that are endemic to Pakistan.
- Presence of five fish species that are included in the IUCN Red List 2013. These include Tor putitora (Endangered), Schizothorax plagiostomus richardsonii (Vulnerable), Cyprinus carpio (Vulnerable), Botia rostrata (Vulnerable), Ompok bimaculatus (Vulnerable) and Ompok bimaculatus (Near Threatened).
- Highest population in the country and breeding habitat for the Endangered fish species Mahseer Tor putitora.
- Breeding ground for commercially important fish of the Mangla Reservoir.
- Natural Reserve for the Twin–banded Loach, Botia rostrata, a beautiful aquarium fish.
- Largest populations of the Labeo dyocheilus in the country which has high commercial importance.
- Supporting healthy population of Garra gotyla.

**Moderately Sensitive Zone**

The zones that have been categorized as Moderately Sensitive include Zone A (Neelum River from Taobat to Dudhnial), Zone D (Jhelum River), one section of Zone F (Mahl Nullah) and Zone I (Downstream Mangla Resrvoir). The reasons for the categorization of each zone are discussed below.

*Zone A (Neelum River from Taobat to Dudhnial)*

- High economic importance of zone due to abundance of economically important fish species Brown Trout Salmo trutta fario that has a very narrow range of occupancy.
- Medium conservation importance of zone due to presence of fish of conservation importance: Snow Trout Schizothorax plagiostomus richardsonii that is listed as Vulnerable in the IUCN Red List 2013 as well as two endemic fish species i.e. the High Altitude Loach Triplophysa stolkiczki and Kashmir Hill stream Loach Triplophysa kashmirensis, both that have restricted ranges.
- Presence of two food fish: Snow Trout Schizothorax plagiostomus and Tibetan Snow Trout Diptychus maculatus that are locally consumed as food fish.
- Some parts this zone are included in the Musk Deer National Park, which is a protected area.

*Zone D – Jhelum River upstream Domel*

- Medium fish diversity shown by 17 fish species.

- Medium economic importance of fish due to the presence of at least six to eight species that are commercially important. These include Cyprinus carpio, Schizothorax plagiostomus, Cyprinus carpio, Labeo dyocheilus, Schizothorax plagiostomus, Schizothorax curvifrons, Racoma labiatus, and Schizopyge esocinus.

- High conservation importance of zone due to presence of Kashmir Catfish Glyptothorax kashmirensis, that is listed as Critically Endangered in the IUCN Red List 2013.

- Breeding ground for fish in downstream sections of zone.

*Zone F (Mahl Nullah)*

- Medium Fish Diversity.

- High conservation importance for fish since the zone forms a breeding habitat for Endangered fish species Tor putitora.

- Presence of Vulnerable fish species Schizothorax plagiostomus.

- Presence of three fish species endemic to Pakistan including Schistura nalbanti, Barilius pakistanicus, Salmophasia punjabensis.

*Zone I (Downstream Mangla Reservoir)*

- High fish diversity shown by 44 reported species.

- Presence of several commercially important fish.

**Least Sensitive Zone**

The following zones have been categorized as least sensitive to hydropower development due to low ecological importance of these river zones as assessed in earlier sections: Zone B (Neelum River from Dudhnial to Nauseri), Zone C (Neelum River from Nauseri to Muzaffarabad), Zone E (Jhelum River downstream Domel) and Zone F excluding Mahl Nullah.

Since no further HPPs can be made on the Mangla reservoir, this zone was not assessed for sensitivity to hydropower zoning.

### 3.4.4 Conclusions

Broadly speaking, the impact of HPPs on ecosystems is usually greater for aquatic ecology as compared to terrestrial flora and fauna. Even though the construction of the power house and associated structures takes place on river banks, the proportion of habitat destroyed is small in relation to the landscape. In addition, the forests found near the rivers are at lower elevation and therefore more likely to be degraded due to anthropogenic impacts and grazing pressures. Thus terrestrial flora and associated fauna such as mammals and reptiles are not likely to be significantly affected by the construction and operation of HPPs.

River–dependent flora including riparian vegetation, and water birds such as ducks and geese, as well as river mammals such as Otter, are more likely to suffer the negative consequences from variations in flow caused by the operation of HPPs (though birds are sensitive to disturbance and tend to avoid disturbed areas). The most significant ecological impact, however, is likely to be on the aquatic ecological resources including the algal flora, macro–invertebrates and fish. The three main concerns regarding the impact of HPPs on the river flora and fauna are outlined below.

- Species of conservation importance i.e. those that are included in the IUCN Red List or are endemic should be protected from population decline. These include the fish species as well as the river–dependent mammals such as the Otter.

- Fish of economic importance including those caught for recreational fishing, those that provide food for local communities as well as fish species that have high commercial value should be protected from decline as the local communities are socially and economically dependent on these fish.

- The aquatic ecosystem integrity should be maintained. Any natural or critical habitat should be identified and protected.

- Different river segments in AJK vary in their ecological importance and thus sensitivity to hydropower development. The approach to management and protection needs to take into consideration these varying sensitivities during the design and operation of HPPs.

## 3.5 Step 6: Socioeconomic Baseline

### 3.5.1 Introduction

The purpose of this section is to provide an understanding of the existing socioeconomic conditions of AJK, especially in areas that are likely to be affected by proposed HPPs. Information provided is based on secondary sources. A considerable amount of background information on the overall socio–economic setting at the State and District levels is included in Appendix C of this report.

In line with the approach taken in the previous section, this part of the report divides the rivers of AJK into six “sensitivity segments”.

### 3.5.2 Socio–economic Indicators

Indicators are the basic building blocks of monitoring and evaluation. They help assess the nature and extent of impacts. Indicators that best capture the socioeconomic impacts of the hydropower development plan in AJK are identified with an understanding of the dependence of communities on river resources for their social and economic wellbeing. The general impacts of the development of HPPs not related to their impact on rivers, such as the creation of employment opportunities, were not considered. Such impacts are considered transient as only a few skilled personnel will ultimately be retained for a HPP once the construction phase ends.

River related dependence indicators important for assessing the socioeconomic importance and sensitivity of segments are described below.

- Fishing – Fishing provides food for local consumption and is also a source of livelihood for individuals involved in commercial fishing. Fish are also important for recreational purposes and boost tourism. Fishing is mainly undertaken in summers, when the fish collect at the shallow banks of the river. Commercial fish are usually sold in local markets and hotels. It does not form the main source of income, even for those households engaged in commercial fishing. Fish are usually caught using nets although in some places, explosives are used to kill and catch fish.

- Sand and gravel mining – more commonly undertaken in the winters (October to March) than in summers, since during low flows the sand is easier to mine along the exposed beds. The mining techniques are crude, involving use of labour for sand dredging. The sand is mined using shovels and spades and loaded onto a trolley–cart and transported to the roadside. It is then piled up along the road and sold to truck drivers passing by to collect sand for larger supply orders or in some cases loaded on a jeep and sold in nearby villages. In cases where sand is mined on the opposite side of the river bank, away from the road, it is transported to the road by the means of a pulley operated using a small diesel generator. In most cases, people undertake sand mining on their own lands. Development of HPPs will result in pressure on existing sand and gravel mines and may expand the mining locations to places previously undisturbed.

- Tourism potential – Tourism potential of the AJK overall remains largely untapped especially in the Poonch and Neelum Valleys. Development of infrastructure and roads/tunnels/reservoirs/canals as a result of hydropower development may lead to increased potential of tourism in AJK. However, only winter tourism is being considered for determining the socioeconomic sensitivity assuming all hydropower projects will release sufficient amounts of water in summers. Lack of flows in the winter season will reduce the number of game fish in the rivers and hence the number of tourists visiting for game fishing. There may also be a reduced volume of water in hydropower reservoirs, adversely affecting fishing in winters for tourists.

River–related dependence on the following has not been considered for determining socioeconomic impacts:

- Cultural and religious importance – No cultural or religious dependence on the rivers has been established in AJK.

- Use of river water for drinking and domestic purposes – People have negligible reliance on rivers for drinking and domestic uses such as washing and cooking. Usually water from streams is used for drinking and other purposes.

- Irrigation – People rely on the side–streams for irrigating agriculture fields. It is difficult to bring water from the river up to the agriculture terraces.

- Resettlement – Settlements tend to be closer to the river throughout AJK where the valley is wide. Resettlement impacts are uniformly important throughout AJK. However, since the bulk of the HPPs planned for development in AJK are RoRs, resettlement is not envisaged.

Photographs showing the tourist potential in AJK along with fishing and sand and gravel mining at different locations are given in Exhibit 3.49, Exhibit 3.50 and Exhibit 3.51.

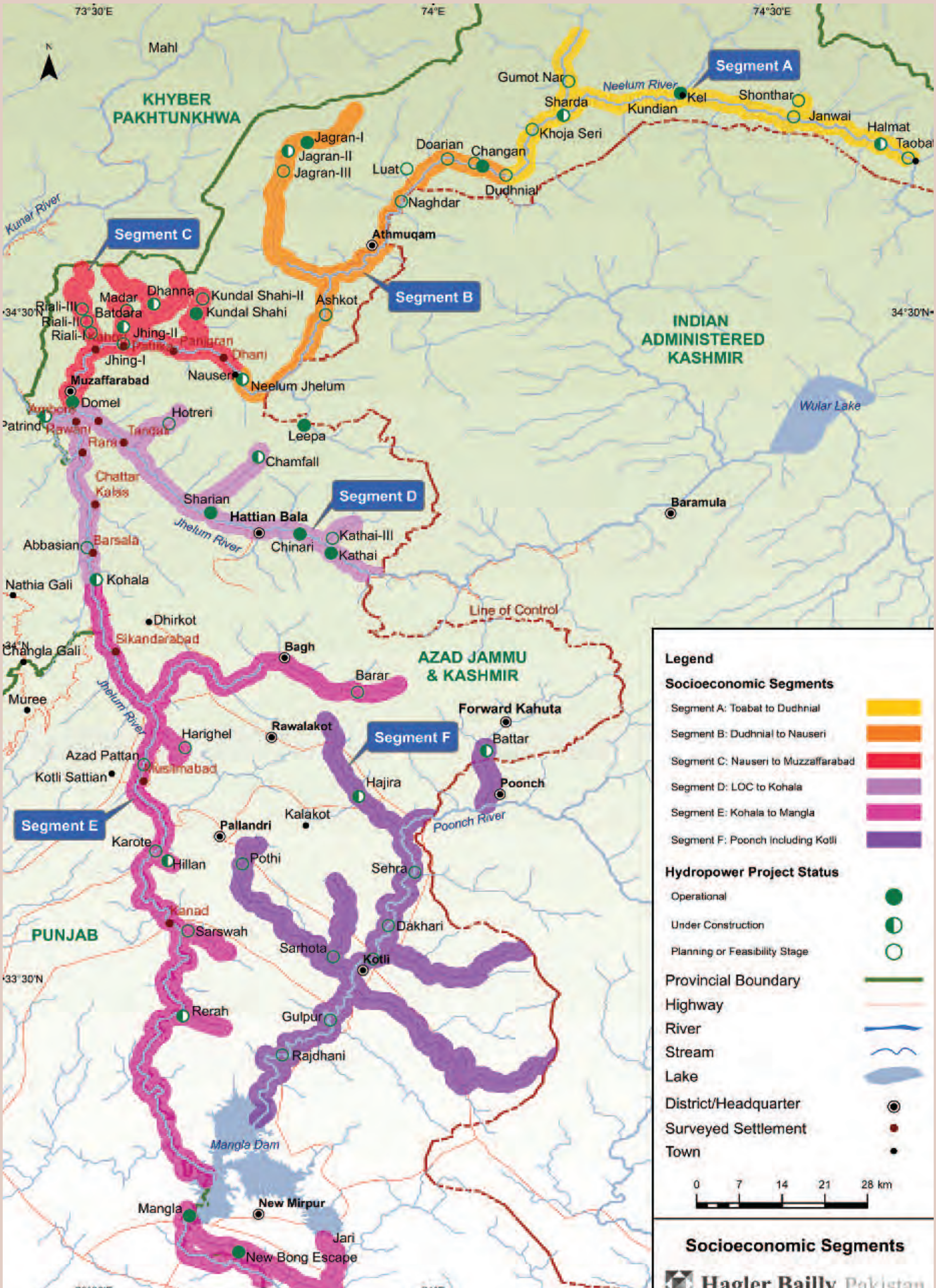
### 3.5.3 Socioeconomic Segments

Based on the socioeconomic indicators discussed in the previous section, the rivers in AJK have been broadly divided into six segments given in Exhibit 3.47. These segments are shown on a map in Exhibit 3.48. The socioeconomic sensitivity of each of these segments to HPP development within the segment is summarized in Exhibit 3.52. This is followed by a rating of the sensitivity of the segments (in Section 3.7) as ‘Least’, ‘Moderate’ or ‘Highly’ sensitive to HPP development.

**Exhibit 3.47: Socioeconomic Segments of HPP Development in AJK**

| *River* | | *Segment* |
|---|---|---|
| Neelum | Segment A | Taobat to Dudhnial |
| Neelum | Segment B | Dudhnial to Nauseri |
| Neelum | Segment C | Nauseri to Muzaffarabad |
| Jhelum | Segment D | LoC (Upstream Jhelum River) to Kohala |
| Jhelum | Segment E | Kohala to Mangla |
| Poonch | Segment F | Poonch including Kotli |

## Exhibit 3.48: Socioeconomic Segments in AJK



## Exhibit 3.49: Fishing at Jhelum and Poonch Rivers


Recreational Fishing – Jhelum River


Fishing with Nets – Poonch River

## Exhibit 3.50: Sand Mining and Transportation


Sand deposits downstream Muzaffarabad


Trucks used for sand transportation – Jhelum River


Sand transportation across Neelum River near Kanad


Sandy Floodplains In Barsala – Jhelum River


Labourers loading trucks with sand – Poonch River


Trucks used for sand transportation – Poonch River

Sand deposits – Poonch River

Sand and gravel at banks – Poonch River

## Exhibit 3.51: Neelum Valley – Tourism Potential

### Exhibit 3.52: Importance of Socioeconomic Segments

| *Segment* | *Socioeconomic Importance* |
|---|---|
| **A – Taobat to Dudhnial** | The segment is entirely rural. Villages with agricultural areas along the banks of the river are common. The villages are mainly located on the right bank, which has low topographic relief, while there is a thick cover of mixed conifer and deciduous trees on the steeper left bank. Agriculture forms the main occupation in this segment and is based on rainfall and water provided by irrigation channels that are fed by tributaries or side streams. Seasonal migration to urban areas downstream for employment is common.<br><br>*Fishing:* Brown Trout, commonly found in this segment, is important commercially and for sport fishing. Alwan Snow Trout and Tibetan Snow Trout are locally consumed as food fish.<br><br>*Sand and gravel mining:* Sand and gravel mining is not very common in this segment.<br><br>*Tourism potential:* Tourism is seasonal in the Neelum Valley. The Valley hosts tourists in summers only because the temperatures in winter drop below freezing. Tourist accommodation is available at Kel, Sharda and Keran. Linkages of the people's livelihoods to the Neelum River in the winter season are limited to river–based tourism and related activities, such as sport fishing. |
| **B – Dudhnial to Nauseri** | Like Segment A, this segment also entirely rural. The sizes of the settlements are larger in this segment in comparison to segment A. People serve as labourers and government servants in the area. Seasonal migration for employment is negligible.<br><br>*Fishing:* Brown Trout has high commercial value but has low abundance in this segment and is only seen in the winter months. Alwan Snow Trout is locally consumed as food fish.<br><br>*Sand and gravel mining:* Sand and gravel mining is not very common in this segment.<br><br>*Tourism potential:* The segment has low importance in terms of winter tourism potential relative to Segment A. |
| **C – Nauseri to Muzaffarabad** | This segment is made up of both rural and urban areas. The area from Nauseri to upstream of Muzaffarabad city is entirely rural. From Nauseri to Pattika, the slopes are steep and communities are located up the slopes away from the river. From Pattika onwards the valley widens in this segment and communities are located both closer to the river as well as up the mountains. The main occupations of people living in the rural areas are drivers, labourers, masons, shopkeepers, and overseas employment as drivers or labourers (mainly Saudi Arabia). Local people are also involved in sand mining (including labourers). The economy of Muzaffarabad city is not centered on the river. Livelihoods mostly relate to district and state governance, in addition to private education and health sectors, and business and trade. Rivers benefit the riverside hotels, which tourists prefer to those located away from the river. The infrastructure for boating and sport fishing is there.<br><br>Dependence on river resources is negligible except for sand and gravel mining.<br><br>*Fishing:* Alwan Snow Trout is the only fish of this zone that has a high commercial importance. However, this fish is found throughout the Neelum River, so fishing has an overall low importance.<br><br>*Sand and gravel mining:* Sand and gravel is mined in this segment and has medium importance in terms of dependence.<br><br>*Tourism potential:* The segment in itself has low importance in terms of tourism potential in winter. It is usually the first stop for tourists heading further north towards the scenic spots in summer. |

| Segment | Socioeconomic Importance |
|---|---|
| D – LoC (Upstream Jhelum River) to Kohala | The area is a combination of small towns and rural agro–pastoral communities. In the towns (Garhi Dupatta and Hattian Bala), people are largely employed as government servants (education and health sectors), military service, traders and shopkeepers. Though the valley widens in these parts and is rather picturesque, tourists prefer the less–developed setting of the Neelum valley (upstream of Nauseri). Household recreational use of river is also less but other than that, there are no river related activities. Sand is imported from Muzaffarabad.<br>In areas closer to Muzaffarabad city such as Tandali and Ambore, livelihoods are mostly connected to the city. Sand mining is extensive in these parts as larger sandy floodplains occur here. Agriculture is common alongside the banks. Fields closer to the banks are flooded in the summers. Irrigation is entirely based on side–streams. Fishing is also observed in this segment but is not very extensive.<br>*Fishing:* At least six to eight fish species found in this zone are commercially important. The economic importance of fish species in this zone is therefore medium.<br>*Sand and gravel mining:* Sand and gravel mining is carried out in this segment.<br>*Tourism potential:* The segment has low importance in terms of winter tourism potential. |
| E – Kohala – Mangla | Downstream Kohala up to Kanad the valley is narrow and settlements are located up the slopes away from the river, closer to the road and side–springs. The dependence on river resources is negligible. The area is entirely rural. Livestock rearing is common in this part. Closer to Hollar Bridge, the Jhelum valley opens up, the climate is warmer and agriculture is more prevalent.<br>*Fishing:* The Alwan Snow Trout and Golden Mahseer are commercially important fish species found in this segment, however, the abundance of these fish is small compared to the Mangla reservoir. Therefore, the economic importance of fish in this segment is counted as low.<br>*Sand and gravel mining:* Sand and gravel is not very common in this segment.<br>*Tourism potential:* The segment has negligible potential for tourism in winter. |
| F – Poonch and Kotli | Population density is high in this segment. It is highly important in terms of dependence of local communities on river resources.<br>*Fishing:* Poonch River is home to a number of commercially important fish including Mahaseer, Alwan Snow Trout, Common Carp, and Butter catfish. Overall, the economic importance of fish in this segment is high.<br>*Sand and gravel mining:* Extensive sand and gravel mining is observed the segment which meets the local demand.<br>*Tourism potential:* Winter tourism has high potential in Poonch due to the warmer climate. People from Islamabad and other areas tend to visit Poonch in winters. |

### 3.5.4 Sensitivity Rating

This section assesses the sensitivity of each segment to hydropower development keeping in the following indicators which were introduced in the previous section:

- Fishing (commercial, subsistence, recreational);
- Sand and gravel mining; and
- Tourism Potential.

First, each indicator is "scored" for each of the six segments, according to the impact of proposed HPPs. The outcome of this scoring exercise is presented in Exhibit 3.53. An indicator is given a score of "1" if impacts are likely to be low, "2" if medium, and "3" if high.

The Total Socioeconomic Assessment Score (TSAS) for each segment is then calculated by adding the scores for each of the three indicators. The following system is used to make the final assessment regarding the sensitivity of the each segment to hydropower development:

**Least Sensitivity Zone – Total Assessment Score of 1 – 3.**

**Moderate Sensitivity Zone – Total Assessment Score of 4 – 6.**

**High Sensitivity Zone – Total Assessment Score of 7 – 9.**

The socioeconomic sensitivity rating of each segment is shown in Exhibit 3.53 and the mapped sensitivity zones are shown in Exhibit 3.54.

**Exhibit 3.53: Socioeconomic Sensitivity of Segments for Hydropower Development**

| *River* | *Segment* | *Socioeconomic Segment* | *Fishing (commercial, subsistence, recreational)* | *Sand and Gravel Mining* | *Tourism Potential* | *Socioeconomic Assessment Score* | *Sensitivity Classification* |
|---|---|---|---|---|---|---|---|
| Neelum | Segment A | Taobat to Dhudnial | High | Low | Low | 5 | Moderately Sensitive |
| Neelum | Segment B | Dhudnial to Nauseri | Low | Low | Low | 3 | Least Sensitive |
| Neelum | Segment C | Nauseri to Muzaffarabad | Low | Medium | Low | 4 | Moderately Sensitive |
| Jhelum | Segment D | LoC (Upstream of Jhelum River) to Kohala | Medium | Medium | Low | 6 | Moderately Sensitive |
| Jhelum | Segment E | Kohala to Mangla | Medium | Low | Low | 4 | Moderately Sensitive |
| Poonch | Segment F | Poonch including Kotli | High | High | High | 9 | Highly Sensitive |

## Exhibit 3.54: Socioeconomic Sensitivity Segments for Hydropower Development

### 3.5.5 Discussion and Conclusion

As shown in Exhibit 3.54, only Segment F, which follows the Poonch River from the Line of Control to the Mangla reservoir, is categorized as 'Highly Sensitive'. Segments A, C, D and E, which respectively cover the areas around the river from Taobat to Dhudnial, Nauseri to Muzaffarabad, Line of Control to Kohala, and from Kohala to Mangla, have been categorized as 'Moderately Sensitive'. Segment B from Dhudnial to Nauseri has been categorized as being 'Least Sensitive' to hydropower development impacts in AJK.

***Highly Sensitive Zone***

Only Segment F that includes the Poonch and Kotli has been categorized as Highly Sensitive to the construction and operation of hydropower projects. This is because in this segment fishing has high commercial, subsistence and recreational importance, sand and gravel mining is extensive and meets the requirements of a large population, and strong potential exists for tourism in the winter months. The socioeconomic condition of the people in this segment therefore has a comparatively higher level of dependence on the river resources as compared to other segments. The following is an overview of principle socioeconomic characteristics of this zone.

- The Poonch River is home to a number of commercially important fish including Mahaseer, Alwan Snow Trout, Common Carp, and Butter Catfish. HPPs on rivers and streams in this zone will adversely affect fish abundance, thereby depriving locals of supplementary income. Fish species able to grow in RoR reservoirs and ponds in AJK do not have the same commercial value as the endemic migratory fish species.

- HPPs requiring materials for construction in this region will put greater pressure on the existing areas for sand and gravel mining. Reduced supply due to trapping of sand and gravel in the reservoirs will lead to an increase in price and hence greater cost of construction raw materials. New mining areas may have to be opened up in the region. The trucking industry transporting the raw materials will benefit from increases in transportation business.

- Relatively warmer winters in this region— compared to northern AJK— offers visiting opportunities to tourists from Islamabad and adjoining areas all year round. The construction and operation of a number of HPPs in this region may have both an increased positive and negative impact. Others interested in water sports or scenic treks may find artificial RoR ponds and reservoirs offering water sports an added attraction to visit even in winters.

***Moderately Sensitive Zone***

Compared to the Highly Sensitive zone, the communities in this zone have relatively lower dependence on commercial fishing, sand and gravel mining, and winter tourism. The following is an overview of principle socioeconomic characteristics of this segment.

- A variety of commercially valued fish species, mainly the Alwan Snow Trout and Brown Trout, helps people in these zones to supplement their diet and incomes. HPPs on rivers and streams in this zone will adversely affect fish abundance, thereby depriving communities of associated benefits.

- Parts of the valleys in this zone, such as the areas near Muzaffarabad, widen and provide floodplains where sand is deposited. Sand and gravel mining is prevalent in these areas and contributes is a source of livelihood for some. The HPPs in this zone do not depend on construction materials from the river as the supply is limited.

***Least Sensitive Zone***

The livelihoods of people in this zone have minimal dependence on commercial fishing, sand and gravel mining, and tourism. Main occupations of people living in this zone are government service, drivers, masons and daily labour.

- Although high–value commercial fish such as Brown Trout exist in this zone, their abundance is very low to provide substantial supplementary income. The HPPs in this region will have little or no impact on incomes of people derived from fishing.

- There is little or no sand and gravel mining in this zone and there is virtually no winter tourism.

### 3.6 Step 7: Results

In this section, the Cumulative Impact Zones identified in Section 3.3.6 are superimposed on the ecologically and socioeconomically sensitive segments of AJK identified in Section 3.4 and Section 3.5 respectively. The identification and demarcation of the Cumulative Impact Zones in Section 3.3.6 did not take into account the existing ecological and socioeconomic baseline conditions existing along the rivers and streams of interest. They were determined on the basis of the drivers of impacts of HPPs of different sizes and the resulting mechanics of cumulative impacts within the context of the topographical, hydrological and social features of the state.

The severity and extent of the environmental and social impacts determined whether the Cumulative Impact Zones were Extremely Critical, Highly Critical or Moderately Critical. Superimposing the Cumulative Impact Zones onto the ecologically and socioeconomically sensitive river/stream segments will allow the HPPs in the hydropower development plan to be ranked according to their cumulative impact potential.

#### 3.6.1 Cumulative Impacts in Ecologically Sensitive Zones

Exhibit 3.55 lists the ecologically sensitive areas of AJK identified at the end of Section 3.4. Exhibit 3.56 lists the number of Extremely, Highly and Moderately Critical Impact Zones within the ecologically sensitive areas, and Exhibit 3.57 illustrates the cumulative impact zones on a map in the different ecologically sensitive segments.

**Exhibit 3.55: Ecological Sensitivity Zones for Hydropower Development in AJK**

| *Sensitivity Classification* | *Ecological Zone* |
|---|---|
| Highly Sensitive | Poonch River and Tributaries |
| Moderately Sensitive | Neelum River from Taobat to Dhudnial |
| | Jhelum River upstream Domel |
| | Mahl Nullah |
| | Downstream of Mangla Reservoir |
| Least Sensitive | Neelum River from Dhudnial to Nauseri |
| | Neelum River from Nauseri to Muzaffarabad |
| | Jhelum River Downstream Domel |
| | Jhelum River at and below the Confluence of Mahl Nullah |

**Exhibit 3.56: Number of Cumulative Impact Zones in Different Ecologically Sensitive Areas of AJK**

| | | *Number of Cumulative Impact Zones* | | | |
|---|---|---|---|---|---|
| *Sensitivity Classification* | *Ecological Zone* | *Extremely Critical Zone* | *Highly Critical Zone* | *Moderately Critical Zone* | *Total* |
| Highly Sensitive | Poonch River and Tributaries | 3 | 1 | 4 | 8 |
| Moderately Sensitive | Neelum River from Taobat to Dhudnial | 3 | – | 2 | 5 |
| | Jhelum River upstream Domel | – | 3 | 2 | 5 |
| | Mahl Nullah | – | – | 1 | 1 |
| | Downstream of Mangla Reservoir | – | 1 | – | 1 |
| Least Sensitive | Neelum River from Dhudnial to Nauseri | 1 | 3 | – | 4 |
| | Neelum River from Nauseri to Muzaffarabad | 2 | 3 | 1 | 6 |
| | Jhelum River Downstream Domel | 2 | – | – | 2 |
| | Jhelum River at and below the Confluence of Mahl Nullah | 2 | 3 | – | 5 |

**Exhibit 3.57: Cumulative Impact Zones Superimposed on the Ecologically Sensitive Areas of AJK**

***Ranking of HPPs Critical to the Ecological Zones of AJK***

Superimposing the Cumulative Impact Zones onto the ecologically sensitive segments of rivers and streams helps to rank the HPPs based on their cumulative impact potential.

Exhibit 3.58 provides the rankings of the HPPs with those at the top having the greatest cumulative impact potential.

The top ten HPPs (1–10) are those located in the Highly Sensitive ecological zones of the State. These are followed by HPPs located in Moderately Sensitive (11–27) and Least Sensitive (28–58) ecological zones. Within each sensitivity zone, HPPs considered being Extremely Critical in terms of their potential to contribute to cumulative impacts are placed at the top. These are followed by HPPs considered Highly Critical and Moderately Critical.

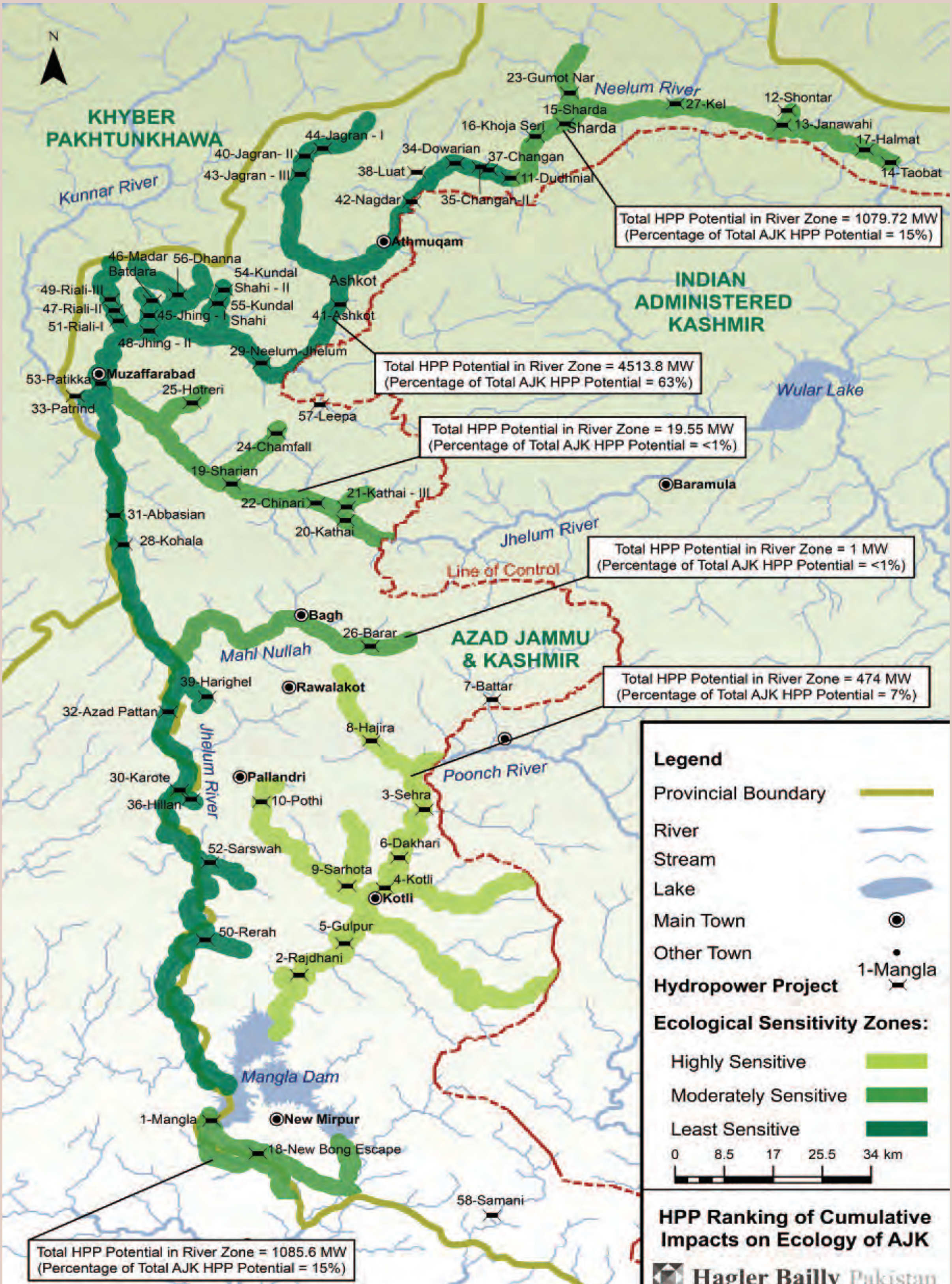
Exhibit 3.59 presents a map of the HPPs in the hydropower development plan of AJK and their ranking based on their ecological impact.

**Exhibit 3.58: HPPs in the Hydropower Development Plan Ranked in terms of their Impact on the Ecology of AJK**

| *Ecological Ranking (out of 58)* | *HPP* | *Installed Capacity (MW)* | *Project Status* | *Executing Agency* | *Sensitivity of Ecological Zone* | *Nature of Impact in the Ecological Zone* |
|---|---|---|---|---|---|---|
| 1 | Mangla | 1000 | Operational | WAPDA | High | Extremely Critical |
| 2 | Rajdhani | 132 | Planning or Feasibility Stage | PPIB | High | Extremely Critical |
| 3 | Sehra | 130 | Planning or Feasibility Stage | PPIB | High | Extremely Critical |
| 4 | Kotli | 100 | Planning or Feasibility Stage | PPIB | High | Extremely Critical |
| 5 | Gulpur | 100 | Planning or Feasibility Stage | PPIB | High | Extremely Critical |
| 6 | Dakhari | 2 | Planning or Feasibility Stage | PPC | High | Highly Critical |
| 7 | Battar | 5 | Under Construction | HEB | High | Moderately Critical |
| 8 | Hajira | 3 | Under Construction | HEB | High | Moderately Critical |
| 9 | Sarhota | 1 | Planning or Feasibility Stage | PPC | High | Moderately Critical |
| 10 | Pothi | 1 | Planning or Feasibility Stage | PPC | High | Moderately Critical |
| 11 | Dudhnial | 960 | Planning or Feasibility Stage | WAPDA | Moderate | Extremely Critical |
| 12 | Shontar | 52 | Planning or Feasibility Stage | HEB | Moderate | Extremely Critical |
| 13 | Janawahi | 12 | Planning or Feasibility Stage | PPIB | Moderate | Extremely Critical |
| 14 | Taobat | 10 | Planning or Feasibility Stage | PPIB | Moderate | Extremely Critical |
| 15 | Sharda | 3 | Under Construction | HEB | Moderate | Extremely Critical |
| 16 | Khoja Seri | 2 | Planning or Feasibility Stage | PPC | Moderate | Extremely Critical |
| 17 | Halmat | 0.32 | Under Construction | HEB | Moderate | Extremely Critical |
| 18 | New Bong Escape | 84 | Operational | PPC | Moderate | Highly Critical |
| 19 | Sharian | 3 | Operational | HEB | Moderate | Highly Critical |
| 20 | Kathai | 2 | Operational | HEB | Moderate | Highly Critical |
| 21 | Kathai – III | 1 | Planning or Feasibility Stage | PPC | Moderate | Highly Critical |
| 22 | Chinari | 0.2 | Operational | PPC | Moderate | Highly Critical |
| 23 | Gumot Nar | 40 | Planning or Feasibility Stage | PPC | Moderate | Moderately Critical |
| 24 | Chamfall | 6 | Under Construction | HEB | Moderate | Moderately Critical |
| 25 | Hotreri | 5 | Planning or Feasibility Stage | PPC | Moderate | Moderately Critical |
| 26 | Barar | 1 | Planning or Feasibility Stage | PPC | Moderate | Moderately Critical |
| 27 | Kel | 0.4 | Operational | HEB | Moderate | Moderately Critical |

| *Ecological Ranking (out of 58)* | *HPP* | *Installed Capacity (MW)* | *Project Status* | *Executing Agency* | *Sensitivity of Ecological Zone* | *Nature of Impact in the Ecological Zone* |
|---|---|---|---|---|---|---|
| 28 | Kohala | 1100 | Planning or Feasibility Stage | PPIB | Least | Extremely Critical |
| 29 | Neelum–Jhelum | 969 | Under Construction | WAPDA | Least | Extremely Critical |
| 30 | Karote | 720 | Planning or Feasibility Stage | PPIB | Least | Extremely Critical |
| 31 | Abbasian | 360 | Planning or Feasibility Stage | PPIB | Least | Extremely Critical |
| 32 | Azad Pattan | 222 | Planning or Feasibility Stage | PPIB | Least | Extremely Critical |
| 33 | Patrind | 147 | Under Construction | PPIB | Least | Extremely Critical |
| 34 | Dowarian | 40 | Planning or Feasibility Stage | HEB | Least | Extremely Critical |
| 35 | Changan–II | 9 | Planning or Feasibility Stage | PPIB | Least | Extremely Critical |
| 36 | Hillan | 1 | Under Construction | HEB | Least | Extremely Critical |
| 37 | Changan | 0.05 | Operational | HEB | Least | Extremely Critical |
| 38 | Luat | 63 | Planning or Feasibility Stage | HEB | Least | Highly Critical |
| 39 | Harighel | 53 | Planning or Feasibility Stage | PPIB | Least | Highly Critical |
| 40 | Jagran– II | 44 | Under Construction | HEB | Least | Highly Critical |
| 41 | Ashkot | 40 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 42 | Nagdar | 35 | Planning or Feasibility Stage | HEB | Least | Highly Critical |
| 43 | Jagran–III | 35 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 44 | Jagran – I | 30 | Operational | HEB | Least | Highly Critical |
| 45 | Jhing – I | 14 | Under Construction | HEB | Least | Highly Critical |
| 46 | Madar Batdara | 10 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 47 | Riali–II | 5 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 48 | Jhing – II | 4 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 49 | Riali – III | 4 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 50 | Rerah | 3 | Under Construction | HEB | Least | Highly Critical |
| 51 | Riali–I | 2 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 52 | Sarswah | 1 | Planning or Feasibility Stage | PPC | Least | Highly Critical |
| 53 | Patikka | 0.05 | Operational | HEB | Least | Highly Critical |
| 54 | Kundal Shahi – II | 600 | Planning or Feasibility Stage | WAPDA | Least | Moderately Critical |
| 55 | Kundal Shahi | 2 | Operational | HEB | Least | Moderately Critical |
| 56 | Dhanna | 2 | Under Construction | HEB | Least | Moderately Critical |
| 57 | Leepa | 2 | Operational | HEB | Least | Moderately Critical |
| 58 | Samani | 2 | Planning or Feasibility Stage | PPC | Least | Moderately Critical |

## Exhibit 3.59: A Map of HPPs in the Hydropower Development Plan of AJK and their Ranking based on their Cumulative Ecological Impact



### 3.6.2 Cumulative Impacts in Socioeconomically Sensitive Segments

Exhibit 3.60 lists the socioeconomically sensitive areas of AJK identified at the end of Section 3.5. Exhibit 3.61 lists the number of Extremely, Highly and Moderately Critical Impact Zones in the socioeconomically sensitive areas. Exhibit 3.62 illustrates the cumulative impact zones on a map in the different ecologically sensitive segments.

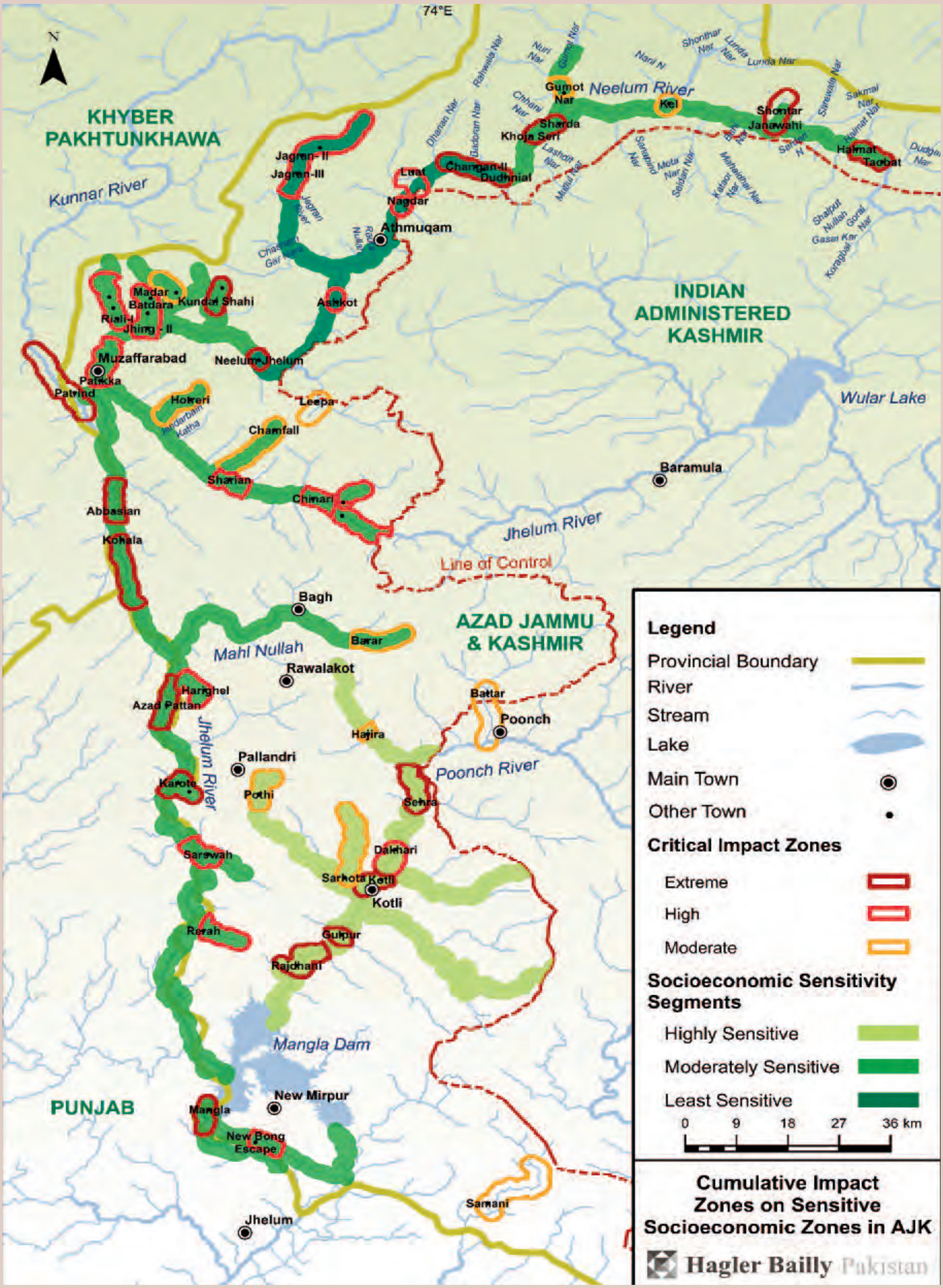
**Exhibit 3.60: Sensitive Socioeconomic Zones for Hydropower Development in AJK**

| *Sensitivity Classification* | *Socioeconomic Segments* |
|---|---|
| Highly Sensitive | Poonch including Kotli |
| Moderately Sensitive | Taobat to Dhudnial |
| | Nauseri to Muzaffarabad |
| | LoC (Upstream of Jhelum River) to Kohala |
| | Kohala to Mangla |
| Least Sensitive | Dhudnial to Nauseri |

**Exhibit 3.61: Number of Cumulative Impact Zones in Different Socioeconomically Sensitive Areas of AJK**

| | | *Number of Cumulative Impact Zones* | | | |
|---|---|---|---|---|---|
| *Sensitivity Classification* | *Ecological Zone* | *Extremely Critical Zone* | *Highly Critical Zone* | *Moderately Critical Zone* | *Total* |
| Highly Sensitive | Poonch including Kotli | 8 | 8 | 8 | 24 |
| Moderately Sensitive | Taobat to Dhudnial | 3 | – | 2 | 5 |
| | Nauseri to Muzaffarabad | 1 | 3 | 1 | 5 |
| | LoC (Upstream of Jhelum River) to Kohala | 2 | 3 | 2 | 7 |
| | Kohala to Mangla | 3 | 4 | 1 | 8 |
| Least Sensitive | Dhudnial to Nauseri | 1 | 2 | – | 3 |

**Exhibit 3.62: Cumulative Impact Zones Superimposed on the Socioeconomically Sensitive Areas of AJK**



***Ranking of HPPs Critical to the Socioeconomic Zones of AJK***

Superimposing the Cumulative Impact Zones onto the socioeconomically sensitive segments of rivers and streams helps to rank the HPPs based on their cumulative impact potential.
Exhibit 3.63 provides the rankings of the HPPs with those at the top having the greatest cumulative impact potential.

The top nine HPPs (1–9) are those located in the Highly Sensitive socioeconomic zones of the State. These are followed by HPPs located in Moderately Sensitive (10–45) and Least Sensitive (46–58) socioeconomic zones. Within each sensitivity zone, HPPs considered being Extremely Critical in terms of their potential to contribute to cumulative impacts are placed at the top. These are followed by HPPs considered Highly Critical and Moderately Critical.

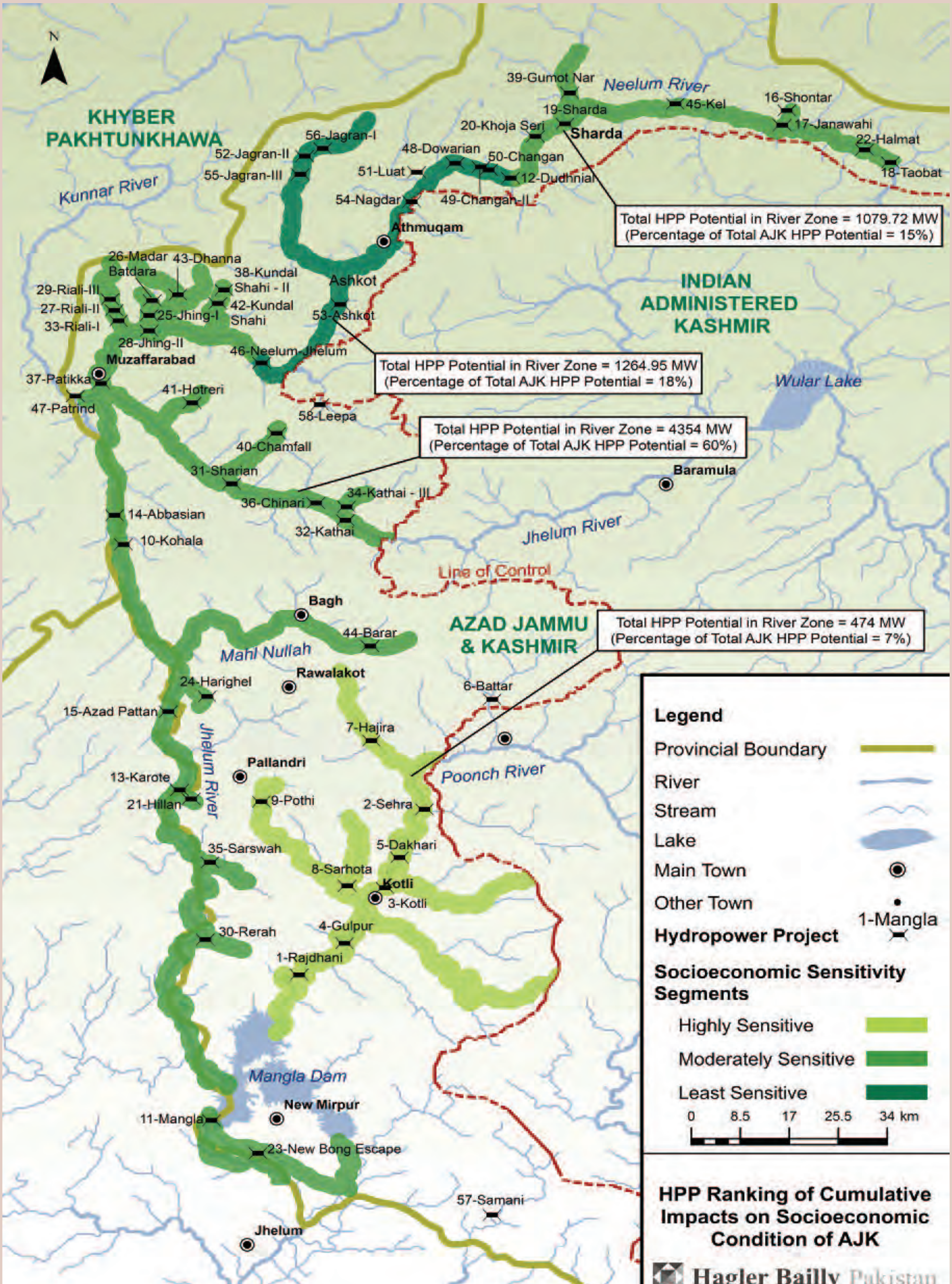
Exhibit 3.64 presents a map of the HPPs in the hydropower development plan of AJK and their ranking based on their cumulative impact potential on the socioeconomic condition of the state.

**Exhibit 3.63: HPPs in the Hydropower Development Plan Ranked in terms of their Impact on Socioeconomic Conditions**

| *Socio-economic Ranking (out of 58)* | *HPP* | *Installed Capacity (MW)* | *Project Status* | *Executing Agency* | *Sensitivity of Socio-economic Zone* | *Nature of Impact in the Socio-economic Zone* |
|---|---|---|---|---|---|---|
| 1 | Rajdhani | 132 | Planning or Feasibility Stage | PPIB | High | Extreme |
| 2 | Sehra | 130 | Planning or Feasibility Stage | PPIB | High | Extreme |
| 3 | Kotli | 100 | Planning or Feasibility Stage | PPIB | High | Extreme |
| 4 | Gulpur | 100 | Planning or Feasibility Stage | PPIB | High | Extreme |
| 5 | Dakhari | 2.2 | Planning or Feasibility Stage | PPC | High | High |
| 6 | Battar | 4.8 | Under Construction | HEB | High | Moderate |
| 7 | Hajira | 3 | Under Construction | HEB | High | Moderate |
| 8 | Sarhota | 1 | Planning or Feasibility Stage | PPC | High | Moderate |
| 9 | Pothi | 1 | Planning or Feasibility Stage | PPC | High | Moderate |
| 10 | Kohala | 1100 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 11 | Mangla | 1000 | Operational | WAPDA | Moderate | Extreme |
| 12 | Dudhnial | 960 | Planning or Feasibility Stage | WAPDA | Moderate | Extreme |
| 13 | Karote | 720 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 14 | Abbasian | 360 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 15 | Azad Pattan | 222 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 16 | Shontar | 52 | Planning or Feasibility Stage | HEB | Moderate | Extreme |
| 17 | Janawahi | 12 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 18 | Taobat | 10 | Planning or Feasibility Stage | PPIB | Moderate | Extreme |
| 19 | Sharda | 3 | Under Construction | HEB | Moderate | Extreme |
| 20 | Khoja Seri | 2 | Planning or Feasibility Stage | PPC | Moderate | Extreme |
| 21 | Hillan | 0.6 | Under Construction | HEB | Moderate | Extreme |
| 22 | Halmat | 0.32 | Under Construction | HEB | Moderate | Extreme |
| 23 | New Bong Escape | 84 | Operational | PPC | Moderate | High |
| 24 | Harighel | 53 | Planning or Feasibility Stage | PPIB | Moderate | High |
| 25 | Jhing – I | 14.4 | Under Construction | HEB | Moderate | High |
| 26 | Madar Batdara | 10.2 | Planning or Feasibility Stage | PPC | Moderate | High |

| Socio-economic Ranking (out of 58) | HPP | Installed Capacity (MW) | Project Status | Executing Agency | Sensitivity of Socio-economic Zone | Nature of Impact in the Socio-economic Zone |
|---|---|---|---|---|---|---|
| 27 | Riali–II | 4.9 | Planning or Feasibility Stage | PPC | Moderate | High |
| 28 | Jhing – II | 4 | Planning or Feasibility Stage | PPC | Moderate | High |
| 29 | Riali – III | 3.7 | Planning or Feasibility Stage | PPC | Moderate | High |
| 30 | Rerah | 3.2 | Under Construction | HEB | Moderate | High |
| 31 | Sharian | 3.2 | Operational | HEB | Moderate | High |
| 32 | Kathai | 1.6 | Operational | HEB | Moderate | High |
| 33 | Riali–I | 1.6 | Planning or Feasibility Stage | PPC | Moderate | High |
| 34 | Kathai – III | 1.15 | Planning or Feasibility Stage | PPC | Moderate | High |
| 35 | Sarswah | 0.7 | Planning or Feasibility Stage | PPC | Moderate | High |
| 36 | Chinari | 0.2 | Operational | PPC | Moderate | High |
| 37 | Patikka | 0.05 | Operational | HEB | Moderate | High |
| 38 | Kundal Shahi – II | 600 | Planning or Feasibility Stage | WAPDA | Moderate | Moderate |
| 39 | Gumot Nar | 40 | Planning or Feasibility Stage | PPC | Moderate | Moderate |
| 40 | Chamfall | 6.4 | Under Construction | HEB | Moderate | Moderate |
| 41 | Hotreri | 5.4 | Planning or Feasibility Stage | PPC | Moderate | Moderate |
| 42 | Kundal Shahi | 2 | Operational | HEB | Moderate | Moderate |
| 43 | Dhanna | 1.5 | Under Construction | HEB | Moderate | Moderate |
| 44 | Barar | 1 | Planning or Feasibility Stage | PPC | Moderate | Moderate |
| 45 | Kel | 0.4 | Operational | HEB | Moderate | Moderate |
| 46 | Neelum–Jhelum | 969 | Under Construction | WAPDA | Least | Extreme |
| 47 | Patrind | 147 | Under Construction | PPIB | Least | Extreme |
| 48 | Dowarian | 40 | Planning or Feasibility Stage | HEB | Least | Extreme |
| 49 | Changan–II | 9 | Planning or Feasibility Stage | PPIB | Least | Extreme |
| 50 | Changan | 0.05 | Operational | HEB | Least | Extreme |
| 51 | Luat | 63 | Planning or Feasibility Stage | HEB | Least | High |
| 52 | Jagran– II | 43.5 | Under Construction | HEB | Least | High |
| 53 | Ashkot | 40 | Planning or Feasibility Stage | PPC | Least | High |
| 54 | Nagdar | 35 | Planning or Feasibility Stage | HEB | Least | High |
| 55 | Jagran–III | 35 | Planning or Feasibility Stage | PPC | Least | High |
| 56 | Jagran – I | 30.4 | Operational | HEB | Least | High |
| 57 | Samani | 1.6 | Planning or Feasibility Stage | PPC | Least | Moderate |
| 58 | Leepa | 1.6 | Operational | HEB | Least | Moderate |

**Exhibit 3.64: A Map of HPPs in the Hydropower Development Plan of AJK and their Ranking based on their Cumulative Socio–Economic Impact**



### 3.6.3 Conclusions

***Summary of the Study Methodology***

To reiterate, the final ranking of HPPs according to their cumulative impact potential was undertaken using the following procedural steps:

- a division of HPPs against a 50 MW benchmark, set as a result of an analysis of the layout and structural components of six HPPs, and identification of the main drivers of impacts;
- identification of the environmental and social impacts of HPPs relevant to the hydrological, topographical and socioeconomic context;
- identification of Cumulative Impact Zones based on the location of HPPs on nullahs or main river stems;
- categorization of the Cumulative Impact Zones based on the extent and magnitude of the impacts of a number of HPPs in different parts of the river systems;
- identification and categorization of sensitive ecological zones;
- identification and categorization of sensitive socioeconomic zones; and,
- ranking HPPs in terms of their potential cumulative impacts on the existing ecology and socioeconomic condition of the State.

The ranking of an HPP based on these procedures enables the proponents of the project, environmental consultants, state agencies and AJKEPA to identify, at a glance;

- the overall existing ecological and socioeconomic picture of the area where a HPP is being planned for development or currently in the process of being constructed and the regions where more detailed studies need to be prioritized;
- the scale of the impact an HPP will have on the ecology and socioeconomic condition of the area where it will be located;
- the contribution of an HPP to the overall cumulative impacts from the development of all the HPPs in the plan;
- the potential need for a change of qualifying conditions for either EIA or IEE studies for different HPPs, and the detail in which the ecological and socioeconomic impact assessment studies need to be conducted for projects based on their location;
- the role and significance of coordination between HEB, PPC, WAPDA, PPIB and AJKEPA in developing the hydropower plan in a manner which minimizes impacts;
- an opportunity for revising the Plan as a whole or revising the type, size, layout and structural components of a HPP to utilize any benefit from other HPPs being built in the vicinity; and,
- the regions in AJK where public awareness campaigns need to be organized by the government to help monitor HPPs during the construction and operation phases.

***Outcomes of the HPP Ranking***

A clear outcome from the cumulative impact assessment is that the area of most concern, both from ecological and socio–economic perspectives, is the Poonch River and its feed–in nullahs from the Line of Control down to the Mangla Dam. The nine proposed HPPs all rank highest for potential ecological and social impact. As indicated in Exhibits 3.58 and 3.63, however, it should be noted that the Poonch River segment only accounts for 7% of the total AJK hydropower generation potential.

Section 4 of this final report examines the implications of the cumulative impact assessment outcomes for decision–making.

# 4. Phase 3: Informing Decision–making

## 4.1 Introduction

Phase 3 of the SEA pilot presented recommendations for institutional reform that will allow overall hydropower planning for AJK to be improved. The following recommendations focus on: clarifying responsibilities for hydropower plan ownership; improving project development planning; guidelines for environmental impact assessment; and, proposing minor regulatory amendments.

## 4.2 Clarifying Responsibilities for Plan Ownership

Section 2 of this final report described, in detail, existing and proposed hydropower projects. According to the latest information available from all the government agencies involved in hydropower development in AJK, there are currently 12 operational hydropower projects in the state; an additional 13 are under construction while 37 more sites have been identified for detailed feasibility studies.

In order to exploit the plentiful hydel resources of the State, the Government of AJK (GoAJK) established the AJK Hydro Electric Board (HEB) in 1989 to plan and undertake development of identified hydro potential, and implement public sector hydropower projects. Subsequently, with the intention of providing a 'one–window' facility and to encourage the development of hydel potential in the private sector, the GoAJK created the AJK Private Power Cell (PPC) in 1995.

HEB and PPC are the two government agencies in AJK that are responsible for the implementation of hydropower projects in AJK with capacities up to 50 MW. This is in accordance with the power policy of 2002 which made provinces and the State of AJK responsible for managing the development and implementation of power projects with capacities up to 50 MW leaving the federal agencies, namely WAPDA – for public sector projects – and PPIB – for private sector projects – to manage hydropower projects in AJK with capacities greater than 50 MW.

Early in the preparation of Phase 1, it became clear that there is no single unified hydropower development plan for AJK. While important policies governing overall hydropower development such as the Policy for Power

Generation Projects (2002)[51] and Vision 2025[52] exist, they are not specifically targeted at the State. Only some aspects of these policies have been adapted for application in AJK which focus primarily on the remit of the agency that developed them. In addition, these are policies, rather than plans, and therefore provide little information on proposed infrastructure developments.

What does exist at the level of infrastructure plans are forward development proposals generated by each of the four agencies. These were provided during Phase 1, and they provide the basis for the consolidated list of projects outlined in Section 3.2 of this final report. It is important to note, however, that these plans are developed in isolation by the agencies in question. There does not appear to be any attempt to coordinate the development of these plans.

The negative environmental and social consequences of this disjointed approach are clear. For example, it is not possible to easily revise the whole hydropower plan to minimize negative impacts, because different agencies may be responsible for different HPPs, even on the same stretch of river or nullah. In addition, the individual agency plans contain inconsistent information, with varying levels of detail. Some agencies provide detailed information covering location, capacity, progress status, energy generation, nature of project and other relevant information. Others, however, simply state names and power generating potential.

There is a clear need for a new, coordinated AJK–wide hydropower planning process. This need not be an expensive or administratively complicated initiative. All that is required is the establishment of a Hydropower Planning Committee that would meet on an occasional basis to produce a regularly–updated State–wide hydropower plan.

**Recommendation 1: Establishment of an AJK Hydropower Planning Committee**
An AJK Hydropower Planning Committee should be established. It should be made up of senior managers from WAPDA, HEB, PPIB, and PPC, along with other relevant AJK government representatives from the wildlife, fisheries, and tourism sectors . The purpose of the Committee should be to develop and regularly update an overall hydropower plan for AJK. Establishment and management of the Hydropower Planning Committee should be the responsibility of the AJK P&DD[53].

**Recommendation 2: Development of a Coordinated Hydropower Development Plan**
A comprehensive hydropower plan or basin development plan needs to be developed and "owned" by all four agencies as members of the Hydropower Development Organization. This plan should be updated on a regular (perhaps 6–monthly) basis.

## 4.3 Improving Project Development Planning

In order to maximize benefits and minimize adverse cumulative environmental and social impacts from the development of HPPs, both the AJK and federal agencies that will make up the Hydropower Development Organization should use the ranking tables presented in Section 3.6.1 and 3.6.2 to coordinate the development of different projects.

By screening projects and their locations the Committee should ideally propose a timetable for the development of new projects based on environmental and social considerations. If required, policies and legislation may need to be introduced and/or amended to ensure that following the timetable becomes a mandatory requirement.

Moreover, coordination between the different regulatory agencies also provides an opportunity

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51. Produced by the Pakistan Ministry of Water and Power.
52. Produced by the Water and Power Development Authority.
53. At a workshop held in Muzaffarabad on February 14, 2014 to present the results of Phase 3, senior officials indicated that a Hydropower Development Organization had been recently established, and that it absorbed the planning responsibilities of HEB, PPIB, and HEC.

for identifying joint capacity building goals and objectives for managing the cumulative impacts of the hydropower plan.

Where more than one project is being built in close proximity on the same tributary or river section, developers have the opportunity to coordinate with each other and redesign projects based on a synergistic approach. This can help maximize positive impacts and mitigate adverse environmental impacts. For example, if there are three projects being planned on the same tributary, the one highest upstream can have a storage wall designed that would regulate flow for all three, and thereby preventing the need for each downstream project to individually store water. It may also help ensure environmental flows downstream, especially during the dry season. Another relevant example is transmission lines from the powerhouse to the local grid. These lines can have a significant impact on project costs. A remote site may require significant investment in transmission infrastructure to connect the project to the local grid. However, with strategic planning, this cost can be shared over more than one project if several RoR projects are developed in close proximity. Similar efficiencies could be obtained for access points, construction sites and work camps.

Coordinated mitigation measures can be incorporated into the design and operation plans to mitigate expected cumulative impacts at the watershed level. These measures include maintaining adequate downstream flow regimes, coordinated design of fish ladders, contribution to native fish hatcheries, open water re–stocking, and designing fish diversion structures at intakes to avoid entrapment.

**Recommendation 3: Promoting Synergistic Project Development**

Where there are HPPs in close proximity to each other, either on a main river, or on tributary nullahs, proponents should be required to consult about project design to enable synergistic development. Such consultation should be required even if project initiation schedules are not synchronized.

### 4.4 Guidelines for Environmental Impact Assessment

Given the potential for cumulative impacts from the approximately 60 projects currently included in the combined lists of agency development plans, each and every IEE or EIA should be required to consider cumulative impacts as part of environmental assessment studies. In this context, the following requirements for considering the cumulative impacts of projects might be incorporated into Terms of Reference for carrying out full EIA studies:

- Define project activities along with other existing, in progress, or planned projects (for the reasonably foreseeable future) in the region that could contribute to cumulative effects on valued ecosystem components (VECs).

- For uncertain cases, scenarios can be developed that include (i) definite future actions, (ii) definite future actions plus probable future actions (still involving some uncertainty), (iii) definite future actions plus probable and less probable future actions (with a higher degree of uncertainty);

- Identify the area of influence for the project (which may vary for different types of potential impacts);

- Identify the time boundary for the study, especially with regard to considering actions in the reasonably foreseeable future (e.g., a concomitant construction period or operation). Scenarios can be developed to identify temporal boundaries as well, particularly when there is uncertainty;

- Identify possible VECs in the region in or close to the project's area of influence;

- Identify the VECs in the area of influence that should be considered in the study based on information related to current or anticipated future conditions, the existence of protected species or habitats, and the presence or anticipated presence of other human activities that would (adversely) affect the VECs; and,

- Identify project–specific standards (PSS), including relevant regulatory and/or international thresholds and standards.

**Recommendation 4: Terms of Reference**
Terms of Reference for full EIA studies associated with relevant HPPs should include the above cumulative assessment requirements.

### 4.5 Need for Detailed Studies

River segments with threatened fish species found nowhere else should be classified as critical natural habitats and, ideally, would receive high level protection from dams or other potentially damaging civil works. The Poonch River, for example, is located in an environmentally sensitive area. It is home to an endangered fish species Mahseer (Tor putitora) and is a declared national park. Thus according to the IFC Performance Standard 6[54] it should be categorized as a 'Critical Habitat.'

Migratory species are important when assessing cascading hydropower projects, since the latter are likely to create barriers that may significantly affect successful completion of important migratory life cycle phases. Species that are of value to local communities will clearly make for good indicators. It is fair to assume that if correct indicator species are selected, conditions and mitigation actions to safeguard them will provide favourable conditions for the rest of the fish species in the river.

Detailed studies should consider hydrological data at a level of resolution that is relevant to ecological communities and should consider any subsistence use of the river. In the process, thresholds should be identified beyond which cumulative change will be considered a concern and expressed in terms of goals or targets, standards and guidelines, carrying capacity, or limits of acceptable change. Thresholds are an essential consideration for both cumulative impact assessment and management, as they play a key role in determining the significance of impacts. One of the most important thresholds to determine will be the environmental flows required downstream of each diversion structure.

**Recommendation 5: Indicator Species and Monitoring**
The AJKEPA should select fish species in different ecological stretches of AJK rivers as indicators of river–health. The number of these indicator–fish species should be monitored regularly throughout the life of the hydropower plan.

**Recommendation 6: Ecological Flow**
Keeping in view the high ecologically sensitivity of the Poonch River and its tributaries, it is recommended that all the hydropower projects planned on the Poonch River should use holistic approaches for determination of downstream environmental flow.

### 4.6 Proposed Regulatory Amendments

The Azad Jammu & Kashmir Environmental Protection Agency Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations 2009 currently specify that HPPs over 50 MW fall in Schedule II, requiring environmental impact assessments (EIAs) and those less than 50 MW fall in Schedule I, requiring only initial environmental examinations (IEEs)[55].

This delineation is based on the Government of Pakistan (1997) Policy and Procedures for the Filing, Review and Approval of Environmental Assessment. According to that Policy, projects in

54. Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.
55. The Azad Jammu & Kashmir Environmental Protection Agency Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations 2009. Notification No. 1123–34/P&DD/Gen/2009.

Schedule A *"are generally major projects and have the potential to affect a large number of people. They also include projects in environmentally sensitive areas. The impact of such projects may be irreversible and could lead to significant changes in land use and the social, physical and biological environment". Projects in Schedule B "include those where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. These are projects not generally located in environmentally sensitive areas or smaller proposals in sensitive areas".*

An examination of HPP rankings based on their critical cumulative impacts on ecologically and socioeconomically sensitive zones shows that the majority of the top 20 HPPs in the ranking tables are less than 50 MW in size. This suggests that using the 50 MW generation capacity figure as the main determinant of environmental assessment standard is misguided. HPPs with capacities less than 50 MW but located in ecologically and socioeconomically sensitive zones do not necessarily exhibit a narrow range of environmental issues, and nor can the potential individual and cumulative impacts of these projects be understood and managed by the limited scope of analysis of IEEs.

**Recommendation 7: Regulatory Amendment**
The 50 MW benchmark should not be the main screening criterion used to determine the required level of environmental assessment. AJK EPA should use the ecological and social sensitivity ranking tables and maps contained in Section 3.6.1 and Section 3.6.2 to determine whether a HPP should require an IEE or EIA.

The Azad Jammu & Kashmir Environmental Protection Agency Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations 2009, Schedule I and Schedule II should be rewritten as follows:

**Schedule I: List of Projects Requiring an IEE**

*B. Energy*

Additional sentence to add to point 1:
Projects under 50MW qualify for an IEE, unless they are located on a "highly sensitive" ecological and/or social segment, in which case they must undergo a full EIA.

**Schedule II: List of Projects Requiring an EIA**

*A. Energy*

No changes required to this Schedule.

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# Appendix A: Impact of Dams on River Ecosystems and their Users

## A.1 Impacts of Dams on River Ecosystems and Their Users

### A.1.1 The River Landscape

River systems are sculptured by their flow regimes, which dictate their overall nature: if they are perennial or non-perennial in flow; have winter or summer floods; pronounced dry and flood seasons; flashy, short-lived flood flows or a long, monsoonal flood season; and so on. The flow regime in turn influences, and largely dictates, the nature of the sediments and the chemistry and temperature of the water, at any point along the system. Fast-flowing water carries more and larger particles from the river bed and surrounding catchment than does slower water, and so steeper river reaches tend to have cobble and boulder beds, whilst sediments settle out in flatter areas creating sand bars, deltas, islands and floodplains. Slower water will be closer to ambient air temperature than faster water as its slow passage through the landscape allows such adjustment. Large volumes of flow dilute concentrations of natural and man-made pollutants and so small floods, for instance, are important regulators of water quality in times of low flow.

There is a constant interchange of materials, energy and nutrients between the water in the river, its banks, its bed and its floodplains. During the course of the water's passage from source to sea sediments are continuously transported, sorted by size, re-sorted, eroded and deposited by the daily, yearly and decadal variations in flow, giving rise to permanent and semi-permanent river-channel features, such as pools, rapids, ox-bow lakes, sandbars and floodplains. The floodplains are areas of fertile soils, replenished by the river during each flood and often highly valued as agricultural land. The dynamic, ever-changing environment creates the physical-chemical template upon which the river's organisms live their lives.

The changing conditions along a river result in an orderly and predictable transition of species. Different plants and animals live in the headwaters than in the lower reaches and different plant communities occur high on banks than lower down near the water. Some fish species need to move onto seasonally inundated floodplains to complete their life cycles whilst others need the conditions provided in-channel throughout their lives. Some animal species need to migrate up and downstream at different times of the year or into and out of tributaries, to find appropriate temperature and other conditions. Some plants and animals live in pools and others in fast-flowing rapids and riffles, some in colder water and some in warmer environments, and so on.

Similarly, species respond to temporal changes in changing flow conditions, with each river's mix of plant and animal species having evolved over millennia to live in synchrony with its unique short and long term cyclical flow patterns. Plant species have evolved to flower and fruit at specific times of the annual flow cycle, fish time their spawning to coincide with the optimal flow and temperature conditions for their young to survive, and insects emerge from the water to mate and release their eggs at specific times of the year when air temperatures, food and other conditions are optimal. Some species thrive in drier years and others in wetter years, and so the balance of species is maintained with none dominating but rather the mix of species changing from year to year. For all of these organisms the river provides breeding sites, a nursery for their young, a highway along which they migrate and a vehicle for dispersing the next generation.

Both the spatial and temporal responses of plants and animals to changing conditions are usually set within quite specific limits—limits that are usually not known or only barely understood by humans. In most cases, we manage river ecosystems without good knowledge of what species they support, even less the needs of those species for survival. In our ignorance, however, we do at least now better understand that any physical or chemical change to an ecosystem outside of its natural range will disrupt relationships between species, probably reduce biological diversity and abundances, and potentially cause community shifts characterized by loss of sensitive, often rare, species and proliferation of robust, often common, species.

Such shifts should concern us because rivers serve humanity in countless ways. The links tend to be strongest in developing countries, where rural livelihoods respond to the annual water cycle and cultural, religious and recreational ties to rivers have deep meaning. All countries, however, benefit from rivers in a range of ways, as they provide ecosystem services (Exhibit A.1) that are vulnerable and will change as water resource developments alter the natural functioning of the river.

### A.1.2 Impacts of Dams on River Ecosystems

If the natural flow patterns of rivers do not provide water when and where people desire it, then dams have become recognized solutions to aid meeting such demand. They have brought humanity many benefits, but their specific purpose is to modify the river's flow regime, and in doing so they impact this fundamental driving force of the river ecosystem, leading to knock-on effects on the sediment, chemical and thermal regimes of the river, the river's biota and all the ecosystem services valued by people. The more the natural flow regime is changed, the greater will be the response of the ecosystem and the greater the potential impacts on people. Dams are thus a mixed blessing, bringing benefits, such as assured water supply, irrigation and hydroelectric power, but also costs such as declining fisheries and water quality, failing estuaries, and the loss of highly productive floodplains. These impacts are expanded on below.

### A.1.3 Impacts on the Flow Regime

Storage and diversion dams have different purposes and, to some extent, different effects on the river ecosystem. Large storage dams store waters in reservoirs for flood control, increased assurance of supply to urban and agricultural areas, or other purposes. Although some stored water may be diverted off channel, much may be released downstream in a pattern of flows that suits human needs but may be greatly different to natural flows. Diversion dams divert water off-channel and have structures that can manipulate downstream releases to a limited extent. If there is a constant offtake from a diversion dam, then it

**Exhibit A.1: Classification of Aquatic Ecosystem Services** [56]

| *Provisioning Services* | *Regulating Services* | *Cultural Services* |
|---|---|---|
| ▶ Edible plants and animals | ▶ Groundwater recharge | ▶ National symbols and borders |
| ▶ Freshwater | ▶ Dilution of pollutants | ▶ Religious and spiritual enrichment |
| ▶ Raw materials: wood, rocks and sand for construction, firewood | ▶ Soil stabilisation | ▶ Aesthetic appeal |
| ▶ Genetic resources and medicines | ▶ Water purification | ▶ Inspiration for books, music, art and photography |
| ▶ Ornamental products for handicrafts and decoration | ▶ Flood attenuation | ▶ Advertising |
| | ▶ Climate and disease regulation | ▶ Recreation |
| | ▶ Refugia/nursery functions | |
| Supporting Services<br>Nutrient cycling, soil formation, pollination, carbon sequestration, primary production | | |

56. After Millennium Ecosystem Assessment 2003.

will impact downstream flows more in the dry season than in the wet, as some or all of dry season flows could be diverted whilst flood flows could still spill over. The extent of the difference between upstream inflows and downstream outflows will be dependent on the size and shape of the reservoirs, the type and size of the spillway or diversion, and the structure's operating rules.

These flow changes have profound implications for the river ecosystem because different flows play different roles in keeping the river healthy (Exhibit A.2). Important characteristics that may be compromised are the difference between dry and flood season flows (the difference could get smaller or larger), the perenniality of dry season flows, and the size and timing of floods.

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**Exhibit A.2: Some Perceived Links between Flow Categories and Ecosystem Functioning in Western Cape Rivers, South Africa**

| *Flow Category* | *Ecosystem Link* |
|---|---|
| Dry season low flows | Maintain perenniality and, thus, wet habitat for survival of aquatic species; trigger emergence of some insect species |
| Flood season low flows | Maintain wetbank vegetation and fast-flow habitat |
| Intra-annual floods 1 | Trigger fish spawning in mid-dry season, flush out poor-quality water |
| Intra-annual floods 2 | Trigger fish spawning in early dry season, flush out poor-quality water |
| Intra-annual floods 3 | Sort sediments by size, maintain physical heterogeneity, flush riffles, scour cobbles |
| Intra-annual floods 4 | Sort sediments by size, maintain physical heterogeneity, flush tree seedlings from edge of active channel |
| 1:2 year floods | Maintain tree line on banks, scour out sedimented areas in active channel |
| 1:5 year floods | Maintain lower part of tree/shrub vegetation zone on banks, deposit sediments in riparian zone |
| 1:10 year floods | Maintain channel, reset physical habitat, maintain middle part of tree/shrub riparian zone |
| 1:20 year floods | Maintain channel, reset physical habitat, maintain top part of tree/shrub riparian zone |

Source: King, J.M. & Brown, C.A. 2006. Environmental flows: striking the balance between development and resource protection. Ecology and Society 11(2): 26 (online).

is a constant offtake from a diversion dam, then it will impact downstream flows more in the dry season than in the wet, as some or all of dry season flows could be diverted whilst flood flows could still spill over. The extent of the difference between upstream inflows and downstream outflows will be dependent on the size and shape of the reservoirs, the type and size of the spillway or diversion, and the structure's operating rules. These flow changes have profound implications for the river ecosystem because different flows play different roles in keeping the river healthy (Exhibit A.2). Important characteristics that may be compromised are the difference between dry and flood season flows (the difference could get smaller or larger), the perenniality of dry season flows, and the size and timing of floods.

**Impacts on the Sediment Regime**

River systems comprise not just the water flowing in the river channel itself, but also the sediment suspended in the water column or deposited along the river bed and banks. The erosion, transportation and deposition of these sediments by the river's water during its passage to the sea is responsible for shaping the features commonly associated with river channels, such as meanders, sandbars, pools and deltas. Working and re-working the sediments, the river creates and maintains complex, shifting mosaics of features that provide the diversity of habitats upon which the river's living organisms depend. Maintenance of these habitats is dependent on a continuing supply from upstream of the raw material—the silt, sand, gravel, cobbles and boulders supplied by the river bed and the wider landscape. The same raw material maintains banks and shorelines and the bed in which the foundations of bridges are sunk.

Dams form barriers to the transportation of much of this raw material, with sediments dropping from suspension as the river slows down upon entering the reservoir. The finer sediments may stay in suspension and pass through the dam outlets during floods and, sometimes, coarser material is scoured out through bottom gates to increase storage in a sediment-choked reservoir. Dams thus can change the total amount of sediment available to the river downstream, with a proportion of a river's sediment load possibly permanently trapped by the reservoir.

If sediments are trapped in this way, downstream reaches are starved of them and may become what is termed sediment hungry, eroding their bed and banks at higher than natural rates. Channel adjustments may manifest as changes in channel width, bed level and slope; down-cutting and entrenchment of the channel; and bed armouring or channel straightening. Land may be lost through bank slumping and bridges and roads threatened. The extent to which any of these is likely to occur will depend on how much the dam changes the river's ability to transport sediment through flow changes, the amount of sediment withheld by the reservoir and the erodibility of the bed and banks.

As the flow and sediment regimes of the river are together altered by dams, the downstream physical environment will change in a way that reflects the interplay of these two forces. Sediments may decrease in the downstream river because they are trapped in the reservoir, causing downstream erosion, or they may increase because the remaining flow in the river is insufficient to transport the sediments still draining in from the downstream catchment. If sediments are flushed from the reservoir periodically, then periods of low sediment loads could be interspersed with intermittent periods of heavy, possibly, anoxic sediments moving downstream—the two conditions together causing extreme conditions, neither of which is natural.

In whatever way the channel adjustments play out, there will be impacts on the downstream riverine habitats, perhaps through sediments clogging important spawning grounds, habitats degrading through erosion, floodplains declining in extent and fertility, pools filling with sediments, or banks collapsing. All of these changes have implications for the riverine plants and animals, as well as for cultivated land adjacent to the channel.

**A.1.4 Impacts on the Chemical and Thermal Regime**

Water stored in reservoirs undergoes physical, chemical and thermal changes, and so downstream reaches may receive water that is quite different from that flowing into the reservoir. Typically, dams that release from near the surface of the reservoir, will deliver water that is warm and rich in oxygen, whereas dams releasing from deeper levels will deliver cold, nutrient-enriched, oxygen-poor water. The downstream water may also be clearer due to the reservoir trapping sediments and organic particles from upstream. These differences would generally be greater the larger the reservoir, with those that retain water for only a few hours or days inducing fairly low change.

**A.1.5 Impacts on the Living River**

In a naturally functioning river ecosystem, the diversity of habitats and the dynamic nature of the flow and other regimes enable a wide range of species to coexist. Species have evolved over very long time spans to live in harmony with the natural conditions they experience. As water-resource developments change these habitat conditions, species may start to disappear and others, more able to cope with the changed conditions, appear. Dominant species in the new communities may have been present in the natural community but in low proportions, whilst the changed conditions allow them to multiply rapidly. Many species that can live in the new conditions may be more robust and hardy than the lost species, these being common attributes of species that negatively impact humans and their livestock. Examples of such robust pest species include mosquitoes that carry malaria and blackflies that can cause river blindness.

Most development-driven changes in river ecosystems manifest as slow declines in condition, but there are a few thresholds or state changes. One is when floods are reduced to the point that they no longer flood floodplains; another is when flow ceases and the riverbed dries out. In the former case, biodiversity and productivity decline radically as floodplains become drylands. In the latter case, aquatic species move away or die from the dried-out areas and, if this situation repeats at intervals, it will favour hardy opportunistic species with short life cycles to the detriment of longer-living, usually more rare, species.

Rivers across the world are now seriously degraded in this way, with dams making significant contributions to the degradation (Exhibit A.3). The impacts can be divided into those that manifest upstream of the dam wall, downstream of the wall, or because of the existence of the wall as a barrier.

**Upstream Impacts of Dams and Weirs**

The upstream reservoir changes the river reach that it inundates from a flowing to a standing water system. This can lead to the disappearance in that stretch of river of species that need flowing water (e.g., many species of fish) and the appearance of those that can exist in still water (e.g., phytoplankton; zooplankton; mosquitoes).

**Downstream Impacts of Dams and Weirs**

The downstream impacts of dams are usually felt over much longer distances than are upstream impacts. The timing and duration of different flow events may be changed downstream, and water depths and velocities may change outside of the range that species have evolved to cope with. In the case of the Kishenganga Dam, the main downstream impact is expected to be the reduction of flows in the dry season as most flow is diverted away from the river. There may be additional impacts through storage of sediments in the reservoir and periodic flushing of some of this load downstream.

**Dams and Weirs as Barriers**

Most large freshwater fish and some invertebrates rely on movement through river systems to complete important phases of their life history or to disperse their young. They need to move between habitats that may be separated by tens or hundreds of kilometres in order to breed, feed, escape extreme flow or thermal conditions or mature from juveniles into adults. Dams represent significant impediments to such movements, resulting in extinctions and declines in population numbers both upstream and downstream of the dam due to the inability of the organisms to reach key habitats. It is possible to mitigate these impacts to some degree by building fish passage facilities such as ladders and lifts, but these are not successful for all species and are very costly to install, operate and maintain. Even where they are well and appropriately designed, the species may not be able to tolerate the journey through the still conditions of the reservoir in order to reach running water again.

### A.1.6 Impacts on Subsistence Users of Rivers in Developing Countries

Although all people are affected to a greater or lesser degree as rivers and their ecosystem services change with river development, poor rural people in developing countries with close livelihood links to rivers tend to be negatively impacted the most and benefit the least from these changes.

People living upstream of new dams may experience a complete loss of their lands and livelihoods, while potentially orders of magnitude more subsistence users living downstream of dams may experience a lesser though still possibly severe impact. Living in mostly remote areas, the river may be a lifeline that delivers water and food over large areas where governments cannot provide. As their river

**Exhibit A.3: Mechanisms Modified by Hydropower Generation and likely Ecosystem Responses**[57]

| *Mechanism* | *Alteration* | *Ecosystem Response* |
|---|---|---|
| ***Flow*** | | |
| Magnitude | Increased variation | Scouring of organisms |
| | Stabilised flows | Dominance of robust species |
| Frequency | Increased variation | Increased erosion |
| Timing | Decreased variation to stabilise production of power | Decreased flushing of sediments; dominance of robust species |
| Duration | Prolonged low flows | Altered abundance and diversity |
| | Prolonged inundation | Altered riparian communities |
| | Shortened low flows | Increased availability of aquatic habitat |
| | Shortened flood peaks | Encroachment of riparian or terrestrial species |
| Rate of change | Rapid changes in river stage, possibly from torrential to de-watered within hours | Stranding and flushing of organisms |
| ***Landscape*** | | |
| Velocity | Conversion of flowing to standing water | Loss of flowing-water species |
| Longitudinal | Disruption of longitudinal corridor | Fragmented plant and animal communities; reduced migration and movement; loss of sediments |
| Lateral | Land and water disconnected due to loss of floods | Loss of floodplains; lower productivity of riparian and aquatic system |
| Vertical | Surface and groundwater disconnected | Reduced water quality, biodiversity, reproductive success |
| Temporal | Reduced environmental heterogeneity | Reduced biological diversity |

57. Modified from Renöfält, B., R. Jansson and C. Nilsson. 2010. Effects of hydropower generation and opportunities for environmental flow management in Swedish riverine ecosystems. Freshwater Biology 55:49-67.

resources degrade with upstream developments and the benefits are enjoyed by people elsewhere, the rural poor have few prospects of compensation.  River resources, such as fish, may decline, for instance, with lower catches and smaller sizes.  Declining cultural and recreational opportunities may force more and more households to abandon livelihoods linked to the river.

A second major impact of dams can be increased health risks.  Both people and livestock can be affected, with significant increases in malaria and bilharzia for people and liver fluke for cattle, for instance, being linked to specific new dams.

**A.1.7 Environmental Benefits of Dams**

The World Commission on Dams found that though there may be an array of social benefits to dams there are few environmental benefits.[58] Although it may be possible to mitigate some of their negative impacts through providing environmental flows, sediment sluicing or fish passage facilities, it is not possible to mitigate all factors.  In many cases, the worst environmental impacts are difficult to predict and remediate.  It may be argued that while dams are detrimental to some species, they provide opportunities for others—such as new fisheries in reservoirs.  Even in this case, however, the effect often is to promote an exotic species at the expense of indigenous species.  The benefits that accrue from dams extend almost exclusively to social and economic spheres rather than to ecological ones.

58. World Commission on Dams (2000) Dams and Development a New Framework for Decision-making.  The Report of the Word Commission on Dams. London: Earthscan Publications, Thanet Press.

# Appendix B: Environmental Baseline: Background Information

## B.1 River Characteristics

AJK is drained by three main rivers viz., Neelum, Jhelum and Poonch, all draining into Mangla Reservoir. The Mangla Dam is the twelfth largest dam in the world. It was constructed in 1967 across the Jhelum River in Mirpur District of Azad Kashmir. A map of AJK along with its rivers is shown in Exhibit B.1.

The rivers draining into the Mangla reservoir have different characteristics as they originate from areas having different geographical and physical features. The Poonch River originates in the western foothills of Pir Panjal Range. The steep slopes of the Pir Panjal form the upper catchment of this river. It is a small gurgling water channel in this tract and descends along a very steep gradient until it reaches the foothills. The river widens as more and more tributaries from both sides enter the main stream. The valley too opens up and Poonch River begins to flow in a leisurely manner in its middle and lower reaches. The upper catchment is covered by dense forests while the vegetation of the middle and lower region is under intense biotic pressure. Poonch River from the Line of Control (LoC) to Kotli town has a steep slope (6.9-8.3 m/km) and the valley is narrow. Below Kotli the river gradient is relatively mild (3.7m/km). The river ultimately joins the Mangla lake.

River Jhelum originates from a spring at Verinag situated at the foot of the Pir Panjal in the southeastern part of the valley of Kashmir. It flows through Srinagar and the Wular Lake before entering Pakistan from Indian Occupied Kashmir (IOK) through a deep narrow gorge. The Neelum River, the largest tributary of the Jhelum — known as Kishenganga River in India and IOK — joins it near Muzaffarabad. River Jhelum in its upper reaches from the LoC to its confluence with the Neelum River has a very steep slope (7.4m/km), while in the lower reaches from Neelum confluence to Mangla Reservoir the gradient is milder (2.7m/km) but the valley is very narrow and the river flows through a gorge.

River Neelum originates from the glaciers of northern Kashmir and flows through the Gurez Valley in its upper reaches and through Neelum Valley in its lower reaches until it joins with River Jhelum at Muzaffarabad. It flows for 250 km in AJK from the LoC at Taobat to Muzaffarabad. River Neelum receives various streams in AJK, the famous being the Dudhgai Nullah, Shountar Nullah, Dudhnial Nullah and Nauseri Nullah.

Neelum is a cold-water river with temperatures less than 15 °C, generally around 12 °C, even during the summer months. The Poonch is the warm water river and the water temperature of the rivers approaches 30 °C during the summer months. Water in the Jhelum River has an intermediate temperature and the water temperatures reach 25 °C during the summer months. Another temperature regime is developed downstream Muzaffarabad after the confluence of Neelum and Jhelum rivers. The temperature of the river water remains around 16-17 °C. These variable temperature regimes provide unique physico-chemical characteristics and hence a variation in fish compositions in the different reaches of the rivers and reservoirs.

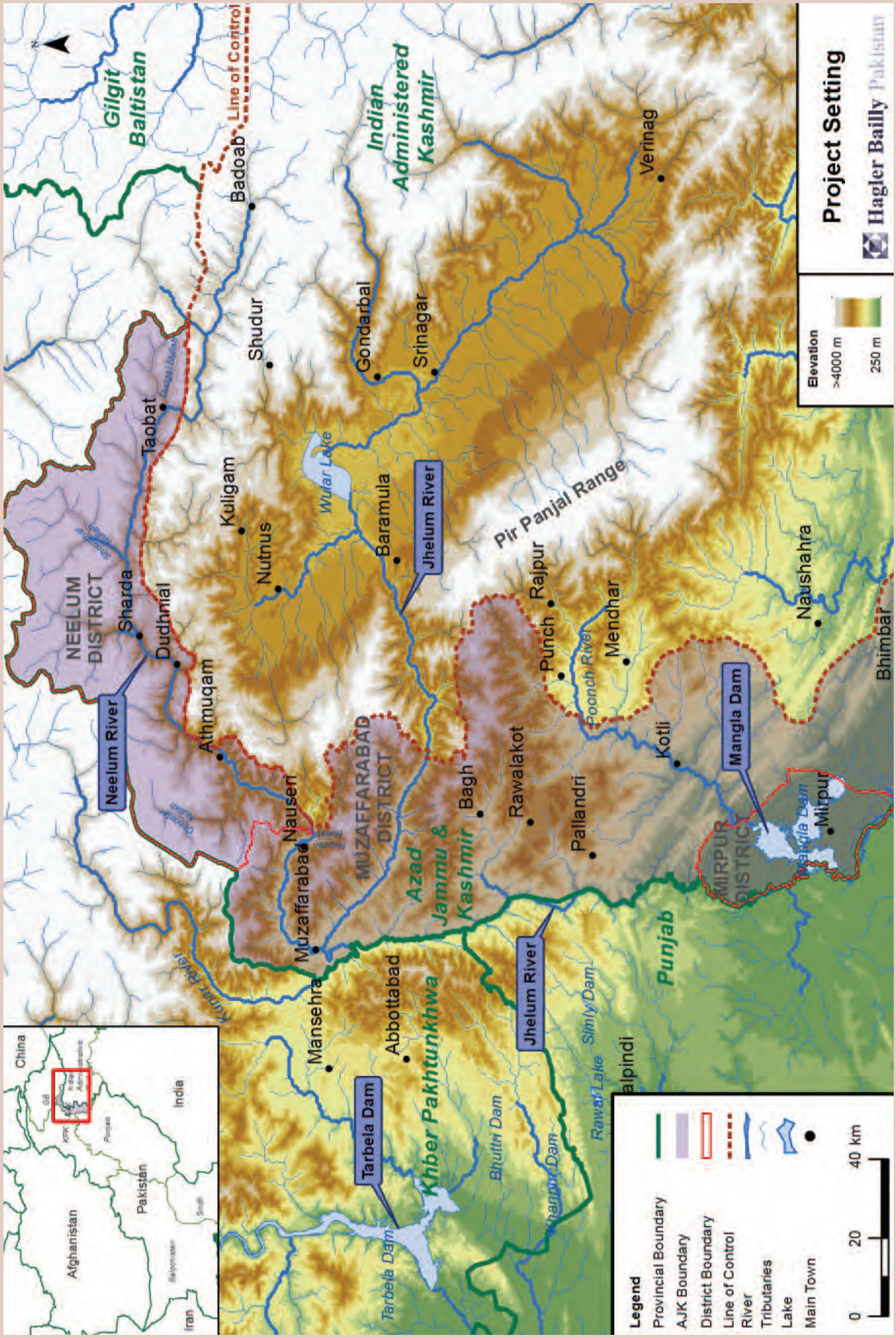
## B.2 Overview of Aquatic Flora and Fauna

This section presents an overview of the fish fauna, benthic macro-invertebrates and algal flora found in the rivers of AJK. A literature review of research articles, previous EIA (Environmental Impact Assessment) reports, relevant books and websites was carried out to gather this information.

### B.2.1 Fish

The upper reaches of the Neelum River are characterized by fast flows, high oxygen

## Exhibit B.1: Major Towns and Rivers of AJK



concentrations, and rocky, stony or gravely beds having occasional sandy or silty patches typical of tropical mountain streams. The resident fish species such as Catfish live on or among the rocks, are of small size and adapted to gripping or clinging to the substratum. Other species may have sinuous shapes, such as the Hillstream Loaches, which enable them to twine through the crevices in the rocky bottom. Some species, such as the Snow Trout or Brown Trout, are adapted to swim sufficiently fast so as to be able to resist the current and even move against it. This they cannot do on a sustained basis, however, and frequently take advantage of the slack water of the pools or hydraulic cover provided by rocks. Because of the severity of the habitat, the diversity of resident species tends to be low.[59]

The abundance and diversity of the fish species increases downstream, in the lower reaches of the Neelum River and warmer waters of the Jhelum River due to warmer air and water temperatures, and more conducive conditions for fish growth and breeding.

The Poonch River is a warm water river and the water temperature approaches almost 30 °C during the summer months. Water in the Jhelum River has an intermediate temperature reaching 25 °C during the summer months. These variable temperature regimes give the Mangla Reservoir a unique physico-chemical characteristic having different temperature regimes, both on horizontal as well as on vertical scales. Different pockets in the Mangla Reservoir have different temperature regimes. The depth of the dam gives temperature stratification throughout its depth. The Jhelum River is deep with fast water flows all along the river. It flows through a "V" shaped valley. On the other hand, the Poonch River is shallow, open, flat and the water flows with a moderate speed. The fish fauna in these water bodies is, therefore, distributed according to their optimal requirements of temperature and other physico-chemical and factors. The vast lake environment of Mangla Reservoir has facilitated large commercial fisheries to be established in the dam area while the typical river fish fauna is distributed in the two rivers according to their physico-chemical requirements.[60]

The Jhelum River, Poonch River and Mangla Reservoir behave differently from each other on the basis of fish species composition. The Mangla Reservoir and Jhelum River are a significant distance from each other and the Poonch River falls in between these two water bodies. The physico-chemical factors and the fish fauna studied previously also reveal similar results. Poonch River is in between the Jhelum River and Mangla reservoir in terms of water temperature, nature of habitat, physical conditions of the breeding grounds, water speed, water volume, relative length of the river and topography of the area of three water bodies.[61]

The three water bodies can be divided into three distinct groups on the basis of their fish fauna at 65% similarity level. The Poonch and Jhelum Rivers are however a bit close to each other due to the flowing water conditions in both of the water bodies and having similar impact of the Mangla reservoir at least in their lower reaches. Moreover, most of the fish fauna found in the Mangla Reservoir, especially the commercially important varieties, are distributed in the downstream areas of the lake in the rivers of Punjab. Construction of the dam has changed the ecosystem from that of running water to that of a huge stagnant water body. The fish fauna of the Indus plain downstream of Mangla Reservoir is distributed throughout the whole stretch of the Poonch in AJK while it is distributed in the River Jhelum to variable extent due to comparatively cold water of the river.[62]

59. Hagler Bailly Pakistan, (HBP) 2011. Environmental Assessment of Kishenganga/Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters. Lahore: Hagler Bailly Pakistan.
60. Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation
61. Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation
62. Ibid.

The River Poonch also shares a number of fish fauna with the Jhelum River. All the cool water fish fauna found in the river Poonch are also represented in the Jhelum River. A total of 15 species are common between the two rivers. The Poonch River, therefore, shares its 52% fish fauna with the river Jhelum. The river Jhelum on the other hand shares 47% of its fish fauna with the Poonch River and these rivers have a similarity co-efficient of 0.49%. The fish fauna of Jhelum River common with the Poonch River is distributed in the lower reaches of the river Jhelum which mainly migrates from Mangla Reservoir upstream in the river during the summer season. Out of 62 species found in the Mangla Reservoir and 32 in the Jhelum River, only twenty species are common in both these water bodies. The similarity co-efficient between the Jhelum River and Mangla Reservoir is 0.47 or 47% (Exhibit B.2.).

### B.2.2 Aquatic Macro-invertebrates

Benthic macro-invertebrates are an important part of the food chain in aquatic ecosystems, especially for fish. Many invertebrates feed on algae and bacteria, which are at the lower end of the food chain. Some shred and eat leaves and other organic matter that enters or is produced in the water. Because of their abundance and position as 'intermediaries' in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients.[63]

There is no peer-reviewed information on the benthic invertebrates of the Kaghan[64], Neelum and Jhelum valleys. Unpublished data indicates that the benthic macro-invertebrate families observed in this study of the Neelum River also occur at the outlet zones of the lakes in the Kaghan Valley (Dudupatsar Lake, Gittidas wetland complex, and Lulusar Lake) and outlets of the lakes in the Neelum Valley (Patlian Lake and Rattigali Lake).[65]

Aubert, 1959[66] reported twenty species of stoneflies (extremely pollution intolerant organisms) belonging to seven genera from Pakistan (Hindukush including Gilgit-Baltistan and Chitral; Karakorum including Neelum Valley, Kaghan Valley; Rawalpindi including Murree). He reported six species of stoneflies species from the Neelum and Jhelum rivers which include *Nemoura* (Amphinemura) *mirabilis* (Muzaffarabad after confluence of Neelum and Jhelum River), *Nemoura* (Amphinemura) *schmidi* (Kel, Neelum Valley), *Nemoura* (Amphinemura) *skardui* (Rampur Neelum Valley), *Nemoura s. s. lilami* (Kel, Neelum Valley), *Nemoura s. s. polystigma* (Lilam, Neelum Valley) and *Cholroperla kishanganga* (Kel, Neelum Valley). Aubert, 1959 identifications were based on adults of stoneflies collected from terrestrial habitats near streams and rivers while the current study was based on collection of immature/ nymphs of stoneflies from water current of streams and rivers.

Ali, 1971[67] reported five orders of benthic invertebrates from Poonch River that is a tributary of the Jhelum River. These include *Oligochaeta, Ephemeroptera, Trichoptera, Chironomidae* and *Tabanidae*. That publication, however, provides

**Exhibit B.2: Similarity Coefficient among Mangla Reservoir, Poonch and Jhelum Rivers**

| | *Mangla* | *Poonch* | *Jhelum* |
|---|---|---|---|
| Mangla | – | 0.63 | 0.47 |
| Poonch | 0.63 | – | 0.49 |
| Jhelum | 0.47 | 0.49 | – |

63. Williams D. D. and Feltmate, B. W. 1992. Aquatic Insects. CAB International Wallingford, Oxon. 360 pp.
64. Kunar River, which is a tributary of the Jhelum River, drains the Kaghan Valley located immediately west of the Neelum Valley.
65. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.
66. Aubert, J. (1959): Plécoptères du Pakistan. Memoires de la Societe vaudoise des Sciences naturelles, 75, Vol. 12, fasc. 3:65-91.
67. Ali, S.R. 1971. Certain Mayflies of Swat and Azad Kashmir. Pak. J. Sci. 23 (5 & 6): 209-214.

very limited information about the composition of the benthic macro-invertebrate assemblages as identification was limited to order level.

Sehgal et al., 1991[68] reported six taxa (order level identification) of benthic macro-invertebrates from streams of the Jhelum River (Indian territory) along with their per square meter abundance at specified locations.

Bhatt et al., 2005 reported twelve taxa (order level identification) from Neelum river (Indian territory) along with their per square meter abundance at specified locations

During the field work conducted by Hagler Bailly Pakistan in 2008, a total of 33 macro-invertebrate taxa were identified in the upper Neelum River.[69] A total of 70 invertebrate taxa were identified from the Neelum and Jhelum rivers during the sampling surveys conducted by HBP in 2011 and 2012.[70]

### B.2.3 Algal Flora

There are three kingdoms of algae recorded from the rivers of Azad Kashmir - the kingdom Monera consists of free-floating phytoplanktons, the kingdom Protoctista consists of attached algae, while the kingdom Protista consists of free-floating as well as attached algae. Macrophytes are largely absent in the Neelum Valley and the attached algae are mainly confined to the rocky and cobblestone substrata. Studies on algae conducted in the adjacent Kaghan Valley west of the Neelum Valley indicate similar patterns of diversity. Temperature is one of the principal regulators of algal abundance, and in temperate rivers like the Neelum there is a minimum algal production during the winter and comparatively higher production during the summer season.[71] The abundance of algal flora is likely to be higher in the warmer waters of the Jhelum River and Poonch River.

## B.3 Overview of Terrestrial Ecology

This section gives a brief overview of the terrestrial ecology of AJK, particularly those ecological resources that are found in the vicinity of the rivers or depend on the river for food, water or habitat.

### B.3.1 Terrestrial Flora

There are four phyto-geographical regions in Pakistan including AJK which are Saharo-Sindian, Irano-Turanian, Sino-Japanese and Indian.[72] Floristically the AJK falls into Sino-Japanese group and is very rich in floral diversity. It comprises evergreen coniferous forest, subtropical thorny forest, and deciduous trees forest. With its good climate, the area has about 10.6% of the total flora of Pakistan.[73] Most of the AJK forest falls in the major forest type 'Montane Temperate Forests'.[74]

The Neelum and Jhelum valleys are surrounded by high mountains with steep or gentle slopes, valleys, and small pitches plains (pasture area) and agricultural fields. The area's vegetation cover varies with various habitats. The slopes are generally good with vegetation cover except for the steepest stony cliffs, where the vegetation in very thin. The extent of degradation also varies from place to place. The degradation of vegetation observed is significant along the river banks as compared to the higher elevation. The bank of rivers and floodplains are usually easily accessible and grazing pressure and extraction of wood for timber and fuel are visible. Grazing pressures on the slopes near the settlements is also significant, as well as in the pastures where both nomadic herdsmen and the local community take the livestock for grazing during summer months.

68. Sehgal, K. L., 1991. Distributional patterns, structural modifications and diversity of Benthic biota in Mountain streams of North Western Himalaya. In: D. Bhatt and P.K. Pandey (Eds.), Ecology of the Mountain Water, pp. 199-247. Ashish Publishing House, New Delhi.
69. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.
70. Ibid.
71. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2013. Environmental Assessment of Neelum Jhelum Hydroelectric Project River Diversion. Interim Report prepared for Ministry of Water and Power, Islamabad.
72. Rafiq, Rubina A., and Nasir, Yasin J. 1995. Wild Flowers of Pakistan, Oxford University Press.
73. Ali S.I. and M. Qaiser. 1986. A Phytogeographical Analysis of Phanerogams of Pakistan. Proceedings of the Royal Botanical Society, 89B: 89-101
74. Champion, Seth and Khattak 1965. Forest ecology; Forests and forestry; Pakistan

Floristically, there are three main ecozones in the vicinity of the AJK rivers; namely temperate mountain forest, mountain sub-tropical forest and a mix of sub-tropical thorn forest deciduous forest. The dominant species of each ecozone are described below.

***Temperate Mountain Zone***

Himalayan moist temperate forests and Himalayan dry temperate forests are found in this zone. These forests are located between 1,500 m and 3,000 m, the former in areas where the annual precipitation is more than 1,000 mm and the latter in areas with less precipitation.

Evergreen Himalayan moist temperate forests are characterized by conifers, with a mixture of oak and deciduous broad-leaved trees. Their undergrowth is rarely dense, and consists of both evergreen and deciduous species. These forests are divided into a lower and an upper zone, in each of which definite species of conifers or oaks dominate. The common species are *Cedrus deodara* (Deodar, diar), *Pinus wallichiana, Picea smithiana, Abies pindrow* (partal). In the Himalayan dry temperate forests, both coniferous and broad-leaved species are present. The main conifers are *Cedrus deodara, Pinus gerardiana* and *Juniperus macropoda*. *Pinus wallichiana* and *Pecea smithiana* are also present. Broad-leaved trees include *Quercus ilex, Fraxinus* sp. and *Acer* sp. Shrubs in the undercover include *Daphne, Lonicera, Prunus, Artemisia, Astragalus* and *Ephedra* sp. Livestock grazing practice is observed in this area.

***Mountain Sub-Tropical Zone***

The forest type found in this zone is the sub-tropical pine forest and forests relatively narrow zone lays with thin floral diversity. These are open flammable pine forests sometimes with, but often without, a dry evergreen shrub layer and little or no undergrowth. The forests consist of *Pinus roxburghii* (chir pine) found between 900 m and 1,700 m elevation in the western Himalayas within the range of the south-west summer monsoon. It is the only pine of these forests though there is a small overlap with *Pinus wallichiana* (biar) at the upper limit. Other dominant plant species of this zone are Quercus incana with under story of shrubs such as *Berberis lyceum, Berberis heteropoda, Carissa oppaca, Cotoneaster* spp. and grasses such as *Themeda anathera* and *Apluda aristata*. The habitat in this zone is relatively degraded at some localities by the furrow agricultural practices and encroachment by the settlements.

**Admix of Sub-Tropical Thorn Forest Deciduous Zone**

In the ecozone between 550–900 m the vegetation is mixed sub-tropical thorny and deciduous vegetation. This habitat can be characterized by lush green vegetation with narrow altitudinal strip. This zone is dominated by plant community of *Acacia modesta, Olia ferruginea, Cassia fistula, Carissa oppaca, Dodonaea viscosa*, on hotter slopes while *Mallotus philippensis, Adhatoda vescosa, Zizyphus nummularia* and *Dodonaea viscosa* on the cooler slopes. The zone has significant proportion of the area covered by agriculture and urbanization. However, the vegetation cover in this zone in some of the areas is largely intact with better floral diversity. The areas covered by this habitat are the low foothills in the vicinity of the rivers.

**B.3.2 Forest Areas**

There is 1,400,415 acres of forest land in AJK and it is distributed in different forest types due to variation in climatic factors. As a result of the differences in climatic conditions there is a wide variety of life, both in fauna and flora.[75]

Forests of AJK are managed by the guidelines provided in the Jammu and Kashmir Forest Regulations of 1930. These guidelines provide the basis for the regulation, protection, conservation, and management of forest in the area. The AJK

75. Official website of the AJK government available at: http://www.ajk.gov.pk/

forest are divided into ten administrative units namely the Forest Divisions. These include Sharda, Keran, Muzaffarabad, Jhelum Valley, Bagh, Havelly, Poonch, Kotli, Mirpur and Bhimber. Each forest division is structured for scientific management of forest resources on sustainable basis to achieve specific silvicultural, social and economic objectives. These ten forest division have been grouped into five management units on the basis of similarity in forest composition, geographic and socio-economic conditions.[76]

The forests of AJK are categorized into the demarcated forest and un-demarcated forest categories. Demarcated forest means forest land or waste land under the control of Forest Department, of which boundaries have already been demarcated by means of pillars of stones or masonry or by any other conspicuous mark, or which may hereafter be constituted a demarcated forest under section 3 of Regulation. Un-demarcated forest means and includes all forest land and waste land (other than demarcated forest) under the management and control of the Revenue Department) which is the property of the Government and is not appropriated for any specific purpose.

The Forests of Azad Kashmir are composed of various forest types that range from subtropical to alpine zones. The main forest types include, scrubs, subtropical Chir pine forests, mixed conifer temperate forests and alpine/sub-alpine forests and pastures. These forest types reflect different vegetation types, composition, densities and silvicultural requirements.

Apart from timber, coniferous forests in AJK provide many species of medicinal plants and nuts which are used by local people as well as pharmaceutical industry. About 50 tons of various plant species are collected annually. The most important among them are; *Saussurea lapa, Dioscorea deltoidea, Ploygonum emplexicaule, Rheum emodi* and *Valeriana wallichii*. Approximately 10 tons of white and black mushrooms are collected annually.

A large number of nomads with their multitude of flocks visit and utilize upland forests of Azad Kashmir for their livelihood as well as for their animals during the season. These people live a primitive life style and put an enormous pressure on forest resources.

Due to anthropogenic pressures, some plants have undergone a significant decline in numbers. such as Yew *(Taxus baccata*) Ash (*Fraxinus spp*.) and Fir (*Abies pindrow*) among trees and Costus roots (*Saussurea lapa*) among herbs. The annual extraction of Costus roots has been disallowed by the AJK Forest Department due to the international ban on the trade of product.

**B.3.3 Riparian Vegetation**

A riparian zone or riparian area is the interface between land and a river or stream. Plant habitats and communities along the river margins and banks are called riparian vegetation. The riparian vegetation flora linked to the AJK can be categorized as marginal (river slope) vegetation and floodplain vegetation. The marginal zone of the river is that part of the river channel, close to the river bank, that is frequently submerged by the active channel width of the river during periods of high flows and left dry during periods of low flows when the active channel width reduces. Unlike flood plains, which are submerged by water during floods only, the marginal zone may be inundated or left dry depending on the varying width of the active channel during high or low tides in the same day or during periods of high rainfall. Water-loving marginal vegetation is situated along the both sides of river, while vegetation in the floodplains is inundated periodically by floods and benefits from the soil deposited by the river.

Some of the dominant plant species of marginal vegetation in the Neelum and Jhelum valleys include *Salix sp., Populus sp., Salix sp., Aesculus indica, Sambucus wightiana, Ribes himalense,* and *Corydalis falconer*. These plants are mostly trees and shrubs, and have strong and spreading

76. Ibid.

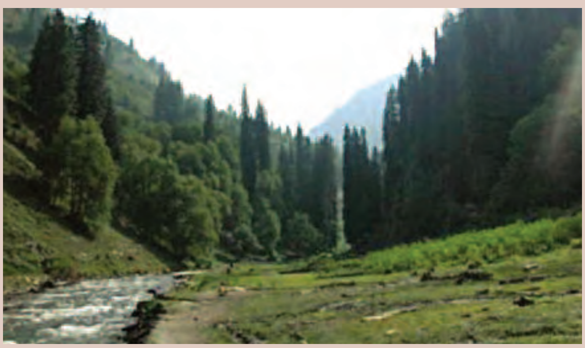
root systems. The level of disturbance in the river banks is relatively high due to ease of access to livestock grazing.

Some photographs of riparian vegetation in the Neelum Valley are given in Exhibit B.3.

### B.3.4 Mammals

Some of the mammal species reported from AJK include Giant Red Flying Squirrel *Petaurista petaurista*, Kashmir White-toothed Shrew *Crocidura pullata*, Himalayan Pipistrelle *Pipistrellus javanicus*, Rhesus Monkey *Macaca mulatta*, Himalayan Grey Langur *Presbytis entellus*, Musk Deer *Moschus leucogaster,* Black Bear *Ursus thibetanus*, Asiatic Jackal *Canis aureus*, Common Leopard *Panthera pardus* and Grey Goral *Naemorhedus goral*.[77] The key species found in the protected areas of AJK are given in Exhibit B.4 below.

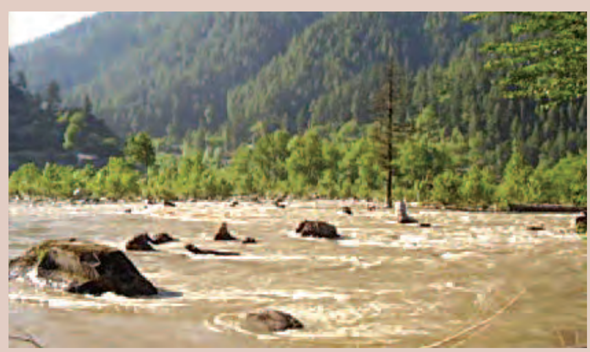
**Exhibit B.3: Photographs of the Riparian Vegetation in Neelum Valley**



a. Aesculus indica, Sambucus wightiana Trees and shrubs on the river bank, near Line of Control,

b. Salix and Poplar trees in floodplain, Taobat

c. Poplars, Aesculus indica, Sambucus wightiana, in floodplain, Sardari,



d. Salix and poplars in floodplains on the bank, near Kel Mahl

e. Acacia modesta and Dalbergia sisso on banks of Poonch river

f. Acacia modesta trees on banks of Poonch river

77. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.

The only mammal found in AJK that is directly dependent on the river for its survival is the Otter. There are two species of Otter found in Kashmir Valley. These include Common Otter (also known as Eurasian Otter (*Lutra lutra*) and Smooth-coated Otter (*Lutrogale perspicillata*). The Common Otter (*Lutra lutra*) was formerly found in the river systems of the entire Himalayan region, extending in summer to small mountain torrents as high as 3,500 m.[78] Like other otter species in Asia, its population is on the decline.[79] Wide hunting for fur of the Common Otter, which has commercial value, has been cited as the main reason for the population decline. Today, it is rare to find Otter in the Neelum Valley, although it has been reported from other parts of the Jammu and Kashmir.[80] Common Otter or Eurasian Otter (*Lutra lutra*) is Near Threatened in IUCN Red List 2013.[81] Officials of Azad Kashmir Wildlife Department have reported observing footprints of Otter in the Upper Neelum Valley in autumn 2008.[82] Since the species is mainly nocturnal, there are difficulties in its observation. However, available information suggests its presence in the upper parts of Kashmir Valley. Smooth-coated Otter (*Lutrogale perspicillata*) is thought to be present in the lower parts of the Kashmir, but exact number and distribution of Smooth-coated Otter (*Lutrogale perspicillata*) in the valley is not known. Smooth-coated Otter (*Lutrogale perspicillata*) is Vulnerable in IUCN Red List 2013. Further studies are required to study Otter distribution, behavior, and dependence on the river for food. The Otter is heavily dependent on the river for its survival. During the day, the otters hide in burrows in the banks of the rivers. As the burrows usually have their entrances below the water level, they are difficult to find and therefore also protect the animals from their natural and human predators. Reduction in river water will, in addition to potentially affecting their source of food, have significant impact on their survivals by exposing their burrows.[83]

**B.3.5 Reptiles**

Very little information is available about the reptiles and amphibians found in the vicinity of the rivers in AJK. Four reptile and one amphibian specie have been reported from the Neelum and Jhelum river banks.[84] These include Kashmir Rock Agama *Agama tuberculata*, Himalayan Rock Agama *Agama himalayana*, Himalayan Pit Viper *Agkistodron himalayanus*, and Cliff Racer *Coluber rhodorachis*. The amphibian species reported is Indus Toad *Bufo andersoni*.

**B.3.6 Birds**

A total of 442 bird species have been reported from AJK.[85] These include members of the family *Phasianidae, Anatidae, Podicipedidae, Ardeidae, Falconidae, Accipitridae, Cuculidae, Strigidae, Corvidae* etc. Most of the bird species are resident. However, some migratory bird species have also been reported from AJK.

A wide variety of water birds have been reported from different water bodies of AJK. These include resident and migratory birds. More than 45 species of water birds have been documented in the valley. Abundant local water birds include the Little Cormorant *Phalacrocorax niger*, Great Egret *Egretta garzetta*, Intermediate Egret *Mesophoyx intermedia*, Black-winged Stilt *Himantopus himantopus*, Little Grebe *Tachybaptus ruficollis* and Indian River Tern *Sterna aurantia*.[86] The migratory birds mostly consist of members of the

78. Roberts, T.J. 1997. The Mammals of Pakistan. Oxford University Press Karachi. 525 pp
79. Conroy, J., Melisch, R. and Chanin, P., 1998. The distribution and status of Eurasian otter (Lutra lutra) in Asia – A preliminary review. IUCN OSG Bull. 15: 15-30
80. HUSSAIN, S.A., 1998. Conservation status of otters in the Tarai and Lower Himalayas of Uttar Pradesh, India. Proceedings 7th International Otter Colloquium, Trebon, Czeck Republic. pp. 131-142
81. IUCN 2011. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 16 September 2013
82. Private communication between HBP ecology team members and officials from the Wildlife Department.
83. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.
84. Baseline Study of Protected Area in North Kashmir, Himalayan Wildlife Foundation 2006
85. Bird Life International website. Accessed on 4 September. http://avibase.bsc-eoc.org/checklist.jsp?region=PKjk&list=howardmoore
86. Azam, M.M.and Rasool, G. 2010-2012. Mid-winter Waterfowl Census Report of Mangla Reservoir, Tanda Dam and Poonch River. Unpublished report of WWF-P and ZSD.

Family Anatidae, which includes ducks and geese.

At least 15 species of ducks and geese have been reported from the Mangla Reservoir, Tanda dam and Poonch River. These include Common Teal *Anas crecca*, Common Pochard *Aythya ferina*, Mallard *Anas platyrhynchos*, Northern Pintail *Anas acuta*, Eurasian Wigeon *Anas penelope*, White-eyed Pochard *Aythya nyroca*, Common Shelduck *Tadorna tadorna*, Ruddy Shelduck *Tadorna ferruginea* and Bar-Headed Goose *Anser indicus*.

All the ducks are listed as Least Concern in the IUCN Red List while White-eyed Pochard Aythya nyroca is a listed as Near Threatened. This waterfowl that has been reported from in and around Poonch River. It is winter visitor and passage migrant and irregular year around visitor. The Bar-headed Goose Anser indicus which is also a rare winter visitor to Pakistan has been reported from Poonch River in good numbers. Common Teal Anas crecca is the most abundant migratory water bird in AJK and more than 10,000 birds annually visit the wetlands of the valley.

## B.4 Protected Areas of AJK

Due to importance of the locality and biodiversity there are 17 declared protected areas in AJK which are scattered over 113,355 acres.[87] A list of the Protected Areas[88] is given in Exhibit B.4. A map of the national parks in AJK is given in Exhibit B.5. The boundaries of the Deva Vatala National Park are not clearly specified in government publications, and therefore, the boundaries for this national park shown in the map are only indicative.

The overall responsibility of managing the protected areas belongs to the AJK WFD. The forests that fall in the protected areas are managed by the AJK FD. There are only two national parks in AJK that lie in the vicinity of the rivers of AJK. These are the Musk Deer National Park (MDNP) and the River Poonch Mahseer National Park.

**Exhibit B.4: Protected Areas in AJK**

| No | Name of Protected Area | Classification | Area hectares | District | Important wildlife species |
|---|---|---|---|---|---|
| 1 | Ghamot | National Park | 27,271 | Neelum | Snow Leopard, Common Leopard, Himalayan Ibex, Musk Deer, Black Bear, Brown Bear, Red Fox, Yellow Throated Martin, Palm Civet, Kashmir Marmot, Giant Red Flying Squirrel, Pheasants (Koklass, Monal), Snow cock, Snow partridge and Himalayan Griffon Vulture |
| 2 | Musk Deer NP Gurez | National Park | 52,815 | Neelum | Common Leopard, Musk Deer, Black Bear, Brown Bear, Leopard Cat, Kashmir stag (Hingol), Yellow Throated Martin, wolf, Giant Red Flying Squirrel, Kashmir Marmot, Pheasants (Koklass, Monal), snow cock and Himalayan Griffon Vulture |
| 3 | Machiara | National Park | 13,532 | Muzaffarabad | Snow Leopard, Common Leopard, Leopard Cat, Himalayan Ibex, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Red fox, Palm Civet, Kashmir Marmot, Pheasants (Western Horned Tragopan, Cheer, Koklass, Monal and Kaleej), Chukar, Himalayan snow cock, snow partridge and Himalayan Griffon Vulture |
| 4 | Toli Pir | National Park | 1,000 | Poonch | Common Leopard, Rhesus Monkey, Jackal, Red Fox, Leopard Cat Black Bear, Palm Civet, Pheasants (Koklass and Kaleej), chukar |
| 5 | Pir Lasura | National Park | 1,580 | Kotli | Common Leopard, Rhesus Monkey, Palm Civet, Jackal, Red Fox, Leopard Cat, Barking deer, grey goral, Jungle Cat, Wild boar, here, Pangolin, Kaleej and Koklass Pheasant, chukar, partridges (black and grey), quails |

87. Official website of the AJK government available at: http://www.ajk.gov.pk/.
88. The list has not been updated in the website to include the recently declared Poonch River National Park.

| No | Name of Protected Area | Classification | Area hectares | District | Important wildlife species |
|---|---|---|---|---|---|
| 6 | Deva Vatala | National Park | 2,993 | Bhimber | Nilgai, Hog deer, jackals, Striped Hyaena, hare, porcupine, wild boar, grey partridge, black partridge, red jungle fowl, Indian peacock; along with water birds, showellers, coots, mallards, and python |
| **Total area of National Parks** | | | **99,191** | | |
| 1 | Salkhala | Game Reserve | 859 | Neelum | Snow Leopard, Common Leopard, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Palm Civet, Red fox, Western Horned Tragopan, Cheer Pheasant, Koklass Pheasant, Monal Pheasant, Kaleej Pheasant, Himalayan Griffon. |
| 2 | Moji | Game Reserve | 3,859 | Muzaffarabad | Snow Leopard, Common Leopard, Pir Panjal Markhor, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Brown Bear, Yellow Throated Martin, Palm Civet, Western Horned Tragopan, Koklass Pheasant, Monal Pheasant, Kaleej Pheasant, Himalayan Griffon. |
| 3 | Qazinag | Game Reserve | 4,830 | Muzaffarabad | Common Leopard, Pir Panjal Markhor, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Red fox, Palm Civet, Western Horned Tragopan, Cheer Pheasant, Koklass Pheasant, Monal Pheasant, Kaleej Pheasant, Himalayan Griffon. |
| 4 | Mori Said Ali | Game Reserve | 273 | Bagh | Common Leopard, Pir Panjal Markhor, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Palm Civet, Western Horned Tragopan, Cheer Pheasant, Koklass Pheasant, Monal Pheasant, Kaleej Pheasant, Himalayan Griffon. |
| 5 | Phala | Game Reserve | 472 | Bagh | Common Leopard, Pir Panjal Markhor, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Palm Civet, Cheer Pheasant, Koklass Pheasant, Monal Pheasant, Kaleej Pheasant, Himalayan Griffon. |
| 6 | Hillan | Game Reserve | 384 | Bagh | Common Leopard, Pir Panjal Markhor, Grey Goral, Musk Deer, Rhesus Monkey, Grey Langur, Black Bear, Yellow Throated Martin, Palm Civet, Western Horned Tragopan, Cheer Pheasant, Koklass Pheasant, Monal Pheasant, Kalij Pheasant, Himalayan Griffon. |
| 7 | Nar | Game Reserve | 558 | Bagh | Chukor, Kaleej Pheasant, Common Leopard, Jackal, Red Fox, Leopard Cat, Palm Civet |
| 8 | Sudhan Gali | Game Reserve | 525 | Bagh | Chukor, Kaleej Pheasant, Koklas Pheasant, Black Bear, Common Leopard, Jackal, Red Fox, Leopard Cat, Palm Civet |
| 9 | Doom Kalla | Game Reserve | 715 | Bagh | Chukor, Kaleej Pheasant, Common Leopard, Jackal, Red Fox, Leopard Cat, Palm Civet |
| 10 | Banjosa | Game Reserve | 558 | Poonch | Chukor, Kaleej Pheasant, Common Leopard, Jackal, Red Fox, Leopard Cat, Palm Civet, Yellow Throated Marten |
| 11 | Junjhal Hill | Game Reserve | 631 | Sudhnutti | Chukor, Kaleej Pheasant, Common Leopard, Jackal, Red Fox, Leopard Cat, Palm Civet |
| 12 | Deva Vatala | Game Reserve | 500 | Bhimber | Nilgai, barking deer, jackals, Striped Hyaena, hare, porcupine, birds (grey partridge, black partridge, red jungle fowl, Indian peacock; along with water birds, showellers, coots, mallards, etc.) and reptile (python) |
| **Total area of Game Reserves** | | | | **14,164** | |
| **Grand Total area of 18 Protected Areas** | | | | **113,355** | |

Source: AJK Government official website available at http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=72&Itemid=103. Acceesed on 16 September, 2013.

## Exhibit B.5: National Parks of AJK

**B.4.1 Musk Deer National Park (MDNP)**

In 2007, the Government of AJK declared a part of the Neelum Valley as a national park under the AJK Wildlife Act, 1975 (AJK Wildlife Act 1975). The national park, called the Musk Deer National Park (MDNP), has an area of 528 km2 (130,510 acres). As envisioned in the Act, the National Park area has been set aside for the protection of the wildlife against hunting and exploitation and for the preservation of natural landscape and habitat, promotion of education and research, and development of sustainable tourism and recreation. Any developmental interventions in a protected or a sensitive area are subject to comprehensive environmental impact assessments under applicable national laws in the region and internationally-accepted guidelines prescribed by agencies such as the World Bank, the International Finance Corporation, and the Asian Development Bank.

Important biological resources that the MDNP aims to protect include the flagship species of musk deer, brown bear, black bear, snow leopard, common leopard, the Kashmir stag, and the Himalayan ibex. The MDNP is also envisioned as an important link in connecting the threatened Brown Bear population in the Deosai National Park located in the adjacent Gilgit-Baltistan province with those in the Gumot National Park located in the AJK towards the west of the MDNP. The MDNP is therefore designed and expected to play an important role in preserving wildlife movement corridors and consequentially in enriching the gene pools of wildlife in the region to prevent a genetic collapse in populations that could otherwise be isolated.[89] (Environmental Assessment of Kishenganga/Neelum River Water Diversion, 2011).

The Neelum River runs through the MDNP and is a central and integral part of the landscape of the national park. Its naturalness is an important component of the overall nature and identity of the MDNP. While the river may not be critical for the survival of the diverse mammal species that the park supports, it is important that a proclaimed natural area has a wild and a scenic river and not one that is artificially modified and highly degraded.

Increasing the wildlife populations and preservation of the natural landscape would benefit the local economy in the long run by improving and supplementing attractions for visitors. It may also be noted that the amended AJK wildlife legislation allows for sustainable use of natural resources in protected areas as notified by the authorities. Angling for brown trout, which is an introduced species in the stretch of the Neelum River that falls in the MDNP, can potentially contribute to the local economy.

**B.4.2 Poonch River Mahseer National Park**

Poonch River is unique in having warm water in its lower and middle reaches and cold water in its upper reaches. It ends at Mangla Reservoir which is one of the major fish producing water body in the country. Many channels join it in its way giving the fishes a lateral access for breeding and feeding. The entire stretch of the Poonch River along with its tributaries has been declared as Mahseer National Park in a notification issued by the President of AJK in December 2010.

The Poonch River was declared as a national park due to its high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish in the IUCN Red List. Mahseer Tor putitora that is important both from the conservation and commercial viewpoint. The Tor putitora has undergone a dramatic decline in population in the last few years and the largest stable population of this fish in the country is found in the Poonch River that also provides a breeding ground for it. In addition, the Poonch River provides a breeding ground for the commercially important fish species of the Mangla reservoir.

89. Hagler Bailly Pakistan, Water Matters – South Africa, Southern Waters – South Africa, National Engineering Services Pakistan (NESPAK), 2011, Environmental Assessment of Kishenganga /Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters, Lahore.

## B.5 Conservation Programs

This section summarizes the existing and planned river-related conservation programs that are underway in AJK, supported by both Government and Non-Governmental organizations.

### B.5.1 Government

The AJK WFD is carrying management and conservation activities in the protected areas of AJK including national parks and game reserves. In December 2010, the Poonch River was declared a national park by the Government of AJK to conserve the population of endangered Mahseer fish Tor putitora. Poonch River is the last refuge of the Mahseer in Pakistan.

AJK Wildlife and Fisheries Department has established three fish hatcheries in Neelum Valley for the breeding of trout and local fish species found in the area. Moreover, the Government of Azad Jammu Kashmir has also initiated the biodiversity conservation of Mangla Dam project to conserve the population of threatened species in the area. The promulgated Wildlife (Protection, Preservation and Management) Ordinance 2013 will be presented to members of the Azad Jammu Kashmir Assembly in the near future to convert this ordinance into Act.

### B.5.2 Non-Government Organizations

There are two major non-governmental initiatives related to management of river ecology that are presently underway in the AJK. The AJK WFD with support from the Himalayan Wildlife Foundation (HWF) is implementing conservation actions in the Neelum River and in the Poonch River.

The initiative in the Neelum River was triggered by the notification of Musk Deer National Park (MDNP) located in Tehsil Sharda of District Neelum. The River Neelum flows through the MDNP. HWF was instrumental in the establishment of the national park, and subsequently conducted baseline resource assessments including those for the Neelum River, both within the national park and downstream. A watch and ward system to control illegal fishing was put in place. The objective was to introduce permitting for trout fishing once the fish populations reach sustainable levels. World Wide Fund for Nature (WWF-P) was involved in the population and distribution estimation of Musk Deer (Moschus chrysogaster) in the Musk Deer National Park.

The conservation initiative in Poonch River evolved in a similar manner as that in the MDNP, where HWF has supported the WFD in establishing the River Poonch Mahseer National Park which was officially notified in December 2010. Preservation of river ecology has been the primary objective of HWF and WFD in this national park. HWF prepared the ecological baseline and set up a system of watch and ward in which both the HWF and the department staff have worked together to control illegal fishing activities in collaboration with local communities. This has been a very challenging situation as illegal fishing using netting, explosives, and poisoning has been rampant.

HWF has also supported the department in setting up a Wildlife Conservation Fund (WCF) which will provide financial resources to the department and the communities for conservation efforts. Conservation of river ecology will be a priority for the WCF.

# Appendix C: Socio-Economic Baseline: Background Information

## C.1 Overview of AJK's Socioeconomic Setting

AJK is an independent political entity within Pakistan. It has its own parliamentary government headed by the President. Administratively, AJK is divided into three divisions and 10 districts with Muzaffarabad city as the capital of the state. The districts are further divided into tehsils, union councils and villages. An administrative map of AJK illustrating the districts and main towns is given in Exhibit C.1. The divisions, districts and tehsils of AJK are listed in Exhibit C.2.

The topography of AJK is dominated by hilly and mountainous terrain with the districts of Neelum, Muzaffarabad, Bagh, Sudhnoti and Poonch located at the foot hills of the Himalayas. Main rivers running through the state include the Neelum, Jhelum and Poonch rivers. The climate of AJK is sub-tropical to temperate highland type with an average yearly rainfall of 1,300 mm. The elevation from sea level ranges from 360 meters in the plains in the south to 6,325 meters in the highest mountains in the north.

### C.1.1 Demography

According to the last census conducted in Pakistan in 1998, AJK had a population of 2.9 million which has increased to 4.25 million in 2013.[90] Only 13% of the population resides in urban centres whereas the rest is rural.[91] The population density is 390 persons per square kilometer. Exhibit C.3 presents official data on district population, population density, growth rates and household–size.

### C.1.2 Livelihoods

The majority of the rural population depends on forestry, livestock, agriculture and informal employment to eke out its subsistence. National average per capita income has been estimated to be USD 1,254. Unemployment ranges from 9 to 13 %.[92]

Agriculture, forestry, livestock and related service sectors is the main source of income which accounts for 30 to 40 % of the household earnings. Area under cultivation is around 478,040 acres, almost 13 % of the total geographical area. Majority of the cultivable area, that is 92%, is rain-fed. About 89 % households have very small land holdings between one to two acres. Major crops are maize, wheat and rice whereas other crops grown in the area include grams, pulses (red kidney beans), vegetables and oil-seeds. Major fruits production includes apple, pears, apricot and walnuts.

Employment (both government services and private), businesses (including cottage industry), labour and remittances received by family members working abroad form the remaining sources of income.

90. The last census of Pakistan was conducted in 1998. The next census, scheduled for 2008, could not be held. Therefore, the demographic information following 1998 is based on surveys and estimated on the basis of intercensal growth rates.
91. Population projection for 2013 based on population and growth rate recorded in the 1998 Census.
92. AJK at a Glance 2010, www.pndajk.gov.pk/Documents/Book%202011.doc (Date Accessed: September 13, 2013)

## Exhibit C.1: Administrative Map of AJK

**Exhibit C.2: Divisions, Districts & Tehsil of AJK**

| *Division* | *District* | *Tehsil* |
|---|---|---|
| Muzaffarabad | Muzaffarabad | Muzaffarabad, Patika (Naseerabad) |
| | Neelum | Athmaqam, Sharda |
| | Hattian | Hattian bala, Leepa, Chikar |
| Poonch | Bagh | Bagh, Dhirkot, Harigahal |
| | Haveli | Haveli, Khurshidabad |
| | Poonch | Rawalakot, Hajira, Thorar, Abbaspur |
| | Sudhnoti | Pallandri, Tararkhal, Mang, Baloch |
| Mirpur | Mirpur | Mirpur, Dadyal |
| | Kotli | Kotli, Khoi rata, Fatehpur, Sahensa, Charhoi |
| | Bhimber | Bhimber, Samahni, Barnala |

| *District* | *Subdivisions* | *Union Councils* | *Villages* |
|---|---|---|---|
| Muzaffarabad | 2 | 25 | 385 |
| Hattian | 3 | 13 | 153 |
| Neelum | 2 | 09 | 84 |
| Bagh | 3 | 19 | 106 |
| Haveli | 2 | 08 | 90 |
| Poonch | 4 | 25 | 115 |
| Sudhnuti | 4 | 12 | 60 |
| Kotli | 5 | 38 | 227 |
| Mirpur | 2 | 22 | 227 |
| Bhimber | 3 | 18 | 207 |
| **AJK** | **30** | **189** | **1654** |

## Exhibit C.3: District and Province-wise Area, Population, Density, Growth Rate and Household–Size

| Districts | Area (Sq.Kms) | Population Census 1998a | | | | MICS 2007-08 | Projected Population 2013 | | | | Density (Persons/Sq.Km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Population | Urban | Rural | Growth Rate | House-hold Size | Total | Percentage share | Urban | Rural | 2013 |
| Muzaffarabad | 1,642 | 454,000 | 129,321 | 368,513 | 2.80 | 5.8 | 686,993 | 16% | 129,321 | 557,634 | 418 |
| Hattian | 854 | 166,000 | 16,100 | 155,424 | 2.80 | 5.8 | 251,191 | 6% | 16,100 | 235,188 | 294 |
| Neelum | 3,621 | 126,000 | 8,660 | 119,989 | 2.80 | 7.6 | 190,663 | 4% | 8,660 | 181,568 | 53 |
| Mirpur | 1,010 | 334,000 | 157,710 | 217,841 | 2.09 | 6.7 | 455,506 | 11% | 157,710 | 297,090 | 451 |
| Bhimber | 1,516 | 302,000 | 23,726 | 285,489 | 2.60 | 6.7 | 443,831 | 10% | 23,726 | 419,566 | 293 |
| Kotli | 1,862 | 563,000 | 67,493 | 517,142 | 2.59 | 7.3 | 826,197 | 19% | 67,493 | 758,901 | 444 |
| Poonch | 855 | 411,000 | 75,428 | 356,932 | 2.24 | 6.8 | 573,000 | 13% | 75,428 | 497,620 | 670 |
| Bagh | 770 | 282,000 | 25,418 | 262,835 | 2.00 | 6.8 | 379,535 | 9% | 25,418 | 353,741 | 493 |
| Haveli | 598 | 112000 | 4,060 | 108,677 | 2.00 | 6.8 | 150,737 | 4% | 4,060 | 146,265 | 252 |
| Sudhnuti | 569 | 224000 | 22,048 | 207,685 | 1.99 | 6.6 | 301,031 | 7% | 22,048 | 279,106 | 529 |
| **Total** | **13297** | **2,974,000** | **531,734** | **2,600,527** | **2.41** | **6.7** | **4,258,686** | **100%** | **531,734** | **3,717,037** | **390** |

### C.1.3 Physical Infrastructure

Roads and air transport are the only modes of transportation in AJK. The total length of roads in the state is 12,719 km of which 6,390 km is metalled and the remaining 6,329 km are fair-weather roads.

The Government of AJK in collaboration with the Civil Aviation Authority (CAA) of Pakistan has constructed two small airports in Muzaffarabad and Rawalakot cities in order to provide easy and quick modes of travel.

In 2010, the installed grid capacity was 438.30 Megavolt Ampere (MVA). Transmission lines of 25,328 km in length have been extended to 1,649 villages out of a total of 1,654 villages with 3.5 million people having access to electricity in 2010. The per capita electricity consumption in 2010 was 284.5 kWh.[93]

About 82% of the urban population and 44% of rural population had access to piped water supply through house connections and public stand posts in 2010.

### C.1.4 Social Infrastructure

Access to health facilities in AJK is inadequate. According to estimates in 2010, approximately 2,249 hospital beds were available in 19 hospitals averaging 1 bed per 1,762 persons. The total number of doctors, including administrative doctors, health mangers and dentists is 781 out of which 450 are medical officers, 67 dental surgeons, 212 specialists and 52 health managers. The total numbers of dispensaries and rural health centers is 310 and 34 respectively, together making up 408 beds.[94]

The literacy rate in 2010 rose to 64 % compared to 55 % recorded in the 1998 census.[95] Education is among the priorities of the Government of AJK. About 26% of its total recurring budget besides 8 % of the total development budget is allocated to this sector.

### C.1.5 Neelum District

Until 2005 Neelum District was part of Muzaffarabad district. The district is administratively divided into two tehsils namely Sharda and Athmuqam. With an area of 3,621 square kilometers, it is the largest district of AJK. The population of Neelum District constitutes only 4% of the population of AJK making it one of the sparsely populated districts. According to the 1998 census, the population of Neelum District was 126,000 whereas the projected population (based on the annual growth rate for Neelum district) in 2013 is 190,663. The estimated population for 2013 shows an increase by 1.5 times compared to 1998. Official data on district population from 1998 and 2013, population density, growth rates and household–size is given in Exhibit C.3.

More than 80% of the population of Neelum District resides within 3 km of the river,[96] mainly because traditional access routes in the Neelum Valley are located closer to the river, typical in valleys with steep slopes. The shape of the valley also affects the population distribution: where the valley is narrow, population is relatively low and where it is wide, it is relatively high. The average household size in Neelum District is 7.6. Seasonal migration in the summer to access the alpine grazing grounds at higher elevations in the valley and in winter to urban areas downstream for employment is common. However, higher migration levels can be observed in Sharda Tehsil and some union councils of Athmuqam Tehsil.

Majority of the population in the district depends on daily wages, forestry, livestock and agriculture for its subsistence. Women have limited opportunities to work outside their homes, and the share of women in the employed workforce is negligible.

Agriculture is mostly based on rainfall and water provided by irrigation channels fed by tributaries

93. AJK at a Glance, 2010, www.pndajk.gov.pk/Documents/Book%202011.doc (Date Accessed: September 13, 2013)
94. Ibid
95. Ibid
96. Of which 80% live within 1 km of the river.

or the side streams. Maize, wheat and paddy are the major food crops in the Neelum District. Linkages of the people's livelihoods to the Neelum River are limited to river-based tourism and related activities, such as sport fishing. The river serves as the main attraction for the tourists frequenting Neelum Valley and tourism-based activities, such as angling for brown trout, generate employment opportunities for the local people.[97] The river is used for transportation of timber. However, timber harvesting in sections that fall in the Musk Deer National Park is restricted as the Government of AJK is gradually moving towards sustainable forestry regimes. Compared to the urban centres in AJK, such as Muzaffarabad, infrastructure and facilities available for visitors in the rural areas in the Neelum Valley are relatively limited. The main reason for this is the backdrop of military conflict close to the LoC hindering the development of the tourism potential of the valley. When compared with similar valleys in other provinces of Pakistan located far from the borders such as Kaghan and Swat, the Neelum Valley has yet to realize its tourism potential.

There is a district headquarter (DHQ) hospital in Athmuqam and a tehsil headquarter hospital (THQ) in Kel. Besides these, dispensaries, basic health units (BHUs) and rural health centres (RHCs) are accessible.

### C.1.6 Muzaffarabad District

Muzaffarabad District consists of Muzaffarabad city, the capital of AJK, and suburban areas located at the confluence of Jhelum and Neelum rivers. It is the second largest district of AJK in terms of population and third area-wise. The population of Muzaffarabad District constitutes 16% of the population of AJK, making it one of the densely populated districts. The district is administratively divided into two tehsils. With respect to the rural-urban divide, Muzaffarabad is the second largest district in terms of urban population following Mirpur District. According to the Multiple Indicator Cluster Survey (MICS) 2007-08,[98] the average household size in Muzaffarabad district was 5.8 which is lower than the average household size reported in the 1998 census (7.1 for both urban and rural). Official data on district population (1998 and 2013), population density, growth rates and household-size is given in Exhibit C.3.

People of Muzaffarabad have diverse means of livelihood. Farming, forestry and livestock rearing are the main occupations, particularly among rural households. Poultry farming is also common and, ponies and donkeys are kept for carrying load to higher altitude areas. Among the mountains are valleys and terraces used for cultivation. Main crops are maize, wheat, rice, oil seed, potato, pulses and a variety of vegetables. The area is famous for fruits such as apple, walnut, pear, plum and apricot. There is no extensive canal system and farming is largely dependent on rain water and small channels connected to perennial water sources. Almost 59% of the district area is covered with forest and is a major source of income (such as timber, firewood, fruits).

Muzaffarabad is also the main trade centre of AJK. Due to the topography of the area, it is not possible to establish large industrial units, however, the cottage industry; mainly carpet weaving, furniture making, wood carving, garment making and embroidery work thrives in the area. There are a few textile centers which produce bed sheets and coarse cloth.

Employment in government offices and in the army as well as overseas employment is quite common in Muzaffarabad city. In-country seasonal migration for employment is also practiced by a large number of people. Special Communication Organization (SCO) operates an extensive telephone network in the district and all main towns in the district have telephone connectivity. Cellular phone services, with considerable coverage in all major towns are also available.

97. Hagler Bailly Pakistan, (HBP) 2011. Environmental Assessment of Kishenganga/Neelum River Water Diversion. Report prepared for Pakistan Commission for Indus Waters. Lahore: Hagler Bailly Pakistan.
98. AJK at a Glance 2010, www.pndajk.gov.pk/Documents/Book%202011.doc (Date Accessed: September 13, 2013)

Muzaffarabad is linked with Pakistan's national grid system. The distribution network within the city and rest of the district is the responsibility of AJK Electricity Department. Most of the villages and towns are quite well serviced in terms of electricity.

**C.1.7 Bagh District**

Bagh District is administratively divided into three tehsils. The population of Bagh District constitutes only 9% of the population of AJK however the population density is higher compared to that of AJK (Exhibit 4.3). According to the 1998 census, the population of Bagh District was 282,000 whereas the projected population (based on the annual growth rate for Bagh District) in 2013 is 379,535. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit C.3.

The major crops of the district are maize and wheat but at some places rice, gram, bajra and jawar are also cultivated. Pulses are also grown in the district. Buffalos and sheep/goat are reared in almost every home for milk and other dairy products. Ponies and donkeys are used for carrying load. Main trade centers of the district are at Dhirkot, Bagh and Kahuta. Wool spinning on hand looms is carried out throughout the district. The articles made from these hand looms, are for domestic use only. Since there is no industry in the district, all essential commodities like textiles, leather goods and other items of daily use are imported from various markets of Pakistan. The major export of the district is apple.

The district is connected with Rawalpindi by two roads, Bagh – Tain Dhalkot - Kotli Sattian Road and Bagh-Kohala-Murree road. Bagh is also connected with Kohala, Haveli via Suddhan Gali and Mallot Las Dana through metalled roads. A total of 3,187 km of link roads (metalled and dirt tracks) have been constructed under the Local Government and World Food Programme (WFP) projects.

Special Communication Organization (SCO) operates an extensive telephone network in the district and all main towns have telephone connectivity. There are 8 digital exchanges, 12 non-digital exchanges and 2 under construction digital exchanges in District Bagh. Cellular phone services with considerable coverage have also become available after the 2005 major earthquake.

Bagh is linked with Pakistan's national grid system. The distribution network within the city and rest of the district is provided by the AJK Electricity Department. According to the census of 1998, overall 68 % of the district area is provided with electricity. In rural areas the percentage stood at 66 % and for urban it was 97%.

**C.1.8 Poonch District**

Poonch District is administratively divided into four tehsils namely Rawalakot, Hajira, Thorar, Abbaspur. Area wise, the district is one of the smaller districts in AJK. However, the population density of the district is 670 persons per square kilometer, the highest in AJK. The reason for high population density is the mountainous terrain. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit C.3.

Means of livelihood in Poonch District include farming, livestock, poultry, government service (both civil and military), business and overseas employment. Industry is minimal in terms of contributions towards livelihoods. In-country seasonal migration for employment is very common.

Poonch District is connected to other districts of AJK and Pakistan by road. According to 2005 statistics, there were a total of 1,822 km of roads in district Poonch with a break up of 617 km of metalled and 1,205 km of fair weather roads. Major towns of the district have telephone connectivity. Similarly cellular phone network is also available in the district. The district is linked with Pakistan's national grid system, however, the responsibility of distribution lies with the Electricity Department of AJK. According to the census of 1998, overall 79% of the district area had access to electricity. In rural and urban areas, the percentage stood at 76% and 98% respectively.

**C.1.9 Sundhoti District**

Sudhnoti District is the smallest of all the districts in AJK in terms of area and is home to only seven percent of AJK's population. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit C.3. Administratively the district is divided into four tehsils, Pallandri, Mang, Baloch and Trarkhal. Pallandri is the district headquarters.

Roads are the main mode of transportation in the district. The total metalled road network in the district is 504 km. Transport facilities are available in the form of passenger vans, taxis, jeeps and buses. The district does not have the facility of a general post office (GPO) but 34 extra departmental branches of post offices exist. There are 14 telephone exchanges in the district.

**C.1.10 Kotli District**

Kotli District is the second largest district in AJK area-wise and the largest in terms of population. The district houses 19% of AJK's total population. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit C.3. It is divided in four subdivisions, Kotli, Fatehpur Thakiala, Sehnsa and Charhoi. Kotli, the districts headquarter is located at a distance of 114 km from Rawalpindi/Islamabad.

Roads are the main mode of transportation in the district. Total metalled road network in the district is 1,014 km. Transport facilities such as passenger vans, taxis, jeeps and buses are used for travelling within the district and other districts. The installed grid capacity in the district is 65 MVA. About 4,598 km of transmission lines have been extended to 230 villages. The district has one general post office (GPO) and 48 extra departmental branches of post offices. There are 25 telephone exchanges functioning in the district.

**C.1.11 Mirpur District**

Mirpur District comprises of 11% of the total population of AJK. It is administratively divided in three tehsils, Mirpur, Dudyal and Chakswari. Mirpur, the district headquarter is situated at an elevation of 459 m above sea level. It is linked with the main Peshawar-Karachi Grand Trunk road at Deena, a small town about 15 km short of Jhelum city. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit C.3.

The district comprises of both mountainous terrain and plains. Its hot climate and other geographical conditions closely resemble those of Jhelum and Gujrat, the adjoining districts of Pakistan. The people of the area are mainly associated with agriculture. As it adjoins the industrial cities of Pakistan, the government of AJK has successfully endeavoured to develop it as an industrial place and promote private investment for establishing textile, vegetable, ghee, garments, scooters, cosmetics and many other industries. Mirpur city is well planned and buildings are of modem design. It has rapidly developed into an industrial city. All the basic amenities of life such as colleges, hospitals, banks, shopping centers, hotels, hostels, telephone; and telegraph units are available here.

The total metalled road network in the district is 1,699 km. The main mode of transport in the district is by road. Transport facilities are in the form of passenger vans, rickshaws, taxis, jeeps and buses that traverse different parts of the district. The installed grid capacity in the district is 130 MVA. About 2,006 km transmission lines have been extended to 231 villages. The district has one general post office (GPO) and 40 extra departmental branches of post offices. There are 15 telephone exchanges functioning in the district.

### C.1.12 Bimber District

Formerly a subdivision of Mirpur District, Bhimber was administratively declared as an independent district in 1996. The district is very rich in archaeology and wild life, and panoramic vistas. Bhimber town is located at a distance of 50 km from Mirpur and 166 km from Rawalpindi. This town is connected both with Mirpur and Gujrat through black top roads.

The population of the district represents 10% of the total population of AJK. Official data on district population (1998 and 2013), population density, growth rates and household–size is given in Exhibit 4.3. The people of the area are mainly associated with agriculture and livestock.

The total metalled road network in the district is 401 km. Roads are the main mode of transportation throughout the district. Transport facilities are available in the form of rickshaws, taxis, jeeps and buses. The district does not have the general post office (GPO) facility, however, 29 extra departmental branches of post offices exist. Seven telephone exchanges are functioning in the district. The installed grid capacity is 52 MVA and about 1,931 km of transmission lines have been extended to 208 villages.

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