PAKISTAN

SNOW AND ICE HYDROLOGY PROJECT

PROJECT INCEPTION REPORT

B.C. HYDRO INTERNATIONAL

WAPDA

REPORT NO. BCHIL.003

JULY 1991

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SECTION 1.0 - INTRODUCTION

1.1 PURPOSE

The purpose of this report is to present the detailed implementation plan for the Pakistan Snow and Ice Hydrology Project. This plan is based on the information provided in the "Statement of Services", which forms Appendix B to the contract between the IDRC and BCHIL; and the "Management Plan, Snow and Ice Hydrology Project, Phase II; Pakistan with International Development and Research Centre". In addition to information in the above two documents, this report includes adjustments for the combined effect of: seasonal constraints; the delayed project start; and, the knowledge gained during a reconnaissance mission to Pakistan and the Upper Indus Basin (UIB) in October 1990 by staff of BCHIL.

1.2 SCOPE

This report presents the following:

1. A summary of the project context including any changes that have occurred since the development of the contract.

2. A summary of actual or potential constraints of institutional, climatic, managerial or other nature.

3. A detailed project description including the Work Breakdown Structure and Logical Framework Analysis.

4. A project organization chart for BCHIL.

5. A project implementation schedule.

6. A resource allocation description.

7. A project disbursement plan.

SECTION 2.0 - PROJECT CONTEXT

Pakistan is one of the largest nations of the world that depends on a single river system. The water from the Indus River and its tributaries supply the bulk of the agricultural water supply for its 125 million people. In addition, on average, 65% of the electrical energy of Pakistan is produced by hydroelectric dams on the mainstem and tributaries.

The Indus River, with an 860 000 km^2 drainage basin and 2880 km length, is one of the largest of the South Asian region. The most productive part of this basin in terms of runoff is the UIB. The UIB is defined as the catchment area drained by the Kabul River at its mouth, the Indus River at Tarbela Dam and the Jhelum River at Mangla Dam. Approximately 69% of the annual runoff at the mouth of the Indus River originates in the 264,000 km^2 UIB.

The demands on the stored water from the UIB comes from two major areas: 1) the agricultural sector for irrigation, and 2) the industrial sector for power. Within the agricultural sector, there are competing demands between the provinces for water, particularly between the provinces of Sind and Punjab. There is also a developing conflict within the irrigation sector between: the need for water for direct irrigation; and, hydropower for pumps on the tube wells used to supply ground water for irrigation.

The agricultural sector has priority over power generation on the water from the UIB. Until recently, the province of the Punjab had the first call on water stored at Mangla Reservoir. The rules have been changed by the government of Pakistan in February of 1991 and now the storage from Mangla and Tarbela is to be used in a manner that will result in maximum benefits to the country as a whole; however, agriculture still has first priority.

In addition to the existing dams on the Indus and its tributaries, new dams are proposed at Basha, upstream of Tarbela and Kalabagh downstream. Both of these projects would have significant storage and increase the benefits of improved inflow estimation.

In order to improve WAPDA's ability to manage the water resources of the UIB and optimize the benefits to the economy of Pakistan from the water stored at Mangla and Tarbela dams, the following information is required:

1. Knowledge of the benefits and costs to the economy of Pakistan of the use of UIB water in the competing agriculture and energy sectors.

2. Accurate and reliable seasonal and short term estimates of inflows to Tarbela and Mangla dams from the UIB and from the Kabul River at its mouth. These in turn require accurate hydrometeorological information from the UIB on a near real time basis.

3. A strategy for the allocation of water from the UIB that, given knowledge of the above benefits and costs, and given seasonal and short term estimates of inflow from the UIB, will yield optimum benefits to the economy of Pakistan subject to the constraint that agriculture will have the highest priority in the allocation of water.

Between 75 to 85% of the annual runoff from the UIB is attributable to snow and ice melt from the Himalayan, Karakoram and Hindu Kush mountain ranges. The fact that a large percentage of the runoff originates from snowmelt means that there is a "stored" component of inflow.

If knowledge of the annual snow pack could be obtained, then estimates of the seasonal potential inflow volume could be made that would be more accurate than the current practice of using historical data only, for seasonal inflow estimates. This would result in better seasonal water allocation. Furthermore, if real time data on the remaining snowpack along with recent weather information, could be provided, then improved short term inflow estimates could be made that would also include knowledge of the remaining "stored" runoff. The combination of those two pieces of information would provide an opportunity to optimize water use as the reservoir fills. At the same time, the risk of not filling the major reservoirs with the resulting adverse consequences for water users in the rabi (fall) season would be minimized.

In addition to the runoff stored in the snowpack, there is a large component of inflow to some tributaries that originates from glacial melt. This

glacial melt depends not only on the incoming solar radiation but also on the amount of snow cover. Significant glacial melt does not take place until the snow cover has been depleted. Thus, in a year where there is a low snow accumulation, there is increased potential for runoff from glacial melt, depending upon the weather during the melt season. Again, real time knowledge of the status of the snow pack is required to estimate what volume of the inflow may be expected from glacial melt. This additional knowledge can then be used to further optimize the use of water from the UIB.

All hydrologic models are dependent on accurate weather predictions. Where these cannot be made, a hydrologic model can use historical weather sequences to produce a range of flow estimates which will include the potential snow and ice storage effects and, therefore, should be more closely centered on actual inflows than an estimate produced purely on a statistical basis.

Present seasonal estimates of inflows to the UIB are based entirely on historical records. Short term (10 day) inflow estimates are based on the volume of runoff to date, supplemented by inflow estimates determined by a relationship with temperatures from Skardu (only for Tarbela inflows) which are related to runoff. There is no ongoing program of snow surveying and thus, planners have no knowledge of potential inflows from residual snow pack. There is a hydrologic model for the Mangla basin; however, the sparseness of data available for this model and the inability to predict the rainfall component over the 10 day period at present limit its reliability.

The need for improved inflow forecasting has been recognized by the Water and Power Development Authority of Pakistan (WAPDA). Between June 1985 and December 1989, a research project was carried out jointly by WAPDA and IDRC. This research identified some of the key elements affecting snow and ice melt and led to the present project.

The objective of this project is to improve the water resources management capability of WAPDA in the context of the UIB. The project will build upon the knowledge gained in Phase I of the SIHP to produce an operational system that will provide more accurate and reliable seasonal and short term forecasts of inflows to the Upper Indus Basin and use this information to optimize water allocation benefits to the Pakistan economy. At the request of WAPDA, priority is to be placed on estimating inflows to Tarbela

reservoir, Mangla reservoir and the Kabul River in that order. Also, at the request of WAPDA and with the agreement of BCHIL and IDRC, one of the early reports to be prepared is a "Project Direction and Review Report" to confirm (or revise) the direction proposed for this study. This report is to be prepared in the first year of the project and is to be reviewed by an outside specialist as it is considered to be very important to the project as discussed in Section 4.2 activity 211.

SECTION 3.0 - CONSTRAINTS

The major constraints that could affect the successful implementation of this project are described below:

3.1 SEASONAL CONSTRAINTS

The installation of remote sensors at high altitudes (up to 5000 m) can only be done during the period June - September when the snow has melted and access can be gained to high elevation sites. Delays in purchases, deliveries and approvals for personnel, equipment and funds can be critical and an entire construction season can be lost if the delays become significant. Even more serious than the loss of a construction season is the resulting loss of data required for analysis.

3.2 DATA CONSTRAINTS

A major difficulty for the project is the lack of data in the UIB, particularly at high elevations. This subjects the design of the remote sites to higher risks of failure as a balance must be drawn between design for portability and design for strength. Hydrologic modelling will be hampered by the lack of good maps for area elevation curves; and, the fact that streamflow data necessary for model calibration has not been finalized.

3.3 INSTITUTIONAL CONSTRAINTS

To date, the project has been strongly supported by WAPDA both in the quality of personnel assigned to the project and access to information. This reflects the personal commitment of the previous General Manager of Planning, Mr. Khalid Mohtadullah. Recently, Mr. Mohtadullah has accepted a new position; however, it is expected that his replacement, Mr. Javed Salem Qamar, will be equally supportive.

The main institutional constraints that may affect the project are of two types:

(a) Procedural

These generally have the potential to cause delays and thus require longer than normal (by Canadian standards) lead times to ensure there are no last minute delays that could affect seasonal construction. Other areas that may be affected by the bureaucratic process are:

1. Slow approval of additional staff for the project to meet the requirements specified in Pakistan's PC-1 approval document.

2. Slow approvals for project staff to be trained outside Pakistan.

(b) Organizational

These constraints are more critical to the long term viability of the project. At present, the project is financed on the basis of the provisions in the PC-1 which provide for a specified number of staff for five years. There is a commitment in the PC-1 that staff and funding will be available for the project to continue, if successful, after the five year period; however, there is often difficulty in getting staff for projects even though a commitment has been made in the PC-1. This makes it difficult to ensure proper staff succession and long term project viability. A further potential complication is the fact that the Pakistan PC-1 was approved nearly 1 1/2 years before the present project. This means that Pakistan funding is out of phase with the funding for the SIHP and theoretically could run out before project completion.

3.4 GEOGRAPHICAL CONSTRAINTS

Installation and maintenance of remote sensors in Pakistan is complicated by the combination of rugged terrain, difficult access, high altitude working environment and lack of helicopters. This results in installations in Pakistan requiring substantially more time

to complete than in Canada. An installation that would require three days, using helicopters in Canada to complete, may require 10 - 12 days in Pakistan because of the difficult access and the requirement to use porters to carry equipment into sites. This limits the number of remote sensor sites that can be maintained and installed in a given season and places severe pressures on limited engineering manpower.

3.5 FINANCIAL CONSTRAINTS

Two forms of financial constraints must be considered:

(a) Foreign Exchange

Difficulties in obtaining foreign exchange may limit the potential options available for signal transmission from remote sites. For example, if the Argos Satellite system is used, there will be a continuing, long term requirement for foreign funds to pay for the satellite fees. This must be considered in system design. Similar limitations must be considered in the long term maintenance of the project components.

(b) Funding Limitations

Internally, funds are very limited and WAPDA staff may find it difficult to get funds for tasks we take for granted (e.g. sending telefaxes). The funding limitations place limits on the design in that, economy of maintenance and repair may over-ride normally more important design decisions.

3.6 POLITICAL CONSTRAINTS

Significant portions of the Indus and Jhelum river basins lie in India or Indian controlled territory. With the present political climate, data from these areas is not available and must be estimated from hydrometeorological stations bordering those territories. In the case of the Indus River, only 5 - 10% inflow originates in India and errors in estimation of this flow should not significantly affect the overall results in estimating Tarbela inflows. As the headwaters of the

Indus River are in China (Tibet), it may be possible to install a remote station there, if necessary, and if agreement could be reached with China. For the Jhelum basin in India, it will likely be necessary to locate stations close to the basin in Pakistan controlled territory in order to obtain the data required to ensure reasonable modelling accuracy.

A similar situation applies to the portion of the Kabul River basin which is in Afghanistan. In this case, it is the present political instability in that area which would prevent any stations being installed there.

SECTION 4.0 - PROJECT DESCRIPTION

4.1 GENERAL

The objective of the project is to improve the capability of WAPDA to manage the water resources of the UIB. This will be accomplished by establishing and operating an ice and snow runoff monitoring and forecasting system. In the first two years, the proposed project will:

1. Determine the streamflow forecasting needs of WAPDA for the UIB.

2. Initiate a program to test remote sensing equipment, site design, construction and installation procedures.

3. Review and recommend the major components of the system including the signal transmission mode, the hydrologic model, remote sensor locations, and remote sensor equipment.

On the basis of the above, the Project will:

1. Expand the existing hydrometeorological network to the high altitude snow-covered and glaciated areas of the UIB.

2. Install, after proper testing, a communication system for rapid and reliable transmission of hydrometeorological data from remote sites to operational runoff forecasting centre(s).

3. Upon determination of positive benefits, install satellite imagery equipment necessary for recording, transmission, reception, and analysis of data for runoff forecasting purposes.

4. Examine the suitabilities and deficiencies of seasonal and short-term streamflow forecasting models as a function of WAPDA's operational needs. One of the best models will be selected for the UIB.

5. Establish procedures for estimating the seasonal and short-term runoff volumes arising from snowmelt, ice melt, and rainfall by calibrating and testing computer models of the catchments upstream of the Indus River at Tarbela, the Jhelum River at Mangla and the mouth of the Kabul River.

6. Continue some of the applied hydrological research activities initiated within Phase I for their integration into the proposed forecasting system.

7. Train WAPDA personnel in all phases of the Project so that upon completion they will be able to capably operate, maintain and modify the system, as required, without further external aid assistance.

8. To a limited extent, establish strategies for reservoir operation as a function of scenarios developed by the hydrologic model.

4.2 WORK BREAKDOWN

The work breakdown structure is outlined in Tables 1-4. With the exception of the activities for training and procurement, this breakdown generally follows the items in the schedule and the "statement of services" of the contract between BCHIL and CIDA. Training was listed in the "Statement of Services", but not shown on the original schedule. Procurement was listed under the various project functions but not as a separate entity. In addition to listing management items for BCHIL, Table 1 also shows corresponding management activities for WAPDA.

The items in the work breakdown structure are discussed below:

100 - MANAGEMENT

140 - BCHIL Management

This block of activities is listed on Table 2 and described briefly below. Where reports are required, the delivery dates are noted in the discussion.

141 - Provide Technical Assistance - Ensure that all resources including manpower, training, equipment and related services are provided to ensure that the project objectives are met and the activities listed in the work breakdown for Technical Assistance are carried out.

142 - Provide technical review of all project studies. Ensure that a high level of quality and consistency is maintained in all technical work, reports and memoranda.

143 - Prepare Project Inception Report. Ensure satisfactory completion of the Project Inception Report and agreement with WAPDA. The report is to provide detailed activity descriptions, budget allocation, and schedules. This will include an updated Project Plan, equipment list and disbursement profile.

Key Dates

First Draft - 15 June 1991
Review with IDRC and WAPDA
Comments - 10 July 1991
Report Finalized - 31 July 1991

144 - Prepare Annual Work Plan - Ensure satisfactory completion of Annual Work Plan detailing revised plans for inputs, activities and outputs, with corresponding financial forecasts, in comparison to previous (inception or annual) work plans.

Key Dates

Year 1 - As for Project Inception Report which is the annual work plan.

Year 2-5 - 60 days prior to the beginning of each year of operation of the project.

145 - Prepare Progress reports - Ensure all progress reports are prepared and agreed to by WAPDA. Reports are to detail activities undertaken and outline: progress achieved in relation to project objectives; problems and constraints encountered; remedial actions taken and any other relevant information including detailed financial reporting.

Key Dates

Semi-Annual - with 30 days from end of reporting period.
Quarterly - within 30 days from end of reporting period.

146 - Procurement - Ensure that all procurement shipping and related matters are carried out to meet project requirements of schedule and budget. Also, ensure that IDRC purchasing guidelines are adhered to. This item is discussed in detail separately under activity 340 BCHIL Procurement below.

147 - Training - Ensure that annual training reviews are carried out both of project needs and WAPDA staff progress. Ensure that identified training needs are met by either on the job training, specialized courses and/or university training.

This item is also discussed separately under activity 460 - WAPDA Training, below.

148 - Participate in Project Review Committee - On an annual basis, at the time of the annual review meeting. The Project Review Committee will be chaired by WAPDA and made

up of representatives from IDRC, CIDA, BCHIL and WAPDA. BCHIL will participate in the Project Review Committee to: review policy matters, progress and budget; approve annual work plans and budgets; resolve by consensus, issues and problems as they may arise; and ensure efficient operation of the project and provide directions, as necessary.

Key Dates

Steering Committee Meetings - Annually with Annual Review Meetings.

149 - Provide Liaison with Other Institutions - Ensure that work on this project is complementary to related projects funded by other donor agencies (WMO/UNDP, ODA, etc.). Ensure good communications between BCHIL and staff of related projects.

150 - Management and Accounting Information - Ensure that the necessary management and control systems are in place to monitor project costs, budgets and schedules. A project cost control system will be set up within BCHIL's project accounting computer to ensure adequate control of IDRC project funds. This system will ensure that information required by WAPDA and IDRC is made available on a quarterly basis for their reporting requirements. Cost versus budget estimates for personnel and disbursements will be reviewed on a regular basis. Budgeting and accounting will be done using a standard accounting package such as AccPac. Scheduling will be done manually.

151 - Site Management - Assist the BCHIL Project Manager and WAPDA personnel. A full time field coordinator will be located in Lahore for a period of two years. It will be the responsibility of the field coordinator to carry out delegated project management responsibilities. In addition, the BCHIL field coordinator will train WAPDA personnel in various project related activities. One of his key responsibilities will be to train his WAPDA

counterpart to take over increasing responsibilities so that at the end of the two year period the WAPDA site engineer can assume responsibility for all day to day project coordination and project management. This transfer of responsibility is imperative for the ultimate success of the project (i.e. complete operational capability and responsibility for the system by WAPDA).

Key Dates

Start - January 1992
Finish - December 1993

160 - WAPDA Management

Work breakdown activities for WAPDA management are listed on Table 2. These items are presented only for comparison with BCHIL management activities and are not discussed in detail. They are intended to indicate the general management responsibilities of WAPDA. As for BCHIL, these activities reflect the management work required to ensure adequate measurement by WAPDA of technical assistance and training. For items such as reporting and training, the lead role is a BCHIL responsibility but input and assistance is required from WAPDA. Site Management starts as a BCHIL responsibility but will be transferred to WAPDA staff during the two year period where BCHIL has a site manager. Provision of personnel and infrastructures and facilities are necessary inputs for the project to succeed. Management, accounting and information systems are required for WAPDA control of its budget schedule and expenditures and adequate record keeping of donated equipment.

200 - TECHNICAL ASSISTANCE

This block of activities includes all work related to the provision of technical assistance and includes work to be done both in Pakistan and Canada. It is very important to note that BCHIL have made a strong commitment to the direct involvement of WAPDA engineers in the design

of the project. In Year 1 of the project, two engineers (and possibly four) will spend 6 - 8 weeks in Canada, learning about the purpose and elements of the system and participating in all phases of the design. Their input will be very valuable and will be expanded by future involvement of additional WAPDA staff. This direct involvement of WAPDA staff will continue both in Canada and in Pakistan. The Technical Assistance activities are listed on Table 3 and described below. The schedule for these activities is presented on Fig. 1.

210 - Review and Planning

In order to ensure that the objectives are met, various aspects of the work will be reviewed in the early stages of the project as detailed below:

211 - Project Direction and Review Report - This activity will be a review of WAPDA's forecasting needs and the best available means of meeting these needs. It will be one of the first activities carried out by the project team and will include discussions with WAPDA concerning the operational benefits to be derived from improved short and long term inflow forecasting in the upper Indus basin. These discussions will include the present system and proposed future developments; the accuracy of forecasting required; and the consequences of uncertainties and errors. Various forecasting methodologies and operating strategies will then be reviewed along with their information requirements, potential accuracy, any limitations, and capital and operating requirements. The results will be analyzed and an optimal solution recommended. The purpose of this report is to ensure that the approach presently proposed is in fact optimal and if it is not so, propose changes to the project that would ensure the best results are achieved. Because of its importance to the overall project success, a final draft of this report will be submitted to an external reviewer retained by IDRC to ensure that its conclusions are reasonable.

Key Dates

Draft Report Issued - November 1991
Final Report Issued - January 1992 (or after review by outside consultant)

212 - Review of Hydrologic Model - This activity will proceed on the assumption that the Project Direction and Review Report supports the application of a hydrologic model. A review will be made of available hydrologic models to ensure that the selected model is most suitable for modelling the hydrologic conditions of the Upper Indus Basin. This review will consider model accuracy requirements; ability of existing models to meet these requirements; data requirements of the models; operating experience and results; ease of modification; cost of operation; availability and quality of documentation; and support for modifications. Past WMO review work will also be objectively examined in this activity but should not unduly influence the model selection.

Key Dates

Draft Report completed - December 1991
Final Report issued - January 1992

213 - Review of Satellite Imagery Requirements - The Nanuk Report (submitted to CIDA) appears to place heavy emphasis on the acquisition and application of satellite imagery. This review will examine the types of satellite imagery available and the benefits of satellite imagery to the calibration and operation of a hydrologic model and the estimation of flows in the Upper Indus Basin. The benefits will be compared to those that could be obtained from other forms of remote sensing (e.g. additional remote hydrometric sensors). The costs of obtaining and analyzing satellite imagery versus the costs of other forms of remote sensing

will also be examined. A report will be prepared recommending the best alternative.

Key Dates

Draft report completed - March 1992
Final report issued - April 1992

214 - Review of Training Requirements - This will be an ongoing process and will be based on the needs of WAPDA staff relative to the project objectives. It will include reviews of both formal University training, specialized courses, training with other companies/agencies and on the job training. Reviews would be carried out at least on an annual basis. In the first year of the project, an interim report on training needs will be prepared. This report will identify overall training needs and, in particular, any immediate training needs that must be met either for the first year's installation or to ensure that adequately trained people will be available for later phases of the project. Subsequently, the training needs will be reviewed annually, prior to the annual review meeting. The presently proposed training program is presented in detail under activity 400 - TRAINING.

Key Dates

Interim Review Issued - May 1991
Annual Training Reviews Issued - October 1991 and Annually thereafter.

215 - Annual Reviews - Annual reports will be prepared summarizing: progress to date; problems encountered and potential solutions; and required changes to project components, schedules or budgets. Any changes to the project plan will be agreed upon by the Project Managers, jointly documented and communicated to IDRC for approval. These reports will be presented at an annual meeting in

Lahore or Vancouver. In the first year of the project, the annual review will include the results and review of the Project Direction and Review Report. This report will rely heavily on, and make reference to, any reports prepared during the year.

Key Dates

Report Issued - October 1991, and annually thereafter.

220 - Remote Sensing

As presently proposed, this block of activities consists of all activities related to the design, installation , testing and maintenance of remote sensing equipment (e.g. DCP's and associated instrumentation).

It should be noted that two DCP's and snow pillows have been installed as part of a World Meteorological Organization Project in the Mangla Basin. These installations will be upgraded and included in the system. There may be applied research needs applicable to this block of work to improve the selected hydrologic model. It is possible that a review of the hydrologic model performance/deficiencies may result in additional specific field research programs being identified as necessary in order to obtain data necessary for hydrologic model improvement. The overall calibration and modification of a hydrologic model of the UIB is in itself, to some extent, an applied research project.

221 - Station Location Studies - In the first year of the project, a preliminary study will be carried out to identify two or three key sub-basins for which the initial installations are to serve as a test basis. Sensor locations will be selected within these sub-basins that will provide suitable sites to test construction and installation techniques and at the same time, provide useful data. The intent is to establish procedures and ensure that the instrumentation can be made to work

satisfactorily in the extreme conditions of altitude and weather in the Himalayas before investing a large amount of money in a system that is later found to be unreliable. An expanded, more detailed basin network design and sensor location study will be carried out in the following year for the entire Upper Indus Basin (UIB). Both studies will have the same general format. These will be office studies and will review the following items as a basis for the sensor locations:

1. Sub-basins priorities (Tarbela, Mangla, Kabul).

2. Climatological factors which affect runoff and its variability.

3. Hydrologic model data requirements.

4. Available data information from Phase I of the Snow and Ice Hydrology Project (SIHP).

5. Basin, geography (maps, aerial photographs).

6. Logistics of installations (mode of transport for installation).

7. Field testing requirements.

8. Local equipment repair capability.

9. Instrument types required and operating limitations.

10. Maintenance considerations.

11. Equipment procurement and installation schedules.

The studies will include consultation with members of the Phase I research team which has already identified a number of potential sites. A memorandum will be prepared upon

completion of each study outlining the proposed sensor locations, types of sensors to be installed, and the basis for the choice. As experience is gained with operation and maintenance of the initial installations, there may be revisions to the initial recommendations which will be documented by memoranda as appropriate.

In the first year a total of six test stations (five remote), will be installed using Argos telemetry. Two stations will use platform transmitter terminals (PTT's), temperature sensors and metal snow pillows supplied as part of an earlier WMO project. These two existing stations in the Kagan Valley will be upgraded using new supporting structures to prevent damage by animals. One new station will use the same WMO equipment as above, which is presently installed in Lahore, with the addition of a precipitation gauge. This station will be installed at Babusar pass at the head of the Kagan Valley. The three remaining stations will use entirely new equipment and will include PTT's, urethane coated nylon snow pillows, temperature sensors, precipitation gauges, solar radiation, relative humidity and wind sensors. These stations will be located at; a site below Rush Lake near Nagar, Burgi La near Skardu, and at Lahore (for training). The overall combination of the equipment and the locations chosen is such that it should provide good experience and training in installation, maintenance, and equipment behaviour. In addition, these stations should provide valuable high elevation data for future project use.

The first year's work on this activity will provide the team with a good overall background on the UIB and the difficulties that may be encountered, not only with remote sensing but also with the forecast model.

Key Dates

Preliminary Sensor Location Studies Memorandum
Draft Memorandum Completed - June 1991
Final Memorandum Issued - July 1991

Basin Wide Sensor Location Studies
Draft Report Completed - April 1992
Final Report Issued - May 1992

222 - Reconnaissance - Prior to each year's field installation program, a site reconnaissance will be necessary to determine the exact sensor locations. For the initial test installations (1991) the limited time available in the first summer for the office studies will mean that this reconnaissance will be carried out immediately prior to the installations. For future installations, the site reconnaissance will be carried out either the summer prior to the installation of the sensors, or early in the installation season to maximize the time available for installation.

In order to gain an appreciation of the overall problems of remote sensing and hydrologic modelling in the UIB, a general reconnaissance into at least part of the UIB was carried out in the fall of 1990.

Reconnaissance diaries will be prepared for each reconnaissance containing a summary of observations and noting any potential problems.

Key Dates: None

223 - Determine Transmission Mode - This activity will include a review the available technologies, their reliability, costs, and other advantages/ disadvantages. It will also

include a review the need for and benefits/costs of, a direct receiving ground station. A report will be prepared near the end of Year 1 recommending the best alternative for the UIB.

For the first year the remote sensing system will use Argos Satellite telemetry. This was chosen as there was insufficient time to obtain equipment for what may be the most reasonable alternative, "Meteorburst" telemetry. A memorandum will be issued outlining the reasons for selecting the Argos system for Year 1.

The first year's installations will therefore serve to test installation procedures/problems and sensor reliability and maintenance procedures/ problems - not the transmission mode.

As part of the first year's studies, a field visit to the U.S. Department of Agriculture's SNOTEL network, which uses the Meteor Burst system, will be undertaken. Meteor Communications, the main manufacturer of Meteor Burst systems, will also be visited on this trip.

Key Dates

Transmission Mode Memorandum
Draft Memorandum Issued - June 1991
Final Memorandum Issued - July 1991

Transmission Mode Selection Report
Draft Report Issued - November 1991
Final Report Issued - December 1991

224 - Prepare Equipment Specifications and Tenders (Remote Sensing) - This activity includes a detailed review of the equipment operating conditions, potential maintenance problems, and data redundancy requirements. In the first year, equipment specifications will be based principally on

B.C. Hydro experience in mountainous terrain. Equipment selected will generally be on the basis of using manufacturers whose equipment has proven to be reliable in B.C. Hydro's network. For the first year's installations, different types of snow pillows and precipitation gauges will be purchased to test their reliability and accuracy in the field. In the second year, specifications and calls for tenders will be prepared. The major purchasing may be carried out in the second year for all major components, or annually prior to the field season, depending upon which procedure is determined to be the most cost effective.

Purchasing related activities and a detailed schedule are presented in more detail under activity 300 - PROCUREMENT.

Key Dates

Complete Specifications and Tenders for Year 1 Assignment by May 1991.

Complete Specifications and Tenders for Year 2 and beyond by February 1992.

225 - Site Selection and Station Design - This activity will be carried out in Year 1 and will consist of the design of the site layout and support stands for the sensors and associated transmitter. The design will include: the basis for specific site selection (given a general location); sensor specific site requirements; structural design of the support stands; and consideration of the logistics of installation and installation procedures. A technical report will be prepared summarizing the design and its basis. The site design may be modified as field experience is gained from the test installations. Any modifications will be documented in technical memoranda along with the reasons for the modifications.

Key Dates

Draft Report Issued - June 1991
Final Report Completed - July 1991

226 - Local Procurement - This activity consists of the purchase in Pakistan of any items of equipment (e.g. equipment support structures) that can be made locally. It would include a review of local manufacturing capabilities and would be a responsibility mainly carried out by WAPDA personnel prior to each field installation season.

227 - Equipment Testing - This activity includes the witnessing of testing in Canada by the manufacturer of any equipment purchased in Canada to ensure it meets specifications; and testing of the equipment in Pakistan to ensure its serviceability prior to installation in the field. This activity would be carried out prior to each field installation season. In the first year, this will require a trip by a BCHIL team member to Guelph, Ontario to witness tests on the transmitters prior to shipping them to Pakistan.

228 - Installation and Maintenance Manuals - This activity includes the preparation of installation operation and maintenance manuals for the remote sensors and associated equipment. The manuals will be updated as field experience is obtained.

The preparation of these manuals will be carried out principally by WAPDA staff with assistance from BCHIL. In the first year, a manual will be prepared for the site installation procedures. A manual on maintenance procedures will be prepared prior to the start of maintenance after one year of service and when the equipment specifications are known.

Key Dates

Draft Installation Manual - August 1991
Final Installation Manual - November 1991
Draft Maintenance Manual - April 1992
Final Maintenance Manual - November 1992

229 - Installation and Maintenance - This activity includes all activities related to the installation of remote stations and the main transmitter/downlink (if required) and their maintenance. It includes the preparation for field trips for installation and maintenance of equipment; preparation and maintenance of equipment inventories and maintenance histories; preparation of site maps, photographs and drawings; and the writing of diaries for each field trip. In considering the logistics for installation, a close look will be taken at heliported support versus land-based support, keeping in view the likelihood of long-term land-based servicing.

In the first year of the project, a total of six stations will be installed/refurbished (five remote).

It is expected that approximately 12 remote stations will be installed in each of the second and third years of the project. As more stations are installed the following years maintenance work increases. This will mean that year three of the project will have the heaviest work load and require careful planning and significant manpower. By this time, WAPDA staff should be capable of supervising and carrying out the major portion of the work.

Key Dates

Total of 6 stations installed/refurbished by October 1991.
Total of 18 stations installed by October 1992.
Total of 30 stations installed by October 1993.

230 - Review of Sensor Performance - This activity will be ongoing and will consist of a review of data received from the remote sensors, problems indicated, and potential solutions. Significant modifications resulting from this ongoing review will be documented in memoranda along with recommendations for modifications to procedures and/or equipment. In the first year of the project, no significant activity other than ongoing monitoring of the data received is planned.

Key Dates: None

231 - Satellite Imagery Equipment - This activity will be based on the outcome of the study of satellite imagery needs (see activity 213 Review of Satellite Imagery). If satellite imagery is recommended, this activity will include the preparation of specifications and tenders, and the operation and maintenance of a satellite imagery processing system. Operation and maintenance manuals will be prepared as part of this activity. Use of SUPARCO (Space and Upper Atmosphere Research Commission) facilities will be considered to achieve optimal Pakistani facilities utilization and to avoid costly duplication of services.

No work on this activity will be carried out in the first year.

Key Dates

Procure Satellite Imagery Equipment (if required) by July 1992.

240 -Data Acquisition Interface

This block of activities includes all tasks related to the design, procurement, installation, testing and implementation of a computer based system for the acquisition of data from the receiving station. This also includes storage, quality control

and review of data transmitted from the remote sensors to the receiving station. Although not included as part of this project, consideration should be given to the integration of WAPDA's existing VHF remote sensing system with the proposed system through the data acquisition interface. The system to be installed will be examined with a view to ensuring compatibility between the existing VHF system (or modifications) and the present project.

241 - Interface Design - This activity consists of the conceptual design of the data acquisition system from the down link receiving station through to acquisition, processing and storage of data. It will define the hardware and software requirements of the system and the general operating, maintenance, data checking and storage procedures. Results and recommendations will be summarized in a memorandum. This work is scheduled to be completed early in Year 2.

Key Dates

Draft Design Memorandum Issued - December 1991.
Final Design Memorandum Issued - January 1992.

242 - Prepare Specifications and Tenders (Interface) - This activity includes the preparation of specifications and tenders of the required hardware and software for the interface system. In the first year, two computers and associated hardware will be purchased and used for this and other activities. Purchasing related activities and detailed schedule are presented in more detail under activity 300 - PROCUREMENT.

Key Dates

Complete Specifications and Tenders by July 1992.

243 - Software Development and Documentation - This activity includes the development of any computer programs required for the data acquisition interface. This will include such programs as an automatic "dial-up" program to access the receiving station; data storage and file manipulation routines; automatic data checking routings and any other programs necessary for the efficient retrieval, checking and modification of data. Data will be stored in a form accessible by a hydrologic model. All computer programs will be fully documented, including operating instructions. It is expected that this system will be modified and updated as the project progresses and specific needs/problems arise.

To facilitate checking of the performance of the sensors in Year 1, data will be sent from SUPARCO to WAPDA on floppy discs. A translation program will be developed to convert transmitted data from remote sites to engineering units for review of sensor performance.

Key Dates

Complete Initial Software Development by May 1992.
Complete Documentation by December 1992.

244 - Back-Up Systems - This activity is listed separately only to ensure that the data acquisition interface design includes provision for back-up of data previously received to ensure against complete loss of data in the event of a system failure. The design would be carried out as a part of the overall design of the data acquisition interface. As part of this design, the purchase of a "write once, read many times" laser disc system will be considered.

245 - Testing and Implementation - This activity will commence in the second year, once the ultimate transmission mode is placed into operation. It will ensure that all aspects of the data acquisition interface are operating

satisfactorily. Detailed documentation of the operation, maintenance of the system and data checking procedures will be prepared during the testing phase.

250 -Hydrologic Model

This block of activities includes all tasks related to the calibration, modification, operation and maintenance of a physically based hydrological model and/or other models (to be determined) for the purpose of short and long term streamflow forecasting in the UIB. The hydrologic model to be used will be selected on the basis of the study to be carried out in activity 212. It should be noted that a significant amount of work using the UBC watershed model has already been carried out in the Mangla basin under the WMO project. This work will be used only upon confirmation by the aforementioned initial review report.

251 - Review Existing Data - This activity includes a review of the data available for calibration of a hydrologic model. It will identify data deficiencies; possibilities for data transfer between sub-basins; stream gauging requirements for model calibration; specific areas for short term research/data gathering to assist in modifying the model; and data needs for long term model operation in a forecasting mode including weather forecasting requirements. It will be done, at least in part, in conjunction with activity 221 - Sensor Location Studies. Results and recommendations will be presented in memoranda as required.

In the first year of the project, activity will be limited to data review required for activities 221 - Sensor Location Studies and 211 - Project Direction and Review Report.

Key Dates: None

252 - Assess Computer System Needs - This activity includes an assessment of the computer equipment required for calibration and operation of the hydrologic model and any other project requirements. It will also include an examination of the interfacing with the data acquisition system, memory storage requirements, display equipment, software, operating conditions, etc. A report will be prepared detailing the specific requirements. Required equipment specifications and tenders will be prepared.

The report will be prepared in the first year of the project and provide a schedule for purchase of equipment. Equipment purchases will be staged according to the recommendations.

The recommendations will be reviewed and revised based on the development of WAPDA staff capability to use the equipment and in light of advances in hardware and software design.

Key Dates

Issue Draft Report on Computer System Requirements - June 1991.
Issue Final Report on Computer System Requirements - July 1991.
Complete purchase and installation of first two computers - August 1991.

253 - Determine Model Modifications - This activity includes consideration of any potential hydrologic model deficiencies or weaknesses identified in activity 212 - Review of Hydrologic Model, and will include a review in detail of the optimum means of remedying these deficiencies/weaknesses. Appropriate literature will be reviewed, along with the computer program and its documentation to determine what modifications/additions should be made to the model and how they should be

incorporated. Any required mathematical equations and numerical analysis techniques will be derived. Specific research required for model improvement will be identified (this may include field studies). The results will be presented in a report if modifications are required.

As experience is gained with the model and further model deficiencies in reproducing the hydrologic regime are identified, supplementary studies and model modifications may be required. These will be reviewed and reported on as necessary. (note - Upon project completion, it will be necessary for WAPDA to carry on this process as additional data is obtained. It is therefore planned to have two M.Sc. level students in Civil Engineering Hydrology attend the University of British Columbia to work on hydrologic modelling as part of their graduate research work).

There will be no work on this activity in Year 1.

Key Dates: None (if and as required).

254 - Prepare Basin Data - This activity includes the preparation of all data necessary for model calibration in a form useable by the hydrologic model. It will proceed on a basin by basin sequence prior to the start of calibration of any one sub-basin (and as data becomes available). Data preparation includes such work as sub-basin delineation, preparation of area elevation curves, determination of temperature and precipitation profiles, reviewing streamflow records, etc. There will be no work on this activity in Year 1.

Key Dates: None (as data becomes available and as required for model sub-basin calibration).

255 - Calibrate Model - This activity includes all work necessary to calibrate a hydrologic model and will proceed on a sub-basin by sub-basin basis, in parallel with activities 253

and 256. By proceeding on this basis, modelling and data deficiencies can be more clearly defined as an aid to model or remote sensing system modification. The calibrations will proceed initially, using already available data, and later including data gathered as the remote sensing system is phased into operation. Calibrations will be tested in a predictive mode during flood seasons as appropriate. The results of the final calibration and the calibration parameters will be documented in a report which will also include an estimate of the model accuracy and any modelling limitations. (A hydrologic model is never "finally" calibrated. The calibration should be reviewed and modified in light of new data - particularly extremes once the model is made operative).

There will be no work on this activity in Year 1.

Key Dates

Preliminary Basin Calibration completed by January 1994.
Complete Draft Report on Calibration by October 1994.
Issue Final Report on Calibration by June 1995.

256 - Modify the Model - This activity will be carried out in parallel with activity 255 Calibrate Model. The initial modifications, if any, will be those identified in activity 253 - Determine Model Modifications. Subsequent modifications, if any, would be in response to problems identified during the calibration. All model modifications will be fully documented and added to the existing hydrologic model documentation.

Key Dates: None (if and as required).

257 - Applied Research - Any applied research required to improve the model will be carried out as part of this activity. Since any major field program proposed by WAPDA as a consequence of Phase I will be funded by IDRC from its

normal research funds, this activity will largely consist of review and integration of the research and liaison with the researchers.

In the first year of the project, discussions will be held with Dr. K. Hewitt. Any applied research in the field that will be directly beneficial to the project and which flows from the SIHP Phase I will be identified.

Key Dates

Identify Research flowing from SIHP Phase I by May 1991.

258 - Test Model in Predictive Mode and Implement Operation - This activity will initially be carried out on individual sub-basins as calibration proceeds. Once all the sub-basins for a given dam have been calibrated, the aggregate will be tested during flood periods to ascertain where further improvements are required; either to the model, the remote sensing system or the weather forecasting system. (Desirable improvements to the weather forecasting system will have to be discussed with, and carried out by, the Pakistan Meteorological Department). The results of the tests and any recommendations for remedial work will be reported in technical memoranda at the end of the flood seasons. The model will be placed in an operational mode on completion of testing.

There will be no work on this activity in Year 1 of the project.

Key Dates

Model operational by November 1995.
Memorandum on first years testing by October 1994.
Final Memorandum on testing by October 1995.

259 - Documentation of Model - This activity consists of a compilation of all documentation prepared in activities 254 and 256.

There will be no work on this activity in Year 1 of the project.

Key Dates

Compilation of documentation and draft of operating procedures by November 1994.
Final Documentation by December 1994.

260 - Stream Gauging - This activity includes any stream gauging and other short term data gathering identified as a requirement in activity 251 - Review of Existing Data. It includes the mobilization, field work and data processing required to meet project requirements. This is expected to be largely a WAPDA-led activity.

There will be no work on this activity during Year 1 of the project other than to identify some potential stream gauging sites.

Key Dates: none (if, and as, required).

270 - System Operations

This activity consists of all tasks related to the design and implementation of a preliminary operating strategy using the information provided by the remote sensing network and the hydrologic model.

271 - Design Operational Strategy - This activity includes a review of the competing demands on the water from the Tarbela and Mangla reservoirs and the Kabul basin; the consequences of not meeting the individual demands (economic and social); and the benefits and risks of

various operational strategies given the accuracy and potential variability of the flood forecasts. A report will be prepared recommending an optimal strategy. It is recognized that this item of work is a major study in itself. For the purposes of this project, the above work would be more in the nature of a preliminary study and may well recommend that a specific, more detailed study be funded to study in detail, and implement, a more refined operating strategy.

There will be no work on this activity in Year 1.

Key Dates

Complete Draft Report on optimal strategy by March 1995.
Complete Final Report by April 1995.

272 - Development and Testing - This activity includes the development and documentation of any computer programs required to implement the recommended operational strategy; and, the testing of the strategy using recorded data.

There will be no work on this activity in Year 1.

Key Dates

Complete draft documentation by May 1995.
Finalize documentation by August 1995.

273 - Implementation - This activity would include any remaining activities required to place the operational strategy into regular use.

There will be no work on this activity in Year 1.

Key Dates

Implementation by December 1995.

280 -Training Course by CIDA

This activity covers any CIDA training for foreign aid workers in Canada or Pakistan. "In country" training will be taken by one team member in 1992. Other training will be on an 'as required' basis.

There will be no work on this activity in Year 1.

290 - Mobilization/Demobilization

This activity covers all travel to Pakistan by BCHIL staff either on a short term or long term basis. Staff will be in Pakistan annually during installation of remote sensors stations and for the annual review meeting. The number of staff in Pakistan at any given time will depend upon the installation program in each year; the requirements for reconnaissance; the requirements for staff backup in case of illness; and, any problems that have occurred in the previous year. It is expected that each team member will make at least one trip to Pakistan having a duration of 6 - 8 weeks annually during the first three years. In addition, there will be a full time site manager for the period January 1992 to December 1994. Field reports will be submitted after each trip. Table 5 lists the travel to Pakistan for the first year of the project.

295 - Consultants

This activity covers the preparation of terms of reference, hiring, review and monitoring of external consultants. It also covers the monitoring of any internal (B.C. Hydro) specialists required to meet project requirements.

296 - The following external consultants will be hired in Year 1:

Dr. K. Hewitt - to provide liaison with SIHP Phase I, advise on sensor locations, and, advise on research possibilities.

Mr. A. Pipes - to provide a report on the feasibility of hydrologic modelling of the UIB.

Key Dates

Dr. Hewitt's recommendations June 1991.
Mr. Pipe's report June 1991.

297 - The following internal specialist services will be required in Year 1:

Structural Design
Computer System/Software Advice
Advice on Telemetry Systems

Key Dates: As required.

300 - PROCUREMENT

340 - BCHIL PROCUREMENT

This block of activities includes all work related to the procurement of equipment by BCHIL and its delivery in Pakistan. Specifications and tendering activities will be carried out as part of specific technical assistance tasks. When specifications and tenders are issued, a copy will be sent to IDRC for review/ comment along with a list of the companies requested to submit tenders. When the purchase is made, the name of the recommended supplier, the cost, and the evaluation forming the basis of the recommendation will be forwarded to IDRC. Table 3 shows the activities in the work breakdown structure. The schedule is shown on Fig. 1.

341 - Specifications - Preparation of specifications and requests for tenders for equipment is presented under activities 224 - Equipment Specifications and Tenders (Remote), 231 - Satellite Imagery Equipment, 242 - Procurement of Equipment (Interface) and 252 - Assess Computer System Needs. These

activities are related to specific technical assistance topics.

342 - Request for Quotations - This activity includes locating and assessing suitable suppliers, issuing requests for tenders and receiving bids. This activity will be carried out by the B.C. Hydro Purchasing Department for the project. In the first year of the project, the quotations will be requested for the following equipment:

- platform transmitter terminals and sensors;
- towers and related hardware;
- outdoor clothing;
- outdoor/mountaineering equipment;
- first aid equipment; and
- computers/software/printers.

Key Dates

All bids received by June 1991.

343 - Analysis of Bids - This activity includes the review and analyses of tenders to ensure that maximum value is received. IDRC or B.C. Hydro purchasing guidelines will be followed, depending upon which is the most stringent. Reviews will be carried out and recommendations made by BCHIL staff. In the first year of the project, the reviews will be for the items listed in activity 342 - Request for Quotations.

344 - Purchasing - This activity covers all purchasing related activities including the issuing of purchase orders, payment, obtaining donation certificates, arranging for delivery in Vancouver, and forwarding information to WAPDA. This activity will be carried out by B.C. Hydro Purchasing Department for the project. In Year 1 of the project, equipment purchases listed in activity 342 - Request for Quotations will be made.

Key Dates

All equipment for Year 1 installations delivered in Vancouver by 22 July 1991.

All equipment for subsequent years delivered in Vancouver to meet seasonal requirements.

345 - Shipping - This activity includes the packing, shipping, expediting and preparation of any necessary clearance documents. This activity will be carried out by B.C. Hydro Purchasing Department assisted by B.C. Hydro Stores and a Freight Forwarding company.

In Year 1 of the project, equipment purchases listed in activity 342 - Request for Quotations will be shipped to Pakistan.

Key Dates

All equipment for Year 1 installations delivered in Pakistan by 1 August 1991.

All equipment for subsequent years delivered in Pakistan to meet seasonal requirements.

346 - Receiving - This activity includes all work in Pakistan necessary to have the equipment cleared through customs and delivered to the project office in Lahore. This activity will be the responsibility of WAPDA staff.

400 -TRAINING

460 - WAPDA Training

Training will be an ongoing process throughout the duration of the project. Where required, the assistance of a training specialist will be utilized to ensure maximum benefit to WAPDA

staff from the training. The schedule for the proposed training plan is shown on Fig. 1. The training plan will be documented in a report prepared under activity 214 - Review of Training Requirements. A training manual documenting how training is to be implemented, monitored, and verified will be prepared in year 2 of the project with the assistance of the training specialist.

461 - Review - The Review of Training Requirements is documented under activity 214 - Review of Training Requirements.

462 - On The Job Training - This activity consists of all on the job training in Pakistan and Canada.

As described throughout the methodology, a considerable amount of on-the-job training will take place and will include training in:

1. On-going project management and administrative procedures for the WAPDA Project Director.

2. Operation and maintenance of remote sensing equipment by suppliers; short courses to be held in Pakistan and attended by technicians and engineers.

3. Mountain and glacier travel safety and first aid.

4. Designing, programming, operation and maintenance of the data acquisition interface for engineer research officers, technicians and electronic engineers.

5. Calibration and operation of a hydrologic model involving a practical stage with the B.C. Hydro System Control Centre and possibly specific individual courses in glaciology, microcomputer programming and water resources optimization techniques.

6. Electrical operations optimization in a practical session at B.C. Hydro.

7. Field training in Canada in the installation, operation and maintenance of a remote sensing system.

In the first year of the project, up to four WAPDA staff members will be trained in one or all of the following:

- installation, operation and maintenance of remote sensing equipment;
- remote sensing system design;
- first aid; and
- computer operation and programming.

Key Dates

Up to 10 WAPDA staff trained by December 1995.

463 - University Training - This activity consists of all University Training in Canada for WAPDA staff.

Formal University training will be carried out at the M.A.Sc. level. Suitable candidates will be identified by WAPDA from outside the Hydrology Research Directorate. Studies will be undertaken in the following fields:

1. Two in Civil Engineering hydrological modelling, probably at UBC and with practical summer work at B.C. Hydro.

2. One in systems analysis and optimization at a university to be determined.

In the first year of the program, one WAPDA engineer will commence university training.

Key Dates

Three engineers trained at a Canadian university by the end of Year 4.

4.3 LOGICAL FRAMEWORK ANALYSIS

The Logical Framework Analysis is presented in Table 6. This has been modified from that prepared by CIDA in September 1990 and presented in the Management plan. Adjustments have been made to resolve differences between various IDRC and CIDA documents particularly related to project goals and objectives.

1. The project goal and objective have been restated.

2. The means of verifying whether the project goal has been achieved have been modified to include WAPDA records of energy production as a means of verification of Project Goal Achievement. It must be noted that, the length of the project (5 years) and the length of meteorological records that will be obtained (2 - 4 years) are short relative to the length of record of meteorological information required for good model calibration (5 - 8 years). This will result in the means of verification of the Project Goals being very limited within the life of the project.

3. The objectively verifiable indicators of the outputs have been modified by changing the date of completion for University training of 3 WAPDA Engineers/Scientists (note: CIDA LFA says scientists whereas the emphasis in this project will be on training engineers). The completion date has been shifted to the end of year 4. This reflects the difference in academic years versus project years.

4. The objectivity verifiable indicators of inputs have been modified to reflect the revised project starting and completion dates. Note that although the start date is listed as January 1991, the actual signing of the contract did not take place until mid-February 1991. BCHIL staff were not authorized

to work on the project until the contract was signed and thus, the actual working time on the project is about 6 weeks less than the dates listed in the contract and on the LFA. Although seemingly not significant over the five year project life, this delay is significant in the first year of the project. The effects of this reduced time were somewhat offset by the reconnaissance this made in October 1990. In addition to the above change of dates, the budget has been revised to reflect uninflated numbers in line with IDRC practice.

5. The Assumptions for Providing Inputs have been modified by the addition of an assumption that WAPDA will be able to obtain an extension to its budget proposed in the PC-1. The PC-1 for the project was approved in June 1989 and thus Pakistan has been working on the project for about one a half years prior to BCHIL involvement. As it is WAPDA policy not to allow carry over of unused funds from one year to the next, this means that, unless an extension is approved, WAPDA will run out of funds one and a half years before the project is scheduled to be completed in December 1995.

SECTION 5.0 - PROJECT ORGANIZATION

The project organization chart for BCHIL staff is shown on Fig. 2. This is a slightly flatter structure than originally proposed and reflects the organization as it has developed to maximize the contributions of team members. The inclusion of WAPDA engineering team members in the organization chart reflects the team approach to the work and BCHIL's responsibility for technical direction of the project. Fig. 3 presents a more general project organization chart showing the relationships between BCHIL, IDRC and WAPDA. Fig. 4 shows the key personnel of the WAPDA team. The positions of Project Director and those listed under the Senior Engineer Snow and Ice, Mr. H. Afzal, are those presented in the PC-1 documents. The project will definitely require the assistance of the Telemetry Group under Mr. Anwar Khan. The assistance of Mr. Sanaullah and his team may be required depending upon the results of the review of satellite imagery.

On Fig. 3, although no direct technical control is shown by the WAPDA Project Director over WAPDA engineering team members, he will have increasing technical control as WAPDA develops the required knowledge and expertise and assumes an increased portion of the work.

SECTION 6.0 - TERMS OF REFERENCE

BCHIL's terms of reference are: to be responsible for all Canadian input to the project as described in its contract with IDRC; and, to be responsible for achieving the Project Objectives in cooperation with WAPDA. This will require BCHIL to do the following:

1. Provide a team of scientific and technical personnel from Canada to work with WAPDA in Canada and in Pakistan on the project.

2. Procure items as agents for and on behalf on the IDRC in accordance with IDRC's procurement guidelines.

3. Provide technical assistance and training to WAPDA.

4. Provide all resources necessary to ensure effective and efficient project and financial management.

5. Cooperate with and provide assistance to the IDRC-appointed Canadian Project Manager and/or Evaluator; and

6. Participate in the Project Review Committee, the role of which is set out in the Project's Management Plan.

7. Carry out activities presented in the work breakdown structure.

The above terms of reference are sufficient broad to ensure that the Project Objective and outputs presented in Subsection 4.0(a) can be met.

SECTION 7.0 - SCHEDULE

The schedule is presented in Fig. 1. It has been modified from the schedule presented in the contract between BCHIL and IDRC and dated November 1990. The basis for the revisions are the delayed start and the need to distribute the work evenly between the team members. The delayed start affects work items in the first year, particularly prior to October. The requirement for more even work distribution results in some work items such as the determination of the transmission mode and the sensor location studies being delayed until late in the first year or early in year two; however, the key project outputs and deadlines are not affected by these changes.

SECTION 8.0 - RESOURCE ALLOCATION

8.1 BCHIL STAFF

Each of the key BCHIL staff members is responsible for specific areas of the project based on their technical background and experience. In addition, each team member is expected to contribute their expertise to all other areas of the project in order to bring as wide a range of experience as possible to the solution of design problems. The key BCHIL team members and their terms of reference are listed below. The working hours for these staff members will follow B.C. Hydro guidelines and procedures for office and field work.

(a) Dr. W. Bell, P.Eng. - Project Manager

(i) Professional Background

Dr. Bell has over 29 years of engineering experience in electrical, hydraulics and hydrology engineering. He has been Manager of the Hydrotechnical Department for B.C. Hydro since 1985. During this time, the Hydrology Section of the department has carried out: several probable maximum flood studies using hydrologic models; reservoir operation studies; hydromet network design studies; and, design and supervision of the construction and installation of over 50 satellite telemetry installations for hydromet data acquisition.

(ii) Responsible for the Following Activities (as detailed in the work breakdown structure):

140 - BCHIL MANAGEMENT
211 - Project Direction and Review report
214 - Review of Training Requirements
215 - Annual Review
290 - MOBILIZATION/DEMOBILIZATION
295 - CONSULTANTS

343 - Analysis of Bids
461 - Review
462 - On-the-job Training

(b) Mr. L.J. Parmley, P.Eng. - Technical Specialist

(i) Professional Background

Mr. Parmley has over 33 years experience in all phases of hydraulics and hydrology engineering. His hydrology background includes experience with hydrologic models, flood forecasting, reservoir operation and satellite telemetry. He is presently the project manager for a climate network re-establishment program involving approximately 50 stations distributed over four river basins. This project involves: the preparation of tender documents; evaluation and selection of tenders for supply and delivery of DCP's, sensors and equipment; network design and station site selection; equipment installation, and operation of the system. Mr. Parmley has overseas experience.

(ii) Responsible for the Following Activities (as detailed in the work breakdown structure):

142 - Technical Review (assist)
211 - Project Direction and Review Report (assist)
213 - Review of satellite Imagery
221 - Sensor Location Studies
222 - Reconnaissance
223 - Determine of Transmission Mode
224 - Equipment Specifications and Tenders (Remote)
227 - Equipment Testing
230 - Review of Sensor Performance
251 - Review Existing Data (assist)
270 - SYSTEM OPERATION
343 - Analysis of Bids
462 - On-the-job Training (assist)

(c) Mr. H. Walk, P.Eng. - Senior Engineer and Deputy Project Manager

(i) Professional Background

Mr. Walk has 17 years experience as an engineer, fourteen of them in the field of Hydrology. He has experience in: computer programming; calibration and operation of hydrologic models; installation, operation and maintenance of satellite telemetry systems; satellite imagery; and reservoir inflow forecasting. He has worked with external agencies on activities relating to data collection as Canadian chairman of the Columbia River Hydromet Committee and as B.C. Hydro representative to the National Environmental Satellite Information Service. Prior to joining this project, Mr. Walk was Supervisor of the Operations Hydrology Section being responsible for reservoir inflow forecasting and the operation and maintenance of a hydromet network of over 70 stations with an annual budget of approximately one million dollars. Mr. Walk will be the Deputy Project Manager in Pakistan for the project.

(ii) Responsible for the Following Activities (as detailed in the work breakdown structure):

140 - MANAGEMENT (assist)
211 - Project Direction and Review Report (assist)
212 - Review of Hydrologic Model
213 - Satellite Imagery
221 - Sensor Location Studies (assist)
222 - Reconnaissance (assist)
226 - Local Procurement
229 - Installation and Maintenance (assist)
240 - DATA ACQUISITION INTERFACE
250 - HYDROLOGIC MODEL
280 - TRAINING COURSE BY CIDA

343 - Analysis of Bids
346 - Receiving
462 - On-the-job Training (assist)

(d) Mr. D.J. Morgan, P.Eng.

(i) Professional Background

Mr. Morgan has 10 years experience as an engineer, eight of them in the field of Hydrology. He has experience in the calibration and operation of hydrologic models; computer programming; and, the installation, servicing and maintenance of data collection platforms (DCP's). He is presently a principal with Via-Sat Data Systems Inc. and will work on contract to BCHIL.

(ii) Responsible for the Following Activities (as detailed in the work breakdown structure):

212 - Review of hydrologic model (assist)
225 - Site Design
226 - Local Procurement (assist)
227 - Equipment Testing (assist)
228 - Installation and maintenance manuals
229 - Installation and maintenance
255 - Calibrate Model (assist)
260 - Stream gauging (if required)
343 - Analysis of Bids
462 - On-the-job Training (assist)

8.2 CONSULTING SERVICES (External)

In addition to the above key BCHIL team members, several specialist consultants may be hired. Consulting services will only be retained after the services described are approved in the annual work plan. Before the services can be contracted out, the following procedures will be followed:

1. Terms of reference and scope of work covering the proposed assignment will be prepared.

2. Budget, proposed schedule and reporting will be defined in collaboration with WAPDA.

3. Submission to IDRC for approval of the above.

4. Approval of fees by IDRC.

The following are noted principally because of their previous involvement in the SIHP Phase I studies:

Dr. Ken Hewitt - required for general background on the UIB and for specialist advice on glaciology-related problems.

Mr. A. Pipes - assistance with the use of the UBC watershed model to examine the feasibility of hydrologic modelling of the UIB.

Dr. M.C. Quick - general advice on hydrologic modelling and data problems in the UIB.

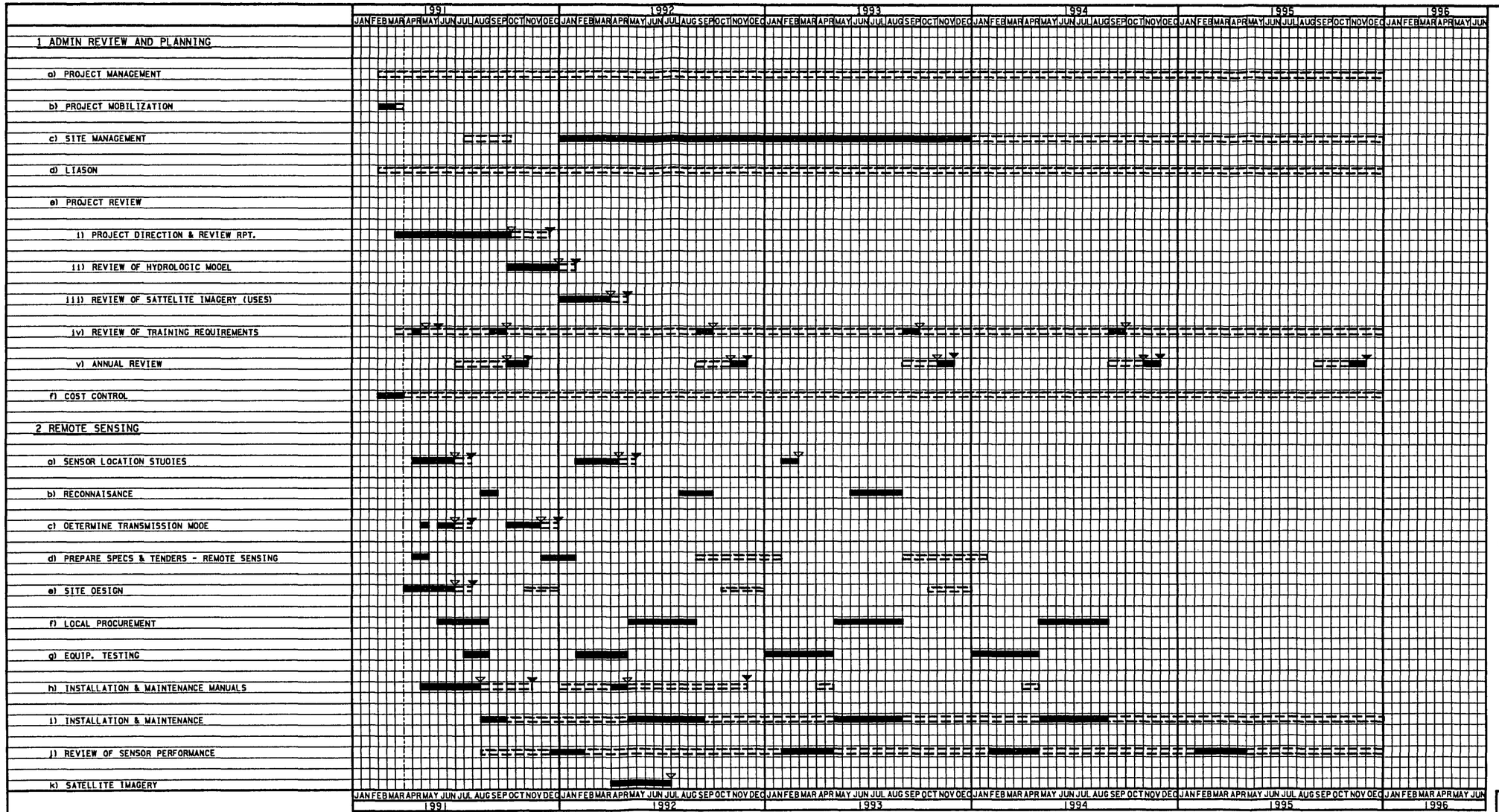
Specialist consultants may also be required for the review of satellite imagery requirements/benefits; review of training requirements and procedures, preparation of specifications for a remote telemetry system; training WAPDA staff in the fundamentals of the hydrologic model selected; meteorology; safe maintain travel; and, wilderness first aid.

8.3 CONSULTING SERVICES (Internal)

Other B.C. Hydro staff may be seconded to BCHIL for the project as required, to provide assistance with computer systems, structural design, communications technology, reservoir operations procedures, airphoto interpretation, purchasing, drafting, and administration.

8.4 WAPDA

The key project staff to be supplied by WAPDA consists of the existing personnel of the Hydrology and Research Directorate (HRD), Hydrology and Water Management Branch, Planning Division plus those individual to be hired as per the PC-1 document.



LEGEND:

- ▽ - DRAFT REPORT COMPLETED
- ▼ - FINAL REPORT
- ▬ - CONCENTRATED EFFORT
- ▭ - REVIEW ONGOING MONITORING OR REDUCED EFFORT

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

PAKISTAN SNOW AND ICE HYDROLOGY PROJECT

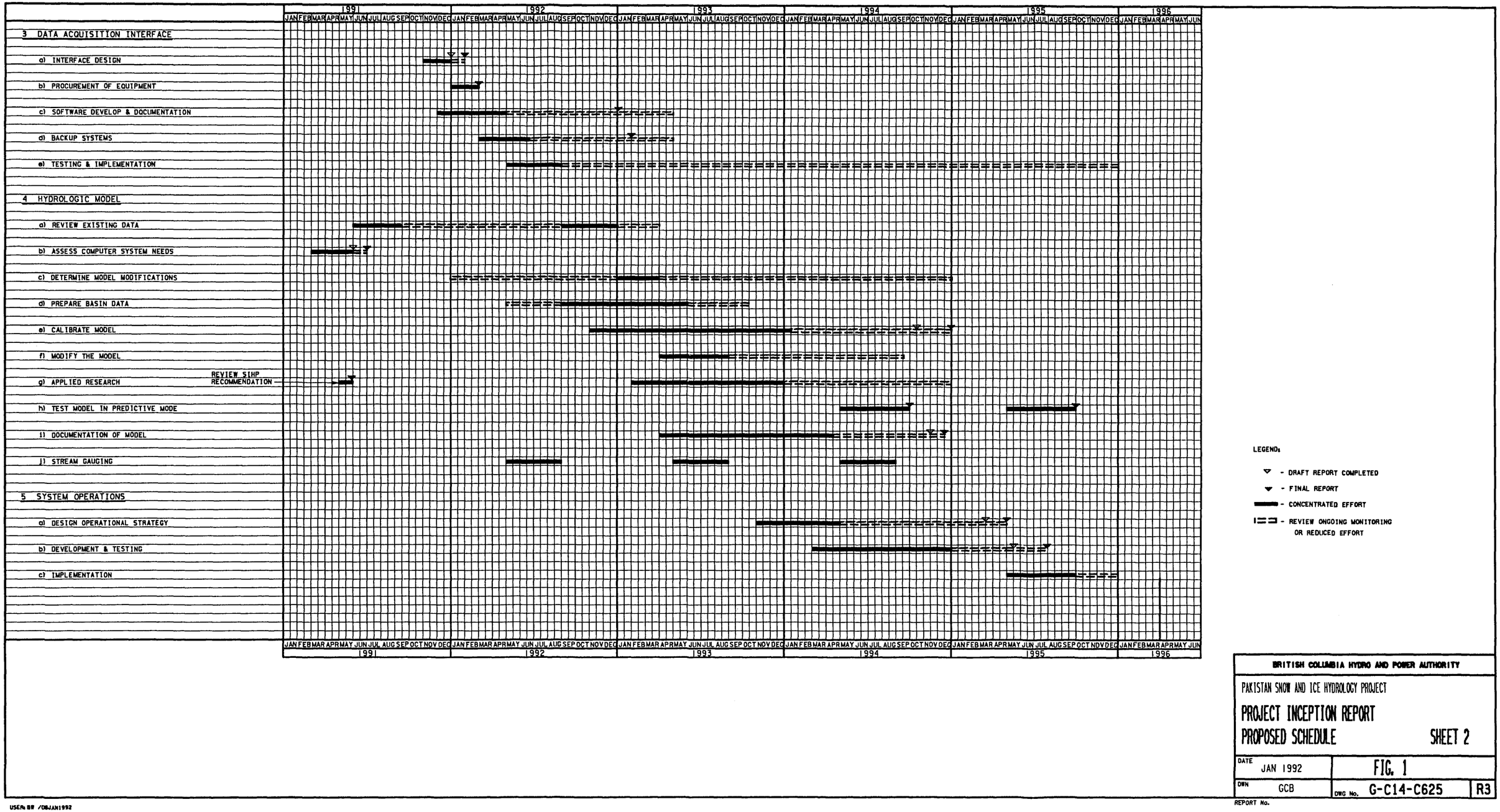
PROJECT INCEPTION REPORT
PROPOSED SCHEDULE

SHEET 1

DATE JAN 1992	FIG. 1
DWN AV/HWW	DWG No. G-C14-C624 R2

REPORT No.

D



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

PAKISTAN SNOW AND ICE HYDROLOGY PROJECT

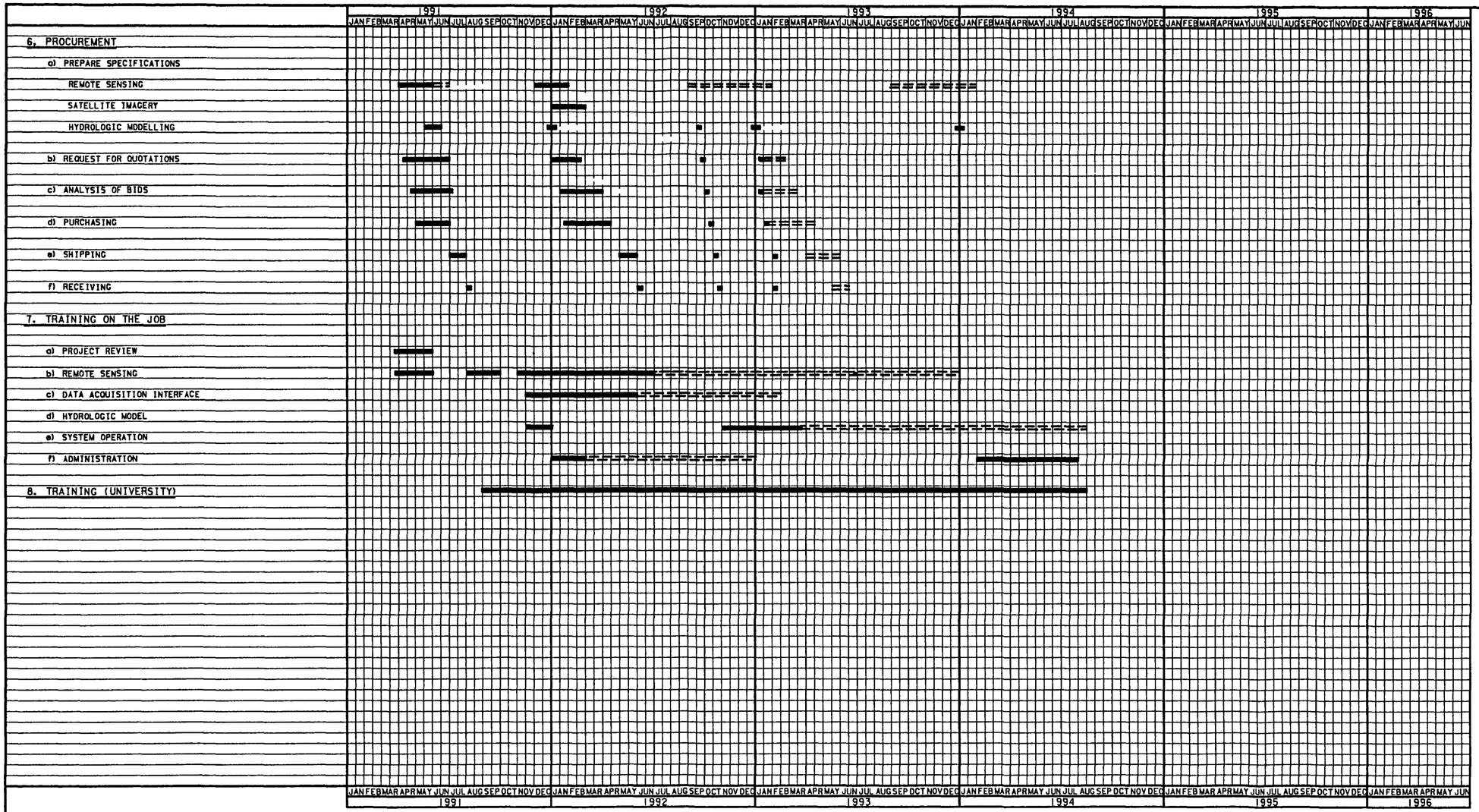
PROJECT INCEPTION REPORT
PROPOSED SCHEDULE

SHEET 2

DATE JAN 1992	FIG. 1
DWN GCB	DWG No. G-C14-C625 R3

REPORT No.

USER: BF /08JAN1992



LEGEND:

- ▬▬ - CONCENTRATED EFFORT
- ⁞═⁞ - REVIEW ONGOING MONITORING OR REDUCED EFFORT

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

PAKISTAN SNOW AND ICE HYDROLOGY PROJECT

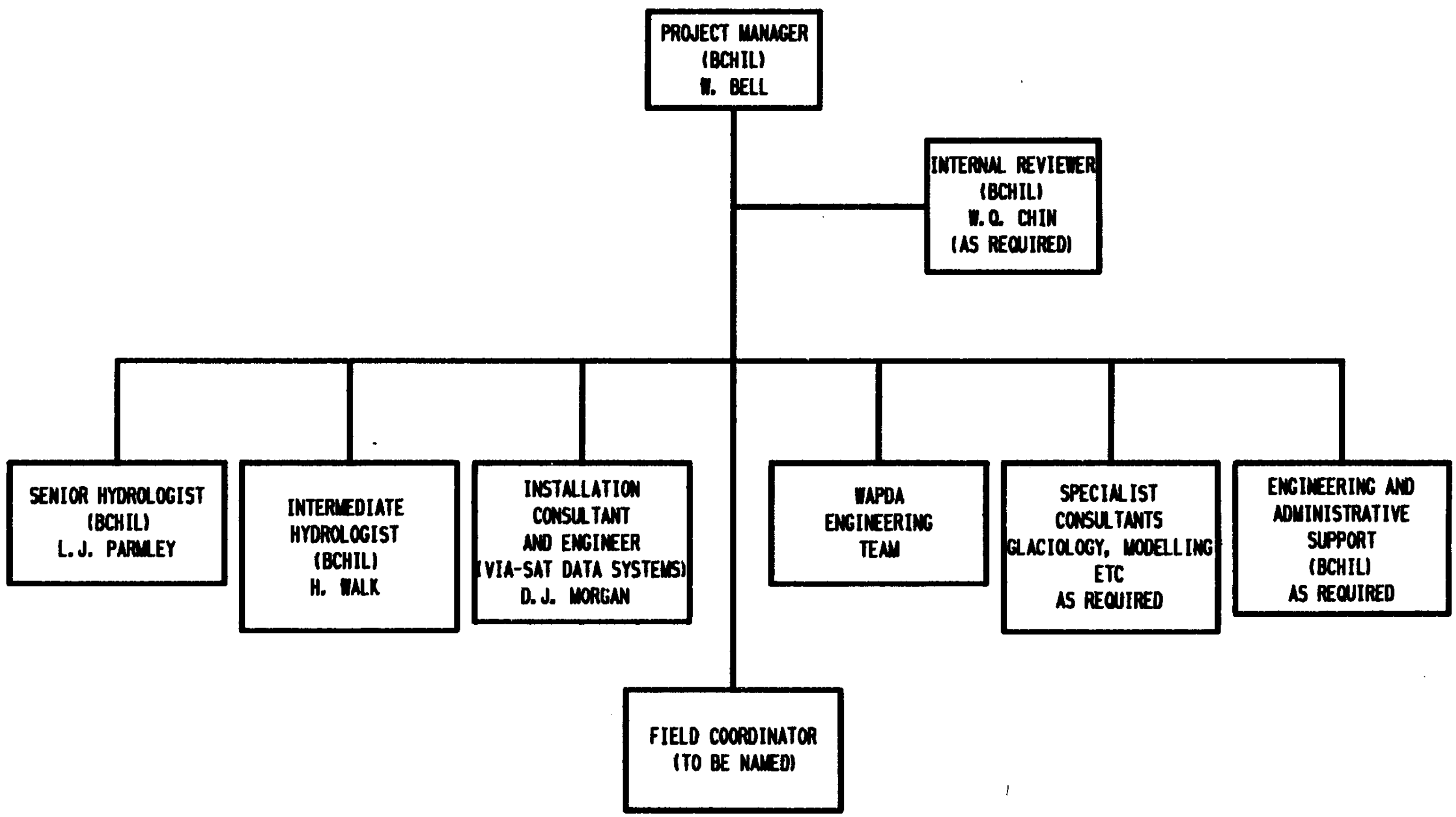
PROJECT INCEPTION REPORT
PROPOSED SCHEDULE SHEET 3

DATE JAN 1992	FIG. 1
DWN HWW	DWG No. G-C14-C1142 R2

USER: B. W/07JAN1992

REPORT No.

USER: BW/08JAN, 1992



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

PAKISTAN SNOW AND ICE HYDROLOGY PROJECT

PROJECT INCEPTION REPORT

BCHIL ORGANIZATION CHART

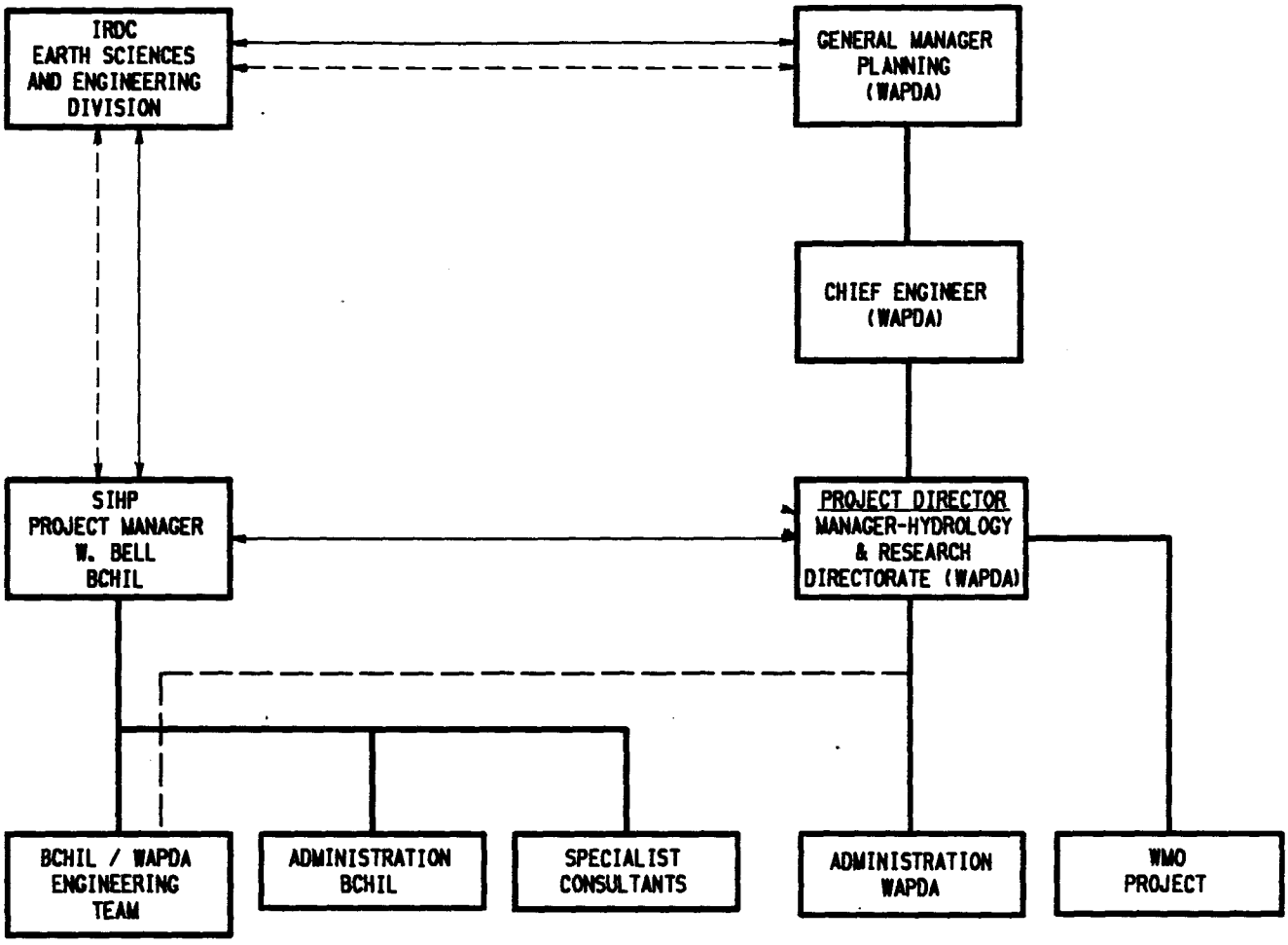
DATE JAN 1992

DWN AWG

FIG. 2

DWG No. G-C14-A1134

REPORT No.



CONTRACTUAL LINKS

COMMUNICATIONS LINKS

ADMINISTRATIVE AND TECHNICAL LINK TO WAPDA STAFF

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

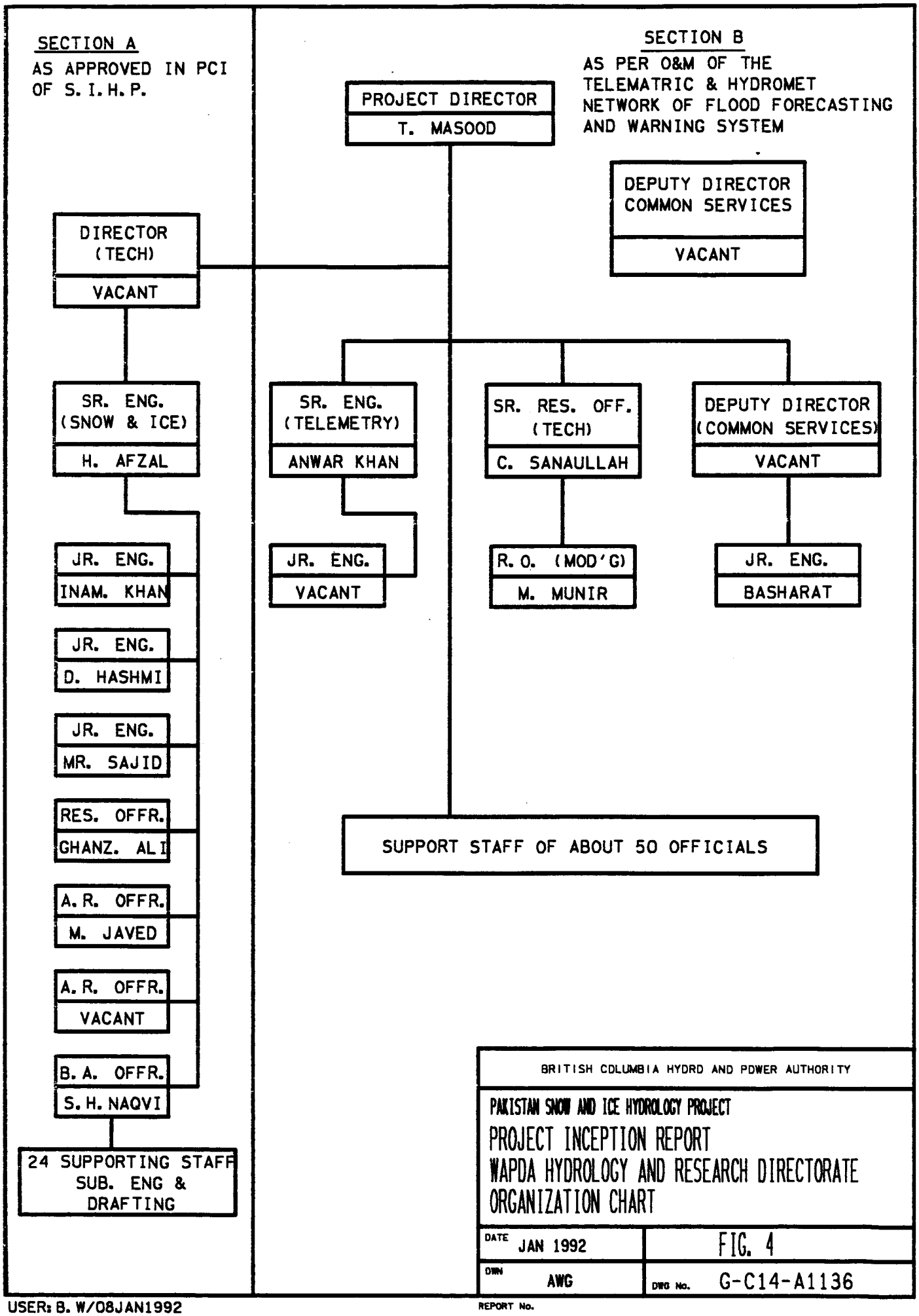
PAKISTAN SNOW AND ICE HYDROLOGY PROJECT

PROJECT INCEPTION REPORT
PROJECT ORGANIZATION CHART

DATE	FIG. 3
JAN 1992	
DSN: AWG	DWG No. G-C14-A1135

USER: BW/08JAN/1992

REPORT No.


SECTION A
AS APPROVED IN PCI OF S. I. H. P.
SECTION B
AS PER O&M OF THE TELEMATRIC & HYDROMET NETWORK OF FLOOD FORECASTING AND WARNING SYSTEM
PROJECT DIRECTOR
T. MASOOD
DEPUTY DIRECTOR COMMON SERVICES
VACANT
DIRECTOR (TECH)
VACANT
SR. ENG. (SNOW & ICE)
H. AFZAL
SR. ENG. (TELEMETRY)
ANWAR KHAN
SR. RES. OFF. (TECH)
C. SANAULLAH
DEPUTY DIRECTOR (COMMON SERVICES)
VACANT
JR. ENG.
INAM. KHAN
JR. ENG.
D. HASHMI
JR. ENG.
MR. SAJID
RES. OFFR.
GHANZ. ALI
A. R. OFFR.
M. JAVED
A. R. OFFR.
VACANT
B. A. OFFR.
S. H. NAQVI
24 SUPPORTING STAFF SUB. ENG & DRAFTING
JR. ENG.
VACANT
R. O. (MOD'G)
M. MUNIR
JR. ENG.
BASHARAT
SUPPORT STAFF OF ABOUT 50 OFFICIALS
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
PAKISTAN SNOW AND ICE HYDROLOGY PROJECT
PROJECT INCEPTION REPORT
WAPDA HYDROLOGY AND RESEARCH DIRECTORATE
ORGANIZATION CHART
DATE JAN 1992
FIG. 4
DWN AWG
DWG No. G-C14-A1136
USER: B. W/08JAN1992
REPORT No.