No.

Japan International Cooperation Agency

Federal Flood Commission
Ministry of Water and Power
The Islamic Republic of Pakistan

The Study on Comprehensive Flood Mitigation and Environmental Improvement Plan of Lai Nullah Basin in The Islamic Republic of Pakistan

Final Report
Volume 1 Summary

September 2003

CTI Engineering International Co., Ltd.
Pacific Consultants International

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PREFACE

In response to a request from the Government of Islamic Republic of Pakistan, the Government of Japan decided to conduct a development study on Comprehensive Flood Mitigation and Environmental Improvement Plan of the Lai Nullah Basin in the Islamic Republic of Pakistan, and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team, headed by Mr. MATSUMOTO Yoshiharu of CTI Engineering International Co., Ltd. to Pakistan three (3) times between August 2002 and August 2003. In addition, JICA set up an Advisory Committee chaired by Mr. MIYAGAWA Yuji of the Ministry of Land, Infrastructure and Transport between May 2002 and September 2003, which examined the Study from specialist and technical points of view.

The Team held a series of discussions with the officials concerned of the Government of Islamic Republic of Pakistan and conducted field surveys at the Study area. Upon returning to Japan, the Team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Islamic Republic of Pakistan for their close cooperation extended to the Study.

September 2003

KAWAKAMI Takao
President
Japan International Cooperation Agency

September 2003

Mr. KAWAKAMI Takao
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Sir:

We are pleased to submit herewith the final report of a Study on Comprehensive Flood Mitigation and Environmental Improvement Plan of the Lai Nullah Basin in the Islamic Republic of Pakistan.

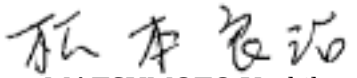
Under a contract with the Japan International Cooperation Agency, the study was conducted by CTI Engineering International Co., Ltd. in association with Pacific Consultants International during the period from May 2002 to September 2003.

This final report presents a formulation of a master plan for comprehensive flood mitigation and environmental improvement of Lai Nullah. The principal component of the overall plan is placed in the structural flood mitigation plan, which aims at producing the immediate effect and ultimately making Lai Nullah free from overflow by the probable flood runoff discharge of 100-year return period. As the principal structures, a community pond, a flood diversion channel and supplementary works to the on-going river channel improvement are proposed. In addition to the above, non-structural flood mitigation plan such as flood forecasting and warning system, related environmental improvement plan and strengthening of institutional setup are proposed.

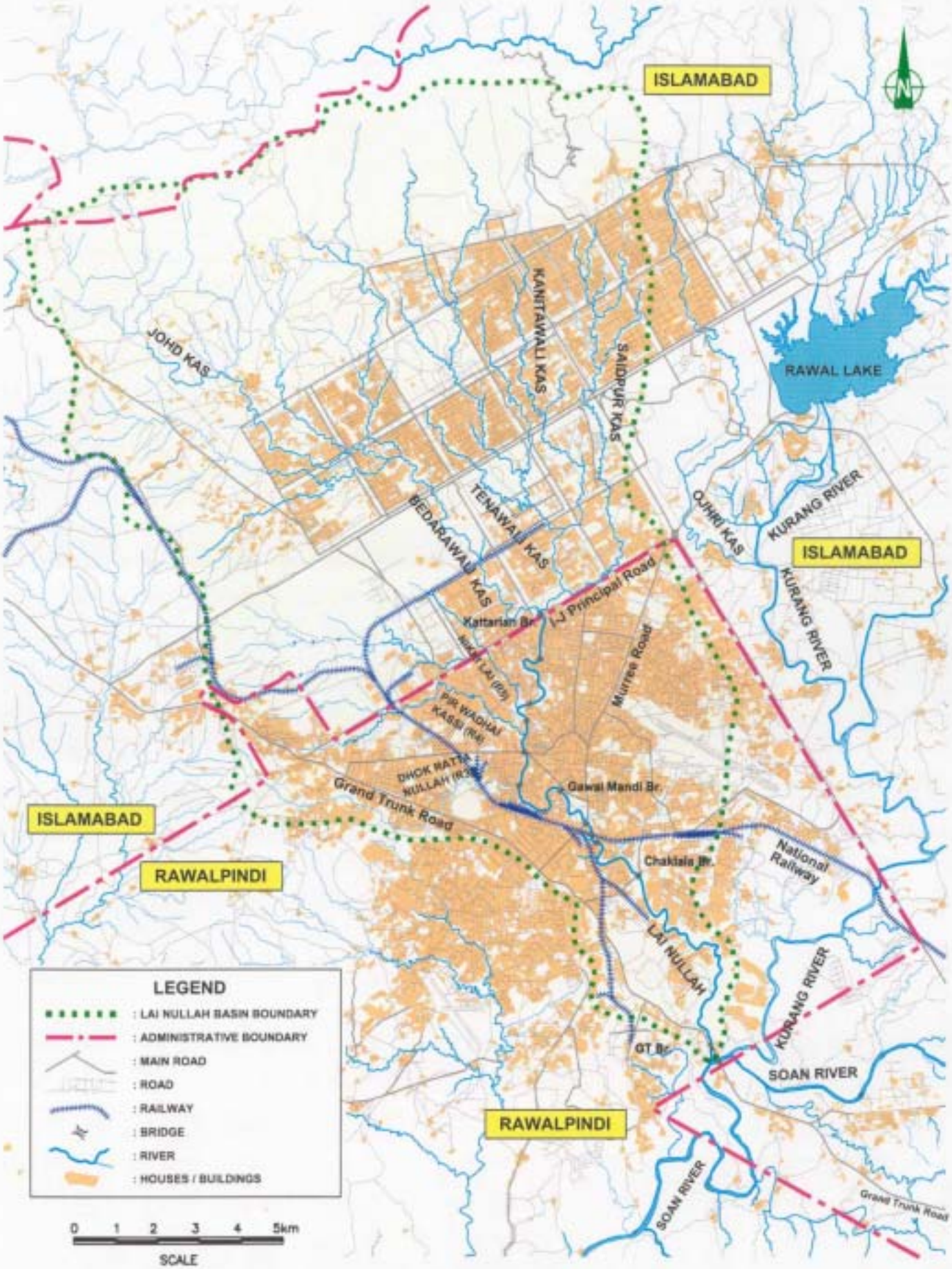
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Land, Infrastructure and Transport. We would also like to extend our deep appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan, Federal Flood Commission, the JICA Pakistan Office and the Embassy of Japan in Pakistan for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to comprehensive flood mitigation and environmental improvement of Lai Nullah and sustainable development of the Islamic Republic of Pakistan.

Very truly yours,



MATSUMOTO Yoshiharu
Team Leader
The Study on Comprehensive Flood Mitigation
and Environmental Improvement of Lai Nullah Basin
in The Islamic Republic of Pakistan


ISLAMABAD
N
JOHD KAS
KANITAWALI KAS
SAIDPUR KAS
RAWAL LAKE
BEDARAWALI KAS
TENAWALI KAS
OJHRI KAS
KURANG RIVER
ISLAMABAD
I-J Principal Road
Kattarian Br.
Murree Road
PIR WADHAI KASSI (R4)
DHOK KATTA NULLAH (R3)
Gawal Mandi Br.
Grand Trunk Road
ISLAMABAD
RAWALPINDI
Chaklala Br.
National Railway
LAI NULLAH
KURANG RIVER
GT Br.
SOAN RIVER
RAWALPINDI
SOAN RIVER
Grand Trunk Road
LEGEND
: LAI NULLAH BASIN BOUNDARY
: ADMINISTRATIVE BOUNDARY
: MAIN ROAD
: ROAD
: RAILWAY
: BRIDGE
: RIVER
: HOUSES / BUILDINGS
0 1 2 3 4 5km
SCALE

GENERAL MAP

EXECUTIVE SUMMARY

1. Background of the Study

Lai Nullah has a catchment area of 234.8 km^2, which is administratively divided into Islamabad in the upper reaches and Rawalpindi in the lower reaches. During a monsoon season, the floods frequently overtop Lai Nullah and inflict severe flood damages in Rawalpindi in particular. To cope with the flood problems, the Study on Comprehensive Flood Mitigation and Environmental Improvement Plan of the Lai Nullah Basin (hereinafter referred to as "the Study") has been commenced through technical cooperation by the Japan International Cooperation Agency (JICA) from May 2002 to September 2003.

2. Objective of the Study

As stipulated in the Scope of Works, the objectives of the Study are: (a) to formulate a master plan for comprehensive flood mitigation and environmental improvement of Lai Nullah; and (b) to transfer the skills and technology relevant to the Study.

3. Outline of Proposed Plan

The principal component of the overall proposed plan is placed in the structural flood mitigation plan, which aims at producing the immediate flood mitigation effect and ultimately making Lai Nullah free from overflow by the probable flood runoff discharge of 100-year return period. In order to materialize these targets, the structural flood mitigation plan is implemented through the phased programs, namely (1) the urgent project, (2) the short-term project and (3) the long-term project. The urgent project is composed of the priority measures to produce the immediate flood mitigation effect by the year 2005. The short-term and long-term projects would be further completed to cope with probable flood runoff discharge of 25-year return period by 2007 and 100-year return period by 2012, respectively. The principal structures composed in each of the phased projects are as below:

(1) **Community pond** is constructed, through the urgent project, within the compound of Fatima Jinnah Park with a catchment area of 26.5 km^2. The effective storage capacity of the pond is 2.9 million m^3, which impounds almost all of the peak flood runoff discharge of 25-year return period.

(2) **Flood diversion channel** is constructed through the short-term and the long-term project. The ultimate goal of the structure is to divert of the flood discharge of 100-year return period from the upper reaches of Lai Nullah to the adjacent Kurang River.

(3) **Supplementary works to the on-going river channel improvement** include: (a) the river improvement of about 1.0km in length below Chaklala bridge to be implemented

through the urgent project, and (b) the side slope protection works of the on-going channel improvement section to be implemented through the short-term project.

In addition to the above structural flood mitigation plans, the following three components are proposed:

Planning Component	Principal Contents
1. Non-structural Flood Mitigation Project	1.1 Establishment of flood forecasting and warning system
	1.2 Establishment of flood risk map
2. Related Environmental Improvement Project	2.1 Control of encroachment of communities into right-of-way of the river*
	2.2 Control of solid wastes dumped into the river*
	2.3 Improvement of drainage and sewerage
3. Strengthening of Institutional Setup	3.1 Establishment of Management Committee for integrated river administration
	3.2 Establishment of Task Force for implementation of flood mitigation project
	3.3 Demarcation of roles and authorities of the relevant land administrators
	3.4 Strengthening of legal setup
	3.5 Capacity building

* : Both of the items 2.1 and 2.2 are categorized as a part of the environmental improvement project but at the same time as a part of the non-structural flood mitigation project.

The non-structural flood mitigation plan aims at mitigating the damage caused particularly by the floods over the design capacity of the structural flood mitigation measures. Moreover, the environmental improvement plan would effect to sustain the design flood mitigation capacity of the structural flood mitigation measures, and at the same time, create the appropriate river environment. The plan for strengthening of the institutional setup would be also an important issue to facilitate the consistent administration and management of Lai Nullah.

4. Project Cost

The initial investment cost and the annual operation and maintenance (O & M) cost for all components of the proposed structural flood mitigation plan and the flood forecasting and warning system proposed as a component of the non-structural plan are as summarized below

Item	Phased Program	Initial Investment Cost (Rs. million)	O & M cost (Rs. million/ year)
Structural Plan	Urgent Project	1,267	3.3
	Urgent + Short-term Project	4,124	4.8
	Urgent + Short-term + Long-term Project	7,615	5.4
Non-structural Plan	Urgent Project	302	3.0

5. Project Evaluation

5.1 Economic Evaluation

The project economic benefit accrues from the flood damage reduced by the structural flood mitigation plan. The non-structural flood mitigation plan, the environmental improvement plan and the plan for strengthening of the institutional setup would also contribute to mitigation of the flood damage as well as improvement of the river environmental, but their economic benefits are intangible in nature. Due to these backgrounds, the economic evaluation was made solely for the phased structural flood mitigation plans. As the results of estimation, the economic internal rate of return (EIRR) and benefit-cost ratios (B/C) for the phased structural

mitigation plans are as summarized in the following Table. It is also estimated that upon completion of the whole structural flood mitigation plan, about 183 thousand people would be free from the risk of overflow of Lai Nullah caused by the probable flood of 100-year return period.

Progress of the Project	EIRR	B/C Ratio*
1 Urgent Project	22.4 %	2.3
2 Urgent + Short-term Project	12.8 %	1.3
3 Whole (i.e., Urgent + Short-term + Long-term Project)	10.4 %	1.0

*: Assuming a discount ratio of 10%

As estimated above, it is evaluated that the proposed structural flood mitigation plan could be economically viable indicating the EIRR over the capital opportunity cost of 10%. However, the EIRR of the long-term project is marginally beyond the opportunity cost of 10%, and may fall below the opportunity cost, when completion of the long-term project is overdue. The progress of the proposed plan would, therefore, need to be closely monitored.

5.2 Financial Evaluation

Out of the several items in the national expenditure, the Public Sector Development Programme (PSDP), which is expected as the eligible financial source for the initial investment cost of the proposed flood mitigation plan. The budgetary source for the annual O & M cost for the plan would be also covered by the budget for the Normal Annual Development Program (NADP) in the National Flood Protection Plan (NFPP), which is allocated as a part of the budget of the water sector in PSDP. According to the projections of the budgets for the PSDP and NADP, the investment cost of the proposed plan would have the annual maximum increment of merely 0.53% of the budget for PSDP. The annual O & M cost would also results in 3% increase on the annual base budget of NADP. Judging from these minimal increment rates of the national expenditure, the initial investment cost as well as the annual O & M cost is judged to fall within the budgetary capacity of the government.

5.3 Evaluation on Social and Environmental Adverse Impacts by the Proposed Plan

According to the initial environmental evaluation (IEE) carried out in the Study, the community pond as the principal component of the proposed plan may pose deterioration of the water quality of its impounding water as the potential adverse impact. This adverse impact on water quality would need to be further examined through the succeeding environmental impact assessment (EIA). It is, however, preliminarily evaluated that the impact would be minimized by construction of: (1) the oxidation pond, (2) the check dam to stop the inflow of garbage, (3) diversion channel to bring the clean discharge from the adjacent river, and (4) alternative sewerage channel not to allow the polluted low flow into the pond.

The initial environmental evaluation (IEE) also identified that the proposed flood diversion channel would require resettlement along Kurang River as the principal adverse impact. The resettlement is the important issue for implementation of the diversion channel, because the objective houses for resettlement are located within the present habitual flood inundation area and the great impediments to flow of flood discharge. The number of houses to be resettled is about 220, which is far smaller than 2,000 houses evacuated by RDA for the on-going channel improvement of Lai Nullah. Nevertheless, the illegal dwellers along Lai Nullah had not been adequately compensated by RDA, which caused difficulties in achieving the smooth house evacuation. Taking this precedents of resettlement for Lai Nullah into account, the resettlement associated with construction of the diversion channel should be carefully made through adopting eligible measures such as the formulation and execution of the stepwise resettlement plan and the support by micro financing.

6. Recommendations

The principal recommendations in this Study are as summarized hereinafter:

1) Implementation of the Proposed Structural Flood Mitigation Project

The low-lying area along Lai Nullah suffers the chronic flood inundation, and further encountered the unforeseen disastrous flood damage including death of human life in 2001 Flood. In order to mitigate the chronic flood inundation, it is strongly recommended to take the early implementation of the proposed urgent project and produce the immediate flood mitigation effect. Moreover, it is inevitable to implement the drastic flood mitigation plan, which could cope with even the recorded maximum scale of 2001 Flood, so as to get rid of the social malaise on the disastrous flood damage. Nevertheless, the plan would take a long implementation period of about 10 years due to its huge work volume. Accordingly, the plan would be progressively implemented through the phased short-term and long-term project. In order to complete these phased programs within due time, the close monitoring on implementation would be indispensable.

2) Feasibility Study on Flood Diversion Plan

The flood diversion channel is proposed as the principal structural measure for the long-term project. A feasibility study would be, however, required to clarify the further details of the proposed diversion structures with a particular attention to a comment given from CDA on the allowable width of the diversion channel (refer to item 2 in the Minutes of Steering committee Meeting on the Draft Final Report as attached to Volume 2, the Main Report). The objectives of the feasibility study should further include clarification on

the detailed river improvement works required to Kurang River, which is proposed as the outlet of the diversion.

3) Involvement of the Federal Government into Implementation and Management of the Project

The principal beneficiary of the proposed flood mitigation plan is biased to the lower reaches of Lai Nullah in Rawalpindi City, while the major flood mitigation structures such as the community pond and the diversion structure are placed in the upper reaches in Islamabad City. This contradiction may lead to conflicts between the regional administrators for the two cities in implementation and management of the proposed flood mitigation. In order to minimize the conflicts, the federal government as represented by the Ministry of Water and Power and/or the Federal Flood Commission would be required to coordinate the overall project implementation and management, and/or further directly undertake a part of them.

4) Implementation of Environmental Improvement Works of Lai Nullah

The environmental improvement particularly in the aspect of control of the garbage dumped into the river and the encroachment in the right-of-way of the river would be the important issues to sustain the flood mitigation capacity and the appropriate river environment of Lai Nullah. From these viewpoints, it is necessary to urge the relevant on-going environmental improvement projects such as enlargement of the capacity of the existing sewerage treatment capacity for Islamabad and the UWSSP-I and II for Rawalpindi City. At the same time, legislation of the new act and enforcement for control of garbage dumping and encroachment in the waterway of the river would be required.

5) Strengthening of Hydrological Data

The existing hydrological gauging data including the rainfall and water level data in Lai Nullah Basin is quite inadequate and less orderly prepared, which is a great hindrance for formulation of the flood mitigation plan as well as other various water resources development plan. In order to retrieve such unfavorable conditions, it is recommended to increase the hydrological gauging stations and orderly arrange the gauged data. It would be further preferable to unify all hydrological data into a database administrated by a single authority.

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ABBREVIATION

Organization

ADB	:	Asian Development Bank
AMC	:	Rawalpindi Agromet Center
CDA	:	Capital Development Authority
ECNEC	:	Executive Center of National Economic Council
FFC	:	Federal Flood Commission
FFD	:	Flood Forecasting Division
JBIC	:	Japan Bank for International Cooperation
JOCV	:	Japan Overseas Cooperation Volunteer
MES	:	Military Engineering Services
MMP	:	Mott MacDonald Pakistan
MWP	:	Ministry of Water and Power
NFFD	:	National Flood Forecasting Division
OECF	:	Overseas Economic Cooperation Fund
PCIW	:	Pakistan Commissioner for Indus Waters
PID	:	Punjab Irrigation and Power Development
PMD	:	Pakistan Metrological Department
RCB	:	Rawalpindi Cantonment Board
RDA	:	Rawalpindi Development Authority
RMC	:	Rawalpindi Municipal Corporation
SDO	:	Small Dams Organization, Irrigation and Power Development, Punjub
TMA	:	Tehsil Municipal Administration Rawalpindi
WAPDA	:	Water and Power Development Authority
WASA	:	Rawalpindi Water and Sanitation Authority

Unit

℃	:	Degree Centigrade
cfs, cusec	:	Cubic feet per second (1 cusec = 0.0283 m^3/s, or 1 m^3/s = 35.3 cusec)
dia.	:	Diameter
g	:	Gram
Ghz	:	Gigahertz
ha	:	Hectare
Kg, kg	:	Kilogram
Km, km	:	Kilometer
L. l. lit.	:	Liter
m	:	Meter
m^3	:	Cubic meter
m^3/s	:	Cubic meter per second
mil.	:	Million
Mhz	:	Megahertz
MLD	:	Million Liter per Day
MGD	:	Million Gallon per Day (1 MGD = 4.546 MLD)
Rs.	:	Pakistan Rupee
sec	:	second
t, ton	:	Tonnage
US$	:	American Dollar
W	:	Watt

Others

CEA	:	Chief Engineering Advisor
CFFC	:	Chairman, Federal Flood Commission
CN	:	Curve Number
ERC	:	Emergency Cell
EIRR	:	Economic Internal Rate of Return
FFWS	:	Flood Forecasting and Warning System
IEA	:	Initial Environmental Analysis
LAA	:	Land Acquisition Act
PST	:	Pakistan Standard Time
SCS	:	Soil Conservation of Services
SME	:	Small and Medium Enterprise
SWM	:	Solid West Management
Sweep	:	Solid Waste Management & Environmental Enhancement Project
UNDP	:	United Nation’s Development Programme
UWSSP-R	:	Urban Water Supply and Sanitation Project for Rawalpindi City
WTP	:	Wastewater Treatment Plant

CHAPTER 1. INTRODUCTION

1.1 Background of the Study

The Lai Nullah originates from Margalla hills, the northern ridge of Islamabad and finally flows into Soan River. The river has a catchment area of 234.8 km^2, which is administratively divided into Islamabad in the upper reaches of 144.3 km^2 and Rawalpindi in the lower reaches of 90.5km^2. During a monsoon season, the floods frequently overtop Lai Nullah and inflict severe flood damages on the lower reaches of Rawalpindi in particular. The flood in July 2001 caused the worst damage including death of 74 people and destruction of about 3,000 houses. To cope with the flood problems, the Study on Comprehensive Flood Mitigation and Environmental Improvement Plan of the Lai Nullah Basin (hereinafter referred to as "the Study") has been commenced through technical cooperation by the Japan International Cooperation Agency (JICA) in May 2002 on a schedule to complete the Study by September 2003.

1.2 Objective of the Study

As stipulated in the Scope of Works, the objectives of the Study are:

(1) To formulate a master plan for comprehensive flood mitigation and environmental improvement in the Study Area; and,

(2) To transfer skills and technology of comprehensive flood mitigation and environmental improvement to counterpart personnel.

1.3 Study Area

The Study Area covers the whole of the Lai Nullah basin. A supplementary clarification is further made to the adjacent Kurang river basin, which is proposed as the outlet of the flood diversion channel.

1.4 Overall Study Schedule

The Study is carried out through the phased field surveys in Pakistan and home office works in Japan within the entire study period of from May 2002 up to September 2003, as below:

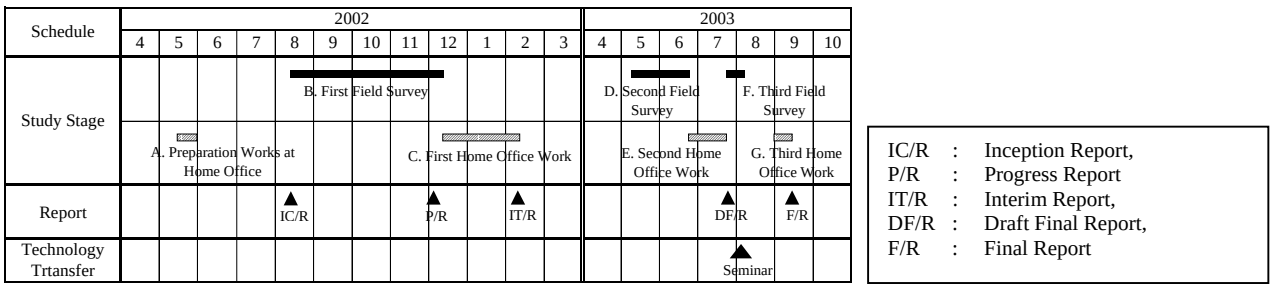

Fig. R 1 Study Schedule

CHAPTER 2. THE STUDY AREA

2.1 Socio-economic Conditions of the Study Area

The urban development including the flood mitigation for both of Islamabad and Rawalpindi cities is now undertaken by three (3) entities, namely: the Capital Development Authority (CDA), the Rawalpindi Development Authority (RDA), and the Rawalpindi Cantonment Board (RCB). Among others, the CDA is solely in charge of urban development of Islamabad City. On the other hand, the development of Rawalpindi City is separately undertaken by RDA and RCB, that is: the northern part of the City is by RDA, while the southern part by RCB.

Islamabad City has been developed since 1963 as the comparatively new national capital. The City forms an urbanized modern city, which is spacious and carefully planned with tree-lined streets, large houses, elegant public buildings and well-organized bazaars. In contrast with Islamabad City, the area of RDA in Rawalpindi City is the old city established in the ancient times and now characterized as the vital commercial activities, which has created the significantly congested urban structures and traffics in the area of RDA in particular. The area of RCB is also a part of Rawalpindi City, and characterized as the military base area (called Cantonment Area), where the general headquarters of the Pakistan Army and its relevant offices but also many Government offices, residential and commercial area are located.

The land use in the Study Area was clarified as listed below based on the Landsat image taken in 2001, the Urban Master Plan 2030 by the relevant government agencies and the population projected in the Study. As listed below, the built-up areas in the Study Area will increase in the future, while agricultural area and green/bare land decrease. The forest area will also slightly decrease to provide more residential areas, as the population increases.

Table R 1 Land Use in the Study Area

Land Use		Present (2001)		2012		2030	
		(km^2)	(%)	(km^2)	(%)	(km^2)	(%)
Built-up Area	Densely Populated	31.2	13.3	35.2	15	38.8	16.5
	Moderately Populated	53.3	22.7	68.6	29.2	95.2	40.5
	Suburbs	6.1	2.6	5.6	2.4	2.3	1
	Sub-total	90.6	38.6	109.4	46.6	136.3	58.0
Non Built-up Area	Agricultural Area	33.4	14.2	29.1	12.4	11.4	4.9
	Forest	34.9	14.8	32.3	13.8	32	13.6
	Green and Bare Land	74.3	31.6	62.4	26.6	53.5	22.8
	Water Body	1.6	0.7	1.6	0.7	1.6	0.7
	Sub-total	144.2	61.3	125.4	53.5	98.5	42.0
Basin Total		234.8	100	234.8	100	234.8	100

The total population of the Study Area is estimated at about 1.56 million as of 1998, which is divided into 28% in Islamabad, 46% in Rawalpindi City (excluding Cantonment Area), and 26% in Cantonment area as listed in Table R 2. The corresponding population density is about 6.7 thousand/km^2 as the average of the basin. It is remarked that Islamabad City now has the

comparatively low density of 2.7 thousand/km^2, while that of Rawalpindi has the extremely high density of 27.4 thousand/km^2, which is more than 10 times of that in Islamabad.

The future population in the Study Area is further estimated to increase from 1.56 million in 1998 to 3.50 million in 2030. The intensive increment of the population is expected in Islamabad City and Cantonment Area in particular.

Table R 2 Population in the Study Area

Jurisdiction Area	Year	Islamabad City	Rawalpindi City	Cantonment Area	Total
Population (persons)	1998	432,678	724,311	407,622	1,564,611
	2012	715,151	1,111,802	676,354	2,503,307
	2030	1,020,697	1,496,339	979,562	3,496,598
Population Density (persons/km^2)	1998	2,682	27,436	8,636	6,661
	2012	4,434	42,114	14,330	10,657
	2030	6,328	56,680	20,753	14,885
Household Density (houses/km^2)	1998	447	4,061	1,330	1,031
	2012	739	6,230	2,208	1,650
	2030	1,055	8,385	3,198	2,304

2.2 Geographical Conditions of Lai Nullah

The Study Area could be geographically divided to the following four areas: (1) the Margalla range, (2) the foot of the range, (3) the alluvium plain and (4) the valley area in the north to south direction. The Margalla range stands behind Islamabad City area as a wall, which forms the north boundary of the Lai Nullah Basin. Below Margalla range, the foot of the range expands over the built-up area of Islamabad City with a gradual slope from North to South. Lower Plain.

Below Islamabad, the alluvium is further developed over the upper part of the Rawalpindi area above Chaklala Bridge (RD6+251)[1]. A substantial part of this alluvium area is on the low-lying ground (refer to Fig. 1). The lowest-ground level is particularly seen along Lai Nullah between Kattarian Bridge (RD17+210) and Chaklala Bridge, where the flood inundation has often occurred due to overflow of Lai Nullah. According to the interview survey from the residents, the July 2001 flood caused the significant of flood inundation of 9.23 km^2 in extent, which covers most of the riverside along Lai Nullah (refer to Fig. 2). In contrast with the area above Chaklala Bridge, the area below the Bridge changes its topography forming a definite steep valley with several cascades.

The river system of Lai Nullah in Islamabad City is composed of three (3) major tributaries (i) “Saidpur Kas”, (ii) “Tenawali Kas” and (iii) “Bedarawali Kas” (refer to Fig. 3). These tributaries originate from Margalla hills and flow into the mainstream of Lai Nullah just

[1] The figure with RD at the head hereinafter means the distance from New G.T. Road Bridge located 320m upstream from the confluence of Soan River. That is, RD17+210 is the point 17,210m upstream from G..T. Road Bridge.

upstream from Kattarian Bridge, which forms the administrative boundary between Islamabad and Rawalpindi. Below Kattarian Bridge, the mainstream meets other nine (9) major tributaries one after another, then flows down through Rawalpindi City and finally pours into Soan River.

The serious flood damage has often occurred along the middle-stretch 11km between Chaklala Bridge and Kattarian Bridge in Rawalpindi. The stretch has a gentle channel slope of 1/1,250 as shown in Fig. 4, and its available flow space has been narrowed by encroachment of houses and buildings. Due to these unfavorable channel conditions, the stretch has a small channel flow capacity of less than 300m^3/s (10,594 cfs), which could meet the probable flood runoff discharge of only 3-year return period (refer to Fig. 5). In order to increase the channel flow capacity, the channel improvement for the stretch was commenced by RDA immediately after flood in 2001 and it is now in progress.

There was a heavily meandering section about 1.0 to 2.2 km below from Chaklala Bridge. The meandering section had a limited channel width causing a rather frequent flood overflow. In order to offset the flood overflow, realignment (short-cut) together with widening of the river channel has been made by RDA as an extension of the above on-going channel improvement of Lai Nullah (refer to Fig. 6). However, the section of about 1.0km in length sandwiched between the realignment/widening of the meandering section and the on-going channel improvement above Chaklala Bridge is left behind without any improvement work. The section contains the several bottlenecks, and the floodwater level tends to abruptly rise just upstream of the section due to the water head swelled at the bottlenecks of the section (refer to Fig. 7). The floodwater level thus abruptly raised causes the adverse backwater effect to the upper on-going channel improvement sections. Should the existing meandering section be remained as it is without any improvement, the actual channel flow capacity within the extent of the backwater effect would be decreased to be below the design flow capacity of the on-going channel improvement project.

In order to remove such adverse backwater effects, it is indispensable to urgently improve the section left behind without improvement. Should the adverse backwater effect be removed and the on-going channel improvement above Chaklala Bridge be completed, the channel flow capacity of Lai Nullah would increase from the existing 300 m^3/s to 640m^3/s (10,594 cfs to 22,601 cfs) at Kattarian Bridge, which is evaluated to meet the probable flood runoff discharge of about 10-year return period.

CHAPTER 3. PLANNING FLAME FOR FLOOD MITIGATION

3.1 Target Scale of Design Flood

The recurrence probability of the recorded maximum flood in 2001 is evaluated to be a little under 100-year return period. Moreover, the Steering Committee for the Study provisionally preferred the recurrence probability of 100-year as the optimum design scale for the objective flood mitigation plan taking social and economic importance of Lai Nullah basin into consideration. Due to these backgrounds, the scale of the probable flood of 100-year return period is proposed as the ultimate goal of the objective flood mitigation plan.

3.2 Phased Program and Target Completion Year

The objective flood mitigation plan is divided into the following three (3) phased programs in order to effect the immediate flood mitigation and at the same time to achieve the ultimate goal of the above target design flood within a limited budget.

Table R 3 Phased Flood Mitigation Program

Phased Program	Target Structural Design Level	Target Completion Year
Urgent Project	Indefinite*	2005
Short-term Project	25-year return period	2007
Lon-term Project	100-year return period	2012

Note: *: Regardless to the design level, the urgent project is implemented as the priority component of the short-term project in order to produce the immediate flood mitigation effect.

The ultimate target design level of 100-year return period for the flood mitigation of Lai Nullah would be achieved through the long-term project. The target completion year for the long-term project is proposed at 2012 considering the implementation period of the relevant national development plans such as National Flood Protection Plan III (1998 to 2012), and Ten Year Perspective Plan (2001-2011). Lai Nullah basin, Islamabad in particular may expand the urban area even after the completion year of 2012. The progress of urbanization would curtail the non-built-up area such as vacant land and natural forest, which are not sealed by pavement and contain many low pits contributing to the natural flood retarding effect. As the results, Lai Nullah may gradually increase its basin peak flood runoff discharge.

CDA has projected to complete the urban development plan of Islamabad by the year of 2030. According to the urban development plan of Islamabad, however, the upper reaches of Lai Nullah basin above Kattarian Bridge (i.e., the jurisdiction area of Islamabad) would have the relatively low progress of urbanization from present up to 2030, and any significant difference is not seen in the probable peak runoff discharges in 2001, 2012 and 2030 as shown in Table R 4. Accordingly, it is expected that the flood safety level achieved by the long-term

project would be ever sustained even after completion of the long-term project, and any flood mitigation program posterior to the long-term project would not be required.

Table R 4 Probable Flood Runoff Discharge and Urbanized Ration of Lai Nullah Basin

Description		Year 2001	Year 2012	Year 2030
1. Probable Flood Discharge of Lai Nullah at Kattarian Bridge	5-year return period	310 m^3/s (10,948 cfs)	330 m^3/s (11,654 cfs)	350 m^3/s (12,360 cfs)
	25-year return period	1,110 m^3/s (39.199 cfs)	1,150 m^3/s (40,612 cfs)	1,180 m^3/s (41,671 cfs)
	100-year-return period	2,200 m^3/s (77,692 cfs)	2,270 m^3/s (80,164 cfs)	2,290 m^3/s (80,871 cfs)
2. Urbanized Ratio* of Lai Nullah Basin above Kattarian Bridge		32.4%	42.7%	49.6%

Note*: Urbanized Ration means the share of built up area (=residential area + commercial area + industrial Area) to the total extent

CHAPTER 4. POTENTIAL STRUCTURAL MEASURES FOR FLOOD MITIGATION

The followings are scrutinized as the possible structural measures for flood mitigation of Lai Nullah considering the physical and socio-economic conditions of Lai Nullah Basin: (1) River Channel Improvement, (2) Flood Mitigation Dam, (3) Community Pond used as the flood detention facility and (4) Flood Diversion (refer to Fig. 8).

4.1 River Channel Improvement

The channel improvement is proposed to increase the channel flow capacity of Lai Nullah below Kattarian Bridge. The objective improvement stretch is from about 1 km downstream of Chaklala Bridge up to Kattarian Bridge. The principal measure for channel improvement from Chaklala Bridge to Kattarian Bridge is oriented to channel deepening without widening of channel due to difficulties in acquiring land for the further channel improvement. On the other hand, the improvement for the section below Chaklala Bridge is to be made by widening of the channel due to the vacant land along the river as the available right-of-way for improvement and less improvement cost required.

The extent of the deepening of the river bed above Chaklala Bridge is assumed at 2 m below the designed channel bed level of the on-going channel improvement in order to restrain the maximum channel velocity below 4 m/s and to avoid excavation of hard rocks, which extensively outcrops below Chaklala Bridge. The salient features of the above channel improvement are as in Table R 5 (refer to Figs 9 to 11):

Table R 5 Salient Features of Proposed Channel Improvement

Item	Description
Design discharge	– 900 m^3/s (31,783 cfs) at Kattarian Bridge (RD 17+210) – 1,400 m^3/s (49,441 cfs) at Chaklala Bridge (RD 6+215) – 1,500 m^3/s (52,972 cfs) at downstream end of the proposed improvement section, i.e., about 1 km downstream from Chaklala Bridge (RD 5+277)
Improvement section	Section of about 12 km in length from Murree Brewery Area to Kattarian Bridge (RD 5+277 – RD 17+210)
Shape of cross-section	Single cross-section with the side slope of 1 to 1.5
Side protection	Bolder Concrete
Depth of cross-section	9.5 m from the bed to the top of the bank including free board of 1 m (The depth is made through deepening of the design river bed of the on-going channel improvement by 2 m)
Channel Bed Slope	1/1,250
Width of cross-section	(1) Top width of 50.0 m and bottom width of 18.5 m at Kattarian Bridge (2) Top width of 69.9 m and bottom width of 38.4 m at Chaklala Bridge (3) Top width of 72.9 m and bottom width of 44.4 m at downstream end of the proposed improvement section, i.e., about 1 km downstream from Chaklala Bridge
Reinforcement and Reconstruction of bridge	Reinforcement: 3 bridges Reconstruction: 9 bridges

Even when the channel improvement by deepening of the riverbed above Chaklala Bridge is not implemented, the improvement of the section (RD 5+277-RD 17+210) of about 1.0 km below Chaklala Bridge is indispensably required in order to offset the backwater effect to the on-going improvement section above Chaklala Bridge. The salient features for this alternative river improvement are as listed below (refer to Fig. 9 and 12):

Table R 6 Salient Features of Alternative River Channel Improvement Required to the Section below Chaklala Bridge
(In case of non-deepening of river channel above Chaklala Bridge)

Item	Description
Design discharge	– 640 m^3/s (22,601 cfs) at Kattarian Bridge – 1,000 m^3/s (35,315 cfs) at Chaklala Bridge – 1,010 m^3/s (35,668 cfs) at downstream end of the proposed improvement section, i.e., about 1 km downstream from Chaklala Bridge (RD 5+277)
Improvement section	Section of 1,150 m to Chaklala Bridge (RD5+277-RD6+251)
Shape of cross-section	Single cross-section with the side slope of 1 to 1.5
Side protection	Bolder Concrete
Depth of cross-section	9.5m
Channel Bed Slope	1/1250 (ground sills are provided to the section of 250m (from RD6+000 to RD6+251)
Width of cross-section	Top width of 48.5m and bottom width of 20.0m

4.2 Community Pond

The community pond is proposed within a compound of the Fatima Jinnah Park of about 3 km^2 located in the central part of Islamabad (refer to Figs. 13 and 14). This aims at detaining the flood runoff discharge and reducing/delaying the peak discharge of the mainstream of Lain Nullah below Kattarian Bridge. At the same time, this could be used as the amenity during a non-flooding time (refer to Fig. 15). The objective river for flood control by this facility is Tenawali Kas, which currently flows through the Fatima Jinnah Park and finally joins the mainstream of Lai Nullah at Kattarian Bridge. Diversion of the flood discharge from the adjacent tributary of Bedarawali Kas to the community pond is also proposed through a new diversion channel (refer to Fig. 16). The salient features of the proposed community pond are as enumerated below:

Table R 7 Salient Features of Proposed Community Pond

Item	Description
Objective river	Tenawali Kas and Bedarawali Kas
Catchment Area	26.5 km^2 (16.6 km^2 for Tenawali Kas and 9.9 km^2 for Bedarawali Kas)
Dam Type	Combined Dam
Dam Height	20 m
Dam Crest Length	1,550 m
Max. Extent of Pond	0.70 km^2 (once for 100 years)
Effective Storage Capacity	2,900,000 m^3
Length of Diversion Channel	1,340 m (to divert the flood discharge of Bedarawali Kas)
Amenity Facility	(1) Multipurpose ground 2 lots
	(2) Tennis courts: 6 lots
	(3) Basket courts: 4 lots
	(4) Others including waterfront, entrance plaza, garden, etc.

The water quality of Tenawali Kas, which runs through the site of the community pond, is seriously deteriorated giving an offensive odor because of the polluted wastewater generated in the urbanized area. In order to maintain the better water quality of the community pond, the following measures were adopted:

(1) To construct the oxidation ponds to improve the water quality of inflow to the community pond;

(2) To construct the check dams to stop the garbage flowing into the pond;

(3) To construct the diversion channel to bring the clean discharge from the adjacent river (i.e., Bedarawali Kas) into the pond; and

(4) To alternate the existing route of low flow of Tenawali Kas, which now gives an offensive odor, and not connect it to the pond.

4.3 Flood Mitigation Dam

The site for flood mitigation dam is proposed at the eastern area of Islamabad (administratively called Block E-11 of Islamabad) (refer to Fig 17). The dam aims at impounding the flood runoff discharge from Johd Kas, the tributary of Bedarawali Kas and reducing/delaying the peak flow discharge of the mainstream of Lai Nullah below Kattarian Bridge. At the same time, the water impounded by the dam reservoir is used as the source for the municipal water supply to Islamabad and Rawalpindi, and/or for recharge to the groundwater. The salient features of the dam structures and reservoir catchment area are as enumerated below:

Table R 8 Salient Features of Proposed Flood Mitigation Dam

Item	Description
Objective river	Johd Kas (tributary of Bedarawali Kas)
Catchment Area	19.7 km^2
Dam Type	Fill Dam
Dam Height	20 m
Dam Crest Length	840 m
Max. Extent of Pond	0.80 km^2
Effective Storage Capacity	2,640,000m^3

4.4 Diversion Channel

The flood diversion channel is proposed to intercept the flood runoff discharges from Bedarawali Kas, Tenawali Kas and Saidpur Kas and, to divert them into the adjoining Kurang River. The optimum route for the diversion channel was examined through comparative study of alternative three (3) routs taking the necessary number of house evacuation and the required work volume into consideration (refer to Fig. 18). The optimum route is finally selected to be along the green belt of the existing Khayaban-E-Johar Road. The catchment area and length of the diversion channel along the optimum route is 129 km^2 and 9.7 km respectively.

It is proposed that the diversion channel would increase its flow capacity through the short-term project and the long-term project. The diversion channel will divert the flood runoff discharges of 25-year return period from Tenawali Kas and Saidpur Kas to Kurang river upon completion of the short-term project, and those of 100-year return period from Bedarawali Kas, Tenawali Kas and Saidpur Kas upon completion of the long-term project (refer to Figs. 19 to 21). The design discharges for diversion are as listed below:

Table R 9 Design Discharge of Proposed Diversion Channels

Section	Design Discharge (m^3/s)	
	Short-term Project (25-year return period)	Long-term Project (100-year return period)
Bedarawali Kas – Tenawali Kas	-	600
Tenawali Kas – Saidpur Kas	70-140	980-1,120
Saidpur Kas – Ojhri Kas	320	1,480
Ojhri Kas – Kurang River	470	1,790

A substantial part of the riverside of Kurang River remains as the natural unused land. However, there exist three (3) settlement areas along the right bank of the river from the proposed outlet point of the diversion channel to about 4.4km downstream point. These settlement areas are encroaching into the river section, which is the great hindrance for flood flow of the river. In order to cope with this issue, the following measures are proposed as the necessary treatment works for Kurang River associated with the proposed flood diversion (refer to Fig. 22):

(1) House evacuation should be made within a limit of 1000 feet from the center of river channel, which has been declared as the “river reserve area” by Capital Development Authority (CDA).

(2) Ring dikes should be constructed to prevent the settlement areas from flooding by overflow of Kurang River.

CHAPTER 5. OPTIMUM STRUCTURAL FLOOD MITIGATION PLAN

5.1 Potential Flood Mitigation Capacity of Structural Measures

The river channel improvement as proposed above could increase the channel flow capacity of Lai Nullah by 260m^3/s (9,182 cfs) from 640m^3/s (22,601 cfs) to 900m^3/s (31,783 cfs) at Kattarian Bridge. The potential flow capacity of the flood diversion channel is also estimated at about 1,700 m^3/s (60,034 cfs), which could cover the whole of the aforesaid flood discharge to be mitigated for the long-term project.

The proposed community pond and the flood mitigation dam could also reduce the peak flood runoff discharges at Kattarian Bridge in a rage of 150 to 320 m^3/s (5,297 to 11,301 cfs) for 25-year return period and 240 to 520 m^3/s (8,476 to 18,364 cfs) for 100-year return period. The potential flood mitigation capacity of structures as estimated above are summarized as below:

Table R 10 Summary on Potential Flood Mitigation Capacity of Proposed Structural Measures

Return Period	Potential Flood Mitigation Capacity (unit: m^3/s)				
	Reduction of Peak Discharge at Kattarian Bridge			Increment of Flow Capacity at Kattarian Bridge	
	Community Pond	Flood Mitigation Dam	Community Pond + Dam	River Improvement	Flood Diversion
25-year	190	150	320	260	1,700
100-yer	240	300	520		

5.2 Required Flood Mitigation Discharge by Structural Measures

Upon completion of the on-going channel improvement from Chaklala Bridge to Kattarian Bridge together with the proposed widening about 1km below Chaklala Bridge, the channel flow capacity of Lai Nullah would increase to 640m^3/s (22,601 cfs) at Kattarian Bridge, which corresponds to the probable flood runoff discharge of about 10-year return period. On the other hand, the target design scales of the short-term project and the long-term project are set at 25-year return period and 100-year return period. The probable flood runoff discharges equivalent to the target design scales for short-term and long-term projects are estimated at 1,150 m^3/s (40,612 cfs) and 2,270 m^3/s (80,164 cfs) at Kattarian Bridge, respectively.

The required flood mitigation discharge by the proposed structural measures is defined as the difference between the above channel flow capacity and the probable flood runoff discharge equivalent to the target design scales, and therefore estimated at 510m^3/s (18,010 cfs) for the short-term project and 1,630m^3/s (57,563 cfs) for the long-term project. These discharges could be mitigated by:

(1) Reduction of the peak flood runoff discharge by construction of the proposed community pond and/or the flood mitigation dam; and/or

(2) Increment of channel flow capacity by the proposed river channel improvement and/or construction of the proposed flood diversion.

5.3 Alternative Flood Mitigation Schemes

As compared between the potential flood mitigation capacity by each of the proposed measures and the required flood mitigation discharge, the flood mitigation capacities of the proposed structural measures other than flood diversion channel could not individually cover the whole of the required flood mitigation discharge of 100-year return period (i.e., the ultimate goal of long-term project). Accordingly, the combination of various structural measures is required to meet the required flood mitigation discharge. Taking all possible combinations of the measures into consideration, the alternative flood mitigation schemes are delineated as listed below:

Table R 11 Alternative Flood Mitigation Schemes

Alt. No.	Measures to be included into the Alternatives			
	Measure to reduce the peak flood discharge		Measures to increase the flood flow capacity	
	Community Pond	Flood Mitigation Dam	River Improvement	Flood Diversion
Alt. 1	○	○	○	○
Alt. 2	○		○	○
Alt. 3		○	○	○
Alt. 4	○	○		○
Alt. 5			○	○
Alt. 6	○			○
Alt. 7		○		○
Alt. 8				○

Note:○ = Included as the component of the alternative

5.4 Optimum Structural Flood Mitigation Scheme

The optimum flood mitigation plan was determined through comparison of the alternative schemes based on the project cost, the compensation works, the immediate flood mitigation effect, and other relevant social/natural environmental impacts by the project into consideration. As the results, the following evaluation was made, and the Alternative 6, which is principally composed of the community pond in Fatima Jinnah Park and the flood diversion, was selected as the alternative scheme.

Table R 12 Evaluation of the Alternative Flood Mitigation Schemes

Alt. No.	Evaluation ○ : Preferable × : Not preferable △ : Fair				Remarks
	Project Cost	Compensation	Immediate Flood Mitigation Effect	Social/Natural Environmental Impacts	
Alt. 1	×	×	○	×	
Alt. 2	△	△	○	×	
Alt. 3	×	×	×	×	
Alt. 4	×	×	○	×	
Alt. 5	△	△	×	×	
Alt. 6	○	△	○	△	Optimum Scheme
Alt. 7	×	×	×	×	
Alt. 8	○	△	×	△	

As described in the under-mentioned Chapter 10, the optimum flood mitigation scheme would be implemented through the phased programs of the Urgent Project, the Short-term Project and the Long-term Project. Upon completion of the Short-term Project in 2007, the designed safety levels of the scheme would increase to 25-year return period and finally reach 100-year return period upon completion of the Long-term Project in 2012. The design discharges of the scheme for the Short-term and Lon-term Project are as shown in Figs. R 2 and R 3.

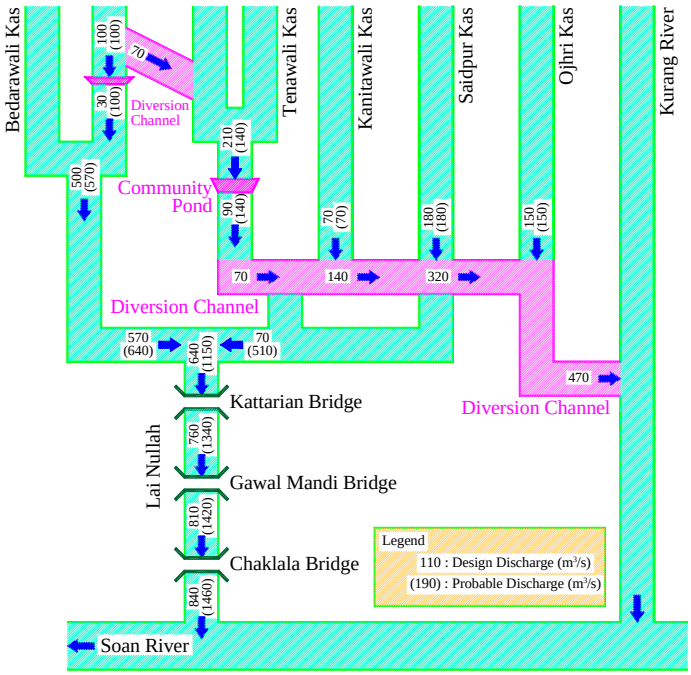

Fig. R 2 Design Discharge for Short-term Project (25-year Return Period)

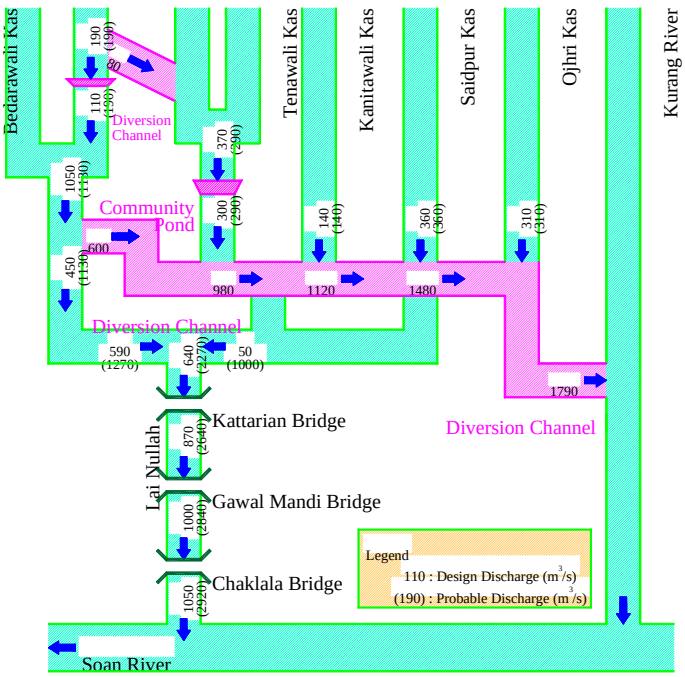

Fig. R 3 Design Discharge for Long-term Project (100-year Return Period)

5.5 Operation, Maintenance and Management Works for the Optimum Structural Flood Mitigation Scheme

The major works required to the operation, maintenance and management for the optimum structural flood mitigation scheme, which consists of the community pond, the river channel and the diversion channels, are as described hereinafter:

5.5.1 Community Pond

The principal works for operation, maintenance and management of the community pond would include the following items:

(1) Removal of deposits in the pond: This would be periodically required during a flood season from July to September in order to secure the designed storage capacity of the pond. In this connection, one (a) backhoe with bucket capacity of 0.45 m^3 and two (b) 10-ton capacity dump trucks were proposed as the required equipments to facilitate the objective control of the deposits.

(2) Safety control: The area of 0.16 km^2 with a ground level below EL. 545 m in and around the pond is subject to the probable flood inundation area of 10-year return period. In order to avoid the eventuality of visitors to be exposed to danger of flood, the area would need to be placed off limits during a flood season.

(3) Sanitary control: The water quality of the pond would be preserved by various facilities such as the oxidation ponds, the check dams and the bypass pipe not to allow the polluted water to flow into the community pond. Nevertheless, the periodical inspection on the water quality of the pond would be required and, in case of the unfavorable water quality detected through inspection, the pond would need to be dried up through the outlet of orifice.

The community pond is placed in the jurisdiction area of CDA, and the usual operation and maintenance would be undertaken by CDA. However, the emergency removal of sediments in and around the pond after a flood may need to be undertaken by the Task Force proposed an entity for implementation and management of the objective flood mitigation project of Lai Nullah (refer to sub-section 8.1),

5.5.2 River Channel and Flood Diversion Channel

The most critical issue on the maintenance for the river and diversion channel is addressed to removal of sediment, solid wastes and any other deposits in the channels particularly at the hydraulic critical points such as inlet of diversion points and piers of bridges. In order to cope with the issue, periodical removal of the deposits would be required throughout a year, and the emergency inspection/retrieval works be further required after a flood. The inspection and

retrieval works on the side slope of the river channel would be also enumerated as an important issue for maintenance of the river channel, and the side protection works particularly against erosion of the side slope would be required according to the results of inspection.

CHAPTER 6. PROPOSED NON-STRUCTURAL MEASURES FOR FLOOD MITIGATION

Strengthening of the existing flood forecasting and warning system and development of the flood risk maps are proposed as the eligible non-structural flood mitigation measures of Lai Nullah Basin. Control of encroachment of houses into the right-of-way of the river as well as control of garbage dumped into the river are the important issues for river environmental improvement. At the same time, however, they are also proposed as the non-structural flood mitigation measures to maintain the designed channel flow capacity.

6.1 Strengthening of Flood Forecasting and Warning System

In the event of July 2001 flood, Pakistan Metrological Department (PMD) observed an extra-ordinary scale of rainfall intensity in Lai Nullah through its weather surveillance radar and rainfall gauging. Judging from the results of the observation, PMD predicted a possibility of serious flood overflow along Lai Nullah a few hours before its actual occurrence. In spite of the advanced awareness of the flood, the flood caused the death of 74 people.

Should the existing flood gauging, communicating and warning system be strengthened, the more accurate and immediate flood information could be systematically collected, and the death calamity as experienced in 2001 flood would be relieved. From these viewpoints, the improvement of the existing flood forecasting and warning system is proposed as an eligible measure to immediately mitigate the flood damage, the calamity of death in particular. The contents of the proposed flood forecasting and warning system are summarized as below:

1) Proposed Organization Setup for Flood Forecasting and Warning System

For smooth operation of FFWS, the following improvement for existing organization is proposed:

Table R 13 Proposed Organization Setup for Flood Forecasting and Warning System

Agency	Basic Role
PMD	Principal execution body for (a) operation, maintenance and management of gauging of the storm rainfall and water level, (b) processing of the gauging data, and (c) prediction of flood conditions based on the gauged data
Rawalpindi Fire Brigade (TMA) and WASA of RDA	Execution body for issuance of flood warning and flood fighting/evacuation within the jurisdiction area of Rawalpindi
FFC	Coordination body for the above relevant agencies to facilitate the daily overall maintenance and management for the whole facilities/equipment of FFWS and the basin-wide flood fighting and/or evacuation works as required

2) Proposed Facilities for Flood Forecasting and Warning System

The proposed FFWS is composed of (a) the rainfall gauging stations at 6 sites, (b) the water level gauging stations at 5 sites, (c) the Master Control Station at PMD, (d) the Monitoring Stations at three (3) offices, namely, FFC, WASA of RDA, and the control office of the proposed community pond, (e) Executive Warning Control Room at Rawalpindi Fire Brigade Office and, (f) the Warning Posts at 10 sites. Location map of these stations are as shown in Fig. 23.

The telemetry line of remote transmission unit (RTU) with UHF band would be connected from each of the rainfall/water level gauging stations to the Master Control Station in order to automatically transmit the gauging data to a server installed at Master Control Station (refer to Fig. 24). The telemetry line would be also linked between the Executive Warning Control Room and warning posts in order to transmit the signal to blow warning sirens to the residents. The Wide Area Network (WAN) with using exclusive 5.2 GHz Wireless LAN would be further linked from the Master Control Station to the Monitor Stations and Executive Warning Control Room in order to monitor the flood information collected and processed by the Master Control Station.

6.2 Dissemination of Flood Risk Map

Dissemination of the flood risk map is broadly adapted in the world as one of the useful non-structural flood mitigation measures. Through dissemination of the flood risk map, the residents could be aware of the extent of the possible flood inundation area and the available evacuation routes during a flood. The flood risk map could also be the guidance for appropriate urban planning and land development.

The flood risk map, in general, contains the information on: (a) the probable extent and depth of flood inundation and (b) the evacuation centers and evacuation routes to be taken during a flood. The base maps for the extent and depth of the probable flood inundation was delineated in this Study (refer to Fig. 25). The available evacuation centers as well as evacuation routes for each unit of the local communities should be further selected by the relevant local government agencies based on the base maps, and the flood risk map should be finalized. The flood risk map thus prepared should be disseminated to the public through a bulletin, an information board and other available information tools.

6.3 Control of Encroachment in Right-of-Way of the River

There remain several communities in the existing right of way reserved for river administration of Lai Nullah. Those communities are in danger of flood overflow of the river, and at the same time the great hindrance for flood discharge to flow down the river. Thus, they cause difficulties

in administrating the river, while the communities in the area currently tend to expand inviting more people like their relatives and friends. Under this current situation, it is indispensable to regulate expansion of the community and finally to prohibit anybody to live in and build any house in the river reserve area. In order to achieve this issue, the following approaches should be taken by the relevant land administrators (i.e., CDA for Islamabad, and TMA/RCB for Rawalpindi):

(1) To investigate the socio-economic conditions of the communities in the river reserve area;

(2) To formulate and execute a step-wise resettlement plan for the communities through approach of the public consultation;

(3) To support the re-settlers by micro-financing, as required; and

(4) To demolish the site after completion of the resettlement.

6.4 Control of Garbage Dumping into River

Most of the residents, who live close to Lai Nullah and its tributaries, are apt to dump garbage into the river channel. The illegal dumping of garbage would reduce the channel flow capacity and at the same time deteriorates water quality of the river. In order to cope with these adverse effects to the river, the following stepwise programs would need to be taken up:

(1) To apprehend the volume of solid wastes dumped into the river as a whole based on the accurate and adequate sample data on weight and component of the solid waste;

(2) To legislate the Act for Solid Waste Management, which prescribes the roles of the residents, the enterprises and the government required to the solid waste management; and

(3) To formulate and execute the program for reduction and recycle of solid waste, which is subject to community participation.

CHAPTER 7. ENVIRONMENTAL ISSUES RELATED TO FLOOD MITIGATION OF LAI NULLAH

7.1 Development and Conservation of Water Resources

Islamabad and Rawalpindi is now suffering from the chronic water shortage. Difficulties in abstracting the groundwater also occur due to the serious drawdown of the groundwater level. Under these conditions, the issues on development and conservation of water resources related to the proposed flood mitigation plan are preliminarily clarified as described below:

1) Community Pond

The proposed community pond is designed to impound the non-polluted flow diverted from Bedarawali Kas during a dry season. The water impounded in the pond could be used as a source for recharge to groundwater. In order to maintain the present suitable water quality of the inflow, however, it is indispensable to reserve the catchment for the inflow (9.9 km^2) as the "Controlled Area" to prohibit any type of land development.

2) Flood Diversion Channel

The proposed flood diversion diverts the flood runoff discharge from Lai Nullah basin to the adjacent Kurang river basin. Should the whole of the basin runoff discharge be diverted to the external basin throughout a year, the present natural recharging capacity to the groundwater in the basin may be dropped. In order to avoid such adverse effect, the flood diversion structure should be designed to divert only the flood discharge over the channel flow capacity of the downstream channel and to remain the non-flood discharge within Lai Nullah basin.

7.2 Improvement of Drainage and Sewerage

The Lai Nullah is currently used as the principal outlet for drainage of storm-rain and sewerage of wastewater in Islamabad and Rawalpindi. Islamabad is located on the gradual slope from North to South, and due to the favorable geophysical condition, its storm rain could be rather well drained into Lai Nullah. On the other hand, the drainage conditions in Rawalpindi are deteriorated due to low-lying ground and the backwater effects of the high water level of Lai Nullah. Moreover, due to poor capacity of the existing sewerage treatment plants both in Islamabad and Rawalpindi, the water of Lai Nullah is seriously polluted giving off a stench during a period of low flow discharge.

In order to retrieve Lai Nullah from the current sewerage problems, improvement of the existing sewerage treatment plant for Islamabad has been launched out in 2002 through financial assistance from French Government. The sewerage and drainage master plan for the city center

of Rawalpindi has been also formulated in 2002 and, in accordance with the master plan, the improvement works are now being implemented through financial assistance from ADB Loan.

The sewerage master plan and the drainage master plan for Rawalpindi are, however, projected to complete in 2020, and 2014, respectively. Thus, it would still take a time to be free from drainage and sewerage problems. Moreover, the drainage and sewerage improvement work in Rawalpindi is limited to the jurisdiction area of WASA and the Cantonment Area in Rawalpindi (i.e., the jurisdiction area of RCB) is left behind from any drainage and sewerage improvement. Taking these conditions into account, the following items would be given as the principal issues on the drainage and sewerage.

1) Clarification of Phased Improvement Programs for On-going of Drainage and Sewerage Improvement

The phased drainage and sewerage improvement programs are likely to have been already formulated by the CDA and RDA. Details of them were, however, unable to be availed in this Study. It is necessary to integrate and clarify the details of all relevant programs and incorporate them into the overall river improvement work of Lai Nullah.

2) Implementation of Drainage and Sewerage Improvement for Jurisdiction Area of RCB

The master plan for improvement of sewerage system in the jurisdiction area of RCB has been formulated by Engineers 10 Corps, Rawalpindi, while the drainage system in the area is left behind without any definitive improvement plan. The master plan for the sewerage plan should be updated, as required, and the necessary budgetary arrangement as well as other relevant necessary works for implementation should be taken immediately. At the same time, the drainage master plan should be formulated in the earliest opportunity taking the on-going river improvement of Lai Nullah, the on-going drainage improvement works for the jurisdiction area of WASA and other relevant flood mitigation works into consideration.

CHAPTER 8. STRENGTHENING OF INSTITUTIONAL SETUP FOR RIVER ADMINISTRATION

The institutional set up related to river management in Pakistan has been improved since the nineteenth century. However, there still remain several issues on the current institutional setup, as seen in case of Lai Nullah. Among others, the major issues on the flood mitigation for Lai Nullah are herein addressed to the following two items: (a) lack of a unified river administration for the consistent and basin-wide flood mitigation works, and (b) inadequacy of legal arrangement to support the unified river administration.

8.1 Strengthening of Organization-setup

The Study emphasizes the necessity of establishment an integrated coordination body and task force for implementation of the overall flood mitigation project of Lai Nullah, whereby the following items are proposed:

(1) To establish the Management Committee chaired by Ministry of Water and Power (MWP) with the principal members of FFC, CDA, RDA, TMA, RCB and SDO to confirm and coordinate the roles required to the members for implementation of the proposed flood mitigation project of Lai Nullah.

(2) To establish a Task Force for Lai Nullah under administration of FFC in order to undertake the overall administration for implementation of the proposed flood mitigation project.

(3) To preserve the present jurisdiction of the relevant authorities (i.e., FFC, CDA, RDA, TMA, RCB and SDO) for Lai Nullah on the premises of the above establishment of the Management Committee and the Task Force.

8.2 Strengthening of Legal Setup

There are many laws, acts and acts for the land administration but less for the river administration in Pakistan. As the results, when the river basin extends over more than two different jurisdiction areas, the river is administrated by the different land administrators, and the consistent river basin administration is hardly achieved. In order to improve such unfavorable conditions, it is indispensable to enact the “River management law or Water law”, which prescribes (a) the definitive unified river administrator, (b) the river reserve area to be administrated by the prescribed river administrator, (c) the authorities and responsibilities given to the administrator and (d) all other necessary items related to the river administration.

CHAPTER 9. CONSTRUCTION PLAN AND COST ESTIMATION

The construction works are prepared for all structures proposed as the components of the optimum structural flood mitigation plan and the flood forecasting and warning system proposed as the eligible non-structural flood mitigation plan.

9.1 Construction Works

9.1.1 Community Ponds

The major works for construction of the Community Pond are as listed below:

Table R 14 Major Construction Works of Community Pond

Work Item			Unit	Quantity
1. Diversion Facilities	1.1 Intake	Fixed Weir	set	1 (H=2.5m)
		Diversion Weir	set	1 (H=5.2m)
		Wet Stone Pitching	m^2	2,500
		Wet Stone Masonry	m^2	2,800
	1.2 Diversion Channel		set	1 (L=1,340m x W=8m)
	1.3 Box Culvert, etc.		L.C.	1
2. Flood Detention Facilities	2.1 Detention Dam (Mixed type)	Foundation Excavation	m^3	90,000
		Earth Fill	m^3	160,000
		Concrete	m^3	31,000
	2.2 Community Pond Excavation		m^3	2,000,000
3. Amenity Facility	3.1 General Facilities	Entrance Gate	set	4
		Car Park	set	4
		Asphalted Main Road	m	4,000
	3.2 Sports & Recreation	Multipurpose Ground	set	2
		Tennis Court	set	6
		Basket Court	set	4
		Other Facilities	set	1
	3.3 Landscape	Water-front Open Area	m^2	15,000
		Entrance Open Area	m^2	4,000
		Flower Bed	m^2	75,000
		Forest Park	m^2	417,000

9.1.2 Flood Diversion Channel

Construction of the flood diversion channel would be made through two (2) phases, namely: the short-term project (2005-2007) and the long-term project (2008-2012). The major works for each of phases are as listed below:

Table R 15 (1/2) Major Construction Works of Diversion Channel

Work Item		Unit	Quantity (Short term)	Quantity (Long term)
1. Diversion Channel (Bedarawali Kas - Tenawali Kas)	1.1 Fixed Weir	place	0	1
	1.2 Diversion Weir	place	0	1
	1.3 Diversion Channel (L=2,450m)			
	Common Excavation	m^3	0	1,148,000
	Revetment (wet stone masonry, wet stone pitching)	m^2	0	76,200
	Concrete (reinforced concrete & floor concrete)	m^3	0	33,840
	1.4 Bridge	place	0	4

…. Continued

Table R 15 (2/2) Major Construction Works of Diversion Channel

Work Item		Unit	Quantity (Short term)	Quantity (Long term)
2. Diversion Channel (Tenawali Kas - Saidpur Kas)	2.1 Hydraulic Drop (Tenawali Kas & Kanitawali Kas)	place	2	2
	2.2 Intake Weir (Tenawali Kas)	place	1	1
	2.3 Diversion Weir (Saidpur Kas)	place	1	1
	2.4 Diversion Channel (L=2,150m)			
	Common Excavation	m^3	184,000	443,000
	Dike Embankment	m^3	26,000	47,000
	Revetment (wet stone masonry, wet stone pitching)	m^2	0	30,400
	Concrete (floor concrete)	m^3	0	21,390
	Drainage Outlet	place	40	50
	2.5 Bridge	place	8	8
3. Diversion Channel (Saidpur Kas - Kurang River)	3.1 Hydraulic Drop (Ojhri Kas)	place	2	2
	3.2 Diversion Channel (L=5,126m)			
	Common Excavation	m^3	1,542,000	2,430,000
	Dike Embankment	m^3	49,000	84,000
	Revetment (wet stone masonry, wet stone pitching)	m^2	0	107,300
	Concrete (floor concrete)	m^3	0	18,400
	3.3 Hydraulic Drop	place	1	1
	Common Excavation	m^3	9,000	9,000
	Concrete (mass concrete)	m^3	11,000	11,000
	Gabion Mattress W 1.0m x B 1.5m x T 0.5m	m^3	11,300	11,300
	3.4 Bridge	place	8	8
4. Improvement of Kurang River	4.1 Excavation and Embankment Works			
	Common Excavation	m^3	82,000	164,000
	Dike Embankment	m^3	82,000	164,000
	4.2 Slope Protection (sodding)	m^2	37,000	74,000
	4.3. Drainage Outlet	place	30	70
5. Compensation	5.1 House Evacuation			
	for Diversion Channel	house	15	20
	for Improvement of Kurang River	house	110	220
	5.2 Land Acquisition	m^2	211,500	348,000

9.1.3 Supplementary Works for On-going Channel Improvement by RDA

The supplementary works are broadly divided in to the following two (2) portions, namely: (1) river improvement of Lai Nullah below Chaklala Bridge ((RD5+277-RD6+215) and (2) side slope protection works for the on-going channel river section of Lai Nullah from Chaklala Bridge to Kattarian Bridge (RD6+251-RD17+210). The major works for these portions are as listed below:

Table R 16 Major Construction Works of Supplementary Works for On-going River Channel Improvement of Lai Nullah

Work Item		Unit	Quantity
1. Downstream River Improvement	1.1 Earth Work (Common Excavation)	m^3	31,000
	1.2 Slope Protection (Wet stone pitching)	m^2	41,000
	1.3. Compensation		
	Land Acquisition	m^2	8,000
	House Evacuation	house	0
2 Slope Protection	2.1 Revetment (Wet Stone Pitching)	m^2	302,000
	2.2 Compensation		
	Land Acquisition	m^2	0
	House Evacuation	house	0

9.1.4 Flood Forecasting and Warning System (FFWS)

The flood forecasting and warning system is to be completed through the urgent project (2004-2005) same as the aforesaid community pond. The principal equipment to be installed for the system are as listed below:

Table R 17 Major Equipment to be installed for FFWS

Principal Equipment	Quantity (unit)
Telemetry Supervisory Equipment	1
Radio Equipment for 5.2 GHz	7
Radio Equipment for 400MHz	24
Antenna System	28
Display System	5
PC type Operation Console	2
Printer & Processing System (FFWS Server)	7
Emergency Power Supply System	23
Warning Supervisory/Control System	1
Remote Terminal Unit (RTU)	10
Sensor Rainfall Gauge with Data Memory Pack	5
Sensor Water Level Gauge with Data Memory Pack	5
Warning Equipment	10
Siren Equipment	10
Audio Amplifier	10
Laud Speaker and Sound Collector	10

9.2 Construction Schedule

In accordance with the phased program, the entire construction/installation period for the major work components of the proposed structural plan as well as the flood forecasting and warning system proposed as the non-structural plan was assumed as shown in Table R 18.

Table R 18 Entire Construction Period of Major Works

Classification	Work Item		Construction and/or Installation Period
Structural	Community Pond		Urgent (2004-2005)
	Diversion Channel	Channel (Tenawali Kas-Kurang River, Qmax= 470 m^3/s or 16,598 cfs)	Short-term (2005-2007)
		Channel (Bedarawali Kas-Kurang River, Qmax=1,790m^3/s or 63,213 cfs)	Long-term (2008-2012)
		Improvement of Kurang River	Short/Long-term (2005-2012)
	Supplementary Works for River Improvement of Lai Nullah	River improvement below Chaklala Bridge	Short-term (2004-2005)
		Side slope protection of the on-going improvement section	Short-term (2005-2007)
Non-structural	Flood Forecasting and Warning System		Urgent (2004-2005)

9.3 Cost Estimation

The initial investment cost and O & M cost are estimated as listed in Tables R 19 to R 21 based on the average prevailing market prices in 2002, and the currency exchange rate of US$ 1.0 =120.06 yen (Japanese currency) = Rs. 58.0.

Table R 19 Project Cost for the Proposed Structural and Non-structural Flood Mitigation Plan

(Unit: Rs. million)

Work Item			Urgent Project	Short-term Project	Long-term Project	Total
Structural	Community Pond		1,137	-	-	1,137
	Diversion Channel	Channel (Tenawali Kas-Kurang River)	-	2,059	-	2,059
		Channel (Bedarawali Kas-Kurang River)	-	-	3,433	3,433
		Improvement of Kurang River	-	55	59	114
		Sub-total	-	2,113	3,492	5,605
	Supplementary Works for Lai Nullah	River improvement below Chaklala Br.	130	-	-	130
		Side slope protection of the river channel	-	743	-	743
		Sub-total	130	743	-	873
	Grand Total of Structural Plan		**1,267**	**2,857**	**3,492**	**7,615**
Non-structural	Flood Forecasting and Warning System	Equipment Cost	248	-	-	248
		Installation Cost	28	-	-	28
		Cost for Civil Works	10	-	-	10
		Materials/ other miscellaneous	16	-	-	16
	Grand-total of Non-structural Plan		**302**	-	-	**302**

Table R 20 Annual Operation and Maintenance Cost for the Components of the Structural Plan

(Unit: Rs. Thousand/year)

Item	Upon Completion of Urgent Project	Upon Completion of Short-term Project	Upon Completion of Long-term Project
(1) Machine operation cost	696	1,006	1,006
(2) Machine maintenance cost*	1,404	1,404	1,404
(3) Cost for administrative and logistic support	542	1,160	1,160
(4) Cost for repair of the structures and office running cost	460	986	1,547
(5) Miscellaneous expenses**	155	228	256
Total	3,256	4,784	5,373

*: Includes cost for regular maintenance, repair of the machineries, supply of spare parts
**: Assuming 5% of the items (1) to (4)

Table R 21 Annual Operation and Maintenance Cost for the Flood Forecasting and Warning System in the Proposed Non-structural Plan

(Unit: Rs. Thousand/year)

Item	Cost
Maintenance cost for equipment, office running cost, etc. *	2,258
Cost for administrative and logistic support	700
Total	2,958

*: 1% of procurement & installation cost of the equipment, civil works and other miscellanies direct cost.

CHAPTER 10. IMPLEMENTATION PROGRAM

The implementation program was prepared for: (1) the structural flood mitigation plan, (2) the non-structural plan, (3) the relevant environmental improvement plan and (4) the strengthening of the institutional setup for administration and management of Lai Nullah. Among others, the structural flood mitigation plan would be progressively completed through the phased programs of the urgent project, the short-term project and the long-term project by the target completion year of 2012, and its phased implementation programs are proposed taking the required construction period and the significance of flood and mitigation effects into account.

The non-structural flood mitigation measures are such as the flood forecasting and warning system and the dissemination of the flood risk maps. These non-structural measures could effect mitigation of the damage particularly caused by the floods over the design scale of the completed structural measures. The implementation program for the non-structural flood mitigation measures is proposed in order to maximize this particular flood mitigation effect expected to the non-structural measures.

In addition to the above structural and non-structural flood mitigation measures, the environmental improvement plan would effect to sustain the designed flood mitigation capacity of the structural measures and create the appropriate environments of Lai Nullah. The strengthening of the institutional setup would be also an important issue to facilitate the overall administration and management of Lai Nullah. The implementation of program for these environmental improvement plan and institutional setup is proposed in accordance with the progress of the above structural and non-structural flood mitigation plan. It is further noted that there are several on-going environmental implement plans such as improvement of sewerage treatment plant at Block I-9 in Islamabad City and the Urban Water Supply & Sanitation Project, Phase -1 and 2 (UWSSP-1 & 2), Rawalpindi City. The implementation schedules for these on-going environmental improvement schedules were also taken into account for the proposed overall implementation program in this Study.

The overall implementation program for the above four principal plans is proposed in accordance with the above concepts and summarized as shown in Table R 22.

Table R 22 Overall Implementation Program

Sector	Scheme	Phased Program		
		Urgent (2004-05)	Short-Term (2005-07)	Long-Term (2008-12)
1. Structural Flood Mitigation Project	1.1 Community Pond at the Fatima Jinnah Park	○		
	1.2 Flood Diversion			
	(1) Flood diversion from Bedarawali Kas to Tenawali Kas			○
	(2) Flood diversion from Tenawali Kas to Kurang River		○	○
	(3) Improvement of Kurang River		○	○
	1.3 Supplementary works for on-going river channel improvement			
	(1) River improvement below Chaklala Bridge	○		
	(2) Side slope protection works of the on-going improvement section		○	
2. Non-structural Flood Mitigation Project	2.1 Establishment of flood forecasting and warning system	○		
	2.2 Establishment of flood risk map		○	○
3. Related Environmental Improvement Project	3.1 Land use control*			
	(1) Formulation of a step-wise resettlement plan	○		
	(2) Execution of the resettlement plan and demolishing of the site		○	○
	3.2 Control of solid wastes dumped into the river*			
	(1) Apprehension of the volume of solid wastes	○		
	(2) Legislation of the acts for the solid waste management		○	○
	(3) Formulation and execution for reduction and recycle and solid waste			○
	3.3 Improvement of drainage and sewerage			
	(1) Improvement of sewerage treatment plant in Islamabad	○		
	(2) UWSSP-I	○		
	(3) UWSS-2		○	
	(4) Drainage and sewerage improvement for area of RCB		○	○
4. Strengthening of Institutional Setup	4.1 Establishment of Management Committee for integrated river administration	○		
	4.2 Establishment of Task Force for implementation of flood mitigation project	○		
	4.3 Demarcation of roles and authorities of the relevant land administrators	○		
	4.4 Capacity building	○	○	○

* : Both of the items 3.1 and 3.2 are categorized as a part of the environmental improvement project but at the same time as a part of the non-structural flood mitigation project.

CHAPTER 11. PROJECT EVALUATION

11.1 Economic Evaluation

The project economic benefit accrues from the flood damage progressively reduced by the phased structural flood mitigation plans, namely, the urgent project, the short-term project, and the long-term project. The non-structural flood mitigation plans and the environmental improvement plan would also contribute to the flood damage reduction as well as the river environmental improvement, but their economic benefits are intangible in nature. Due to these backgrounds, the economic evaluation was made solely for the phased structural flood mitigation plans as listed below:

Table R 23 EIRR and B/C Ratio of the Proposed Structural Measures

Progress of the Project	EIRR			B/C Ratio*
	Base Case	10% Reduction in Benefit	10% Reduction in Cost	**Base Case**
1 Urgent Project	**22.4 %**	20.4 %	20.5 %	**2.3**
2 Urgent + Short-term Project	**12.8 %**	11.6 %	11.7 %	**1.3**
3 Whole (Urgent + Short-term + Long-term Project)	**10.4 %**	9.3 %	9.4 %	**1.0**

*: Assuming the discount ratio of 10%

As the results of estimated of the EIRR, the proposed structural flood mitigation plans could be evaluated to be economically viable indicating the EIRR over the capital opportunity cost of 10%. Moreover, the population of about 183,000 could be relieved by the structural flood mitigation measures as a whole. However, the EIRR of the long-term project is marginally beyond the opportunity cost 10 %, and may fall below the opportunity cost, when completion of the long-term project is overdue. The preparation and construction of the proposed structures would, therefore, need to be closely monitored.

11.2 Financial Evaluation

As listed below, the initial investment cost of the proposed flood mitigation plan is Rs. 7,615 million in total, while the annual O & M cost for the plan will gradually increase to Rs. 3.3 million upon completion of the urgent project in 2004 to Rs 5.4 million upon completion of the Long-term Project in 2012, which would imposes a fiscal burden during the entire project life (refer to Chapter 9).

Table R 24 The Project Initial Investment Cost and Annual O & M Cost

Project	Initial Investment Cost (Rs million)	O & M cost (Rs million/ year)
Urgent Project	1,267	3.3
Urgent + Short-term Project	4,124	4.8
Urgent + Short-term + Long-term Project	7,615	5.4

These costs for flood mitigation are subsidized in most case, and not recovered directly from beneficiaries. From these viewpoints, the financial evaluation was made to clarify the fiscal

capacity of the government to afford the project with referring to the results of the recent public expenditures.

The national expenditure in 2001 has amounted to Rs 837.6 billion in total. Out of the national expenditure, Rs. 127 billion (about 15%) was used for the Public Sector Development Programme (PSDP), which is expected as the eligible financial source for implementation of the proposed flood mitigation plans. According to the "Ten Year Perspective Development Plan 2001-2011", the whole budget of PSDP is projected to increase from to Rs. 127 billion in 2001 to Rs. 418 billion in 2010 with an annual growth rate at 14%. In order to clarify the fiscal burden of the initial investment cost to the government budget, the annual disbursement schedule of the project investment cost is compared with the whole budget of PSDP and its budget in the water sector as listed below.

Table R 25 Project Investment and Ten Year Perspective Development Plan 2001-2011

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
(1) Whole Budget of PSDP (Rs. million)	130,000	150,000	180,000	202,000	227,000	255,000	287,000	324,000	367,000	418,000	-	-
(2) Project Cost (Rs. million)	-	-	69	813	1,194	1,066	1,084	658	677	680	707	666
(3) (2)/(1)	-	-	0.04%	0.40%	0.53%	0.42%	0.38%	0.20%	0.18%	0.16%	-	-

Source: Ten Year Perspective Development Plan 2001-11 and Three Year Development Programme 2001-04

As compared above, the project will have the maximum increment of merely 0.53% of the budget for PSDP, and the annual expense with implementation of the proposed flood mitigation plan is, therefore, generally deemed to fall within the capacity of the government. In addition, recent development in tax reform including broadened tax base has increased tax revenue of the central government by 13% from 2001-02 to the 2002-03, which is expected to contribute to balanced budget in the future.

In addition to the above clarification the fiscal burden of the initial investment cost, the fiscal burden of the annual O & M cost to the government budget was also clarified. The eligible budgetary source for the annual O & M cost would accrue from the budget for the Normal Annual Development Program (NADP) in the National Flood Protection Plan (NFPP), which is allocated as a part of the budget of the aforesaid water sector in PSDP. According to the draft National Flood Protection Plan-III issued on May 2001, it is planned to invest Rs 2,400 million in total for the NADP for a period from 1998 to 2012. The annul average budget for NADP is estimated at about Rs. 185 million, while the project would require the annual O & M cost of Rs. 5.4 million, which will results in 3% increase on the annual base budget of NADP and be affordable within the limit of the budget.

11.3 Initial Environmental Evaluation

The initial environmental examination (IEE) for the community pond and the flood diversion channel proposed as the principal components of the optimum flood mitigation plan was carried out to confirm the necessity of the succeeding environmental impact assessment (EIA) and to preliminarily delineate the possible countermeasures against the potential adverse impacts.

The checklists for the objective structural measures were clarified as shown in Tables R 26 and R 27. As the results of the checklists, it is evaluated that the flood mitigation plan proposed in the Master Plan will induce relatively insignificant adverse impacts. Several potential adverse impacts were, nevertheless, identified in the evaluation, and it is concluded that the EIA is required in the succeeding study period. The particular evaluations for each of the community pond and the flood diversion channel are as described below:

1) Community Pond

The community pond poses far less adverse environmental impact as compared with the flood diversion in the initial screening level, in addition, it will have a significant beneficial impact on improvement of the living environment by increased aesthetic, recreational and partly educational value of the park. However, as listed in the checklist on Table R 26, one of the adverse environmental would be addressed to *waste* of construction during the construction phase, whereby a special attention should be given to selection of disposal site of excavated soil. The adverse impacts on *fauna and flora* in the existing park are also expected during the construction phase, whereby it is necessary to confirm that there exist no threatened or rare species of fauna and flora in the park.

The adverse impact during both of the construction and operation phases would be further brought about through *water pollution* of the pond, resulting in increase of *offensive odor* and emergence of water-borne disease. Increased waste disposal from visitors of the park needs to be properly collected to maintain cleanliness of the park. These adverse impacts on water quality should be the principal items for the succeeding EIA. Nevertheless, it is preliminarily evaluated that these adverse impacts would be minimized by construction of: (1) the oxidation pond, (2) the check dam to stop the inflow of garbage, (3) diversion channel to bring the clean discharge from the adjacent Bedarawali Kas and (4) alternative sewerage channel of the polluted low flow from Tenawali Kas.

Table R 26 Checklist for Community Pond

Category of Environmental Impact	Overall Assess.	Planning and Design Phase				Construction Phase				Operation Phase				Beneficial		
		Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal
Social Environment																
Involuntary Resettlement																
Economic Activity																
Traffic and Public facilities																
Split of Communities																
Cultural Properties																
Water and Common Rights																
Public Health Conditions																
Waste	B					B	S	D	H	B	L	I	M			
Hazards (risk)																
Other social impacts														A	L	D
Natural Environment																
Toporaphy and Geology																
Soil Erosion																
Groundwater																
Changes in Hydrology																
Fauna and Flora	B					B	S	D	H							
Meteology																
Landscape																
Other natural impacts																
Pollution																
Air pollution	C					C	S	D	M							
Water Pollution	B					B	S	D	M	B	L	I	M			
Soil contamination	C					C	S	D	M							
Noise and vibration	C					C	S	D	M							
Land sussistence																
Offensive odor	B					C	S	D	M	B	L	I	M			
Other impact in pollution control																

Note:

Magnitude of Impact	A:	Major impact is anticipated. Mitigation measure is judged r
	B:	Potential major impact is anticipated. Detailed study requir
	C:	Some impact is anticipated.
		Blank represents no anticipated impact.
Duration of Impact	L:	Long-term impact
	S:	Short-term impact
Causal relationship	D:	Direct Impact
	I:	Indirect impact
Probability	H:	Highly probable,
	M:	Moderately probable,
	U:	Unpredictable

2) Flood Diversion Channel

The flood diversion channel will require *involuntary resettlement* along Kurang River as the outlet of the diversion channel during the planning and design phase, which would be enumerated as one of the principal objectives of the succeeding EIA. The resettlement would be, however, indispensable regardless to construction of the diversion channel, because the objective houses for resettlement are located within the present habitual flood inundation area and the great impediments to the flow of flood discharge. The number of house to be resettled is about 220, which is far less than 2,000 houses evacuated by RDA for the on-going river channel implement. Accordingly, the objective resettlement associated with construction of the diversion channel would be realizable provided that the stepwise resettlement plan and the support by micro financing are formulated and executed

as described in the foregoing subsection 6.3. Interaction with *traffic and public facilities* will be also a potential impact in construction phase. Due to linear alignment of the diversion channel, it will result in *split of community* as well as damage on *cultural properties*. In order to cope with these adverse affects, it would be necessary to construct temporary bypasses as well as several bridges. Adverse impacts in *waste disposal* will also occur in two distinct occasions in construction and operation phases, and control of the garbage dumped into the channel should be carefully made based on legislation of the Act for Solid Waste Management and formulation/execution of the program for reduction and recycle of solid waste (refer to subsection 8.2).

Table R 27 Checklist for Flood Diversion Channel

Category of Environmental Impact	Overall Assess.	Planning and Design Phase				Construction Phase				Operation Phase				Beneficial		
		Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal	Probability	Magnitude	Duration	Causal
Social Environment																
Involuntary Resettlement	B	B	L	D	M											
Economic Activity	B	B	L	D	M											
Traffic and Public facilities	B					B	S	D	H	B	L	D	H			
Split of Communities	A					B	S	D	H	A	L	D	H			
Cultural Properties	A					A	S	D	M							
Water and Common Rights																
Public Health Conditions																
Waste	A					B	S	D	H	A	L	I	H			
Hazards (risk)																
Other social impacts																
Natural Environment																
Toporaphy and Geology																
Soil Erosion																
Groundwater																
Changes in Hydrology	A									A	L	I	M			
Fauna and Flora	C					C	S	D	H	C	L	D	M			
Meteology																
Landscape	C									C	L	D	M			
Other natural impacts																
Pollution																
Air pollution	B					C	S	D	M							
Water Pollution	B					B	S	D	M							
Soil contamination	B					C	S	D	M							
Noise and vibration	B					C	S	D	M							
Land sussistence																
Offensive odor	B					C	S	D	M							
Other impact in pollution control																

Note:

Magnitude of Impact	A:	Major impact is anticipated. Mitigation measure is judged r
	B:	Potential major impact is anticipated. Detailed study requir
	C:	Some impact is anticipated.
		Blank represents no anticipated impact.
Duration of Impact	L:	Long-term impact
	S:	Short-term impact
Causal relationship	D:	Direct Impact
	I:	Indirect impact
Probability	H:	Highly probable,
	M:	Moderately probable,
	U:	Unpredictable

CHAPTER 12. RECOMMENDATIONS

The principal recommendations in this Study are as summarized hereinafter:

1) Implementation of the Proposed Urgent Project

Lai Nullah would cause the serious flood overflow by the comparatively small probable flood, even upon completion of the on-going river channel improvement above Chaklala Bridge by RDA, due to the limited right-of-way availed to the on-going improvement and the bottlenecks left behind below Chaklala Bridge. Thus, Lai Nullah still has the high flood damage potential, and it is strongly recommended to take the early implementation of the proposed urgent project and produce the immediate flood mitigation effect.

2) Implementation of the Phased Short-term and Long-term Project

Lai Nullah Basin has experienced the disastrous damage by 2001 Flood including death of 74 people and destruction of about 3,000 houses. The 2001 Flood is the recorded maximum flood, and the design scale of the above urgent project is still far less than the scale of 2001 Flood. The flood damage potential would further increase with the expansion of population in the basin as projected from 1.0 million in 1998 to 2.3 million in 2030.

Under the above conditions, it is inevitable to implement the drastic flood mitigation plan, which could cope with even the scale of 2001 Flood. Nevertheless, the plan would take a long implementation period of about 10 years due to its huge work volume. Accordingly, the plan would be progressively implemented through the phased short-term and long-term project. In order to complete these phased programs within due time, the close monitoring on implementation would be indispensable.

3) Feasibility Study on Flood Diversion Plan

The flood diversion channel is proposed as the principal structural measure for the long-term project. A feasibility study would be, however, required to clarify the further details of the proposed diversion structures with a particular attention to a comment given from CDA on the allowable width of the diversion channel (refer to item 2 in the Minutes of Steering Committee Meeting on the Draft Final Report as attached to Volume 2, the Main Report). The objectives of the feasibility study should further include clarification on the detailed improvement works for Kurang River proposed as the outlet of the diversion.

4) Involvement of the Federal Government in Implementation and Management of the Project

The principal beneficiary of the proposed flood mitigation plan is biased to the lower reaches of Lai Nullah in Rawalpindi City, while the major flood mitigation structures such

as the community pond and the diversion structure are placed in the upper reaches in Islamabad City. This contradiction may lead to conflicts between the regional administrators for the two cities in implementation and management of the proposed flood mitigation. In order to minimize the conflicts, the federal government as represented by the Ministry of Water and Power and/or the Federal Flood Commission would be required to coordinate the overall project implementation and management works, and/or further directly undertake a part of them.

5) Implementation of Environmental Improvement Works of Lai Nullah

The environmental improvement particularly in the aspect of control of the garbage dumped into the river and the encroachment in the right-of-way of the river would be the important issues to sustain the flood mitigation capacity and the appropriate river environment of Lai Nullah. From these viewpoints, it is necessary to urge the relevant on-going environmental improvement projects such as enlargement of the capacity of the existing sewerage treatment capacity for Islamabad and the UWSSP-I and II for Rawalpindi City. At the same time, legislation of the new act and enforcement for control of garbage dumping and encroachment in the waterway of the river would be required.

6) Budgetary Arrangement

According to the recent national policy in Pakistan, the public development investment is deemed to tend toward the regions other than the capital territory of Islamabad. This national policy may lead to difficulties in securing the necessary budget for the proposed flood mitigation plan. The budgetary arrangement would need, therefore, to be deliberated thoroughly by the federal agency as represented by the Ministry of Water and Power and the relevant local government agencies such as CDA, the provincial government of Punjabi, TMA, RDA and RCB.

7) Strengthening of Hydrological Data

The existing hydrological gauging data including the rainfall and water level data in Lai Nullah Basin is quite inadequate and less orderly prepared, which is a great hindrance for formulation of the flood mitigation plan as well as other various water resources development plan. In order to retrieve such unfavorable conditions, it is recommended to increase the hydrological gauging stations and at the same time, an attempt should be given to orderly arrange the gauged data.