Final Evaluation Report

Snow and Ice Hydrology (Pakistan)

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Joan McArthur-Blair
Marvin Lamoureux

For additional copies, or for further information about this document, please contact Manon Thérien at the following address:

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE
P.O. BOX 8500
OTTAWA, ONTARIO
CANADA, K1G 3H9

TELEPHONE (613) 236-6163 EXTENSION 2073.

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Table of Contents

Pakistan Snow and Ice Hydrology Project
Final Evaluation Report
Executive Summary

The Snow and Ice Hydrology Project Final Evaluation Report presents the findings and conclusions of the participatory evaluation of the Snow and Ice Hydrology Project Phase-II. The evaluation time frame cover time frame from late 1995 to early 1997

Snow and Ice Hydrology Project Phase II (SIHP-II) was started in 1991 and completed in early 1997. Its primary goal was to positively impact the water resource management capability of WAPDA on the flows from the Upper Indus Basin. The Project was funded by the Canadian International Development Agency (CIDA); executed by the International Development Research Centre (IDRC); and implemented by British Columbia Hydro International Limited (BCHIL) and the Water and Power Development Authority of Pakistan (WAPDA).

The participatory evaluation was implemented by Lamoureux and Associates in conjunction with Vancouver Community College as contracted evaluators for IDRC. The evaluation process was designed, developed and implemented in liaison and collaboration with the stakeholders involved in the Project. Data and information collected during the evaluation were analyzed for patterns which were indicators of the Project's impact, successes and challenges. Much of the evaluation data/information collection was conducted by Evaluation Team Leaders who were involved with the implementation of the Project.

SIHP-II was a successful Project for two primary reasons. First, the infrastructure outputs that were identified in the initial planning have been successfully transferred to Pakistan. Twenty-two Data Collection Platform

Stations installed in high elevation regions of Pakistan. The meteor burst communication system is functioning reliably and consistently transmitting data to the master station in Lahore. The data management and its related capability to produce a seasonal and 10 day flow forecast are in place. Second, the Pakistani personnel within the Project are trained and capable to technically support and sustain the Project over time.

SIHP-II also faces three major challenges to its success and sustainability. The first is the conditional nature of its sustainability. SIHP-II sustainability is predicated on WAPDA's willingness to support and utilize the ongoing efforts of SIHP-II as its ability to produce reliable forecasts increases as more inflow data is acquired. The second is the maintenance of trained SIHP-II personnel. For the duration of the Project the personnel remained constant but will now be open for transfer. Thus, importance of back filling with trained personnel and cross training can not be over emphasized. The third is the utilization of the inflow forecasts within the water management structure of Pakistan. Work has just begun in late 1996 on this aspect of the utilization of the forecasts for reservoir management. This move to using the seasonal and ten day forecasts for reservoir management will be a foundation of sustainability and lead to a series of long term impacts on Pakistan water management capability.

SIHP-II was found to be a dynamic and viable Project built upon the motivation and commitment of the individuals and organizations involved in the Project. Given that primary objectives of the Project have been successfully met, it now remains for the positive outcomes of the Project to be used and incorporated into the water management strategies of Pakistan.

Pakistan Snow and Ice Hydrology Project
Final Evaluation Report

Section One: Introduction and Background

1.0 Introduction

The Pakistan Snow and Ice Hydrology Project Final Evaluation Report constitutes the outcome of the SIHP-II Final Evaluation conducted for IDRC by Lamoureux and Associates and Vancouver Community College. The design and implementation of this evaluation was a collaborative effort amongst the stakeholders involved with the Project and the evaluators.

1.1 Background On SIHP-II

The Pakistan Snow and Ice Hydrology Project was designed to improve the ability of the WAPDA to manage the water resources of the Upper Indus Basin and optimize the benefits from the water stored in the Mangla and Tarbela reservoirs. This was accomplished by establishing an operating an ice and snow run off monitoring and forecasting system. The ultimate goal of the Project was to produce economic benefits leading to an improvement in Pakistan's living conditions through better water management and by increased energy production, and farm output. (adapted from BCHIL/WAPDA, 1993). The Project was started in 1991 and will be completed at the end of June 1997.

The main goal of the Project is essentially to strengthen the water resources management capability of WAPDA on the flows from the Upper Indus Basin.

The Project document lists several specific objectives:

- to determine the stream flow forecasting needs of WAPDA for the Upper Indus Basin
- examine suitabilities and deficiencies of seasonal and short-term flow forecasting systems as a function of WAPDA's operational needs
- select the best available model for stream-flow forecasting that will be adapted to meet the WAPDA requirements

and depending upon the results of the above:

- to expand the existing hydrometeorlogical network to the high altitude snow-covered and glaciated areas
- to install, after proper testing, a communication system for rapid and reliable transmission of mountain hydro-meteorological data to operational run off forecasting centre(s)
- upon determination of positive benefits, to install equipment necessary for recording, transmission, reception and analysis of remotely sensed data for run off forecasting purposes
- to establish procedures for the estimation of snow, glacier-melt and rainfall
- to estimate the seasonal and short-term run off volumes arising from snow melt, ice melt, and rainfall by calibrating and testing computer models of the catchments upstream of: the mouth of the Kabul River, the Indus River at Tarbela, and the Jhelum River at Mangla
- to continue some of the applied hydrological research activities within Phase 1 for their integration into the proposed forecasting system

- to train WAPDA personnel in all phases of the Project, so that upon completion they will capably operate, maintain and modify the system, as required, without outside assistance

- to establish strategies for the reservoir operations as a function of inflow scenarios developed by the hydrological model. (IDRC, 1991)

1.1.1 Administrative Structure of SIHP-II

SIHP-II is a CIDA Project managed by IDRC. IDRC has the responsibility for monitoring BCHIL's (the implementing agency) Project activities and reports to CIDA in accordance with the schedule set out in SIHP-II's Management Plan. IDRC delegated to BCHIL the lead responsibility to implement the Project. BCHIL worked in a team with WAPDA personnel. WAPDA carried out most of the Project activities with guidance, training and technical assistance provided by BCHIL.

1.1.2 Activities of SIHP-II

The Project comprised: (i) the installation of a network of automatic data collection platforms (DCP) at different altitudes in the headwaters of the main rivers; (ii) and, the development of a inflow forecasting system based on a hydrological model for enhancing the water management of the Upper Indus Basin. This model, designed to satisfy the needs of WAPDA in stream flow (10 day and season inflow volumes) forecasting, used data from 22 remote hydrometeorlogical stations in 16 sub-basins of the high Himalayas, (Karakoram and Hindu Kush ranges) (plus one station in Lahore), as well as data from some existing river gauging stations in the basin.

The flow forecasting model required the installation of sensors for measuring different parameters and a communication system that fed the information to a Data Processing Centre located in Lahore.

The Project is divided into four blocks of activities: (IDRC, 1995)

A. Project Management

B. Technical Assistance which included:

- Remote Sensing System
  - installation of twenty remote sensing sites, selected through reconnaissance visits will be installed
  - annual maintenance of the sites to: verify the sensors; replace anti-freeze in the precipitation gauge; check and/or replace the battery; and repair or replace any malfunctioning sensors
- Data Decoding and Quality Control
  - the electronic data received from the field are decoded, verified and regularly entered into a data base.
- Hydrological Model
  - decoded data are used as input to a computer model of the Upper Indus Basin
  - the steps in the use of the model are: set-up, calibration, and application
  - the model output is a volume of flow which forms the basis for the operations of reservoirs and the allocation of water from the Upper Indus Basin
- System Operation

C. Procurement

D. Training

1.2 SIHP-II Evaluation

The Pakistan Snow and Ice Hydrology Project Final Evaluation provides evaluative information on the Snow and Ice Hydrology Project Phase Two. The evaluation implementation was carried out by Lamoureux and Associates in conjunction with Vancouver Community College. The primary objective of the evaluation was to:

- examine the Project outcomes in relation to the project's stated objective and goals
- examine the Project in relation to its implementation outputs, practices and procedures

The SIHP-II Evaluation was a participatory evaluation which included the stakeholders in the design of the evaluation and in the implementation of the evaluation. The stakeholders included:

- IDRC personnel
- BCHIL personnel
- WAPDA personnel

The design of the evaluation was completed in collaboration with the stakeholders in March 1996. The collaborative implementation was completed in late 1996 and the Final Evaluation Report was produced in early 1997.

Section Two Evaluation Design, Methodology

2.0 Introduction

The evaluation process chosen by IDRC was predicated on the hypothesis that in a highly technical Project like SIHP-II the stakeholders involved in the Project were best situated to provide valid and reliable data on the Project outcomes. This hypothesis lead to the creation of an evaluation terms of reference that included the implementation stakeholders in the

data collection and first level interpretation of data. The evaluation methodology: (i) utilized current trends in results based management with particular emphasis on defining realistic expected results; (ii) and, evaluated those results in relation to Project specific performance indicators. The sections that follow outline the design and methodology processes.

2.1 Evaluation Design

The design was intended to link the data and information acquisition process, and the evaluation outputs with the direct involvement of the Project stakeholders. Thus, a participatory self-evaluation design was open to all involved and the evaluation outputs were directly related to the time, effort and commitment by the stakeholders. In addition, the traditional role of a "Project Evaluator" was shifted to that of "evaluation monitor" wherein this individual, i.e. Lamoureux & Associates, guided the stakeholders in implementing the design.

The evaluation process used a combination of three approaches:

- interviews
- focus groups
- questionnaires

Each evaluation approach targeted specific groups within the Project who could best reflect on the outcomes, successes and challenges of the SIHP-II Project.

Three agents held primary responsibility for the implementation of the evaluation:

- Pakistan and Canadian Advisory Committee (see Appendix II)

- Evaluation Team Leaders (see Appendix II)
- Evaluation Monitor (Lamoureux and Associates, see Appendix II)

Within the evaluation design Lamoureux and Associates (Lamoureux) and the Advisory Committee were designated:

- to ensure the timely and accurate collection of data
- to facilitate the involvement of stakeholders in the participatory self-evaluation process

This direct involvement allowed the design to remain with those individuals who were part of the Project's development and had been involved, or are presently involved, in the implementation of the Project.

The Advisory Committee's primary functions were to:

- liaise with Lamoureux while the design was being implemented, especially as the latter relates to the evaluation data and information collection methods
- designate and monitor the Evaluation Team Leaders
- assist Lamoureux in ensuring the validity and reliability of the evaluation data and information collected
- ensure the design as implemented remained participatory
- provide clarification on the technical aspects of the Project during the evaluation analysis function
- advise on data collected and interim evaluation reports

Advisory Committee consisted of the following stakeholders:

- the management group
- WAPDA Project implementing staff
- BCHIL Project implementing staff (see Appendix II)

The Advisory Committee, with the involvement of Lamoureux, nominated Evaluation Team Leaders. These individuals interacted with the three stakeholder groups in order to collect evaluation-related data and information by:

- leading Project evaluation focus groups, including the exact documentation of the group responses
- assisting in the delivery of Project questionnaires
- ensuring adherence to the evaluation output scheduled time lines
- categorizing the information and data received from the focus groups and questionnaires
- forwarding categorized data and information to Lamoureux for analysis

The Evaluation Team Leaders were: (see Appendix II)

- appointed by the Advisory Committee
- selected from BCHIL and WAPDA as appropriate

(note: the evaluation team leaders were Canadian and Pakistani personnel directly involved with the Project)

Lamoureux and Associates were responsible for the design's overall coordination and provided evaluation monitoring and advice services to the participants, Specifically, and with input from the Advisory Committee, Lamoureux :

- trained Evaluation Team Leaders in evaluation techniques
- monitored the implementation and progress of the participatory self-evaluation design

- provided advise to Advisory Committee
- supervised data and information collection
- conducted one-on-one interviews
- analyzed the data and information collected
- wrote interim evaluation reports
- ensured report content validity and reliability
- wrote the Final Evaluation Report

2.2 Evaluation Methodology

The Evaluation methodology developed from the participatory design included three stages:

1. - establishing evaluation time lines
   - training evaluation team leaders
   - identifying items to be evaluated
   - developing collection instruments

2. - data collection by evaluation team leaders and Lamoureux and Associates, and Vancouver Community College

3. - analysis of the collected data
   - development of the final evaluation report

2.2.1 Stage One

The Evaluation Timelines were driven by the SIHP-II schedule. It was important to collect the data in the later stages of the Project to allow for as much accomplishment within the Project as possible. The data collection completion date was set as November 1, 1996 and was completed and delivered by December 1, 1996. (For a complete evaluation timeline see Appendix I)

The Training Of Evaluation Team Leaders from the stakeholder groups was conducted in Canada and in Pakistan. Two Canadians and four Pakistanis were trained in focus group leadership and in questionnaire administration. The role of the Evaluation Team Leaders was data collection and first level analysis of the data.

The Establishment Of The Items To Be Evaluated was done through participatory forums in Canada and Pakistan. The three stakeholder groups, BCHIL, IDRC, and WAPDA SIHP-II, participated in the forums led by Lamoureux and Associates.

The Development of Collection Instruments was based upon the items to be evaluated. Three types of collection instruments were developed by Lamoureux and Associates with input from the stakeholders. There were interview schedules, focus groups, and questionnaires. (See Final Evaluation Design, IDRC report March 1996 for versions of these instruments.)

2.2.2 Stage Two

The data collection procedure was coordinated and executed by Lamoureux and Associates and Vancouver Community College, in collaboration with the Evaluation Team Leaders. The Evaluation Team Leaders conducted 90% of the focus groups and administered the questionnaires. Lamoureux and Associates and Vancouver Community College conducted the interviews, and assisted in 10% of the focus group activity. Reliability and validity was ensured in this process. The reliability of the data was confirmed by: (i) adequate training of the focus group leaders; (ii) collecting data from all of the stakeholders: (iii) and, confirming that each focus group included enough individuals to

provide reliable data. Validity was ensured by repetitive methods of collecting data. Questions that garnered similar responses were asked in the interview process, the focus groups and on the questionnaires.

The breakdown of the data collected was as follows:

- interviews conducted: **11 in total**

  7 in Pakistan
  4 in Canada

- focus groups conducted: **10 in total**

  5 in Canada
  5 in Pakistan

- questionnaires **15 in total**

  6 in Canada
  9 in Pakistan

Data were collected in the following areas:

- Project objective and goals
- assumptions driving the Project
- management of the Project
  - human resource management, e.g., communication, working relationships
  - technical management, e.g., hardware sites
- training systems
- critical outputs and impacts
- focus on future related projects
- systemic, organizational and future issues
- use and understanding of Project components
- training outputs

- working relationships
- human resource management
- cultural influence
- timeliness of events/inputs
- adequacy of inputs

Note: Some of these items were combined into single items in the implementation and reporting of the evaluation

2.2.3 Stage Three

Analysis of the collected data was conducted through a method of relating the data collected to the goals of the Project and the areas that were selected for examination. The data were analyzed for over-arching patterns and were organized around the objective, goals and selected evaluation areas.

The draft final evaluation report was completed in December 1996 and was provided to the stakeholders for final input. The final evaluation report was completed in February 1997.

Section Three Evaluation Findings

3.0 Introduction

This section contains the findings of the evaluation. The section is organized in four major categories:

3.1 Findings Related to the SIHP-II Goal

3.2 Findings Related to the SIHP-II Objectives

3.3 Findings Related to the SIHP-II Areas Chosen by the Stakeholders for Examination

3.4 Findings Related To Sustainability, Organizational and Future Issues

In each of these categories consolidated data are presented in point form with conclusions drawn from the data. Where applicable the origin of the data has been noted in parenthesis. For example BCHIL (which includes the Project Manager), SIHP-II staff, WAPDA management, IDRC. No origin has been noted if the comment was found to be generalized across the stakeholder categories.

3.1 Findings Related To The SIHP-II Goal

SIHP-II Goal

The main goal of the Project is essentially to strengthen the water resources management capability of WAPDA on the flows from the Upper Indus Basin

Findings

This goal reflects a long term outcome of the Project. The Project has not fully met this goal but has the potential of doing so. This potential rests in the utilization of the Project outcomes. The findings related to this potential are:

- this was a unique Project on ice and snow hydrology and has the potential to significantly reduce the uncertainties of water availability and improve consensus on water releases and water management (BCHIL, WAPDA management)
- 22 remote sensing data collection platforms were installed, (see appendix three for locations) and are currently transmitting data to the master station in Lahore for processing
- a master station and a test station were installed in Lahore

- Pakistan personnel have developed the capability to refit, design, maintain and modify the existing system. (BCHIL, IDRC, WAPDA management)

- the potential for improved water management through more efficient reservoir operation exists

  This potential relies upon:

  - continued data collection to ensure reliability and validity of the forecasting data and continued calibration of the system

Note: There are three issues related to data:

1. it was known at the outset of the Project that it would require 3 to 4 years past the completion date of the Project to have enough data from the high elevation stations to produce forecasts using only this data as historical data
2. there has been an ongoing issue in the Project with acquiring historical data for low level stations which could be used to accurately calibrate the model (the agency responsibility for this data rests outside SIHP-II)
3. there was an ongoing issue in the Project with acquiring realtime stream flow data (the agency responsibility for this data rests outside SIHP-II)

   (WAPDA has committed to resolving both item 2 and item 3)

  - WAPDA incorporating the forecasting model into its reservoir operation planning and implementation strategies

  - WAPDA does not have final authority on water management issues in Pakistan, therefore utilization is reliant upon cooperation with other agencies (IDRC, BCHIL, WAPDA management)

- SIHP-II can currently produce 10 day and seasonal forecasts based upon the current data available (BCHIL, SIHP-II staff)

- the minor section of the Project related to reservoir management strategies rather than technical capability has just recently being undertaken.

- there has been improved cooperation with other agencies in Pakistan and within WAPDA. SIHP-II is situated in a powerful position to influence other agencies which could use the data being produced, for example, Indus River System Authority, Provincial Irrigation Department, Federal Flood Commission and other agencies within Water And Power Development Authority. (WAPDA management, BCHIL)

Conclusions

Although this goal has not currently been fully met the potential for its being met is very clear. However, this potential resides clearly with WAPDA and its ongoing support for data collection and utilization of the flow forecasting model. It should be noted that the wording of this goal stresses "strengthen water resources management capability". This Project, which focused primarily on the technical installation and operation of remote sensing platforms and a flow forecasting model, has provided the foundation for enhanced "capability"

Now that the tools for enhanced water management have been set in place, a follow-up Project would allow the goal of "strengthened water resources management capability" to be more fully met. In particular, a follow-up Project which had a broader focus revolving around the involvement of all agencies which have a stake in , or authority for water management in Pakistan would allow for full utilization of this project's outcomes.

3.2 Findings Related To The SIHP-II Objectives

3.2.1 SIHP-II Objectives

- *to determine the stream flow forecasting needs of WAPDA for the Upper Indus Basin*

- *examine suitabilities and deficiencies of seasonal and short-term flow forecasting systems as a function of WAPDA's operational needs*

- *select the best available model for stream-flow forecasting that will be adapted to meet the WAPDA requirements*

Findings

These first three objectives of the Project were successfully met. After examination of the needs within Pakistan the University of British Columbia (UBC) Watershed Model was chosen for implementation in Pakistan. The following information reflects this assertion:

- the UBC watershed model, designed for mountainous regions, was already being successfully used by B.C. Hydro. (BCHIL) Ten models were examined by Canadian and Pakistani staff within the Project and the UBC model was selected. (BCHIL)
  (Note: SIHP-II staff reported in the evaluation that not enough work had been conducted on the selection of the model but upon examination this appeared to be a communication issue about the research that had been conducted not a comment on the quality or quantity of the research)

- a proper representation of the basins was possible due to the flexibility in the model and the model was able to represent data in multiple bands (for example with the input of three elements the model produces a detailed output for plus or minus eleven elements). The model was the considered the right choice for the Pakistani environment. (BCHIL, SIHP-II staff)

- the model simulates the rainfall, ie. snow melt adequately with the exception of one basin where some further calibration and data are still required (SIHP-II staff)

- the involvement of Dr. Quick from UBC and the Masters level training provided at UBC assured a strong foundation for the technology to be

transferred (IDRC, BCHIL, WAPDA management)

- the choice of a meteor burst communication system rather than a radio communication system proved a reliable choice
- the integrated data management process is up and functioning within the Project

Note: There was some concern expressed by SIHP-II personnel that ongoing liaison with the author of the model would be required to provide upgrades and support. The model was originally developed as an academic model and extensive modification and additional software was required to produce an integrated inflow forecasting system such as flow routing, batch programme operation, preparation of forecasting bulletin and statistical interpretation of weather patterns. It was not indicated by respondents whether this delayed the successful outcomes of the Project.

Conclusion

The choice of the model and the communication system were crucial to the success or failure of SIHP-II. The model, the communication system, and data decoding are fulfilling the requirements of the Project, and have the potential of fulfilling the ongoing requirements of WAPDA for flow forecasting.

3.2.2 SIHP-II Objectives (continued)

and depending upon the results of the above:

- *to expand the existing hydrometeorlogical network to the high altitude snow-covered and glaciated areas*
- *to install, after proper testing, a communication system for rapid and reliable transmission of mountain hydro-meteorological data to operational run off forecasting centre(s)*

- *upon determination of positive benefits, to install equipment necessary for recording, transmission, reception and analysis of remotely sensed data for run off forecasting purposes*

Findings

Currently, as the SIHP-II ends, there have been 22 remote sensing data collection platforms installed. Each of these data collection platform stations transmits every hour using a meteor burst communication system to a master station in Lahore. Each station transmits temperature, wind speed gust and direction, precipitation, solar radiation, snow-water equivalent, and battery voltage to the master station in Lahore. From the master station in Lahore this information is transferred to the maintenance and engineering office and then into computer software systems for analysis and use in the forecasting model. All these systems are now working and functional. The following data were found which related to these objectives:

- high altitude data is now being collected through these stations on a regular and consistent basis
- the capability to design, install and maintain the DCP's has been successfully transferred to a cadre of trained personnel in Pakistan (SIHP-II staff, WAPDA management)
- SIHP-II personnel overcame rugged terrain to install the remote stations
- regular maintenance schedule for the stations
- the meteor burst communication system was chosen as it did not rely upon regular satellite communication. This system was the most economical, offered equal or better reliability when compared to other systems. It had a overall reliability of 70.0% and when there were no power interruptions a reliability of 98.8% (BCHIL)

- the process of data decoding and quality control is functioning although there are some ongoing issues with quality control (SIHP-II staff)

- there is an ongoing difficulty with the snow pillow interface card from Meteor Communication Corporation that provides the snow-water equivalency reading. This should be resolved by the end of the Project by the manufacturer with advice from SIHP-II personnel and BCHIL, although there is concern about the Project coming to an end and this issue still being outstanding. BCHIL suggested that pressure cells rather than shaft encoders may have been more suitable for the system that was installed although pressure transducers may present difficulties as well.

- data is not totally reliable from the precipitation bucket. At some sites four foot buckets were installed where five foot buckets were required. There is an ongoing issue of evaporation from the buckets. It is unlikely that these issues will effect the reliability of the model if it is taken care of during routine maintenance. It has been suggested that bucket replacement and the installation of bucket shields would alleviate these issues.

Conclusion

With the exception of the snow pillow interface card the system that has been installed is functioning well and can be maintained and modified by the trained personnel in Pakistan. For the Tarbela catchment region a seasonal forecast, for the period April to September 1996, was carried out and the results were encouraging.

3.2.3 *SIHP-II Objectives (continued)*

- *to establish procedures for the estimation of snow, glacier-melt and rainfall*

- *to estimate the seasonal and short-term run off volumes arising from snow melt, ice melt, and rainfall*

by calibrating and testing computer models of the catchments upstream of: the mouth of the Kabul River, the Indus River at Tarbela, and the Jhelum River at Mangla

Findings

As stated earlier, the UBC watershed model was chosen for use as the forecasting model to produce seasonal and 10 day forecasts. Currently the model is capable of producing forecasts with a reasonable percentage of error. This emphasises the need for continuous and accurate data for up to four more years so that the model can be properly calibrated. "The current version of the UBC watershed model is calibrated on low level data and could produce reliable results without this further calibration if flow data from low level stations was collected weekly". (Site Manager) The evidence found in the evaluation was:

- prior to this Project there was no computer model available for flow forecasting in Pakistan other than a manual statistical process
- seasonal and 10 day forecasts can now be produced with an unknown margin of error depending on data availability. (IDRC, SIHP-II -staff) Because no reliable weather forecast is available for 10 day or longer periods, historic weather patterns were used as future scenarios and the forecasts are issued in probability terms with a 95% confidence limit (BCHIL)
- there has been difficulty in acquiring historical flow data from other branches of WAPDA due to workload issues and unavailability of data. This unavailability of data has considerably slowed the process of producing a viable forecast (SIHP-II staff, BCHIL)

  Note: "Despite the glitches, SIHP-II staff showed that they have a good understanding and command of the implemented system when they conducted a successful seminar for the CIDA and IDRC representatives in

April" . (excerpt from Draft PRC minutes, 1996) The seminar was in Lahore Pakistan.

- the use of CLICOM as the data base management system provided challenges until it was better adapted to the system (SIHP-II staff)

- the SIHP-II personnel have been trained in flow forecasting and can utilize and modify the software to meet the needs of water management

Conclusion

Currently, the process and capability are in place to produce forecasts. The only concerns in relation to the forecasts are in the sustainability of the Project until four more years of data are collected and in the availability of historical data required to properly calibrate the model.

3.2.4 SIHP-II objectives (continued)

- *to continue some of the applied hydrological research activities within Phase 1 for their integration into the proposed forecasting system*

Findings & Conclusion

Over the duration of the Project three individuals obtained their masters level education in engineering at UBC. All three conducted applied research in the area of snow and ice hydrology and/or water management and utilization. It was clear that these individuals gained from the academic experience in Canada and from the cross cultural experience. Inferential data in the evaluation clearly indicated that their research was applied in Pakistan and directly towards the positive outcomes of the SIHP-II.

3.2.5 SIHP-II Objectives (continued)

- *to train WAPDA personnel in all phases of the Project, so that upon completion they will capably operate, maintain and modify the system, as required, without outside assistance*

Findings

The evaluation respondents, in particular the line staff of SIHP-II, indicated that the major successes of the Project were related to the transfer of the technology and training. Data collected showed:

- repeatedly in the evaluation the stakeholders stated that one of the major successes of the Project was increased capability and confidence on the part of SIHP-II personnel
- the BCHIL and SIHP-II personnel had a strong sense of ownership in the Project
- the overall training will be dealt with in a later section, however the quality of training and the transfer of technological capability can not be overstated

Conclusion

As will be noted in later sections of the evaluation document, the successful transfer of capability to refit, maintain and modify the entire system can be counted as a major success of the Project.

3.2.6 SIHP-II Objectives (continued)

- *to establish strategies for the reservoir operations as a function of scenarios developed by the hydrological model.*

Findings & Conclusion

This objective was intended as the last to be addressed in the Project. A SIHP-II junior engineer completed his masters research in this area in 1996 and is currently working on application strategies in Pakistan. To date, no strategies have been applied to the Project. The success of this objective is predicated upon the capability to produce forecasts that are reliable and can be used for reservoir operation. Both BCHIL and IDRC noted during the evaluation process that a follow-up Project is required to properly address strategies related to reservoir operation.

3.3 Findings Related To The SIHP-II Areas Chosen By The Stakeholders For Examination

The following areas were chosen by the stakeholders in the Project as areas worthy of examination in addition to the project's goal and objectives. These areas were chosen through a collaborative process designed to produce a viable list of items requiring examination.

3.3.1 Finding Related To Assumptions Driving The Project

- neither the Canadians nor the Pakistanis were prepared for the terrain of the remote sites where DCP's were installed. The lowest DCP in Pakistan is higher than the highest station in British Columbia. This caused difficulties in access and travel. It was not possible to determine if this was an avoidable issue.

  Note: IDRC and CIDA set-aside a 15% contingency fund at the Project outset because the planning, design, and construction of an operational hydrology system had never been previously done in a country with Pakistan's characteristics, and nowhere in the world with terrain so difficult or so high. This contingency fund remains untouched and will remain untouched -- in fact the

Project will come in slightly under budget. This is extraordinary and reflects the huge success of this Project. (IDRC)

- some areas that required stations were inaccessible because of terrain and/or sectarian violence in Northern Pakistan. Work that would be performed in Canada by helicopter had to be accessed by poorly maintained roads and in some cases on foot. (BCHIL)

- it was assumed that data would be available for some flows originating in other countries. This in fact was not the case.

- there is not a proper capability to gather real time and historical flow data. The data from some sites are slow to be translated for use by SIHP-II and in some cases the data are not available. These data are not controlled by SIHP-II but by other water agencies in Pakistan. This lack of data affects the updating of the model calibration and the ability to produce accurate forecasts

- the UBC water shed model was an academic model and had to be adapted to real time forecasting

Conclusion

SIHP-II staff overcame and adapted to the above noted challenges. The erroneous assumptions caused delays in the Project and provided hurdles which the SIHP-II personnel had to solve. Generally the SIHP-II staff overcame these hurdles which provided a focus for learning and adaptation. This led to increased ownership within the Project and increased motivation for success by all stakeholders.

3.3.2 Finding Related To Management Of The Project

- IDRC contributed motivated and organized Project Managers who was committed to the success of the Project

- repeatedly in the evaluation BCHIL was noted for its positive management style and management capability

- BCHIL contributed well trained and capable personnel to the Project

- the contribution of a western style management system had both positive and negative impacts on the Project

    - it was useful for SIHP-II to experience western management style and the Canadian management style will remain and have some positive HRD benefits
    - it would have been useful for the SIHP-II office administrative/clerical/accounting staff to receive training from BCHIL to reduce the time the technical personnel now spend in clerical/accounting procedures
    - it was difficult to obtain financial information from Pakistan in a format compatible to BCHIL's requirements
    - some SIHP-II personnel found the non-hierarchical Canadian style difficult to adapt to when still working within a Pakistani hierarchical structure

- WAPDA contributed well-trained and capable staff to the Project that remained with the Project throughout rather than being transferred as is the normal procedure

- there was an ongoing difficultly with WAPDA accounting procedures regarding allowances and incentives for members of SIHP-II (SIHP-II staff)

- it was suggested by SIHP-II staff that BCHIL could have provided greater assistance to SIHP-II in personnel management issues as they arose during the Project. It was recorded that there were difficulties, related to the motivation of some personnel within the Project, that continued throughout the duration of the Project. Although this was given by respondents as feedback on the Project it was clearly not within BCHIL's mandate to become involved personnel management. Clearly BCHIL's

role was of an advisory capacity to WAPDA management and respondents did conclude that personnel advice by the Site Manager and BCHIL management was provided.

Conclusion

Overall the management style of IDRC, BCHIL and WAPDA worked well together with each organization adapting and modifying its style to the SIHP-II working culture. The inherent difficulties within the WADPA structure re: allowances and accounting appear to be systemic rather than Project related, and are not valid as part of the Project evaluation although they may have had a influence on the Project morale.

3.3.3 Findings Related To Critical Outputs And Impacts

- the major outputs of the Project are: (i) the meteor burst communication system; (ii) the collection of high altitude data through the newly established communication system; and, (iii) the infrastructure that has been established for forecasting
- the flow forecasting model is giving acceptable results considering the current level of available data
- the positive impact of having a BCHIL manager on site in Pakistan was stressed throughout the evaluation, although there was some cultural adaptation required to be fully effective
- there was a positive impact from the training received in all areas as there was high level of ownership regarding job categories and responsibility, with some individual exceptions. The positive impact of training was particularly stressed by the staff of SIHP-II who directly received the training.
- the greatest impact will come in the Project when other Pakistanis are trained to understand and use the model. There appeared to be some

contradictions in the evaluation findings related to the communication flow about the Project and its possible uses. The findings varied from the communication flow to other Pakistan agencies being adequate, to the assertion that sustainability would be adversely effected because other areas within and without WAPDA were not well informed of the project's successes and capabilities.

Conclusion

The critical impact and outputs of the Project are related to the essential capability of SIHP-II to continue to build upon what has been done in the Project. All of the required hardware and software are in place for this to occur, and the system is functional with some operational anomalies (ie. snow pillow). The outputs of the Project rely heavily upon sustained effort by WAPDA in the area of utilization, dissemination of information and production/utilization of trial forecasts.

3.3.4 *Findings Related To Training Systems And Training Outputs*

- providing training for people who were unfamiliar with hydrology and related data handling techniques was a challenge because for many of the SIHP-II personnel the technology was new. (BCHIL)

- the training plan that was created by NUTEC and revised by Johnson Management Inc. (private consulting firms), was not utilized by either BCHIL or SIHP-II staff to deliver and/or measure training; yet the staff appears to have been trained in all aspects listed in the training plan. (SIHP-II staff, IDRC) The non utilization appears to have been a result of the design chosen for the training plan and a lack of orientation of SIHP-II staff to utilizing training plans.

  In the second half of the Project relevant training needs were established through a training advisor

from IDRC. Some respondents, particularly Canadian personnel, identified this needs analysis activity as very useful and leading to relevant training. One WAPDA management respondent noted that extensive budget was used to establish training needs which may have negatively effected the funds available for actual training. This does not appear to have been the case as the training advisor ensured relevant training was delivered and there were no indicators in the evaluation that the amount of training delivered was affected by the process used.

- there is a need for cross-training between the different areas in SIHP-II and within WAPDA to ensure for trained backup, and to acquaint others with the Project (SIHP-II staff, BCHIL)

- personnel have been trained and have the demonstrated capability to:

  - install, operate and maintain equipment
  - repair meteor burst equipment
  - run a maintenance facility
  - ability to run and repair computers
  - create operational plans
  - build remote stations
  - determine new location and relocate present stations
  - decode data and control data quality
  - use the hydrological computer modelling skills calibrate and operate the UBC watershed model
  - modify forecasting model to Pakistani conditions
  - prepare inflow forecasts (10-daily and seasonal)
  - update the model forecasts
  - train the trainer (BCHIL, IDRC, SIHP-II staff, WAPDA management)

- SIHP-II staff were introduced to the use and application of computers which for most was a new skill (BCHIL)

- SIHP-II personnel emphasized certain aspects of training as the most important to them:

- training seminars on training needs
- UBC formal education
- on the job training
- train the trainer

- training in Canada was considered by SIHP-II personnel to be more productive than training in Pakistan (SIHP-II staff)

- for training to work in this situation it would have been useful to marry the engineering style with an adult education style which would have provided a better flow from training plans to learner outcomes (IDRC)

- training in self-evaluation was stated as an area that would have assisted in the establishment of training needs and quality measurements (IDRC)

- sub-engineers were not fully included in the training processes although one technologist did receive overseas training. There appeared to be two reasons for this: language and hierarchy. They particularly stated a need for computer training and network training. (SIHP-II staff)

- there were some delays for SIHP-II personnel going to Canada because of WAPDA rules and regulations. This was particularly true for one of the three UBC students who experienced as much as a two year delay.

- The selection criteria used for the selection of UBC students could have been clearer and involved both the SIHP-II personnel and BCHIL to a fuller extent (SIHP-II staff)

- training in data quality control was missing until late 1996 which influenced data management quality and timeliness of data availability (SIHP-II staff)

Conclusion

The Project transferred the critical sustainable elements of skills, knowledge and attitudes required to: sustain, refit, modify, and maintain the forecasting and related systems.

Evidence, as cited above, exists to indicate that this area has been highly successful in the Project. There appears to have been extensive 'just in time' training on the job as the Project developed. (note: just in time training refers to training that is tied directly to the arising needs of staff in the workplace)

SIHP-II personnel indicated that they are skilled and capable in their areas of expertise. The only consideration in the training process was the development of a training plan in Canada that was not easily usable either by Canadians or Pakistanis. The later process of needs analysis and training re-design, which was used in the second half of the Project, appears to have been more effective and better matched to the needs of the personnel.

3.3.5 Findings Related To Adequacy Of Inputs, Timeliness Of Events/Inputs And Adequacy Of Physical Inputs

- initial delays were experienced in establishing the remote stations. Some of this was due to sectarian violence in the northern regions and some was due to the terrain. The delay in establishing the stations affected the amount of data available for use in the forecasting model.

- all equipment and materials were available to SIHP-II for the installation of DCPs, the master stations, computer systems, and software required. Requests were made for updated non forecast related software but the requested software appears not to be critical to the success of the Project.

- BCHIL personnel indicated that there were enough spare parts to ensure proper sustainability of the remote sites, however, SIHP-II personnel stated a shortage of spare parts. An attempt was made to clarify this situation and there appears to be confusion as to what spare parts exist and how many spare parts would be required for sustainability

- the season was very short for maintenance and the planning that occurred in relationship to starting the maintenance cycle was adequate but could be assisted by further organizational input around prior planning, personnel release and accounting procedures (SIHP-II staff)

Conclusions

Evidence was found during the evaluation to indicate that the required inputs occurred in a timely manner throughout the Project. In particular the inputs required to put the remote DCPs in place were adequate. There is some concern regarding internal WAPDA issues that are related to sustainability and are discussed later in this report.

3.3.6 Findings Related To Human Resource Management, Working Relationships And Cultural Influence

- IDRC/WAPDA/BCHIL all were new at 'real time' international projects. (IDRC, BCHIL)

- it can not be over-stressed that one of the primary factors of success in this Project has been the extraordinary personal commitment of individuals in this Project. Some of this resulted from the team building and managerial capability of IDRC and BCHIL, the on-site management and WAPDA leadership.

- during the Project there a good rapport was developed and mutual confidence building between Canadian and Pakistani counterparts. The group began to develop as a team and work as a team. Respondents noted that continued group building was required. (IDRC, SIHP-II staff)

- WAPDA's greatest contribution to the Project was commitment to the success of the Project at the highest levels. Although, as noted earlier there were some administrative and accounting procedural difficulties, the WAPDA management clearly was

committed to this Project (BCHIL, WAPDA management)

- institutional culture influenced how much the Project was advertised in Pakistan. SIHP-II personnel stated that they wanted to have sufficient confidence in the process before involving other agencies. They went on to state that "culture exists in Pakistan that things must have a strong backing". (WAPDA management)

- some cultural adaptations were required for both the Canadians and the Pakistani staff. It was noted that this provided challenges early in the Project. For example, the Canadian model of vocal participation was encouraged without any guidelines as to the limitations of this model. CIDA cross cultural briefing for stakeholders would have been useful. (SIHP-II staff)

- Pakistani families rely on the men in a family more so than Canadian families therefore the long periods of being away in the northern areas caused disruptions and difficulties for Pakistani families. It was also noted that the UBC students were not given an allowance to bring their families to Canada for two years although BCHIL staff was given an allowance to take their families to Pakistan for two years. In Phase One Pakistani personnel had an allowance to bring family to Canada. (SIHP-II staff)

- the inclusion of Canadian women in the Project was appreciated by the Pakistani personnel although they did not see a role for Pakistani women in the Project outside of clerical activities due to cultural restraint on travel and being away from family.

- the current IDRC manager is Pakistan born and Urdu speaking. Although comments about language were not gathered during the evaluation it was apparent during the execution of the evaluation that the ability to speak Urdu would have enhanced Project communication within SIHP-II. Particularly with personnel who did not have advanced English language skill.

Conclusion

Upon examining the human factor within SIHP-II, one is impressed by the dedication and loyalty to the Project goals and outcomes. There were cross cultural issues around working styles and workplace management but this is to be expected in an international Project. There is evidence to indicated that cross cultural aspects of the Project were dealt with adequately with the exception of family issues in relationship to school and remote travel.

3.3.7 Findings Related To Use And Understanding Of Project Components

- the staff working on the Project had a varying knowledge of aspects of the Project outside of their area of responsibility. This had a negative impact because personnel did not clearly understand how their part of the Project related to the Project as a whole. For example quality control in data management was essential for the data to be used in forecasting but it was late in the Project when SIHP-II personnel recognized this essential relationship. SIHP-II staff and BCHIL stated that the train the trainer assisted with integrating knowledge across the Project areas.

Conclusion

Aspects of the Project such as group debriefing sessions assisted to transfer knowledge from one area to the other, however, more of this process earlier in the Project might have been useful.

3.4 Findings Related To Sustainability, Organizational And Future Issues

3.4.1 Organizational

- the mid-point evaluation did not provide the Project with a useful framework for reflection or growth (IDRC, BCHIL)
- the Project fit into CIDA's Country Planning Framework in the areas of social issues, environment, social living conditions. (IDRC)
- IDRC and BCHIL provided flexibility within the Project allowing success to occur. This also allowed WAPDA to be more flexible in its management structure. (BCHIL)

Conclusion

The broad organizational structures worked for the success of the Project by allowing flexibility in process and outcomes.

3.4.1 Sustainability

- there is a stated commitment on WAPDA's part to sustain the Project both financially and through infrastructure support. However, concerns were expressed that financial constraint would effect the maintenance of the remote sites. Clearly the sites would need to be maintained in order for the Project outcomes to succeed. (WAPDA management)
- concern was expressed that when the incentives acquired during the Project ended personnel would not be willing to maintain the level of work required to sustain the Project. Concern was also expressed that WAPDA would not encourage responsibility and accountability amongst the SIHP-II personnel. (SIHP-II staff)

- the cadre of people trained and working on the Project is smaller than required. This may have an influence on sustainability unless consideration is given to cross training and increasing numbers of staff in SIHP-II (BCHIL, SIHP-II staff)

- the dedication to keeping WAPDA fully involved in the progress of the Project lead to increased potential of sustainability for the Project

Conclusion

Project sustainability is conditionally assured. Although the stakeholders have strong personal and corporate commitment to the sustainability of the Project the influencing factors may reside in the realm of finance and priority outside the influence of IDRC, WAPDA or BCHIL. If finance and priority is given to SIHP-II the technical capability to sustain and influence Pakistan's water management strategies exists. It was stated by one respondent, in the evaluation, that three things were required for sustainability: "Rupees, Coordination and Appreciation".

3.4.2 Future Issues

- requests were made by all Pakistani respondents during the evaluation for some foreign involvement that would assist in sustainability and provide continuity for the work that has already been done

  - in particular assistance over the next two to three years was requested to make the transfer from the ability to produce a forecast to the implementation of the data for reservoir management (WAPDA management, SIHP-II - staff)

- BCHIL and IDRC also clearly stated during the evaluation that a follow-up Project expanding into utilization strategies was needed

Conclusion

It was clear during the evaluation that a follow-up Project was desirable and was considered tied to the sustaining of the outcomes of SIHP-II. In discussion with BCHIL, it was stated that a follow-up Project was required to meet two needs:

1. A follow-up Project would "support WAPDA until a reasonable length of record of high elevation data is available and more reliable forecasts can be produced. At that time there will be a need to merge log term low elevation data and shorter term high elevation data to produce a good data base for the production of a range of inflow forecasts. There is also a need to expand the network to stream gauge and valley stations to provide the real time data required for forecasting".

2. A follow-up Project would " develop a group of users who could use the information (forecasts) provided by the Project to maximum advantage and who would then, in turn, support the Project. Users would be agencies such as : Provincial Irrigation Departments, Indus River System Authority, WAPDA Power Wing, Pakistan Meteorological Department, Federal Flood Commission, and Environmental Groups".

It was apparent that all respondents to the evaluation felt that a follow-up Project was required to operationalize the use by Pakistan agencies of the considerable outputs of SIHP-II.

Section Four Global Conclusions

SIHP-II was a successful Project for two primary reasons. First, the infrastructure that was identified in the initial planning has been successfully transferred to Pakistan. There are currently 22 Data Collection Platform Stations installed. The meteor burst communication system is functioning reliably and consistently transmitting data to the master station in Lahore. The data

management and its related capability to produce a seasonal and 10 day flow forecast are in place. Second, the Pakistani personnel within the Project are trained and capable to technically support and sustain the Project over time.

SIHP-II also faces three major challenges to its success and sustainability. The first is the conditional nature of its sustainability. SIHP-II sustainability is predicated on WAPDA's willingness to support and utilize the ongoing efforts of SIHP-II as its ability to produce reliable forecasts increases as more inflow data is acquired. The second is the maintenance of trained SIHP-II personnel. For the duration of the Project the personnel remained constant but will now be open for transfer. Thus, importance of back filling with trained personnel and cross training can not be over emphasized. The third is the utilization of the inflow forecasts within the water management structure of Pakistan. Work has just begun in late 1996 on this aspect of the utilization of the forecasts for reservoir management. This move to using the seasonal and ten day forecasts for reservoir management will be a foundation of sustainability and lead to a series of long term impacts on Pakistan's water management capability.

SIHP-II was found to be a dynamic and viable Project built upon the motivation and commitment of the individuals and organizations involved in the Project. Given that primary objectives of the Project have been successfully met, it now remains for the positive outcomes of the Project to be used and incorporated into the water management strategies of Pakistan.

Section Five Appendices

Appendix One: Evaluation Timeline/Markers

September 1995/January 1996

- Met with IDRC to discuss terms of reference for evaluation
- Conducted BCHIL Canadian focus groups to establish baseline evaluation topics
- Interviewed Johnson Management Inc. to determine background concerning curriculum development
- Conducted SIHP-II Pakistan focus groups to establish baseline evaluation topics
- Created draft SIHP-II Evaluation Design and Implementation Plan
- Collected feedback from all stakeholders and produced final SIHP-II Evaluation Design and Implementation Plan
-

March/April 1996

- Constructed the evaluation implementation methodology
- Establish Advisory Committee
- Select Evaluation Team Leaders
- Designate interviewer
- Conduct workshops in Canada and Pakistan to acquaint all stakeholders with evaluation design
- Conduct workshop to provide Evaluation Team Leaders with process skills for focus groups
- Conduct initial interviews

April/September 1996

- Monitor submission of data by Evaluation Team Leaders
- Prepare interim reports
- Conduct initial analysis by Lamoureux and Associates
- Monitor data collection from focus groups and questionnaires
- Complete interviews

September 1996/January 1997

- Prepare draft evaluation report
- Circulate through IDRC draft report
- Prepare final report

Appendix Two

Advisory Committee

Current Project Manager, IDRC,	Dr. Naser Faruqui
Project Manager, BCHIL,	Dr. Warren Bell
Acting Director, H&RD,	Mr. Hasnain Afzal
IDRC, Training Advisor,	Dr. Nancy George (ad hoc member)

Evaluation Team Leaders

BCHIL, Director Latin America Operations	Ms. Renata Adamcik
BCHIL, Hydrotechnical Engineer	Mr. Hamed Assaf
SIHP-II, Junior Engineer	Mr. Inam Khan
SIHP-II, Research Officer	Mr. Ghazanfar Ali
SIHP-II, Junior Engineer	Mr. Danial Hashmi
SIHP-II, Assistant Research Officer	Mr. Muhammad Javid
SIHP-II, Research Officer	Mr. Muntasr Usmani

Lamoureux and Associates

Evaluation Project Manager	Dr. Marvin Lamoueux
Evaluation Team Leader	Ms. Joan McArthur-Blair

Appendix Three Locations of DCPs

Sr. No.	Station Name	Province	Latitude		Longitude		Drainage Basin	Elev: (masl)
01.	BABUSAR	Northern Areas	35	08'45"	74	02'40"	Indus	4160
02.	DEOSAI	Northern Areas	34	57'00"	74	23'00"	Indus	4356
03.	NALTAR	Northern Areas	36	07'40"	73	11'05"	Hunza	2100
04.	ZIARAT	Northern Areas	36	51'10"	74	16'40"	Hunza	3688
05.	KHUNJERAB	Northern Areas	36	51'00"	75	24'00"	Hunza	5182
06.	DAINYOUR	Northern Areas	35	55'40"	74	12'35"	Hunza	1530
07.	YASIN	Northern Areas	34	22'00"	73	18'00"	Gilgit	3353
08.	USKORE	Northern Areas	36	01'03"	73	21'30"	Gilgit	3353
09.	HUSHEY	Northern Areas	35	22'00"	76	24'00"	Shyok	3010
10.	SHIGAR	Northern Areas	35	31'48"	75	35'30"	Shigar	2470
11.	RAMA	Northern Areas	35	21'30"	74	48'20"	Astore	3140
12.	RATTU	Northern Areas	35	09'10"	74	49'00"	Astore	2920
13.	BURZIL	Northern Areas	34	54'20"	75	05'30"	Astore	4030
14.	BURAWAI	N.W.F.P	34	56'25"	73	52'05"	Kunhar	2926
15.	SHOGRAN	N.W.F.P	34	38'00"	73	29'15"	Kunhar	3835
16.	SAIF UL MULUK	N.W.F.P	34	54'15"	73	38'40"	Kunhar	3250
17.	ZANI	N.W.F.P	36	20'00"	72	10'00"	Chitral	3895
18.	SHENDURE	N.W.F.P	36	05'10"	72	31'30"	Chitral	3719
19.	KELASH	N.W.F.P	35	39'00"	71	37'00"	Chitral	3048
20.	KHOT	N.W.F.P	36	31'00"	72	35'00"	Chitral	3505
21.	KALAM	N.W.F.P	35	28'00"	72	22'00"	Swat	2225
22.	SHANGLA	N.W.F.P	34	52'30"	72	35'45"	Swat	2134
23.	LAHORE	Punjab	31	30'00"	74	20'00"	Ravi	200
24.	BADOKI	Punjab	31	16'00"	73	22'00"	Ravi	200

Appendix Four Evaluation Respondents

IDRC

Former Project Manager, IDRC,	Mr. Sylvain Dufour
Current Project Manager, IDRC,	Mr. Naser Faruqui
IDRC, Training Advisor,	Dr. Nancy George

WAPDA

General Manager, Planning,	Haji Muhammad Chawdhary
Chief Engineer, H&Wm,	Mr. Saleem Warsi
Chief Engineer, P&I,	Mr. Tariq Masood

SIHP-II

Acting Director, H&Rd,	Mr. Hasnain Afzal
SIHP-II, Senior Electrical Engineer,	Mr. Jawed Bhatti
SIHP-II, Senior Civil Engineer,	Mr. Anwar Hussain Gillani
SIHP-II, Senior Engineer	Mr. Inam Khan
SIHP-II, Research Officer	Mr. Ghazanfar Ali
SIHP-II, Research Officer	Mr. Muhammad Munir
SIHP-II, Engineer	Mr. Danial Hashmi
SIHP-II, Research Officer	Mr. Muhammad Javid
SIHP-II, Engineer	Mr. Shafiq ur Rehman Muhammad Ilyas
SIHP-II, Engineer	Mr. Asim Rauf Khan
SIHP-II, Engineer	Mr. M. Usmani
SIHP-II, Engineer	Mr. Hamed Manzoon
SIHP-II, Sub Engineer	Mr. Mohammed Anwar
SIHP-II, Sub Engineer	Mr. Imtiaz Hussain
SIHP-II , Sub Engineer	Mr. G. Qasim
SIHP-II, Driver	Mr. Mohammed Hassan
SIHP-II, Driver	Mr. Mohammed Hussain
SIHP-II, Driver	Mr. Mohammad Siraj
SIHP-II, Driver	Mr. Irshad Haider
SIHP-II, Driver	Mr. Nasir Khan
SIHP-II, Computer Specialist	Mr. Hamid Manzoor
SIHP-II, Telecom Supervisor	Mr. Ashfaq Qureshi
SIHP-II, Telecom Mechanic	Mr. Sarfraz Khan
SIHP-II, Field Coolie	Mr. Shafique

BCHIL

Project Manager, Bchil,	Dr. Warren Bell
Former, Project Manager,	Bill Thompson
BCHIL, Hydrotechnical Engineer	Mr. Vladimir Plesa,
BCHIL, Site Manager,	Mr. William C. Thompson

BCHIL, Hydrotechnical Engineer	Mr. Heiki Walk
BCHIL, Project Engineer	Ms. Renata Adamcik
BCHIL, Hydrotechnical Engineer	Dr. Hamed Assaf

Other

University Of British Columbia,	Dr. M.c. Quick

Appendix Five Acronyms

BCHIL	British Columbia Hydro International LImited
CIDA	Candian International Development Agency
DCP	Data Collection Platform
IDRC	International Development Research Centre
MCC	Meteor Comunication Corporation
SIHP-II	Snow and Ice Hydrology Project Phase II
UBC	University of British Columbia
UIB	Upper Indus Basin
WAPDA	Water and Power Development Authority

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