spurs, it is important to monitor the conditions before and after the flood. In case some damages are found, it is crucial to repair immediately to recover the function for coming floods. A repair in time will save many amounts for repair and reconstruction works. Moreover, the local residents will ensure any objects hooked to the piles or the gabion should be removed. In case of gabion spurs, it is also desirable to plant grass or shrubs on the sand-deposit areas. Dike works are subject to scouring of their slopes, and will thereby require the local communities to undertake timely repairs of slope failures.

Land Use Management: Along the Lakhandei river, bank erosion has been aggravated by improper land use. The main issue concerning land use along the Lakhandei is cultivation right on the riverbanks. The people residing in the riverbanks will be encouraged to stop over cultivation. In addition, those individuals residing close to the rivers, who will recover cultivable land through river training, will be assisted in adopting proper land use practice in future.

7.4.4 Location-Specific Strategies (Lakhandei River)

This section will describe what community development strategies will be taken in the sites, where additional flood control measures are planned (i.e., mainly dike and spur works), within the overall framework.

(1) Patharkot VDC

At the northern sites, the communities will be assisted to:

1) Control open grazing at the backside of the existing structure, to stabilize the ground adjacent to the existing revetments.
2) Plant shrubs/grass, both at the backside of the revetment, as well as at the sand deposit areas.

At the remaining two sites top the south of the VDC:

3) Evolve the traditional warning practices (by observing changes in the water flow) into collective efforts (not individual efforts).
4) Learn from the northern VDC where the local irrigation group participated in the construction of DIO-support revetments.

(2) Gurkauli VDC

At the site:

1) Develop a pathway along riverbank (after stabilized through bank protection

work), for promoting bed material collection, vegetable marketing, etc.

2) Enable VDC and DDC to sort out which agencies will be responsible for bed material collection.
3) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso)

(3) Haripur VDC

At both the two sites:

1) Adopt catch crops (e.g., groundnuts, cucurbit, sweet potato) to cope with sedimentation of infertile sand.
2) Grow bamboo on the riversides, as a measure to curtail flood flows, and also as materials for flood fighting.
3) Disseminate Ward 9's practice of Ward Chairman/Members taking charge of warning and evacuation of the local residents, to other Wards where overflow problems are relatively new.

At the southern site:

4) Assist in converting the existing Government forestry into a community forest, to enable people to utilize tree products.

(4) Pidari VDC

For both the sites:

1) Learn from the participation method adopted in the old dike lying between the two proposed sites, where all the households to contribute on the equity basis (workloads allocated in proportion to their land-holding).
2) Improve the east-west roads (through installation of culverts, bridges, gravel, etc.), to enhance the people's mobility (evacuation, etc.) to the north-south highway going to the district center (Malangwa municiplity).
3) Adopt catch crops (e.g., groundnuts, cucurbit, sweet potato) to cope with sedimentation of infertile sand.

(5) Janaki Nagar VDC

At the north side:

1) Gravel the existing earthen road (about 3 km in length, running north-south) leading to the Bagmati Irrigation siphon, to facilitate transportation of boulders,

etc., that the local residents are ready to participate in.

2) Upgrade the drainage system for agricultural land, since the lack of proper agricultural drainage has caused inundation problems in the area.

At the southern site:

3) Evolve the tradition of collective river watching (for which 50 households form a group) into to a group that takes upon wider disaster management responsibilities, e.g., the maintenance of the revetment work.
4) Reforest to promote the types of trees that can provide durable housing materials (e.g., Sal) to strengthen the local housing structures.

(6) Shripur VDC

At the proposed site:

1) Encourage the farmers to produce extra paddy seedlings, to prepare for flood damages that require them to restart paddy plantation.
2) Adopt catch crops (e.g., groundnuts, cucurbit, sweet potato) to cope with sedimentation of infertile sand.
3) Disseminate the locally practiced installation of bamboo piles with a view to minimizing sedimentation onto their farmland.

(7) Padariya VDC

At the northern site:

1) Improve the road leading to a nearby market (through installation of culverts, bridges, gravel, etc.), as a route for the local residents to move to evacuation sites during flooding, and to shift valuable using carts and other means.
2) Strengthen the bamboo structure by introducing such external materials as boulders, and also introduce this practice to the southern proposed site.

At the southern site:

3) Plant trees (Sisoo, Mango) on new land to be available through river training, to produce fuel wood, as well as to create "refuge area" during emergencies.
4) Disseminate the local practice of "Sarpat" plantation that is effective in flood flow control with its strong stems, and also can be used for a range of purposes, i.e., roofing and fencing.

(8) Belhi VDC

At the proposed site:

1) Plant trees (e.g., Sisoo, Mango) on new land to be available through river training, to produce fuel wood, as well as to create "refuge area" during emergencies.
2) Promote the existing practice of using artificial mounds with some bamboo and woods as reinforcement work, to promote flood proofing of the houses.

(9) Sundarpur VDC

At the proposed site:

1) Install small-scale embankments for about 2 km from the confluence of Dhengrana (one tributary) and Lakhandei rivers, to prevent overflow from disconnecting the road during monsoon.
2) Initiate systematic warning, using the existing facilities, such as mosque speakers and the PCO (Public Call Office), both of which exist in Ward 1.
3) Encourage the farmers to produce extra paddy seedlings, to prepare for flood damages that require them to restart paddy plantation.

(10) Laksmipur VDC

At both the two sites:

1) Install tube wells to secure clean water, since the existing wells for drinking water get contaminated during rainy season.
2) Plant trees (Sal, Mango) on new land to be available through river training, to produce housing materials, to produce fuel wood, as well as to create refuge area.
3) Encourage the farmers to produce extra paddy seedlings, to prepare for flood damages that require them to restart paddy plantation, and also to adopt alternative catch crops (e.g., groundnuts, cucurbit, sweet potato).

(11) Sakaraul VDC

At the northern site for one closing work:

1) Develop a pathway linking the Sakaraul and Kaudena VDCs, using the closing works as part of the road, in order for the Sakaraul villagers to use for evacuation during flooding, to reach market centers, and to receive other social services such as education and medical treatments.

At the southern site proposed for bank protection work:

2) Disseminate the existing agricultural recovery strategies (i.e., planting

vegetable, e.g., sweet potato, cucurbits, watermelon) to more farmers.

7.4.5 Community Mobilization (Babai River)

Workshops for Local Government Institutions (LGIs): In addition to the four general topics explained in Chapter 4, LGI Workshops for the Babai will deal with the post-project repair and maintenance. In a workshop held in July 1998, local agencies (DIO, LGIs, line agencies, and communities) came up with an idea of forming a separate district-level Post-project Maintenance Fund. Recognizing that the sustainability will depend upon availability of resources and local participation, the Fund is partly financed by the central Government and donors, while the concerned LGIs will also share the costs. Moreover, since local-based, regular preventive maintenance (rather than costly post-damage repair) will be more cost-effective, local communities will be trained in regular monitoring of the physical facilities. Babai LGI Workshops will provide a forum for the local agencies to further discuss this idea with the DOI Project Management Office.

Formation of Community Organizations (COs): Along the Babai river, there exist local irrigation systems (with their leaders called "Chaudary") for the maintenance and repair of irrigation canals. As shown in Table 7.9, Chaudary groups exist in almost all the localities affected by Babai floods. The flood mitigation program will tap this Chaudary tradition (to involve all beneficiary households based upon equity principles, i.e., the larger benefit, the more contribution each household makes), just as already practiced by some of the DIO-supported flood mitigation works (e.g., Bagnaha VDC, Padnaha VDC, Baniyabhar VDC).

Promotion of Public Awareness, Knowledge and Skills:

1) **Technicalities of Flood Control Measures:** Most of the affected communities along the Babai river are aware of, and concerned about increased run-off and erosion from the upper streams. The CO training along the Babai will inform the people that the forest and grass belts have been designed in such a manner to temper the flood flow and trap the sediment. Moreover, the local residents tend to believe only in continuous dikes, although they are not proposed under the Plan. Another focus of the CO training will therefore be to enable the people to learn why the continuous dikes are not chosen (refer to Section 4.2, (4)).
2) **Skills in Masonry and Gabion Netting:** Only a few villages along the Babai

river (Bagnaha VDC, Dhadhawai VDC) have people skilled in masonry and gabion netting. Some CO representatives will be trained so as to be hired for the construction of flood control works. Their skills will also be crucial for the COs in maintaining the structures at later stages.

3) **Community Participation in Flood Mitigation:** There exist several examples of community-based actions for flood mitigation, principally building upon the local tradition of self-organized activities. They include community contributions for the construction of DIO-supported structures (Baniyabhar VDC, Padnaha VDC, Gulariya Ward 8) planting of Behiya and other shrub for bank protection (Bagnaha VDC, Mahamdpur VDC), and drainage construction (Sano Shri VDC). These will be used as references, in training the local people on participation.

Generation of Financial Resources by COs: There exists a tradition of group savings under the Chaudary systems. To undertake the irrigation management, each member pays a membership fee, and there are also provisions to punish the violators of the established rules, which will also go to the group fund. This tradition is utilized in initiating groups savings, as part of Babai River Flood Mitigation Plan.

7.4.6 Local Coping Measures (Babai River)

Flood Proofing: When new irrigation will become available, the farmers will be assisted to switch to rice cultivation, or adjusting the cropping cycles (e.g., Mahamadpur VDC). Where flooding brings infertile sand onto agricultural land, the people will be encouraged to adopt catch crops (Bitter Gourd, Pigeon Pea, and Groundnuts, etc.), of which list is provided in Table 7.10. Another strategy is plantation-related, such as reforestation (e.g., Gulariya Ward 2), development of mixed forests (e.g., Gulariya Ward 5, Mahamadpur VDC), with a view to enhancing the forests' functions for soil conservation, as well as containing flood overflows. Moreover, where soil erosion accelerates the land cutting (e.g., Gulariya Ward 8, Sano Shri VDC), support will be provided to develop drainage.

Forecasting, Warning and Evacuation: Judging from the runoff system of the whole Babai river, flood forecasting by telemetering system would be applicable in future, establishing base points at the Babai barrage and the confluence of the Sharada river at about 70 km upstream from the barrage). At present stage, support will be extended to promote systematic warning, using the existing facilities (e.g., Bagmati Irrigation

Barrage, in Bagnaha VDC, P.C.O. offices located in almost all VDCs). In the places where flooding is an imminent issue (e.g., part of Dahdhawar VDC, Gulariya Ward 10), the Plan will assist in improving road networks to facilitate the people mobility to safe land. The riverbanks where spurs and/or revetments are built will be stabilized, which provide ample opportunities to develop gravel or earthen roads (e.g., Gulariya Ward 10).

Flood Fighting: The DIO supplies bamboo and sandbags, during emergencies, to construct temporary revetments, which however is limited in geographic coverage (e.g., Gulariya Ward 5 & 6). The local communities, where flooding is an issue, will therefore be encouraged to adopt such simple measure through their local efforts to produce and/or procure materials for flood fighting.

7.4.7 Community-based Sustainable Measures (Babai River)

Forest and Grass Belts as Dike Works: Along the Babai river, there exist a range of local trees and grass that can be used as fuel, fodder, timber, roofing, etc (Table 7.11). Moreover, since different localities exhibit unique variations in their needs the selection of the species should be tailored to a particular situation surrounding each community (Table 7.12). Especially relevant in the context of flood mitigation is the fact that there is ample scope to promote local production of flood fighting materials, as mentioned above, to link the forest/grass belt with the flood fighting.

Preventive Bank Protection Works: A type of shrub (i.e., Behiya) has been utilized to augment the DOI-provided structures (e.g., Gulariya Ward 8, Bagnaha VDC), planting the shrubs at the back side of the structures, and at the sand deposit areas of the spurs. In other places, the shrubs are planted as stand-alone protection work (e.g., Gulariya Ward 6, Mahamadpur VDC, Dhdhawar VDC). Such practice will be disseminated to other localities where feasible. In addition, support will be extended to change the species from Behiya, whose use is rather limited, to other more versatile species of shrubs or grasses, such as Amlisso (used for fodder and broom-making, etc.) and Khar (roofing, paper-making etc.).

Access Improvements Using Flood Control Facilities: After the river banks are consolidated through spur and/or revetment, assistance will provided to develop gravel, or earthen roads (e.g., Gulariya Ward 10, Baniyabhar VDC, Padnaha VDC) for various reasons, e.g., facilitate people's movement to safer grounds during flooding. Moreover, in places where closing dike works are proposed (e.g., Bagnaha VDC,

Gulariya Ward 2, Gulariya Ward 5), the people will be assisted in using the structure as pathways, and to develop gravel roads to link the closing dikes with other existing roads.

Bed Material Collection as Channel Excavation Works: The full potentialities of bed material collection have not been exploited along the Babai river, due to the lack of clarity as to which agency is responsible. Some parts of the river come under jurisdictions of the Department of Forest (DOF), and the Department of National Park (DONP). The DOF/DONP and the DDC (also responsible for the bed material collection under the Local Government Act) will be assisted to clarify the responsible party. For this purpose, guidelines will also be developed and enforced to enable village and district authorities to monitor and ensure that extraction is undertaken in proper places.

Operation and Maintenance (O&M) of Flood Control Structures: The COs will constantly monitor these structures, and undertake minor repairs, and will seek external support only when they go beyond local capacity. For revetment works, the COs will monitor the riverbed, and when it is scoured, place stones and rubbles on the riverbed. When the gabion wire is cut, they will request the DIO, through the DDC/VDC, for additional nets. It is also required to regularly remove objects hooked to the G.I. boxes. For spurs similarly, it is important to monitor the level of the riverbeds, and to see to it that any objects hooked to the piles or the gabion will be removed. In case of gabion spurs, it is also desirable to plant grass or shrubs on the sand-deposit areas, which will serve to stabilize the land adjacent to the structures.

Land Use Management: There exists substantial vegetation along the Babai river. Still, bank erosion has been accelerated by improper land use. The people residing in the river basins will be advised to control overgrazing on the riverbanks, through the introduction of rotational grazing, fodder plantation, etc. Moreover, the farmers will be encouraged to stop over cultivating on the riverbanks.

7.4.8 Location-Specific Strategies (Babai River)

This section will describe what community development strategies will be taken in the sites, where additional flood control measures are planned (i.e., mainly bank revetment and spur works), within the overall framework.

(1) Bagnaha VDC

At the site close to the East-West Highway, the farmers will be assisted to:

1) Adopt the catch crops to be grown on sand-covered land (e.g., pointed gourd, pigeon pea, and sweet potato).
2) Obtain prior information of flooding from the Babai Irrigation Office, which manage irrigation barrage in the locality.

At the other two locations for revetments:

3) Adopt bioengineering measures to stabilize the soil adjacent to the structures (following another exemplary example, in the same VDC, of the farmers' planting shrubs on the sand deposit areas of the DIO-provided spurs).

At the upper part of the two locations,

4) Initiate a new community forest, to promote soil conservation near the proposed bank protection work.

At the lower part of the two sites:

5) Expand the already well-managed community forest, and also to control open grazing.

(2) Baniyabhar VDC

At both the two location:

1) Develop a road linking the two proposed construction sites, which would benefit especially the northern residents in going to markets through Padnaha, the neighboring VDC in the south.
2) Disseminate catch crops, such as pigeon peas and groundnuts, to be grown on farmland covered by sand.

At the northern site:

3) Initiate bioengineering measures for the existing DIO-provided spurs, in order to contain scouring at the backside of the spurs

In the southern part of the VDC,

4) Improve the trenches of agricultural land, through the use of such materials as stones and rubble, and also through plantation along ditches.

(3) Sano Shri VDC

At the sites for revetment work of more than 1.5 km:

1) Convert the drainage into more durable structure through paving stones and rubble, etc., with a view to controlling gully erosion on the riverbank.

2) Initiate more organized grassland management, e.g., rotational grazing of pasture lands, and plantation of ground-coverage grass.

(4) Padnaha VDC

At the bank protection in the north:

1) On the stabilized riverbank, develop pathway linking the site and Baniyabhar. VDC, as road leading to a major market in Sano Shri VDC (the opposite side of Padnaha), then onto the district center (Gulariya Municipality).
2) Implement bioengineering measures to stabilize the land adjacent to the existing physical structures.

At both the sites:

3) Install crossings over one main irrigation canal running through the VDC, which otherwise would impede the people's movements towards safer land in the northeast of the VDC.

At the site in the south:

4) Improve management of irrigation drainage, e.g., by increasing discharge capacity of the drainage, and by looking into the existing water distribution in the VDC during the rainy season.

(5) Dhadhawar VDC

At both the sites,

1) Develop the existing social emergency fund (penalties collected from violators in the use of common property resources, e.g., forests, and irrigation), into disaster management fund.

At the western proposed site in the low land (called Jabdi):

2) Develop more accessible rural road leading to the east side (called Belbhar) to enable the villagers to move to the center of the VDC both during flooding as well as normal times.
3) Install tube wells for drinking water in the village that suffers severely from endemic disease during rainy season due to the contamination of the existing wells.

In the eastern site (called Belbhar)

4) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso).

(6) Mahamadpur VDC

In the uppermost site:

1) Disseminate a traditional slope stabilization measure, using some shrubs and branches, to strengthen the bank adjacent to the proposed revetments.
2) Divert the irrigation drainage (currently flowing toward the north, i.e., against the river flows), to run in parallel with the river course.

At the two remaining two sites:

3) Switch from maize production to paddy (more flood-prone compared with maize), when the World Bank-funded irrigation scheme is completed.

At the site located in the middle:

4) Convert the community forest of sisoo (that is not as useful as fuel and fodder, and hardly alleviate overflow) to a mixed forest.

In the southern end:

5) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso).

(7) Gulariya Ward 2

At the bank protection site of about 1 km:

1) Reforest the community forest, which would thereby serve to alleviate problems arising from flooding and sedimentation.
2) Replace the current free grazing with more organized management of pasture land, in order to stabilize the revetment work to be install at the grassland.

(8) Guraliya Ward 5

At the northern site,

1) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso).

In both the sites:

2) Improve the agricultural trenches, through the use of such materials as stones and rubble, and also through plantation along ditches.
3) Organize warning activities (currently undertaken individually) in which the local residents form a group to watch the river on a rotational basis.

(9) Gulariya Ward 6

At the proposed site:

1) Initiate more organized grassland management, e.g., rotational grazing of pasture lands, together with plantation of ground-coverage grass.
2) Convert the community forest of sisoo (that is not as useful as fuel and fodder, and hardly alleviate overflow) to a mixed forest.
3) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso).

(10) Gulariya Ward 8

At the site where the existing revetments will be expanded:

1) Replace Behiya (currently being used for bank protection), with alternative species of shrubs/grasses that can be used for a variety of purposes (e.g., Khar, and Amlisso).
2) Promote more organized management of pasture land, e.g., rotational grazing of pasture lands, and plantation of ground-coverage grass.
3) Expand and strengthen the existing community ponds which would thereby better serve as retarding basins at the times of flooding.

(11) Gulariya Ward 10

At the proposed site for revetment works of 1km length:

1) Develop an earthen road along the riverbank, leading to the highway linking Gulariya and Nepalganj, to secure an evacuation route at the times of monsoon, and to facilitate the vegetable marketing during normal times.
2) Adjust the timing of transplant Babul (not during the month of July) to wait until end-August , to prevent the young seedlings from being washed away.
3) Develop one pond in Ward 10 created as a result of flooding, into a fishpond.

7.5 Proposed Project Works

As a summary of project planning in the previous sections, general location map and general plans for the river control works and community development activities for flood mitigation are shown in Figs. 7.11 through 7.13 for the Lakhandei river and in Figs. 7.14 through 7.16 for the Babai river.

The community surveys have revealed unique variations among different localities, in terms of requirements for community development activities. Instead of formulating straightjackets, therefore, VDC- or ward-wise strategies should be developed based upon the overall framework provided in Table 7.13. Moreover, several villages have their own peculiar needs that are not common to other localities. At this stage, the VDC- or ward-wise community development strategies are briefly presented in the Figs. 7.13 and 7.16, which shows some examples of how the river control component and the community development component can be combined to work toward "Comprehensive Flood Mitigation".

7.6 Project Implementation Program and Maintenance Plan

7.6.1 Project Implementation Plan

(1) Sequence of Works

The project works must be carried out effectively in orderly manner, and the people shall enjoy the effect of the project even in the course of project implementation. In view of these, consideration was given to the work sequence.

Preparatory Works: Upon completion of the Feasibility Study, the following activities should be taken immediately:

1) **Fund arrangement:** Any possible sources of fund and resources, from domestic and international or governmental and non-governmental ones, will be sought for the implementation of whole or part of the project.
2) **Definite plan/detail design:** A definite plan of the flood mitigation works, including establishment of river boundary line (RBL), will be drawn up after getting consent of the agencies and communities concerned. A detailed design will be prepared of the project facilities.
3) **Environmental study:** In parallel with the definite plan and detail design,

environmental study will be conducted in accordance with the procedures stipulated in the Environmental Conservation Rules (ECR) to get approval of MOPE for the project implementation.

4) **Preservation of lands:** More and more people are living in flood prone areas close to the rivers. Therefore, it is essential to preserve the lands for flood mitigation facilities. This should start immediately after the preparation of definite flood mitigation plan. Appropriate land use should also be encouraged according to the definite plan and detail design.
5) **Coordination among agencies and communities:** Coordination should be started as soon as possible after completion of the Feasibility Study, in order to mobilize agencies and communities concerned toward project implementation.

Community Development:

1) Community development activities should precede the implementation of the river control works.
2) Community mobilization and local coping measures should go first in parallel with the definite plan study. Community mobilization is a key for the successful project implementation.
3) Community-based sustainable flood mitigation measures will be executed in line with the definite plan.

Watershed Management:

1) Afforestation/reforestation and land use regulation, and publicity activities can be started immediately.
2) The erosion control test works in the Lakhandei watershed will be commenced upon completion of the detailed design.

River Control:

1) Flood hazard map will be refined further during the definite plan stage, based on those prepared in this stage.
2) The river control works will be started upon completion of the detailed design.
3) Sequence of implementation among the component works is not important. Any work can be started basically at any places where the inceptive procedures are ready.

Associate Activities: The following associate activities are required to be started soon. These activities will support the effective project implementation.

1) **Research and Investigation:**

- **Flood and sediment runoff:** Study on flood and sediment runoff especially for class III rivers originating at Siwalik hills. Observations on a designated model basin would serve this purpose.
- **Bank erosion mechanism:** Characteristics of bank erosion in the Terai have yet to be investigated. Erosion mechanisms, erosion speed and width, etc. should be investigated in relation with the river segment, riverbed and bank materials, river flow condition, etc.
- **Bank protection works:** Various types of bank protection works should be introduced and investigate the works fit with the conditions of rivers in the Terai. Hydraulic model tests in the laboratory and prototype in field will evaluate the effect of bank protection work.
- **Bioengineering technology:** In order to introduce bioengineering technology as a component of flood mitigation, research works are necessary mainly for the selection of plant species, type and function of work applicable, cultivation techniques, and contribution to income generation.
- **Construction materials:** Effective and economic use of local materials such as boulders, sands, bamboo, trees, etc. should be investigated.

2) **Technical Guidance:**

- **Publicity of existing technical know-how:** Accumulation of experience and know-how related to the flood mitigation, and supply them to the implementing agencies and organizations.
- **Consultation on technical problems**
- **Training:** Training of local leaders for basic techniques necessary for the river training and bank protection works, etc.

(2) Time Schedule

Target year for the Master Plan was set in the year 2017 and the implementation of the Master Plan project was proposed in three (3) phases as follows:

1) 1st Phase (Ninth plan: 1997-2002)
2) 2nd Phase (Tenth plan: 2002-2007)
3) 3rd Phase (Eleventh and twelfth plan: 2007-2017)

Considering the crucial roles as pilot project, the priority project (the Lakhandei and Babai river) was further proposed for completion by the end of 2nd phase (2007) in advance to those of other rivers.

Proposed implementation schedules for the Babai and Lakhandei rivers are shown in Figs. 7.17 and 7.18, respectively. The schedules are outlined as follows:

1) Implementation of the works for the Lakhandei and Babai rivers are scheduled in advance to the other river basins for M/P study as priority project.
2) Period of definite plan/detailed design for the Lakhandei river was scheduled one year longer than that of the Babai river. The Lakhandei river includes route alternatives and it is anticipated that longer time period would be necessary to reach to a consent among the peoples and VDCs concerned.
3) Time schedule for the Babai river is outlined as follows:
   - June1999 to June 2001: Fund arrangement, definite plan, and other inceptive procedures
   - June 2000 to June 2001: Definite plan, detailed design, environmental study, and community mobilization
   - June 2000 to June 2007: Intensive implementation of community development activities, though the activities should be continued ever since.
   - June 2001 to June 2005: Civil works for river control component
   - June 2001 to June 2007: Intensive implementation of local flood mitigation works, the works should be continued ever since.
4) Time schedule for the Lakhandei river is outlined as follows:
   - June 1999 to June 2001: Fund arrangement, definite plan, and other inceptive procedures
   - June 2000 to June 2002: Definite plan, detailed design, environmental study, and community mobilization
   - June 2000 to June 2007: Intensive implementation of community development activities, though the activities should be continued ever since.
   - June 2002 to June 2005: Civil works for river control component
   - June 2001 to June 2007: Intensive implementation of local flood mitigation works, the works should be continued ever since.

(3) Roles of Agencies/Organizations Concerned

Various agencies and organizations are incorporated for the implementation of the project works. The following are the proposed roles of concerned agencies/ organizations in the project implementation (Fig. 7.19):

1) Overall coordination by DOI.
2) Technical guidance by DOI, DOSCWM, DPTC, and other institutes as required.
3) Works to be implemented, in principle, by the beneficiaries such as local communities and VDC/DDC.
4) Large scale works and basic facilities for flood mitigation by DOI or DOSC.
5) Urgent works to be implemented by DOI, DOSC, and other organizations.

(4) Required External Input

Considering the financial situation of the MHG/N, the domestic government fund would be used out only for the operation and maintenance activities of the existing flood mitigation facilities and urgent recovery works. The proposed project requires intensive implementation as pilot project, and the project is very important for the sound development of the Terai plain. Therefore, following external inputs are required for the project implementation:

1) Financial assistance, especially for the river control component
2) Technical assistance for watershed management, river control and community development components. Especially for the community development, it is proposed that a expert group stations in the community and promote the activities collaborating with the community peoples. The expert group should include various field of expert such as community development, forestry, agriculture, and flood mitigation.

7.6.2 Organization for Project Implementation

(1) Coordinating/Implementing Agencies

The flood mitigation program will be managed by the DOI Project Management Office (PMO) to be set up at the district level. The PMO will comprise three divisions, i.e., an Upper Catchment Conservation Division, Flood Control Division, and Community

Development Division. As shown in Fig. 7.20, it is expected that DOSCWM will depute its staff to work as the Chief of the Upper Catchment Division, while DOI staff will fill all the other key posts.

The River Control Division will take the lead in the design and construction management of the river control component. At the same time, the local government institutions (LGIs) also play an important role to match the DOI's resources with local communities. The LGIs will assist DOI in aggregating local information required for the design of the physical facilities, and also will encourage community organizations (COs) to make in-kind (labor, land, and material)/cash contributions to the construction of the flood control facilities. During the maintenance phase, also, LGIs will assist COs, when necessary, to liaise with DOI and other agencies to provide external skills and resources for the rehabilitation of flood control facilities. The river control component will draw largely upon bioengineering measures. The River Control Division will therefore seek, as and when necessary, technical as well as material inputs (e.g., seedlings and samplings) from technical line agencies such as the DOF and DOSCWM.

The Community Development Division will implement the community development component. The Division will maintain close coordination with the LGIs. Under the overall coordination and supervision of the Division, the LGIs will undertake community mobilization to assist communities to organize themselves, and will assist their community organizations (COs) to implement community-based flood mitigation measures. The community development activities envisage a range of activities which no single agencies can handle on its own. Accordingly, the Community Development Division will mobilize technical line agencies, e.g., DOSCWM, and DOA to provide technical and material inputs for community development activities.

A District-level Coordination Committee (DCC) will also be established, to provide coordination between the PMO and other relevant agencies which will participate as Cooperating Agencies (the details of the Cooperating Agencies' roles are provided in the following section). As shown in the Figure on the implementation arrangement, the DCC will draw membership from the District Development Committee (DDC) as well as other line agencies. The latter include the Departments of Soil Conservation and Watershed Management (DOSCWM), Forest (DOF), and Agriculture (DOA). The Chief District Officer (CDO) will also serve as a DCC member.

At present, all the district-level DOI's resources for flood control are channeled through the District River Training Coordination Committee (DRTCC). It is proposed to replace DRTCC with DCC, since the latter has the following advantages over DRTCC:

1) **All the flood-prone villages will be directly represented in DCC,** to provide an open and transparent forum for interactions between the district and the villages (whereas DRTCC is composed only of district-level representatives, which often is the cause of irrational allocation of funding).
2) **DCC will draw members from pertinent line agencies,** i.e., DOSCWM, DOF, and DOA for a more comprehensive approaches to river training (whereas DRTCC does not include any line agencies, which makes it difficult to coordinate river training, with other related developmental activities).

(2) Cooperating Agencies

The DCC member institutions will participate in the project implementation, as the cooperating agencies. The flood mitigation project is a multi-sectored undertaking which no single agencies can handle on its own. Accordingly, DOI will mobilize technical line agencies as well as local government institutions, who will take on the tasks and responsibilities explained below.

Technical Line Agencies:

1) **DOSCWM:**
   - Initiate project aimed at soil conservation in the Siwalik hills.
   - Provide seed and seedlings, as well as technical support for soil conservation.
   - Offer technical advice and also provide seedlings to protect infrastructure, soil erosion and flooding.
2) **DOF:**
   - Assist in establishing forest/grass belts along riverbanks.
   - Provide seed and saplings, as well as technical support.
   - Hand over forest and riverbed management to local communities wherever feasible.
   - In the watershed, hand over management of the forests to the local communities wherever feasible, and assist in their management.
3) **DOA:**
   - Provide technical advice on safe cultivation on the riverbank.

- Offer awareness building and seedlings to support in crop production that would minimize river cutting and flood damage.

4) **CDO:**
   - Resolve conflicts when DDC/VDCs alone cannot handle.
   - Make available district-level Natural Calamity Fund for community-level flood management.
   - Coordinate relief activities with the overall flood mitigation plan.

Local Government Institutions (LGIs):

1) **DDC:**
   - Undertake the community development component for the flood mitigation, in collaboration with the VDCs and communities.
   - Contribute some funding and other resources for community development, in accordance with financial capacity.
   - Promote inter-VDC coordination, and/or coordination between DIO/other line agencies and the VDCs.
   - Shoulder the responsibility of regular monitoring and minor repair in partnership with the VDC/municipality.
   - Resolve conflict among different VDCs.
   - Include the program as a priority sector in district planning.

2) **VDC / Municipality:**
   - Collaborate with the DDC and local communities to conduct the community development component.
   - Contribute some funding and other resources for community development, in accordance with financial capacity.
   - Undertake regular maintenance and minor repair.
   - Mobilize community participation.
   - Set criteria of community and individual contribution on the basis of equity.
   - Control encroachments and inappropriate practices along riverbanks.
   - Take the main role to minimize and resolve conflicts, if any.

In view of upgrading the LGIs' capabilities to undertake these crucial roles for community development, a series of training workshops will be undertaken at the inception of community development activities.

7.7 Project Cost

7.7.1 Basic Conditions for Cost Estimates

Price Level: All unit costs are expressed under the economic conditions prevailing in October 1998.

Currency Exchange Rate: Currency exchange rates are assumed as follows:

US$1.00 = NRs.67.93 = ¥115.14 (NRs.1.00 = ¥1.69)

Composition of Project Costs: Project costs are composed of construction base cost, compensation cost, administration cost, engineering service cost, physical contingency, price contingency and value added tax. Calculation is carried out based on the following:

1) Construction base cost: Unit cost basis
2) Compensation cost: Unit cost basis
3) Administration cost: 5% of [(1) + (2)]
4) Engineering service cost: Lump sum basis
5) Physical Contingency = 10% of [(1) + (2) + (3) + (4)]
6) Price contingency (for financial cost only): At annual escalation rate of 3 % for the foreign currency, and 10 % for the local currency portions

Labor Wage: Basic labor wages were obtained from government agencies and the private sector. These rates were carefully examined and are shown in Table 7.14.

Unit Operation Cost of Heavy Equipment: Unit operation costs of heavy equipment are shown in Table 7.14. Operator, fuel and other administrative fees such as insurance, maintenance and so on are not included in the costs.

Unit Prices of Materials: Unit prices of construction materials available at the site and those delivered from other districts through suppliers or dealers are determined using current market prices. The construction material costs are listed in Table 7.15.

Foreign Currency and Local Currency Portion: Project cost consists of the foreign currency portion (F.C.) and the local currency portion (L.C.). The composition rates of the major work items are assumed as follows:

(Composition Rates of Foreign and Local Currency Portions)

Item	F.C. (%)	L.C. (%)
1. Labor wage	0	100
2. Owing cost of heavy equipment	100	0
3. Material unit cost		
- Cement	50	50
- Aggregate	60	40
- Fuel	50	50
- Deformed reinforcing bar	80	20
- Timber	10	90
4. Compensation cost	0	100
5. Administration cost	0	100

Financial Cost and Economic Cost: Financial cost is estimated as an actual expenses of the project owner on the market price basis, whereas economic cost for project evaluation is reckoned in terms of net usage of sources. The transfer cost such as tax and duty, and contractor's profit are, therefore, not included in the economic costs. Hence, the economic project costs were estimated from the financial project costs deducting 10% for transfer costs and contractor's profit.

7.7.2 Estimation of Project Cost

Project cost was estimated based on the design and construction schedule described in the previous sections.

(1) Unit Cost of Construction Works

Construction base cost was estimated as a product of unit cost and corresponding work quantity. Preparatory and miscellaneous works were estimated on lump sum basis, respectively, at 10 % of main works. The unit cost for each work item includes the costs of materials, labor and equipment. Contractor's indirect cost is also incorporated in the unit cost of each work item.

Unit costs, by work item, were established by analyzing the data of similar works implemented in recent years. The local conditions in Study Areas were also taken into consideration. In addition, the fittest unit prices of materials estimated through the detail research in the Study Areas were applied to both the Lakhandei and Babai rivers. The unit work costs are shown in Table 7.15.

(2) Project Cost of River Control Works

The project costs of the proposed river control works for the Lakhandei river and the Babai river were estimated as shown in Table 7.16 and Table 7.17 respectively and summarized below:

(Project Cost of River Control Works)

Item	Lakhandei river (million NRs)	Babai river (million NRs)
1. Construction Base Cost	280.5	338.7
2. Compensation Cost	45.4	26.6
3. Administration Cost	16.3	18.3
4. Engineering Cost	56.1	67.7
5. Physical Contingency	39.8	45.1
6. Value Added Tax	43.8	49.6
7. Grand Total	**481.9**	**546.1**

(Note) Price Contingency is not included in the Grand Total.

(3) Project Cost for Erosion Control Experimental Works

Several erosion control test works are planned in main channel, tributaries and whole watershed area in the Lakhandei river. The project costs of proposed erosion control works were estimated to be NRs. 52.3 million, excluding price contingency, as shown in Table 7.18.

(4) Operation and Maintenance Cost

The annual operation and maintenance (O&M) costs include the salaries of project administrative and operation staff, the material and labor costs for project facilities. The annual O&M costs were estimated to be 0.5 % of the total construction base cost.

7.7.3 Annual Disbursement Schedule and Fund Required

Annual disbursement of investment costs was estimated according to the implementation schedule. The disbursement schedules of financial costs for the Lakhandei river and the Babai river are shown in Table.7.19 and Table 7.20, respectively. The funds required for the project implementation were estimated at NRs. 689.3 million for the Lakhandei river and NRs. 744.7 million for the Babai river as summarized below.

(Fund Required)

Items	Lakhandei river (million NRs)	Babai river (million NRs)
Project cost	481.9	546.1
Price contingency	207.5	198.6
(1) Fund required	**689.3**	**744.7**

7.8 Evaluation

7.8.1 Economic Evaluation

Economic viability was examined for the flood mitigation projects proposed for the Feasibility Study (the Lakhandei and Babai river basins). Flood damage reduction benefit, bank protection benefit and indirect benefit were considered for the evaluation.

Flood Damage Reduction Benefit: At the beginning of the Feasibility Study stage, topographic mapping and river survey were conducted for the Lakhandei and Babai rivers. These additional data enable the estimation of flood damage reduction benefit based on the results of flood flow simulation in these rivers. The flood reduction benefit is defined as a balance of flood damages under the conditions without and with project.

Bank Protection Benefit: The bank protection benefit was estimated as a loss of land and properties on it.

Evaluation: Annual cash flows of the project cost, maintenance cost and benefit were prepared according to the proposed implementation schedule. Based on the implementation schedule, annual disbursement schedules for project evaluation were assumed as follows:

1) Lakhandei river: Detail design in 2001 and construction works 3 years from 2002 to 2005.
2) Babai river: Detail design in 2000 and construction works 4 years from 2001 to 2005.

Cash flows of the project cost, maintenance cost and benefit are shown in Table 7.21. As indexes of the economic viability, the EIRR, B/C and NPV-values were worked out in the table. The results are summarized below.

(Result of Economic Evaluation: Feasibility Study Level)

River	Existing basin			Future basin		
	EIRR (%)	B/C	NPV (10^6Rs)	EIRR (%)	B/C	NPV (10^6Rs)
Lakhandei	9.5	0.95	-14.6	20.8	2.05	308.0
Babai	9.7	0.98	-8.7	15.2	1.54	188.7

(Note) B/C and NPV were calculated under the discount rate of 10%.

(In-depth Methodology and procedures of economic evaluation of the project are compiled in SUPPORTING REPORT-C: BASIC INVESTIGATIONS AND STUDIES.)

7.8.2 Environmental Screening

(1) Environmental Screening

An environmental screening has been undertaken for all the eight rivers included in the Master Plan. This screening follows the JICA environmental screening process, since there is no statement for environmental screening in Environmental Conservation Rules (ECR) of Nepal. The screening is termed an "initial environmental examination" by JICA. However, it should not be confused with the IEE as specified in Environmental Conservation Rules of Nepal. This latter is a detailed and prolonged environmental assessment, where as the former is an environmental screening to determine which specific projects or areas within a project require detailed environmental studies. Thus in order to avoid confusion the JICA "initial environmental examination" will be termed as "environmental screening" or ES.

(2) Results of Environmental Screening

The social, natural and pollution environmental screening and the overall evaluation were undertaken for each of the eight rivers. The results of overall evaluation can be applied to all the rivers with few exceptions. However, two of the rivers, the Lohandra and Lakhandei, do not have designated wetlands along their lengths, thus no Environmental Impact Assessments (EIA) are envisaged for these floodplains, just Initial Environmental Evaluations (IEE) where structural river-work of over 1 km is proposed.

In addition, the Narayani river runs through the Royal Chitwan National Park and Babai river runs through the Royal Bardiya Wildlife Reserve. Both of these areas have buffer zones round them. No flood mitigation measures are contemplated in these parks or reserves, and the interventions in the buffer zones may be strictly limited by the

management plans already approved for these areas. Thus, the proposed flood mitigation interventions for these rivers are confined to areas outside the reserves, but nevertheless are comprehensive. If interventions are proposed for the buffer zones, an EIA should not be necessary if it conforms to the existing management plan.

For each of the eight rivers, the environmental screening gives very positive results. IEEs only have to be undertaken on areas where large-scale mechanical (structural) riverbank protection is required, (1 km or more) and perhaps where people are displaced. Discrete EIAs are necessary for designated wetlands along the rivers but not where interventions in buffer zones are proposed. Otherwise, this environmental screening should be sufficient to satisfy the environmental obligations of the project, provided the local people are fully involved in the decision making process.

(The results of environmental screening of respective rivers are given in SUPPORTING REPORT-A (A1 through A8): FLOOD MITIGATION.)

7.8.3 Technical Evaluation

The flood mitigation activities must be undertaken in a sustainable way. Therefore, the plan must fit well with the local situation, the technical capability and financial solvency of the central and local government agencies, non-governmental organizations and local communities concerned. In planning the flood mitigation plan of the rivers in the Terai plain, efforts were made for the plan to meet these requirements as presented below.

1) **Consideration on Local Situation:**
   - Bottom-up procedures by community development activities are proposed for planning and implementation of the project.
   - Maximum use of local materials is proposed, and the works proposed are labor intensive.
   - Considering the potential disastrous situation of the Study Area, stage-wise approaches are proposed so that the residents could enjoy the benefits soon after they have been finished the component works invested.
   - The proposed works are selective for their sizes and able to enhance their function depending on the requirements and solvency of the local communities.

2) **Consideration on Technical Capability:**

- The proposed works are mostly simple for their construction and maintenance as far as the appropriate instructions are given timely by the DOI/DIO engineer.
- Participation of local communities in flood mitigation work is proposed. Through the experience of participation, local community will also learn the technique for flood mitigation and improve their awareness. This would contribute much to the sustainability of the project operation.
- The proposed river control measures will be improved through on-site experience so that the measures will be more effective, practical and economic.

3) **Consideration on Financial Solvency:**

- Taking into consideration the financial strictures of the country, low cost and labor intensive project is proposed with full use of local materials.
- In addition to the procurement of fund from central and local government, in-come generation measures are proposed as a part of community development activities.

ROUTE OF LAKHANDEI BETWEEN LAKSMIPUR AND BELHI VILLAGES

Descriptions	Alternative-1 (Existing route)	Alternative-2 (Eastern route)	Alternative-3 (Western route)
SCHEME DESCRIPTION	Improvement of existing channel with intensive revetment works	Bypassing Sundarpur and Laksmipur villages on the east side by new channel of about 2.3km long.	Bypassing Sundarpur and Laksmipur villages on the west side by new channel of about 2.1km long.
TECHNICAL ASPECT			
- Major quantity of work	- New channel: None Excavation: None - Spur: 97 pcs. - Revetment: 450 m - Closing dike: 7,730 m^3	-New channel: 2.3 km Excavation: 97,750 m^3 - Spur: 67 pcs. - Revetment: None - Closing dike: 7,730 m^3	- New channel: 2.1 km Excavation: 89,250 m^3 - Spur: 83 pcs. - Revetment: None - Closing dike: 7,730 m^3
- Difficulty in work	Not difficult	New channel	New channel
- Ranking (Wt=0.15)	1	2	2
FINANCIAL ASPECT			
- Project cost	Rs 27.9 million	Rs 23.6 million	Rs 27.6 million
- Maintenance cost	High	Medium	Medium
- Ranking (Wt=0.40)	2	1	3
ECONOMIC ASPECT			
- Project effects	- Same as other scheme	- Same as other scheme	- Same as other scheme
- Other positive/negative effects	- Though the bank protection will be achieved, villages still suffer from direct attack from flood flows.	- Route is most smooth among the three, and no village suffers from direct flood attack.	- Route is more smooth than the existing route, but Sundarpur still suffers from direct flood attack.
- Ranking (Wt=0.15)	3	1	2
SOCIAL ASPECT			
- Relocation of houses	9 houses	None	None
- Land acquisition	None	12 ha	11 ha
	Easy to get consent	Beneficiaries live near the new channel	Beneficiaries live near the new channel
- Ranking (Wt=0.15)	3	1	1
ENVIRONMENTAL ASPECT			
- Negative impact	Not identified	Not identified	Not identified
- Positive impact	Not identified	Not identified	Not identified
- Ranking (Wt=0.15)	1	1	1
OVERALL EVALUATION			
- Summary of ranking	**1.97**	**1.14**	**2.08**
- Special remarks	None	None	None
- Evaluation	Not selected	SELECTED	Not selected

(REMARKS) Wt: Weight for overall evaluation

Table 7.1

SEVERE MEANDERING OF BABAI RIVER AT INDRAPUR BRIDGE

Descriptions	Alternative-1 (Existing route)	Alternative-2 (Cut-off channel)
SCHEME DESCRIPTION	Intensive bank protection of existing river channel	Cut-off channel
TECHNICAL ASPECT		
- Quantity of work	- New channel: None Excavation: None - Spur: 38 pcs. - Revetment: 2,750 m - Closing dike: None	- New channel: 1.4 km Excavation: 390,000 m^3 - Spur: 7 pcs. - Revetment: 1,450 m - Closing dike: 44,880 m^3 - Reclamation of land: 100 ha
- Difficulty in work	Not difficult	New channel
- Ranking (Wt=0.15)	1	2
FINANCIAL ASPECT		
- Project cost	Rs 52.0 million	Rs 48.7 million
- Maintenance cost	High	High
- Ranking (Wt=0.40)	2	1
ECONOMIC ASPECT		
- Project effects	- Same as other scheme	- Same as other scheme
- Other positive/negative effects	- Though the bank protection will be achieved, flood flows in meandering channel still attack the bridge approaches.	- A part of existing river area can be reclaimed
- Ranking (Wt=0.15)	2	1
SOCIAL ASPECT		
- Relocation of houses	None	None
- Land acquisition	None	11 ha of land on opposite side bank of beneficiaries 100 ha of reclaimed land on Glaria side
- Ranking (Wt=0.15)	1	2
ENVIRONMENTAL ASPECT		
- Negative impact	Not identified	Small portion of forest on right bank must be cut.
- Positive impact	Not identified	Not identified
- Ranking (Wt=0.15)	1	2
OVERALL EVALUATION		
- Summary of ranking	1.53	1.44
- Special remarks	None	None
- Evaluation	Not selected	**SELECTED**

(REMARKS) Wt: Weight for overall evaluation

Table 7.2

SHARP BEND OF BABAI RIVER NEAR KUSUMBA BAZAR

Descriptions	Alternative-1 (Existing route)	Alternative-2 (Cut-off channel)
SCHEME DESCRIPTION	Intensive bank protection of existing river channel	Cut-off channel
TECHNICAL ASPECT		
- Quantity of work	New channel: None Excavation: None - Spur: 62 pcs. - Revetment(Type-Rb): None Revetment(Type-Rc): 1,450 m - Closing dike: None	New channel: 1.3 km Excavation: 825,000 m^3 - Spur: 24 pcs. - Revetment(Type-Rb): 2,950 m Revetment(Type-Rc): None - Closing dike: 44,880 m^3
- Difficulty in work	Not difficult	New channel
- Ranking (Wt=0.15)	1	2
FINANCIAL ASPECT		
- Project cost	Rs 88.9 million	Rs 109.5 million
- Maintenance cost	High	High
- Ranking (Wt=0.40)	1	2
ECONOMIC ASPECT		
- Project effects	- Same as other scheme	- Same as other scheme
- Other positive/negative effects	- Though the bank protection will be achieved, flood flows still attack the bridge approaches.	- Flood attack to downstream left bank can be alleviated
- Ranking (Wt=0.15)	2	1
SOCIAL ASPECT		
- Relocation of houses	None	None
- Land acquisition	None	25 ha Forest land
- Ranking (Wt=0.15)	1	2
ENVIRONMENTAL ASPECT		
- Negative impact	Not identified	Forest on the left bank must be cut.
- Positive impact	Not identified	Not identified
- Ranking (Wt=0.15)	1	2
OVERALL EVALUATION		
- Summary of ranking	**1.13**	**1.84**
- Special remarks	None	None
- Evaluation	**SELECTED**	Not selected

(REMARKS) Wt: Weight for overall evaluation

Table 7.3

COSTS ESTIMATED FOR ALTERNATIVE SCHEMES

ALTERNATIVE ROUTES OF LAKHANDEI RIVER BETWEEN LAKSMIPUR AND BELLI VILLAGES

(unit: NRs1,000)

Item	Unit	Alt.1 (Existing Route)			Alt.2 (East Route)			Alt.3 (West Route)		
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount	Quantity	Unit Price	Amount
Spur	pc	97	211.20	20,539	67	211.20	14,150	83	211.20	17,503
Revetment	m	450	9.85	4,431	0	9.85	0	0	9.85	0
Closing Dike	m3	10,000	0.11	1,100	10,000	0.11	1,100	10,000	0.11	1,100
Excavation	m3	0	0.09	0	97,750	0.09	8,798	89,250	0.09	8,033
Land Acquisition	ha	0		0	12	270	3,105	11	270	3,005
House Evacuation	pc	9	200	1,800	0	0	0	0	0	0
Land Development	ha	0		0	18	203	-3,544	10	203	-2,025
Total				27,870			23,609			27,616

ALTERNATIVES AT SEVERE MEANDERING OF BABAI RIVER AT INDRAPUR BRIDGE

(unit: NRs1,000)

Item	Unit	Alt.1 (Existing Route)			Alt.2 (Cut-off-channel)		
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount
Spur	pc	38	580.80	22,288	13	580.80	7,696
Revetment	m	2,750	10.79	29,673	1,850	10.79	19,962
Closing Dike	m3	0	0.11	0	11,440	0.11	1,258
Excavation	m3	0	0.09	0	390,000	0.09	35,100
Land Acquisition	ha	0	240.00	0	11	240.00	2,640
House Evacuation	pc	0			0		
Land Development	ha	0		0	100	180.00	-18,000
Total				51,961			48,656

ALTERNATIVES AT SHARP BEND OF BABAI RIVER NEAR KUSUMBA BAZAR

(unit: NRs1,000)

Item	Unit	Alt.1 (Existing Route)			Alt.2 (Cut-off-channel)		
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount
Spur	pc	62	580.80	36,191	24	580.80	14,121
Revetment(Type-Rb)	m	0	10.79	0	2,950	10.79	31,831
Revetment(Type-Rc)	m	1,450	36.32	52,664	0	36.32	0
Closing Dike	m3	0	0.11	0	11,440	0.11	1,258
Excavation	m3	0	0.09	0	825,000	0.09	74,250
Land Acquisition	ha	0	240.00	0	25	240.00	6,000
House Evacuation	pc	0			0		
Land Development	ha	0		0	80	180	-18,000
Total				88,855			109,460

Table7.5

LIST OF LOCAL ORGANIZATIONS IN FLOOD-AFFECTED VDCs ALONG LAKHANDEI RIVER

VDCs	Local/Indigenous Groups	Externally Induced Organizations
Patharkot VDC	Irrigation Group (only in Ward 1 & 3) Forestry Group (only in Ward 1,2 &9) Youth Sports Club	Women's Group (Supported by District Woman Development Office)
Netragunj VDC	-	Women's Group (Supported by Rural Woman Development Organization)
Gurkauli VDC	Tamang Gheding Committees Langhali Sang (Magar Community Group)	Women's Group (Supported by District Woman Development Office) Farmers' Groups (Supported by Agriculture Development Bank)
Haripur VDC	Manab Chhahari Sangh (Livestock Groups) Tharu Welfare Committee Group	-
Pidari VDC	Tharu Welfare Committee Group	Women's Group (Supported by SFDP - Small Farmer Development Program)
Pipariya VDC	-	Women's Group (Supported by Agricultural Development Bank)
Janaki Nagar VDC	Irrigation Group (Only in Ward 6 &7)	-
Shripur VDC	-	-
Bheli VDC	Shree Jan Kalyan Youth Club. Belhi Market Committee	Goat Farming. Group (Support By Social Welfare Council)
Padariya VDC	-	-
Sunderpur VDC	Muslim Language School Committee	-
Laksmipur VDC	-	-
Phul Parasi VDC	-	-
Sakrual VDC	-	-
Bhadsar VDC	Gan Joyti Youth Club Dairy Cooperative	-
Simara VDC	Mahadev Temple Committee Purnima (Religious Group) Shree Panchimi. (Religious Group)	-

POSSIBLE CATCH CROPS AT FLOOD AFFECTED AREA (LAKHANDEI R.)

NAME OF THE VDC	WARD NO. - VILLAGE	CROPS/VEGETABLES/ OTHERS
Netragunj	4. Magar Tole	Sugarcane, Lentil Pigionpea & Groundnut
Gurkauli	1. Chheda Tole	Groundnuts, Pointed Gourd & Cuccurbits,
	7. Kingring Tole	-
Haripur	1. Jagatpur, Jutpani	
	7. Kacchadiya Tole, Pulchoke, Sano Jagatpur & Sakuwa	
	8. Haripur	Sugarcane & Pigionpea
	9. Balrampur	Sugarcane & Pigionpea
Pidari	1-9 Dhapa Tole	Sugarcane
Pipariya VDC	3,4 & 5 Pipariya	Sugarcane & Banana
Janaki Nagar	1. & 2. Khaira Tole, Nakha Tole, Janakinagar	Sugarcane, Lentil & Groundnut
	6. & 7. Gangapur	Sugarcane, Pointed Gourd, Sweet Potato, Groundnut & Banana
Shripur	7,8 & 9. Shreepur	Sugarcane, Banana, Groundnut
Belhi	5,7,8 & 9 Belhi	Sugarcane
Padariya VDC	1-5 Pakriya	Sarpat (very good for river training also) Sugarcane
	6,7,8, & 9 Shivnagar	Sugarcane, Groundnut
Sundarpur	1. Sundarpur	Sugarcane
Laksmipur	2-4 Laxmipur	-
	5-9 Sukhchaina	Sugarcane & Banana
Phul Parasi	1-9 Phool Parasi/Inruwa	Pigionpea, Sugarcane, Groundnut & Banana
Sakraul	1 & 7 Sakraul	Sugarcane, Banana, Groundnut & Pointed Gourd.
Bhadsar	2,3,4 & 5 Malaha Tole	-
Simara	2-3 Simara	Sugarcane

TREES/SHRUBS/GRASS ALONG LAKHANDEI RIVER

	Name of Plants	Uses
1.	Sisso (tree)	Fuel , Furniture , Timber
2.	Khayer (tree)	Fuel , Katha , Piller
3.	Simal (tree)	Timber for House Construction , Fuel
4.	Sal (tree)	Timber
5.	Babul (tree)	Fuel, Make for cart , Live Fence
6.	Teak (tree)	Furniture
7.	Behiya (shrub)	Live Fence , River Training (Bio-Engineering)
8.	Bamboo	Local Furniture, House Construction
9.	Kusum (tree)	Fodder, Furniture, Fruit, Fuel
10.	Jamun (tree)	Timber, Fuel
11.	Karma (tree)	Timber, Furniture
12.	Bhady (tree)	Timber, Furniture
13.	Barro (tree)	Fuel, Furniture
14.	Eucalyltus (tree)	Fuel Timber
15.	Badahar (tree)	Fodder
16.	Paddy	Fuel, Green Compost
17.	Jackfruit (tree)	-
18.	Litchi (tree)	-
19.	Coconut (tree)	-
20.	Pepal (tree)	-
21.	Salpat (grass)	Sal Leaf(Long Grass Use For House Fence, Roof And Very Good For River Training)
22.	Mango (tree)	Best Timber Fuel And Fruit)
23.	Guwava (tree)	-
24.	Banana (tree)	-
25.	Tilka (shrub)	-
26.	Hatle (tree)	-
27.	Karam (tree)	-
28.	Dadape (tree)	-

Table 7.8

TREES/SHRUBS/GRASS AVAILABI/ NEEDS IN VARIOUS LOCALITEIS (LAKHANDEI)

	What Trees/Shrubs/Grass Are Available Locallly ?	What Trees/Shrubs/Grass Are Needed Most by People ?
Patharkot VDC Ward 7 & 9	Sal, Sissoo, Euclyptus, Mango, Jackfruit, Sal, Hatle, Khayer, Karam And Dadape	
Netragunj VDC 4	Sisau, Tik, Ecupltus).	
Gurkauli VDC 1	Sasau, Babul, Bamboo.	
Gurkauli VDC 7	Ecupltus, Sisau	Sissoo, Mango, Jack Fruits
Haripur VDC 7, 8& 9	Sal, Karma, Jamun, Bhady, Kusum.	Sissoo, Mango, Jack Fruits, Euclyptus, And Khayer
Janaki Nagar VDC 1 & 2	Sisau Ecuplentus Badahar Bamboo, Sal, Simal, Paddy Kusum And Jamun	Sissoo, Mango, Jack Fruits And Leechi
Pidari VDC 1- 9	Sisau, Mango Bamboo Ecupltus	Sissoo, Mango, Euclyptus
Pipariya VDC 3, 4 & 5	Sisau, Ecupltus, Sal, Tik, Mango, Simal, Jackfruit, Leechi And Coconut.	Mango
Janaki Nagar VDC 7& 6	Sisau, Ecupltus, Bamboo, Mango.	
Shripur VDC 7, 8,& 9	Sisau, Simal, Mango, Bamboo, Euclyptus.	Sisso, Mango, Bamboo, Tik, Euclyptus
Belhi VDC 5, 7 & 8	Sisau, Mango, Bamboo Jackfruit, Simal, Jamun And Ecupltus	Sisau
PadariyaVDC – 6, 7, 8 & 9	Sisau, Mango, Simal	Sisau, Mango
PadariyaVDC 1-5	Sisau, Mango, Salpat	
Sundarpur VDC 1	Sisau, Mango, Bamboo, Jamun And Pepal.	Sissoo, Khayer, Simal
Laksmipur VDC 5	Mango, Sisau, Guava, Jackfruit, Bamboo, Badahar Simal.	Mango
Phul Parasi VDC 1-9	Sisau, Bamboo, Mango.	Sal
Sakraul VDC 1 & 7	Sisau, Mango, Simal, Bamboo, Jackfruit, Tilka (Local Name), Banana.	
Bhadsar VDC 2, 3, 4 & 5	Sisau, Mango, Banana.	
Simara VDC 2, 3 & 7	Sisau, Mango, Bamboo, Jackfruit.	Sisau, Mango

LIST OF TRADITIONAL IRRIGATION GROUPS (CHAUDARY) IN FLOOD-AFFECTED VDCs

Bargadaha System

Bagnaha VDC

Ward	No. 2	Bargadaha
	No. 3	Mrchaiya
	No. 4	Mainubar
	No. 6	Govindpur
	No. 7	Bagnaha
	No. 8	Bawanpur
	No. 8	Sainubar
	No. 9	Manpur
	No.	Sutapur

Dhodhari System

Bagnaha VDC

Ward	No. 1	Shaipur
	No. 1	Dugrahawa
	No. 5	Banbir
	No. 6 (A)	Takiwaha
	No. 6 (B)	Bankari
	No. 7	Bagnaha

Sano Shri VDC

Ward	No. 1 (A)	Shreekaida
	No. 1 (B)	Bada gau
	No. 2 (A)	Indrapur
	No. 2 (B)	Kashipur
	No. 3 (A)	Shivanagar
	No. 3 (B)	Durgapur
	No. 4	Ganeshpur
	No. 5 (A)	Shreenagar
	No. 5 (B)	Shreenagar
	No. 6	Buddhanagar
	No. 7 (A)	Santinagar
	No. 7 (B)	Saktipur
	No. 8	Krishnapur
	No. 9	Ramnagar

Buddahan System

Padhanaha VDC

Ward	No. 1.	Padanaha
	No. 2.	Bairia, Jagtiya
	No. 3.	Banghusri
	No. 4.	Bardiya
	No. 5.	Sorhabigha, Borfardiya
	No. 6.	Padanaha
	No. 7.	Ghorpitta
	No. 8.	Ranipur, Barbatta, Shreepur
	No. 9.	Guruwagaon, Phatterpur, Rajapur

Bhaniyabhar VDC

Ward	No. 1	Bhaniyabhar, Jamuniya
	No. 6/7	Bellabajha
	No. 9	Mudba

Manjhara System

Baniyabhar VDC

Ward	No. 2	Jodhipur, Baniyabhar, Pahadipur, Kusumdemda
	No. 3	Kumrahwa Gaon, Pachgharawa
	No. 4	Dhongarahi, Naryanpur, Gauripara, Patuwaripur
	No. 5	Jongigau,, Ghidharpur, Lathuwa, Bepptapur, Jitpur, Hasnapur, Gonghipur, Namidashara, Bethunidanda
	No. 6	Rampur, Laxmanpur

Dhadhawar VDC

Ward	No. 1	Dhadhawar
	No. 2	Bakalbhar
	No. 3	Katarniya
	No. 4	Baida, Gumsta
	No. 5	Jabdi, Khumtipur
	No. 6	Akalgharaia, Phakchawa
	No. 7	Dhudha, Thanagfna
	No. 8	Bakalbhar

Source: Note Prepared by Chaudary (Leader) of Bargadaha System

Note:

1: Along Babai there are five chaudary system , and four of them cover flood – affected VDC.

2: Gulariya municipality and Mahamadpur VDC have no chaudary systems.

Table 7.10

POSSIBLE CATCH CROPS AT FLOOD AFFECTED AREA (BABAI R.)

NAME OF THE VDC/MUNACIPALITY	WARD NO. - VILLAGES	CROPS/VEGETABLES
Baghna VDC	1. Shahipur, Khunpur, Chandanpur	Pigeon Pea
	2. Bargadaha	Sugarcane, Sweetpotato Pigionpea
	6. Bankatti	
	9. Manpur	-
Sano Shree VDC	3. Shivnagar	-
Baniyabhar VDC	3,4. Kumargau Dhungrigu	Sweetpotato, Groundnut Pigionpea, Gourd, Bitter Gourd, Pointedgourd, Tomato
	9. Jhakipur	Pigionpea, Tomato
Padanaha VDC	8, 9. Sarjipur, Rajpur, Ranipur	Groundnut, Sweetpotato Pigionpea
Dhadhawar VDC	5. Jabdi, Khumtipur	Pigionpea, Tomato, Bittergourd, Gourd
	8. Belbhar	Pigionpea, Sweetpotatato Groundnut
Mohmadpur VDC	7. Indrapur	Pointedgourd, Sweetpotato Bittergourd, Gourd, Pigionpea
	8, 9. Bhaisai, Bikri	Sugarcane, Groundnut, Pigionpea, Pointedgourd Bittergourd, Gourd, Sweetpotato
Guleriya Municipality	2. Panditpur	Pigionpea, Groundnut Tomato, Bittergourd
	5. Tulsipur	Pigionpea
	6. Shuhelwa	Pigionpea
	8. Kothiya	Bittergourd, Pigionpea Sugarcane, Groundnut
	10. Thapuwa	Bittergourd, Pointedgourd Cuccurbits, Watermelon Tomato, Ladyfinger
	13. Ratanpur	Pointedgourd, Bittergourd Watermelon, Gourd (Lauka) Pigionpea, Cuccurbits
	14. Parsiya	Pointedgourd, Bittergourd Watermelon, Gourd, Pigionpea, Cuccurbits

TREES/SHRUBS/GRASS ALONG BABAI RIVER

Name of Plants	Uses
1. Sisso (tree)	Fuel , Furniture , Timber
2. Khayer (tree)	Fuel , Katha , Piller
3. Simal (tree)	Timber for house construction, Fuel
4. Sal (tree)	Timber
5. Khar (Grass)	Thatch/Roofing
6. Peruwa	-
7. Babul (tree)	Fuel , Make for cart , Live Fence
8. Tik (tree)	Furniture
9. Dhumre (Grass)	Fodder
10. Behiya (shrub)	Live fence , River Training (Bio-Engineering)
11. Bamboo (tree)	Local Furniture, House Construction
12. Kusum (tree)	Fodder, Furniture, Fruit, fuel
13. Ashrey (Bushy types) (shrub)	Fuel
14. Kharse (tree)	Fodder
15. Khori (tree)	Fodder
16. Tote (tree)	Fodder
17. Rohini (tree)	Fodder, Use as dam at irrigation cannel
18. Asna (tree)	Timber (Can use for house construction where water does not hit direct)
19. Jamun (tree)	Timber, fuel
20. Paya (shrub)	Fuel
21. Dhouti (tree)	Fuel
22. Bell (tree)	Fuel, Fruit
23. Tenu (tree)	Fodder
24. Saj (tree)	Timber, Furniture

TREES/SHRUBS/GRASS AVAILABI/ NEEDS IN VARIOUS LOCALITEIS (BABAI)

	What Trees/Shrubs/Grass Are Available Locally ?	What Trees/Shrubs/Grass Are Needed Most by People ?
Gulariya Ward 6	Sissoo, Khair	Sisso, Khair
Gulariya Ward 5	Khair, Simal	Khair, Simal
Gulariya Ward 13	Sal, Khar and Peruwa	Sal, Khar, Peruwa
Gulariya Ward 14	Babul, Mango, Sissoo and Sagum (Tik)	Babul, Mango, Sissoo and Sagum
Gulariya Ward 8	Sissoo, Sal, Khayer, Mango, Simal, Dhunre and Bheu	Sissoo, Sal, Khayer, Mango, Simal, Dhumre, and Bheu
Gulariya Ward 10	Babul, Bamboo, Guava	Babul, Bamboo, Guava
Gulariya Ward 2	Kusum, Simal, Sissoo, Khayer, Ashre, Khari Tote, Rohini, and Khasse	Kusum, Simal, Sissoo, Khayer Asna, Khari Tote and Rohini
Sano Shri Ward 3		Sissoo, Sal, Asna
Bagnaha Ward 1	Sal, Sissoo, Khayer, Asna, Kusum, Janum, Rohini, Payr, and Dhoti Simal	Sal. Sissoo, Asna, Kusum
Bagnaha Ward 2	Sisso, Babul	Sal, Sissoo, Asna, Kusum
Mahamadpur Ward 7	Babul, Sissoo, Simal	Baboor, Sissoo, Simal
Mahamadpur Ward 9	Sal, Khayer	Baboor, Sissoo, Simal
Padanaha Ward 8	Khayer, Sissoo, Simal, Babul	Khayer, Sissoo, Simal, Baboor
Baniyabhar Ward 3/4	Simal, Khayer, Sisoo, Sal Eculyptus, Mango, Guava, Bheu, Janum, Khar, Sentha, Bayer, Khaniya, Rohini, Neeu, and Nigot	Simal, Baboor, Rohini, Sal
Baniyabhar Ward 9	Babul, Simal, Sal, Sissoo, Neem, Khar and Churki	Simal. Baboor, Rohini, Sal
Dhadhawar Ward 8	Simal, Sal, Soj, Khair, Bel, Dhanti, Khusum, Janum, Kachari, Bakino, Pipal, Ficus and Neem	Sissoo, Babul, Bamboo
Dhadhawar Ward 5	Sissoo, Babul ,Bamboo	Sissoo, Babul, Bamboo

OVERALL FRAMEWORK OF COMMUNITY DEVELOPMENT

Lakahndei River

Community Mobilization

1) Formation of Community Groups
- Learning from a limited # of outstanding cases of community mobilization

2) Creation of Awareness, Knowledge & Skills
- Education on technical measures for flood control (spurs, dikes etc.)
- Skills training on gabion netting and masonry
- Promotion of proper land use practices

3) Groups Savings for Disaster Management
- Resource mobilization for regular maintenance of river training facilities
- Local contributions for community-based actions
- More emphasis on women's participation

Local Coping Strategy

1) Flood Proofing
- Agricultural adjustments (esp. through flood-proof varieties, & storage of rice saplings)
- Housing structure through plantation of trees for durable construction materials

2) Forecasting, Warning, & Evacuation
- Warning utilizing existing facilities (e.g., PCO, & mosques)
- Accessibility enhancement for evacuation

3) Flood Fighting
- Supply of materials not available locally (e.g., boulders, gabion)
- Dissemination of flood fighting activities

Multi-purpose Facility

1) Collection of Bed Materials
- Clear-cut rules for sand/gravel extraction
- Enforcement of guidelines for proper extractions

2) Forest/Grass Belts
- Use of trees/grass for livelihood improvements (fuel, fruits etc.)
- Plantation of trees for evacuation & housing

3) Preventive Bank Protection
- Introduction of high-value grass /shrubs
- Simple protection works using local materials
- Dissemination of bio-engineering

4) Road Network Development
- Access improvement using river control facilities (esp. dikes)
- Road improvements for flood mitigation & to meet other local needs

Babai River

Community Mobilization

1) Formation of Community Groups
- Working through, or building upon, traditional irrigation groups

2) Creation of Awareness, Knowledge & Skills
- Education on technical measures for flood control (spurs, revetments etc.)
- Skills training on gabion netting and masonry
- Promotion of proper land use practices

3) Groups Savings for Disaster Management
- Resource mobilization for regular maintenance of river training facilities
- Local contributions to undertake community-based disaster management actions

Local Coping Strategy

1) Flood Proofing
- Agricultural adjustments (esp. through irrigation, & flood-proof varieties)
- Reforestation/aforestation
- Installation of drainage

2) Forecasting, Warning, & Evacuation
- Forecasting & warning utilizing existing facilities (e.g., irrigation barrage)
- Organized strategy for river watching

3) Flood Fighting
- Local production and procurement of flood fighting materials (e.g., bamboo, sandbags)
- Dissemination of flood fighting activities

Multi-purpose Facility

1) Collection of Bed Materials
- Exemption of prohibitive rules
- Enforcement of guidelines for proper extractions

2) Forest/Grass Belts
- Use of trees/grass for livelihood improvements (fuel, fodder, roofing, etc.)
- Plantation of trees for flood fighting

3) Preventive Bank Protection
- Introduction of high-value grass /shrubs
- Simple protection works using local materials
- Dissemination of bio-engineering

4) Road Network Development
- Access improvement using river control facilities (esp. bank protection)

LABOR WAGE & CONSTRUCTION EQUIPMENT COST

BASIC LABOUR WEGES (NRs)

Item	Unit	F.C.	L.C.	Total
Foreman	md	0	150	150
Welder	md	0	140	140
Operator	md	0	120	120
Electrician	md	0	140	140
Mechanic	md	0	120	120
Mason	md	0	140	140
Painter	md	0	140	140
Driver	md	0	100	100
Concrete Worker	md	0	140	140
Steel Worker	md	0	140	140
Carpenter	md	0	140	140
Skilled Labour	md	0	100	100
As.Operator	md	0	100	100
As.Driver	md	0	80	80
Common Labour	md	0	60	60

(REMARKS) F.C:Foreign currency portion, L.C:Local currency portion

UNIT OPERATION COST OF MAJOR CONSTRUCTION EQUIPMENT (NRs)

Item	Capacity	Unit	F.C.	L.C.	Total
Backhoe	0.7 m^3	hour	1,440	360	1,800
Backhoe	1.2 m^3	hour	2,560	640	3,200
Bulldozer	21 ton	hour	3,200	800	4,000
Bulldozer	11 ton	hour	1,440	360	1,800
Tractor Shavel	2 m^3	hour	1,440	360	1,800
Dump Truck	8 ton	hour	640	160	800
Air Compressor	11 m^3/min	day	3,360	840	4,200
Leg Hammer		day	800	200	1,000
Tire Roller	8 ton	hour	960	240	1,200
Vibratory Roller	3 ton	hour	560	140	700
Vibratory Roller	8 ton	hour	1,120	280	1,400
Truck Crane		hour	2,080	520	2,600
Aggregate Plant		hour	7,200	1,800	9,000
Batcher Plant	25 m^3/h	hour	4,320	1,080	5,400
Concrete Mixer		day	240	60	300
Crawle Crane	30 t	hour	3,200	800	4,000
Concrete Vibrator		day	400	100	500

MATERIAL PRICE AND WORK COST IN LAKHANDEI RIVER FOR FEASIBILITY STUDY

UNIT PRICES OF CONSTRUCTION MATERIALS (NRs)

Item	Unit	F.C.	L.C.	Total
Portland Cement	ton	3,100	3,100	6,200
Concrete Aggregate; Coarse	m^3	324	216	540
Concrete Aggregate; Fine	m^3	240	160	400
Boulder Stone	m^3	276	184	460
Crushed Stone	m^3	324	216	540
Formwork Timber	m^3	2,000	18,000	20,000
Plywood (t=1.2 cm)	m^2	168	112	280
Bamboo; (L=5m)	pc	10	90	100
Deformed Bar	t	25,520	6,380	31,900
Gabion Wire	kg	36	9	45
Asphalt	kg	13	13	25
Gasoline	ltr	15	15	30
Light Oil	ltr	5	5	10
Hydraulic Oil	ltr	40	40	80
Grease	kg	35	35	70
Drain Pipe; PVC(D=40mm)	m	36	144	180
Hume Pipe (D=0.9m)	m	700	2,800	3,500
Hume Pipe (D=1.2m)	m	1,080	4,320	5,400
Water Stop; t=250mm	m	200	200	400
Log Pile (ϕ 0.15m)	m	35	318	353
RC Pile (□ 0.2m x 0.2m)	m	180	180	360

(REMARKS) F.C:Foreign currency portion, L.C:Local currency portion

UNIT COSTS OF CONSTRUCTION WORKS (NRs)

Work Item	Unit	F.C.	L.C.	Total
Stripping of Top Soil	m^2	0	5	5
Excavation(soft soil)	m^3	0	45	45
Excavation(boulder mixed soil)	m^3	0	90	90
Excavation(weathered rock)	m^3	252	28	280
Excavation(rock)	m^3	324	36	360
Embankment	m^3	51	34	85
Back Filling	m^3	24	16	40
Plain Concrete(1:3), inc.formwork	m^3	1,920	2,880	4,800
Reinforced Con.(1:3.), inc.form&steel	m^3	4,500	4,500	9,000
Wet Masonry	m^3	800	1,200	2,000
Rubble Concrete	m^3	1,200	1,800	3,000
Boulder Pitching	m^3	480	720	1,200
Gabion	m^3	680	1,020	1,700
Boulder Riprap	m^3	240	360	600
Gravel Work	m^3	340	510	850
Turfing	m^2	3	12	15
Log Pile Piling (ϕ 0.15m)	m	42	398	440
RC Pile Piling (□ 0.2m x 0.2m)	m	218	282	500
Tree Planting	ha	17,420	50,700	68,120
Grass Planting	ha	24,900	101,000	125,900

MATERIAL PRICE AND WORK COST IN BABAI RIVER FOR FEASIBILITY STUDY

UNIT PRICES OF CONSTRUCTION MATERIALS (NRs)

Item	Unit	F.C.	L.C.	Total
Portland Cement	ton	3,100	3,100	6,200
Concrete Aggregate; Coarse	m^3	474	316	790
Concrete Aggregate; Fine	m^3	240	160	400
Boulder Stone	m^3	462	308	770
Crushed Stone	m^3	474	316	790
Formwork Timber	m^3	2,000	18,000	20,000
Plywood (t=1.2 cm)	m^2	168	112	280
Bamboo; (L=5m)	pc	10	90	100
Deformed Bar	t	25,520	6,380	31,900
Gabion Wire	kg	36	9	45
Asphalt	kg	13	13	25
Gasoline	ltr	15	15	30
Light Oil	ltr	5	5	10
Hydraulic Oil	ltr	40	40	80
Grease	kg	35	35	70
Drain Pipe; PVC(D=40mm)	m	36	144	180
Hume Pipe (D=0.9m)	m	700	2,800	3,500
Hume Pipe (D=1.2m)	m	1,080	4,320	5,400
Water Stop; t=250mm	m	200	200	400
Log Pile (ϕ 0.15m)	m	35	318	353
RC Pile (□ 0.2m x 0.2m)	m	185	185	370

(REMARKS) F.C:Foreign currency portion, L.C:Local currency portion

UNIT COSTS OF CONSTRUCTION WORKS (NRs)

Work Item	Unit	F.C.	L.C.	Total
Stripping of Top Soil	m^2	0	5	5
Excavation(soft soil)	m^3	0	45	45
Excavation(boulder mixed soil)	m^3	0	90	90
Excavation(weathered rock)	m^3	252	28	280
Excavation(rock)	m^3	324	36	360
Embankment	m^3	51	34	85
Back Filling	m^3	24	16	40
Plain Concrete(1:3), inc.formwork	m^3	2,024	3,036	5,060
Reinforced Con.(1:3.), inc.form&steel	m^3	4,630	4,630	9,260
Wet Masonry	m^3	924	1,386	2,310
Rubble Concrete	m^3	1,324	1,986	3,310
Boulder Pitching	m^3	604	906	1,510
Gabion	m^3	804	1,206	2,010
Boulder Riprap	m^3	364	546	910
Gravel Work	m^3	444	666	1,110
Turfing	m^2	3	12	15
Log Pile Piling (ϕ 0.15m)	m	42	398	440
RC Pile Piling (□ 0.2m x 0.2m)	m	223	277	500
Tree Planting	ha	17,420	50,700	68,120
Grass Planting	ha	24,900	101,000	125,900

SUMMARY OF PROJECT COST FOR LAKHANDEI RIVER (FINANCIAL) FEASIBILITY STUDY

(NRs1,000)

Item	Unit	Quantity	Amount		
			F.C.	L.C.	Total
I . Construction Base Cost			108,045	172,411	280,456
1. Preparatory Works	L.S.	1.00	9,822	15,674	25,496
2. Bank Protection			32,806	48,522	81,328
2-1 Pile Spur	km	4.10	10,497	13,165	23,662
2-2 Gabion Spur	km	11.46	22,309	35,357	57,666
2-3 Revetment	km	0.00	0	0	0
3. Dike Embankment			38,947	68,578	107,525
3-1 Forest and Grass Belt	ha	377.50	9,471	40,059	49,530
3-2 Dike Road	km	6.55	10,247	7,849	18,096
3-3 Ring Dike	km	5.30	10,623	9,980	20,603
3-4 Closing Dike	place	8.00	8,607	10,690	19,297
4. Channel Excavation	km	9.88	17,540	25,387	42,928
5. Miscellaneous Works	L.S.	1.00	8,929	14,249	23,178
II . Compensation Cost	L.S.	1.00	0	45,384	45,384
III . Addministration Cost	L.S.	1.00	0	16,292	16,292
IV. Engineering Cost	L.S.	1.00	33,655	22,436	56,091
V . Physical Contingency	L.S.	1.00	14,170	25,652	39,822
VI. Total			155,870	282,176	438,046
VII. Value Added Tax	L.S.	1.00	0	43,805	43,805
VIII. Grand Total			155,870	325,980	481,850

Note: 1: Price Level in October 1998
2: Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
3: Cost does not include price contingency
4: Figures may not add up to totals due to rounding
F.C:Foreign currency portion
L.C:Local currency portion

SUMMARY OF PROJECT COST FOR BABAI RIVER (FINANCIAL) FEASIBILITY STUDY

(NRs1,000)

Item	Unit	Quantity	Amount		
			F.C.	L.C.	Total
I . Construction Base Cost			138,837	199,821	338,658
1. Preparatory Works	L.S.	1.00	12,622	18,166	30,787
2. Bank Protection			87,178	120,310	207,488
2-1 Pile Spur	km	13.19	46,627	57,917	104,544
2-2 Gabion Spur	km	5.21	11,873	18,460	30,333
2-3 Revetment	km	3.30	28,678	43,934	72,611
3. Dike Embankment			12,743	23,381	36,125
3-1 Forest and Grass Belt	ha	284.00	2,509	10,612	13,120
3-2 Closing Dike	place	8.00	10,234	12,770	23,004
4. Cut-off Channel	km	1.40	14,820	21,450	36,270
5. Miscellaneous Works	L.S.	1.00	11,474	16,514	27,988
II . Compensation Cost	L.S.	1.00	0	26,640	26,640
III . Addministration Cost	L.S.	1.00	0	18,265	18,265
IV. Engineering Cost	L.S.	1.00	40,639	27,093	67,732
V . Physical Contingency	L.S.	1.00	17,948	27,182	45,130
VI. Total			197,424	299,001	496,425
VII. Value Added Tax	L.S.	1.00	0	49,642	49,642
VIII. Grand Total			197,424	348,643	546,067

Note: 1: Price Level in October 1998
2: Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
3: Cost does not include price contingency
4: Figures may not add up to totals due to rounding
F.C:Foreign currency portion
L.C:Local currency portion

Table 7.18

SUMMARY OF PROJECT COST FOR EROSION CONTROL TEST WORKS (FINANCIAL)

(NRs1,000)

Item	Unit	Quantity	Amount		
			F.C.	L.C.	Total
I . Construction Base Cost			16,123	18,610	34,733
1. Preparatory Works	L.S.	1.00	1,347	1,504	2,851
2. Groundsill Work	place	4.00	2,650	4,432	7,082
3. Slope Protection Work	km	1.00	5,304	8,388	13,692
4. Check-dam Work	place	2.00	1,302	2,070	3,372
5. Gauging Instrument Work	set	8.00	4,177	661	4,838
6. Miscellaneous Works	L.S.	1.00	1,343	1,555	2,898
II . Compensation Cost	L.S.	1.00	0	0	0
III. Addministration Cost	L.S.	1.00	0	1,737	1,737
IV. Engineering Cost	L.S.	1.00	4,168	2,779	6,947
V . Physical Contingency	L.S.	1.00	2,029	2,139	4,168
VI. Total			22,320	25,264	47,584
VII. Value Added Tax	L.S.	1.00	0	4,758	4,758
VIII. Grand Total			22,320	30,022	52,343

Note: 1: Price Level in October 1998
2: Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
3: Cost does not include price contingency
4: Figures may not add up to totals due to rounding
F.C:Foreign currency portion
L.C:Local currency portion

ANNUAL DISBURSEMENT SCHEDULE OF LAKHANDEI RIVER PROJECT (FINANCIAL)

(NRs1,000)

Discription	Amount			1999/2000		2000/2001		2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		2006/2007	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	108,045	172,411	280,456	0	0	0	0	0	0	42,563	67,919	32,741	52,246	32,741	52,246	0	0	0	0
1. Preparatory Works	9,822	15,674	25,496	0	0	0	0	0	0	9,822	15,674	0	0	0	0	0	0	0	0
2. Bank Protection	32,806	48,522	81,328	0	0	0	0	0	0	10,935	16,174	10,935	16,174	10,935	16,174				
3. Dike Embankment	38,947	68,578	107,525	0	0	0	0	0	0	12,982	22,859	12,982	22,859	12,982	22,859				
4. Channel Excavation	17,540	25,387	42,928	0	0	0	0	0	0	5,847	8,462	5,847	8,462	5,847	8,462				
5. Miscellaneous Works	8,929	14,249	23,178	0	0	0	0	0	0	2,976	4,750	2,976	4,750	2,976	4,750	0	0	0	0
Sub-total	108,045	172,411	280,456	0	0	0	0	0	0	42,563	67,919	32,741	52,246	32,741	52,246	0	0	0	0
II. Compensation Cost	0	45,384	45,384	0	0	0	0	0	15,128	0	15,128	0	15,128	0	0	0	0	0	0
1. Compensation	0	45,384	45,384		0	0	0	0	15,128	0	15,128	0	15,128	0	0	0	0	0	0
III. Addministration Cost	0	16,292	16,292	0	0	0	0	0	756	0	6,281	0	5,006	0	4,249	0	0	0	0
1. Administration	0	16,292	16,292	0	0	0	0	0	756	0	6,281	0	5,006	0	4,249	0	0	0	0
IV. Engineering Cost	33,655	22,436	56,091	0	0	0	0	16,827	11,218	6,629	4,419	5,099	3,399	5,099	3,399	0	0	0	0
1. Detail Design	16,827	11,218	28,046	0	0	0	0	16,827	11,218										
2. Construction Supervision	16,827	11,218	28,046	0	0	0	0	0	0	6,629	4,419	5,099	3,399	5,099	3,399				
V. Physical Contingency	14,170	25,652	39,822	0	0	0	0	1,683	2,710	4,919	9,375	3,784	7,578	3,784	5,989	0	0	0	0
VI. Value Added Tax	0	43,805	43,805	0	0	0	0	0	4,832	0	15,723	0	12,498	0	10,751	0	0	0	0
VII. Total	155,870	325,980	481,850	0	0	0	0	18,510	34,645	54,111	118,845	41,624	95,855	41,624	76,635	0	0	0	0
VIII. Price Contingency	23,215	184,272	207,487	0	0	0	0	1,716	11,468	6,791	55,156	6,630	58,520	8,077	59,128	0	0	0	0
IX. Grand Total	179,085	510,253	689,337	0	0	0	0	20,226	46,113	60,903	174,001	48,254	154,375	49,701	135,763	0	0	0	0

Note: *1 Price Level in October 1998
*2 Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
*3 Figures may not add up to totals due to rounding

ANNUAL DISBURSEMENT SCHEDULE OF BABAI RIVER PROJECT (FINANCIAL)

(NRs1,000)

Discription	Amount			1999/2000		2000/2001		2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		2006/2007	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I . Construction Base Cost	138,837	199,821	338,658	0	0	0	0	44,175	63,580	31,554	45,414	31,554	45,414	31,554	45,414	0	0	0	0
1. Preparatory Works	12,622	18,166	30,787	0	0	0	0	12,622	18,166	0	0	0	0	0	0	0	0	0	0
2. Bank Protection	87,178	120,310	207,488	0	0	0	0	21,795	30,078	21,795	30,078	21,795	30,078	21,795	30,078				
3. Dike Embankment	12,743	23,381	36,125	0	0	0	0	3,186	5,845	3,186	5,845	3,186	5,845	3,186	5,845				
4. Cut-off Channel	14,820	21,450	36,270	0	0	0	0	3,705	5,363	3,705	5,363	3,705	5,363	3,705	5,363				
5. Miscellaneous Works	11,474	16,514	27,988	0	0	0	0	2,869	4,129	2,869	4,129	2,869	4,129	2,869	4,129	0	0	0	0
Sub-total	138,837	199,821	338,658	0	0	0	0	44,175	63,580	31,554	45,414	31,554	45,414	31,554	45,414	0	0	0	0
II . Compensation Cost	0	26,640	26,640	0	0	0	6,660	0	6,660	0	6,660	0	6,660	0	0	0	0	0	0
1. Compensation	0	26,640	26,640		0	0	6,660	0	6,660	0	6,660	0	6,660	0	0	0	0	0	0
III. Addministration Cost	0	18,265	18,265	0	0	0	333	0	5,721	0	4,181	0	4,181	0	3,848	0	0	0	0
1. Administration	0	18,265	18,265	0	0	0	333	0	5,721	0	4,181	0	4,181	0	3,848	0	0	0	0
IV. Engineering Cost	40,639	27,093	67,732	0	0	20,320	13,546	6,465	4,310	4,618	3,079	4,618	3,079	4,618	3,079	0	0	0	0
1. Detail Design	20,320	13,546	33,866	0	0	20,320	13,546	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision	20,320	13,546	33,866	0	0	0	0	6,465	4,310	4,618	3,079	4,618	3,079	4,618	3,079				
V. Physical Contingency	17,948	27,182	45,130	0	0	2,032	2,054	5,064	8,027	3,617	5,933	3,617	5,933	3,617	5,234	0	0	0	0
VI. Value Added Tax	0	49,642	49,642	0	0	0	4,494	0	14,400	0	10,506	0	10,506	0	9,736	0	0	0	0
VII. Total	197,424	348,643	546,067	0	0	22,351	27,088	55,705	102,698	39,789	75,773	39,789	75,773	39,789	67,312	0	0	0	0
VIII. Price Contingency	25,579	173,043	198,622	0	0	1,361	5,688	5,165	33,993	4,994	35,166	6,337	46,260	7,721	51,935	0	0	0	0
IX. Grand Total	223,003	521,686	744,689	0	0	23,713	32,776	60,870	136,691	44,783	110,939	46,126	122,033	47,510	119,247	0	0	0	0

Note: *1 Price Level in October 1998
*2 Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
*3 Figures may not add up to totals due to rounding

COST BENEFIT FLOW

(Existing Basin)

River: Lakhandei (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	0	0	0	0	0	0
3 2001	43,491	0	43,491	0	35,943	0
4 2002	141,510	0	141,510	0	106,319	0
5 2003	112,483	795	113,278	16,400	77,371	11,282
6 2004	96,757	1,427	98,184	29,436	60,965	18,278
7 2005	0	1,971	1,971	40,650	1,113	22,946
8 2006	0	1,971	1,971	40,650	1,012	20,860
9 2007		1,971	1,971	40,650	920	18,964
10 2008		1,971	1,971	40,650	836	17,240
11 2009		1,971	1,971	40,650	760	15,672
12 2010		1,971	1,971	40,650	691	14,248
13 2011		1,971	1,971	40,650	628	12,952
14 2012		1,971	1,971	40,650	571	11,775
15 2013		1,971	1,971	40,650	519	10,704
16 2014		1,971	1,971	40,650	472	9,731
17 2015		1,971	1,971	40,650	429	8,847
18 2016		1,971	1,971	40,650	390	8,042
19 2017		1,971	1,971	40,650	355	7,311
20 2018		1,971	1,971	40,650	322	6,647
21 2019		1,971	1,971	40,650	293	6,042
22 2020		1,971	1,971	40,650	266	5,493
23 2021		1,971	1,971	40,650	242	4,994
24 2022		1,971	1,971	40,650	220	4,540
25 2023		1,971	1,971	40,650	200	4,127
26 2024		1,971	1,971	40,650	182	3,752
27 2025		1,971	1,971	40,650	165	3,411
28 2026		1,971	1,971	40,650	150	3,101
29 2027		1,971	1,971	40,650	137	2,819
30 2028		1,971	1,971	40,650	124	2,563
31 2029		1,971	1,971	40,650	113	2,330
32 2030		1,971	1,971	40,650	103	2,118
33 2031		1,971	1,971	40,650	93	1,925
34 2032		1,971	1,971	40,650	85	1,750
35 2033		1,971	1,971	40,650	77	1,591
36 2034		1,971	1,971	40,650	70	1,446
37 2035		1,971	1,971	40,650	64	1,315
38 2036		1,971	1,971	40,650	58	1,195
39 2037		1,971	1,971	40,650	53	1,087
40 2038		1,971	1,971	40,650	48	988
41 2039		1,971	1,971	40,650	44	898
42 2040		1,971	1,971	40,650	40	817
43 2041		1,971	1,971	40,650	36	742
44 2042		1,971	1,971	40,650	33	675
45 2043		1,971	1,971	40,650	30	613
46 2044		1,971	1,971	40,650	27	558
47 2045		1,971	1,971	40,650	25	507
48 2046		1,971	1,971	40,650	22	461
49 2047		1,971	1,971	40,650	20	419
50 2048		1,971	1,971	40,650	18	381
Total	394,241	88,956	483,197	1,831,437	292,652	278,075

EIRR: 9.5%

B/C: 0.95

NPV(B-C): -14,577 (NRs.1,000)

COST BENEFIT FLOW
(Future Basin)

River: Lakhandei (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	0	0	0	0	0	0
3 2001	43,491	0	43,491	0	35,943	0
4 2002	141,510	0	141,510	0	106,319	0
5 2003	112,483	795	113,278	35,424	77,371	24,195
6 2004	96,757	1,427	98,184	63,583	60,965	39,480
7 2005	0	1,971	1,971	87,804	1,113	49,563
8 2006	0	1,971	1,971	87,804	1,012	45,057
9 2007		1,971	1,971	87,804	920	40,961
10 2008		1,971	1,971	87,804	836	37,237
11 2009		1,971	1,971	87,804	760	33,852
12 2010		1,971	1,971	87,804	691	30,775
13 2011		1,971	1,971	87,804	628	27,977
14 2012		1,971	1,971	87,804	571	25,434
15 2013		1,971	1,971	87,804	519	23,122
16 2014		1,971	1,971	87,804	472	21,020
17 2015		1,971	1,971	87,804	429	19,109
18 2016		1,971	1,971	87,804	390	17,372
19 2017		1,971	1,971	87,804	355	15,792
20 2018		1,971	1,971	87,804	322	14,357
21 2019		1,971	1,971	87,804	293	13,052
22 2020		1,971	1,971	87,804	266	11,865
23 2021		1,971	1,971	87,804	242	10,786
24 2022		1,971	1,971	87,804	220	9,806
25 2023		1,971	1,971	87,804	200	8,914
26 2024		1,971	1,971	87,804	182	8,104
27 2025		1,971	1,971	87,804	165	7,367
28 2026		1,971	1,971	87,804	150	6,697
29 2027		1,971	1,971	87,804	137	6,089
30 2028		1,971	1,971	87,804	124	5,535
31 2029		1,971	1,971	87,804	113	5,032
32 2030		1,971	1,971	87,804	103	4,574
33 2031		1,971	1,971	87,804	93	4,159
34 2032		1,971	1,971	87,804	85	3,781
35 2033		1,971	1,971	87,804	77	3,437
36 2034		1,971	1,971	87,804	70	3,124
37 2035		1,971	1,971	87,804	64	2,840
38 2036		1,971	1,971	87,804	58	2,582
39 2037		1,971	1,971	87,804	53	2,347
40 2038		1,971	1,971	87,804	48	2,134
41 2039		1,971	1,971	87,804	44	1,940
42 2040		1,971	1,971	87,804	40	1,764
43 2041		1,971	1,971	87,804	36	1,603
44 2042		1,971	1,971	87,804	33	1,458
45 2043		1,971	1,971	87,804	30	1,325
46 2044		1,971	1,971	87,804	27	1,205
47 2045		1,971	1,971	87,804	25	1,095
48 2046		1,971	1,971	87,804	22	996
49 2047		1,971	1,971	87,804	20	905
50 2048		1,971	1,971	87,804	18	823
Total	391,241	88,956	483,197	3,962,383	292,652	600,641

EIRR: 20.8%
B/C: 2.05
NPV(B-C): 307,989 (NRs.1,000)

COST BENEFIT FLOW
(Existing Basin)

River: Babai (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	40,450	0	40,450	0	36,773	0
3 2001	129,602	0	129,602	0	107,109	0
4 2002	94,551	0	94,551	0	71,038	0
5 2003	94,551	763	95,314	17,168	65,101	11,726
6 2004	87,628	1,527	89,155	34,335	55,358	21,320
7 2005	0	2,234	2,234	50,246	1,261	28,363
8 2006	0	2,234	2,234	50,246	1,146	25,784
9 2007		2,234	2,234	50,246	1,042	23,440
10 2008		2,234	2,234	50,246	947	21,309
11 2009		2,234	2,234	50,246	861	19,372
12 2010		2,234	2,234	50,246	783	17,611
13 2011		2,234	2,234	50,246	712	16,010
14 2012		2,234	2,234	50,246	647	14,554
15 2013		2,234	2,234	50,246	588	13,231
16 2014		2,234	2,234	50,246	535	12,028
17 2015		2,234	2,234	50,246	486	10,935
18 2016		2,234	2,234	50,246	442	9,941
19 2017		2,234	2,234	50,246	402	9,037
20 2018		2,234	2,234	50,246	365	8,216
21 2019		2,234	2,234	50,246	332	7,469
22 2020		2,234	2,234	50,246	302	6,790
23 2021		2,234	2,234	50,246	274	6,173
24 2022		2,234	2,234	50,246	249	5,611
25 2023		2,234	2,234	50,246	227	5,101
26 2024		2,234	2,234	50,246	206	4,638
27 2025		2,234	2,234	50,246	187	4,216
28 2026		2,234	2,234	50,246	170	3,833
29 2027		2,234	2,234	50,246	155	3,484
30 2028		2,234	2,234	50,246	141	3,167
31 2029		2,234	2,234	50,246	128	2,880
32 2030		2,234	2,234	50,246	116	2,618
33 2031		2,234	2,234	50,246	106	2,380
34 2032		2,234	2,234	50,246	96	2,163
35 2033		2,234	2,234	50,246	87	1,967
36 2034		2,234	2,234	50,246	79	1,788
37 2035		2,234	2,234	50,246	72	1,625
38 2036		2,234	2,234	50,246	66	1,478
39 2037		2,234	2,234	50,246	60	1,343
40 2038		2,234	2,234	50,246	54	1,221
41 2039		2,234	2,234	50,246	49	1,110
42 2040		2,234	2,234	50,246	45	1,009
43 2041		2,234	2,234	50,246	41	918
44 2042		2,234	2,234	50,246	37	834
45 2043		2,234	2,234	50,246	34	758
46 2044		2,234	2,234	50,246	31	689
47 2045		2,234	2,234	50,246	28	627
48 2046		2,234	2,234	50,246	25	570
49 2047		2,234	2,234	50,246	23	518
50 2048		2,234	2,234	50,246	21	471
Total	446,782	100,582	547,364	2,262,327	349,010	340,325

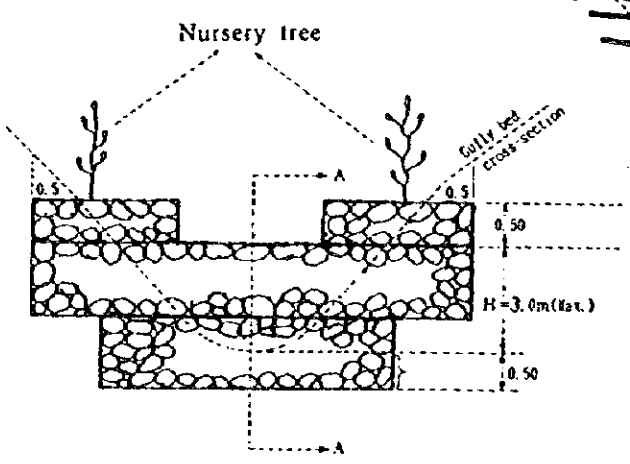
EIRR: 9.7%
B/C: 0.98
NPV(B-C): -8,715 (NRs.1,000)

COST BENEFIT FLOW
(Future Basin)

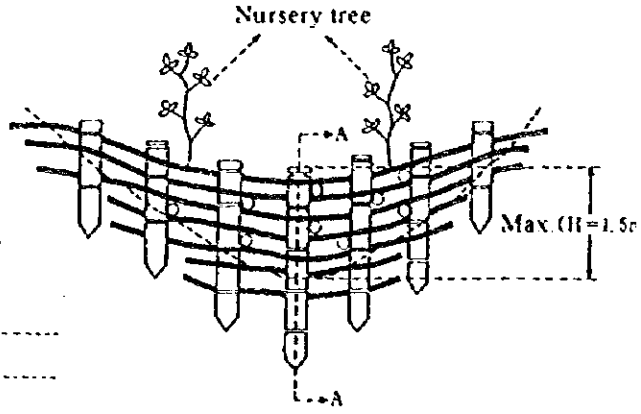
River: Babai (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	40,450	0	40,450	0	36,773	0
3 2001	129,602	0	129,602	0	107,109	0
4 2002	94,551	0	94,551	0	71,038	0
5 2003	94,551	763	95,314	27,125	65,101	18,527
6 2004	87,628	1,527	89,155	54,250	55,358	33,685
7 2005	0	2,234	2,234	79,389	1,261	44,813
8 2006	0	2,234	2,234	79,389	1,146	40,739
9 2007		2,234	2,234	79,389	1,042	37,035
10 2008		2,234	2,234	79,389	947	33,669
11 2009		2,234	2,234	79,389	861	30,608
12 2010		2,234	2,234	79,389	783	27,825
13 2011		2,234	2,234	79,389	712	25,296
14 2012		2,234	2,234	79,389	647	22,996
15 2013		2,234	2,234	79,389	588	20,906
16 2014		2,234	2,234	79,389	535	19,005
17 2015		2,234	2,234	79,389	486	17,277
18 2016		2,234	2,234	79,389	442	15,707
19 2017		2,234	2,234	79,389	402	14,279
20 2018		2,234	2,234	79,389	365	12,981
21 2019		2,234	2,234	79,389	332	11,801
22 2020		2,234	2,234	79,389	302	10,728
23 2021		2,234	2,234	79,389	274	9,753
24 2022		2,234	2,234	79,389	249	8,866
25 2023		2,234	2,234	79,389	227	8,060
26 2024		2,234	2,234	79,389	206	7,327
27 2025		2,234	2,234	79,389	187	6,661
28 2026		2,234	2,234	79,389	170	6,056
29 2027		2,234	2,234	79,389	155	5,505
30 2028		2,234	2,234	79,389	141	5,005
31 2029		2,234	2,234	79,389	128	4,550
32 2030		2,234	2,234	79,389	116	4,136
33 2031		2,234	2,234	79,389	106	3,760
34 2032		2,234	2,234	79,389	96	3,418
35 2033		2,234	2,234	79,389	87	3,107
36 2034		2,234	2,234	79,389	79	2,825
37 2035		2,234	2,234	79,389	72	2,568
38 2036		2,234	2,234	79,389	66	2,335
39 2037		2,234	2,234	79,389	60	2,122
40 2038		2,234	2,234	79,389	54	1,929
41 2039		2,234	2,234	79,389	49	1,754
42 2040		2,234	2,234	79,389	45	1,595
43 2041		2,234	2,234	79,389	41	1,450
44 2042		2,234	2,234	79,389	37	1,318
45 2043		2,234	2,234	79,389	34	1,198
46 2044		2,234	2,234	79,389	31	1,089
47 2045		2,234	2,234	79,389	28	990
48 2046		2,234	2,234	79,389	25	900
49 2047		2,234	2,234	79,389	23	818
50 2048		2,234	2,234	79,389	21	744
Total	446,782	100,582	547,364	3,574,477	349,040	537,714

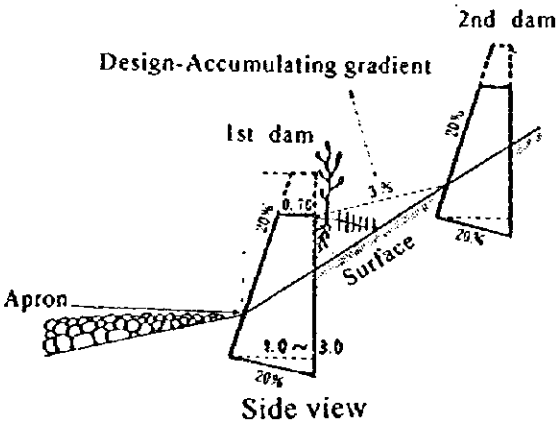
EIRR: 15.2%
B/C: 1.54
NPV(B-C): 188,674 (NRs.1,000)



Front view

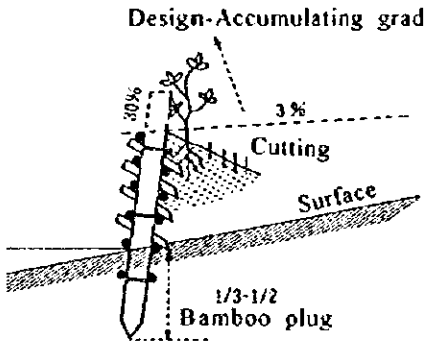


Front view



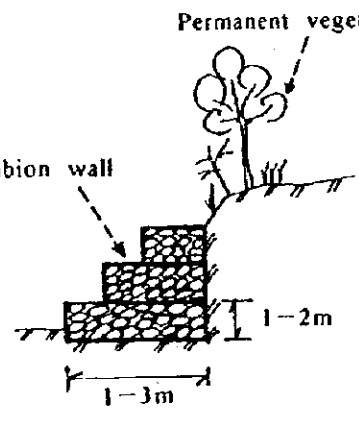
Side view

(b) Small gabion check dam for gully control

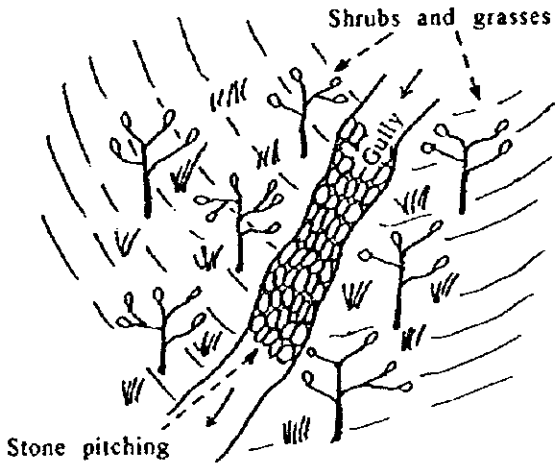


Side view

(a) Bamboo gully plug fence



(d) Gabion wall and permanent vegetation



(c) Stone pitching gully control with shrubs and grasses

EROSION CONTROL MEASURES IN WATERSHED AREA

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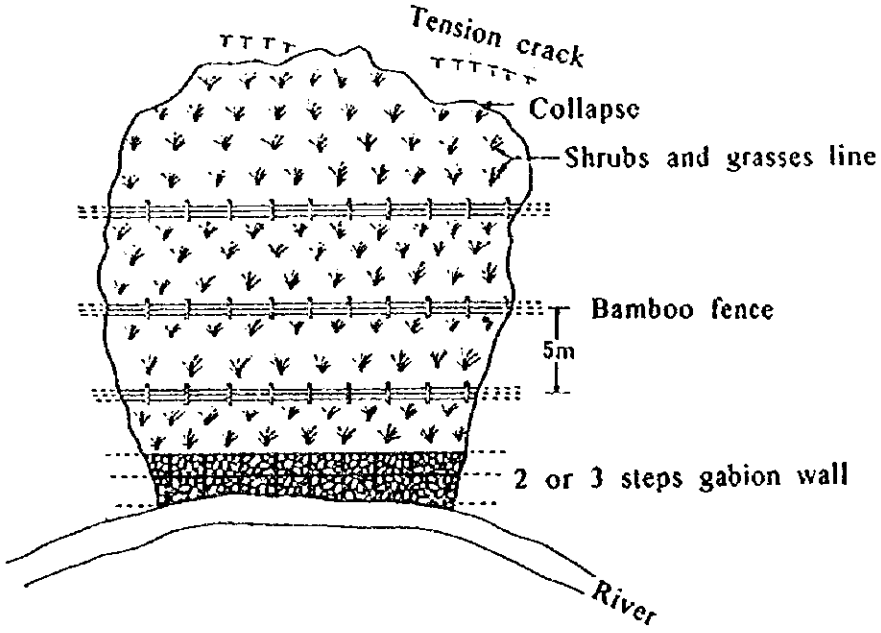
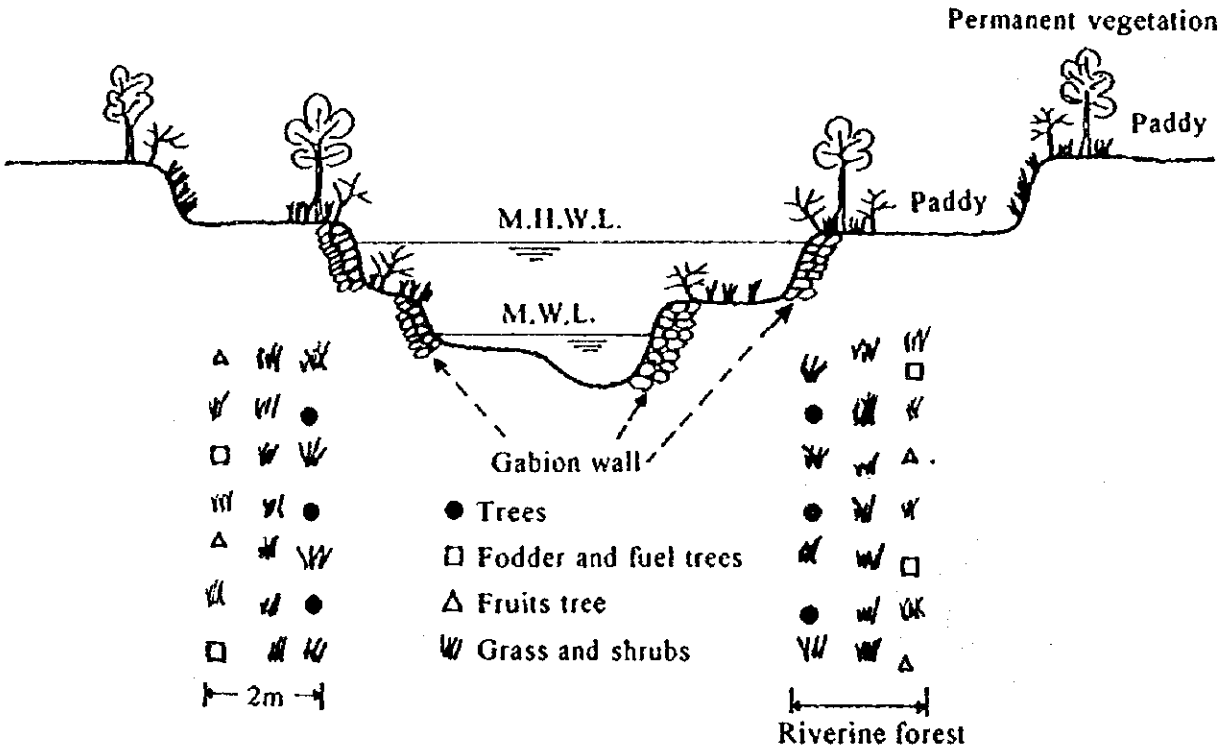
JAPAN INTERNATIONAL COOPERATION AGENCY



(e) Repair works of small collapse



(f) Bank erosion control of mountain stream terraces by gabion works and riverine forest

EROSION CONTROL MEASURES IN WATERSHED AREA

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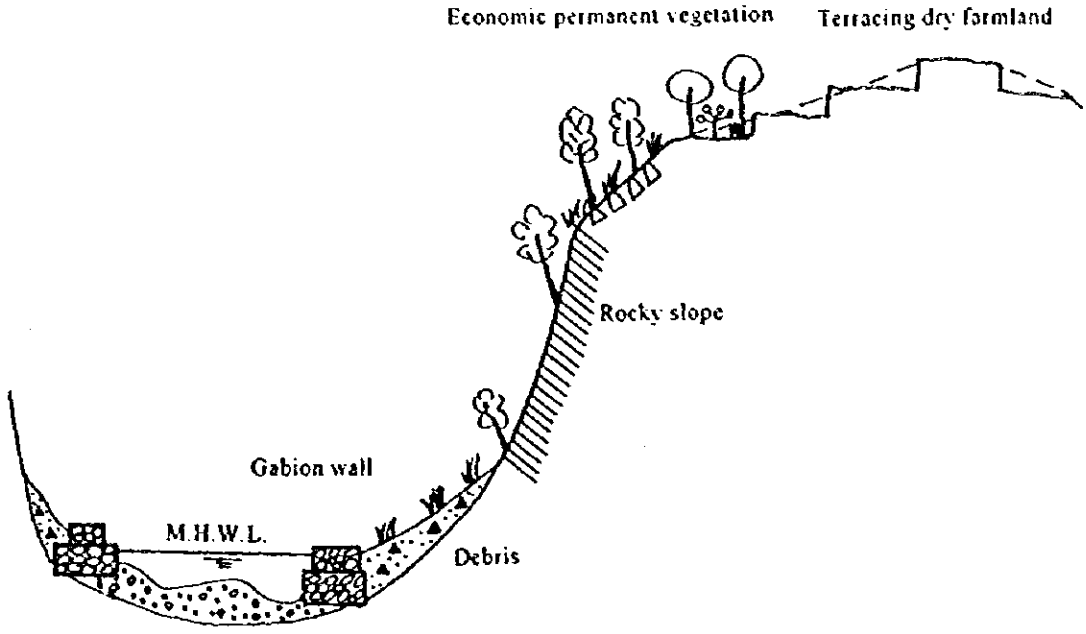
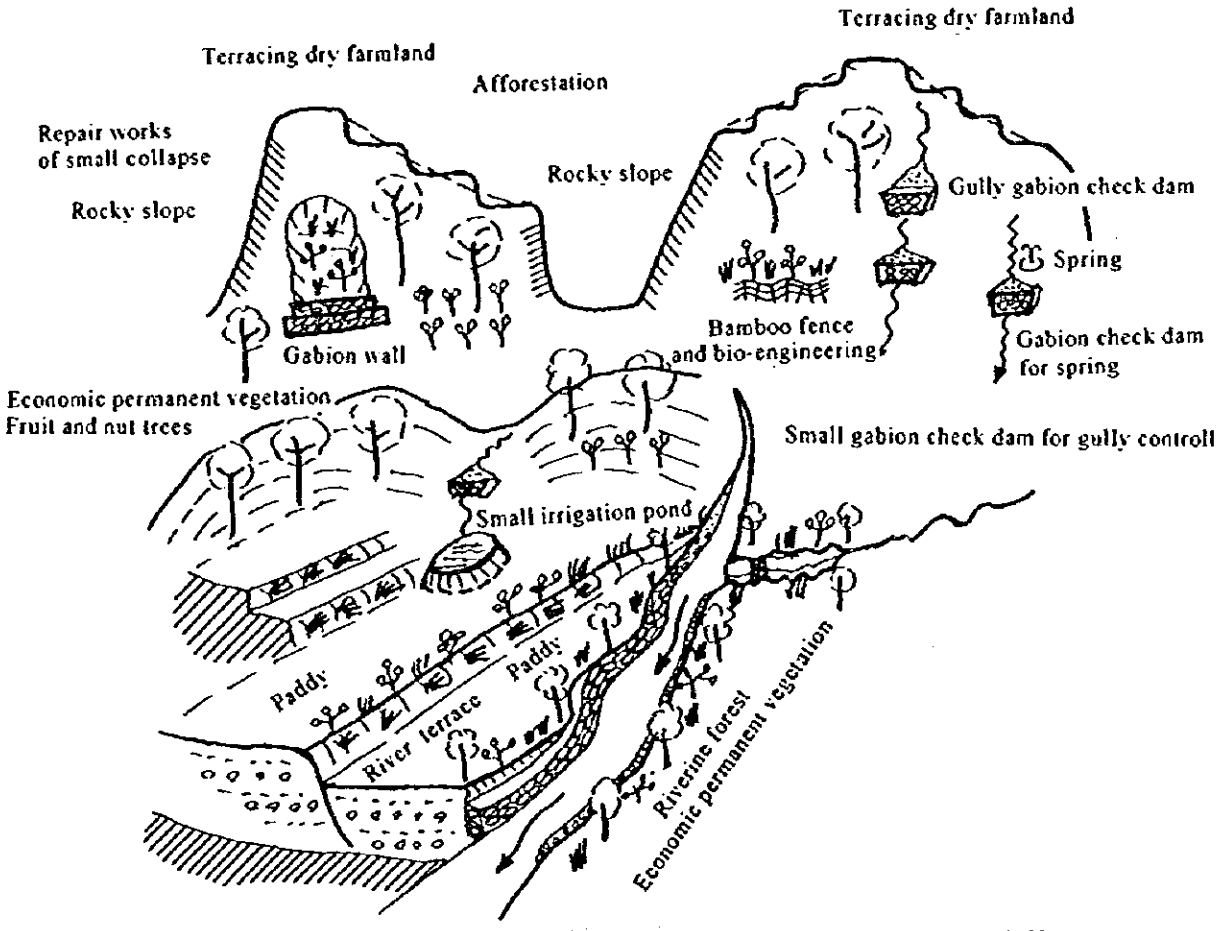
JAPAN INTERNATIONAL COOPERATION AGENCY



(g) A schematic cross-section of a slope showing different segments.



(h) A schematic panorama view of total watershed maintenance shoeing different segments.

EROSION CONTROL MEASURES IN WATERSHED AREA

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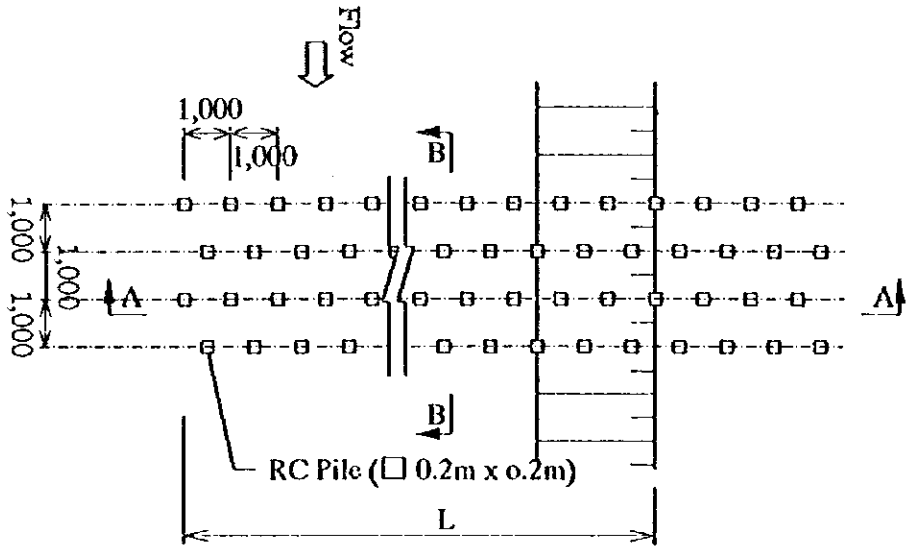
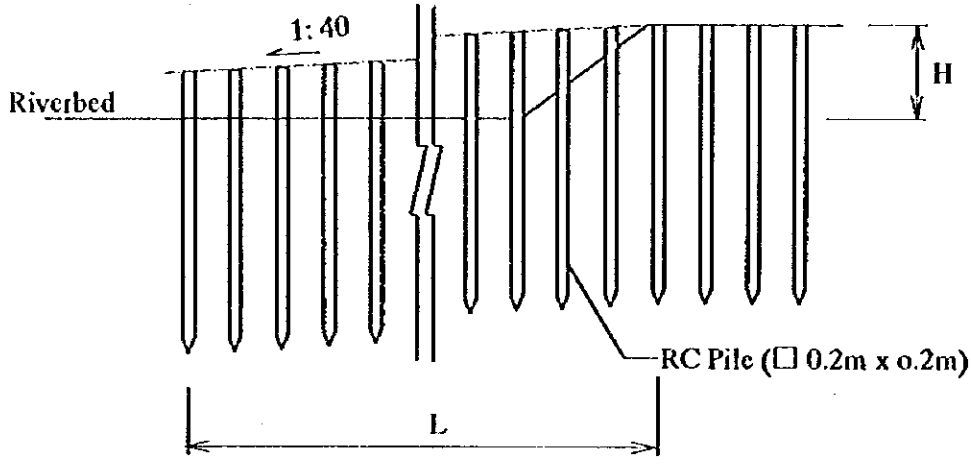
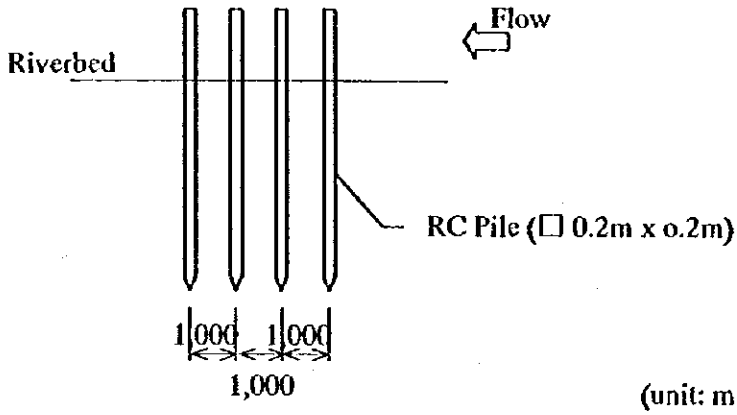


PLAN



SECTION A-A

Type	L (m)	H (m)
Type-Pa	20.0	1.0
Type-Pb	40.0	2.0



(unit: mm)

SECTION B-B

TYPICAL DESIGN OF PILE SPUR

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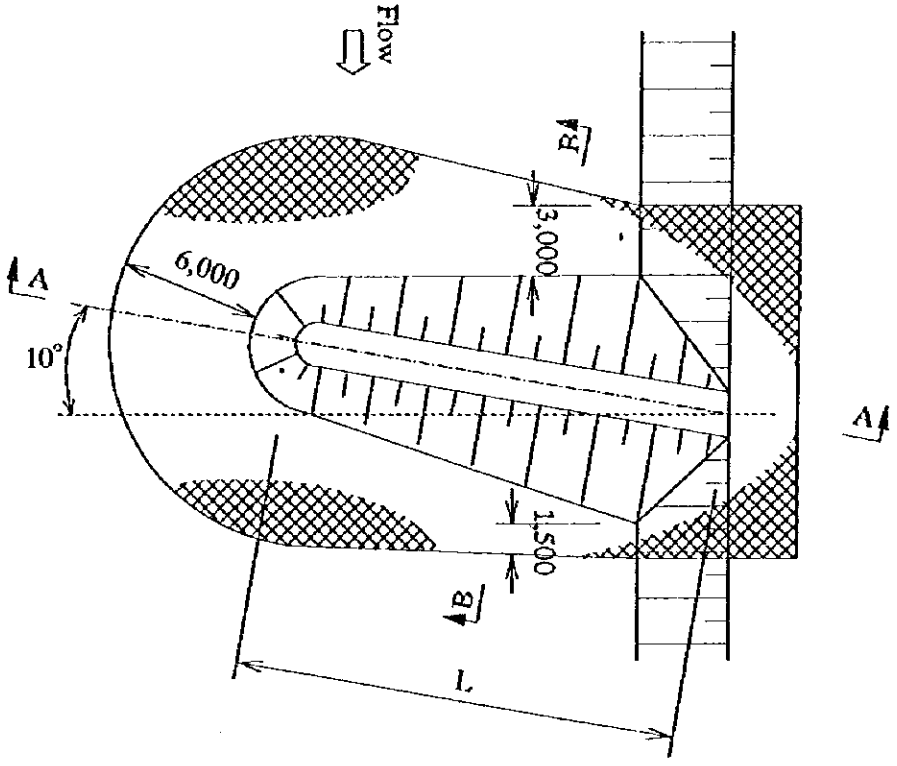
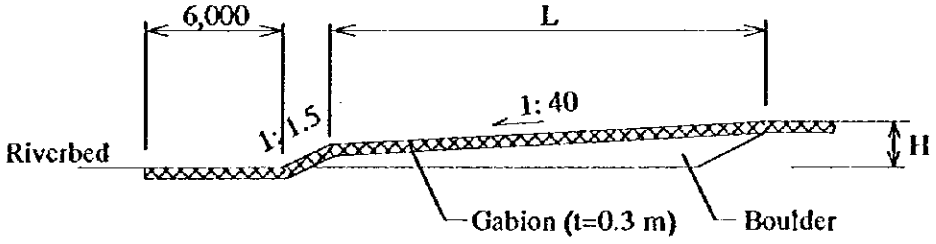
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

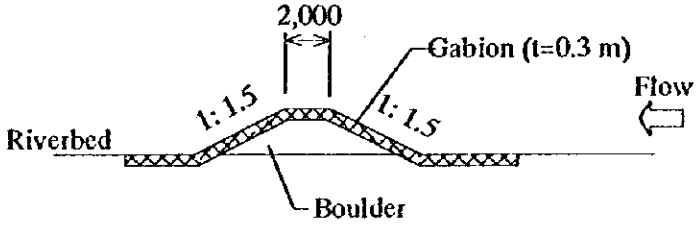


PLAN



SECTION A-A

Type	L (m)	H (m)
Type-Ia	20.0	1.5
Type-Ib	20.0	3.0
Type-Ic	40.0	2.5
Type-Id	40.0	3.0



(unit: mm)

SECTION B-B

TYPICAL DESIGN OF GABION SPUR

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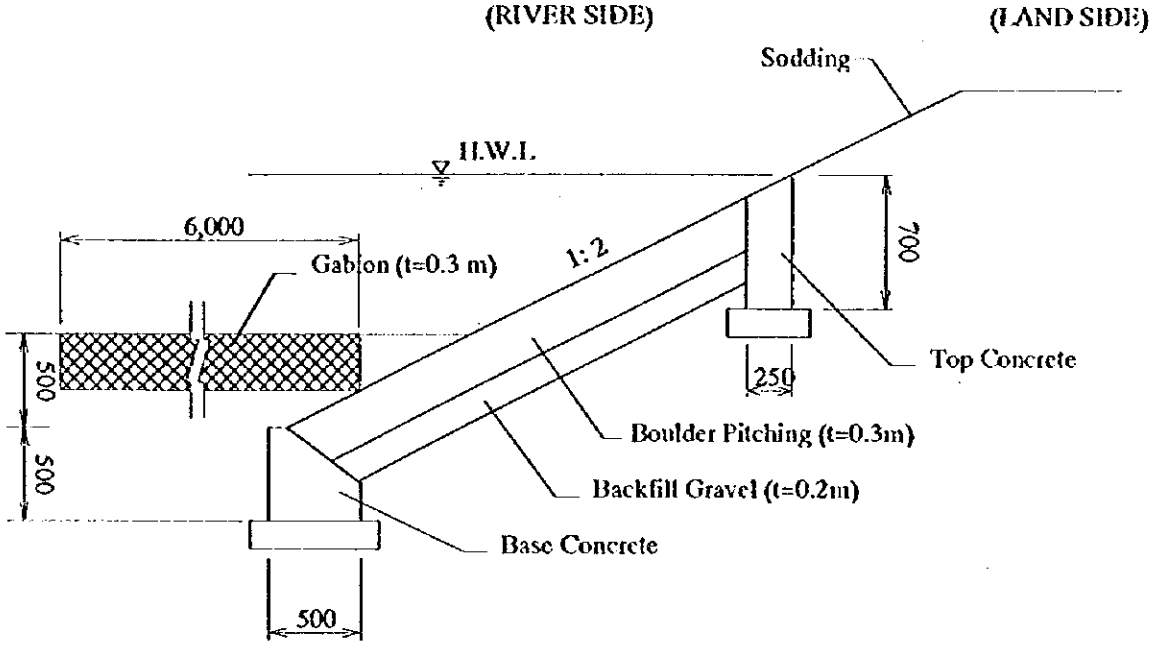
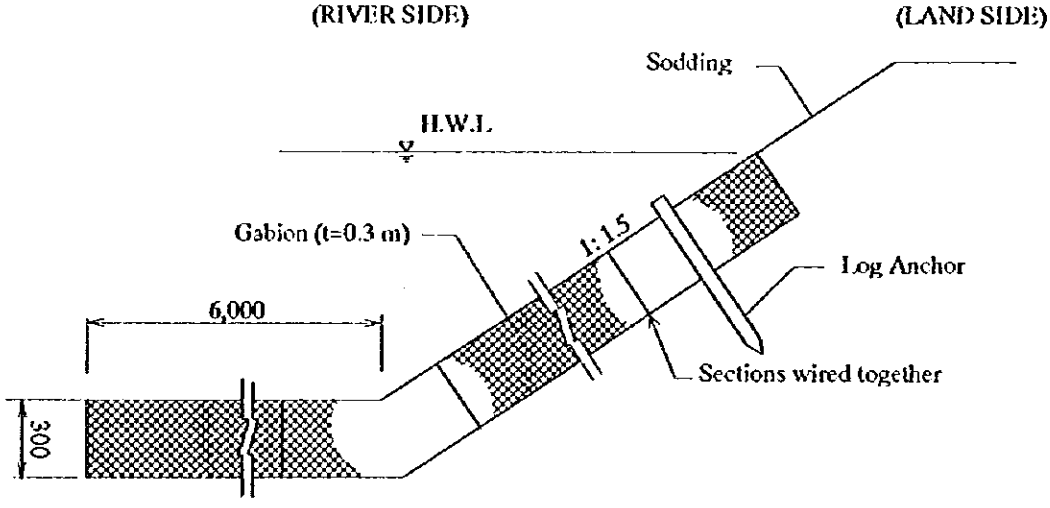
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



REVETMENT (TYPE -Ra)



REVETMENT (TYPE -Rb)

(unit: mm)

TYPICAL SECTION OF REVETMENT

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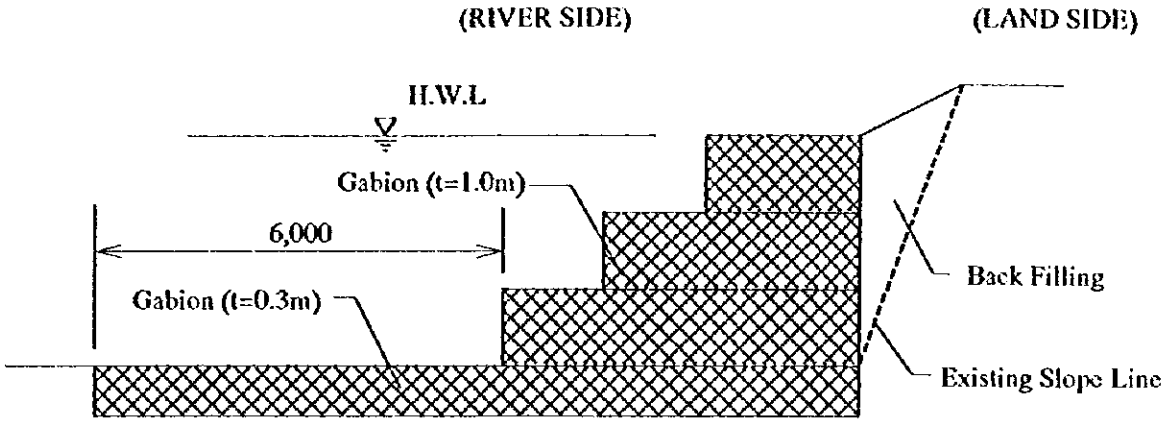
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



REVETMENT (TYPE -Rc)

(unit: mm)

TYPICAL SECTION OF REVETMENT

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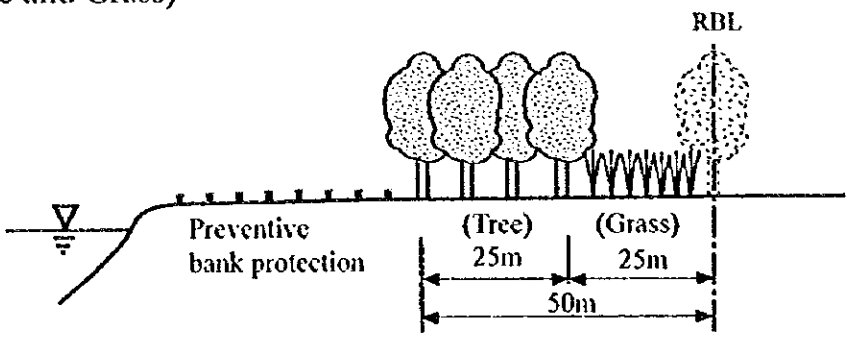
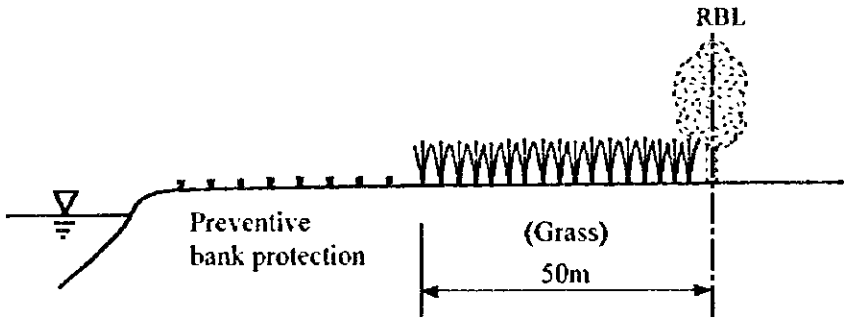
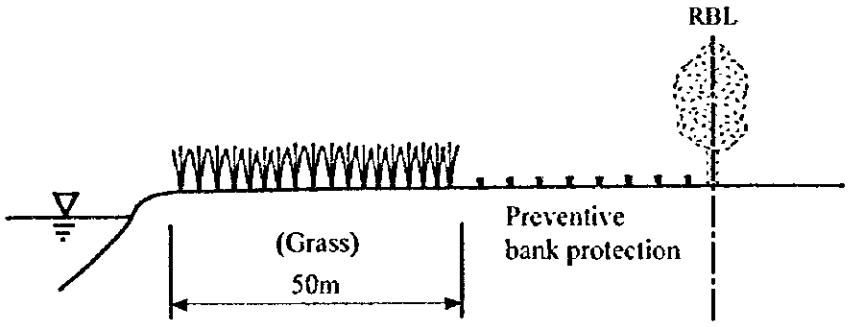
Forest Belt
(Tree and Grass)



Grass Belt



Grass Belt along Low Water Channel (Seg.2-2 of Lakhandei R.)



- RBL shall be marked clearly in field by tree-row or stacker.
- If there are forests more than 50m-wide on river side of RBL, tree/grass belt is not necessary.
- If the river side bank area of RBL is less than 50m in width, width of grass belt should be reduced.

FOREST/GRASS BELT AND RIVER BOUNDARY LINE

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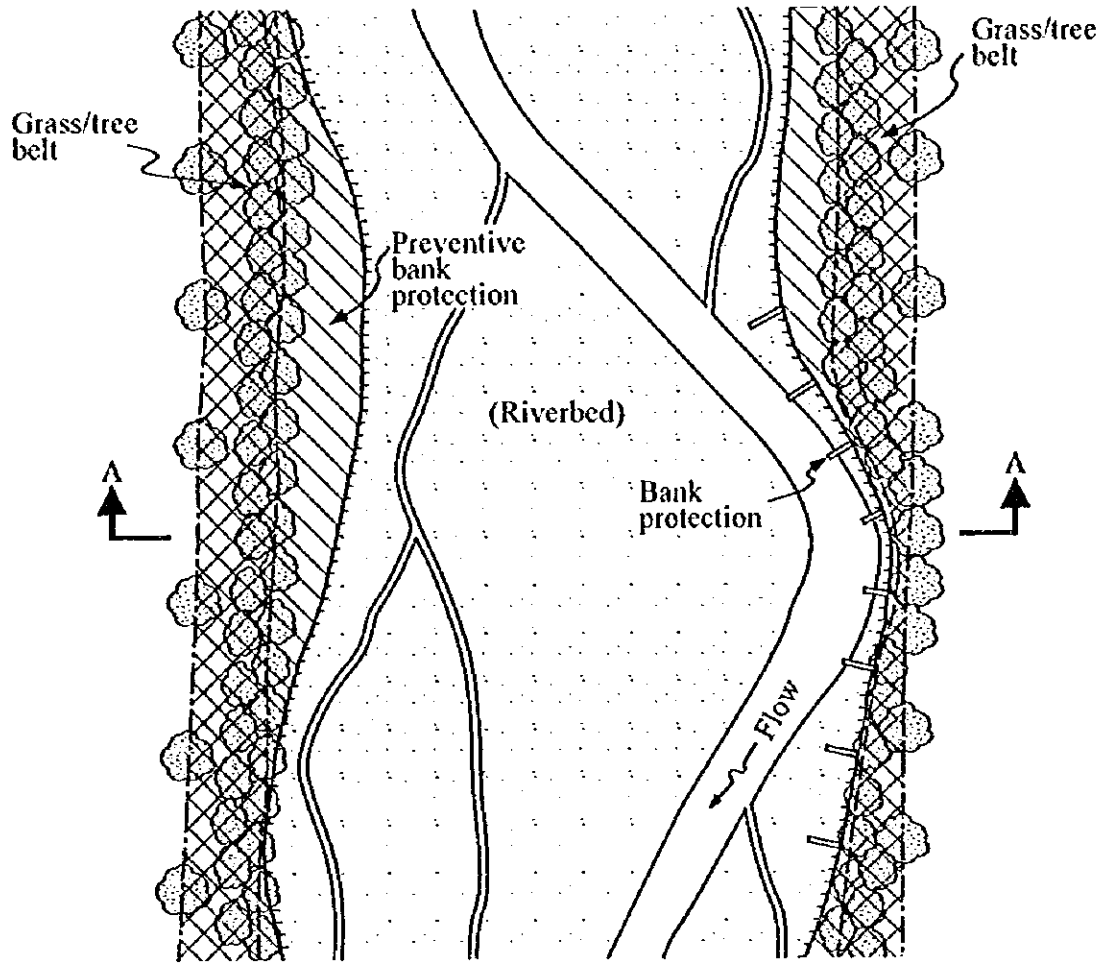
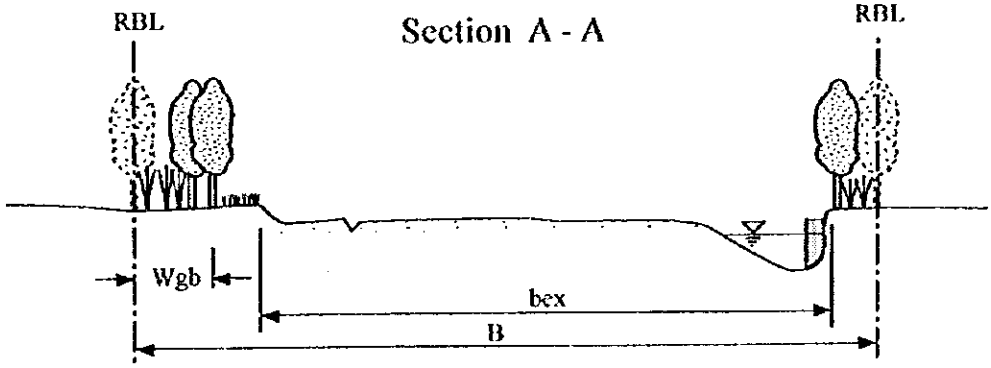
FOREST BELT





RBL : River boundary line
B : Width of river zone
Wgb : Width of grass/tree belt
bex : Existing channel width

FOREST/GRASS BELT AND RIVER BOUNDARY LINE

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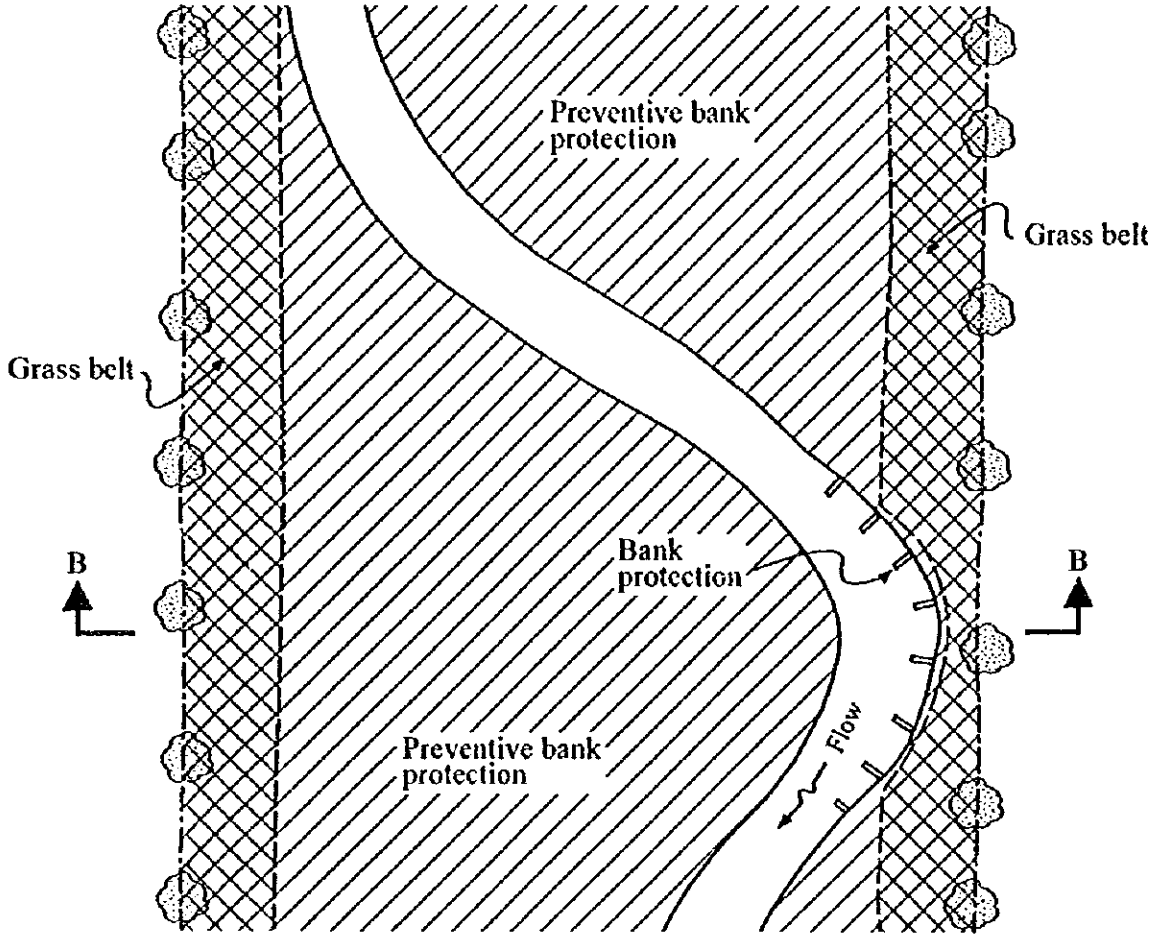
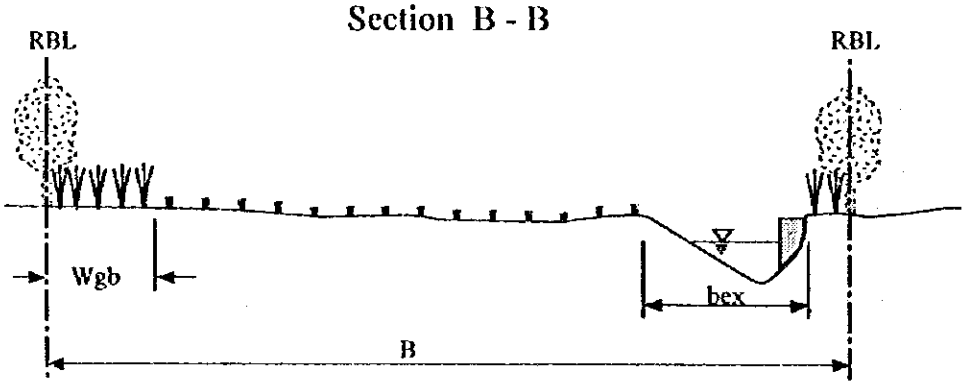
GRASS BELT



Section B - B



RBL : River boundary line
B : Width of river zone
Wgb : Width of grass belt
bex : Existing channel width

FOREST/GRASS BELT AND RIVER BOUNDARY LINE

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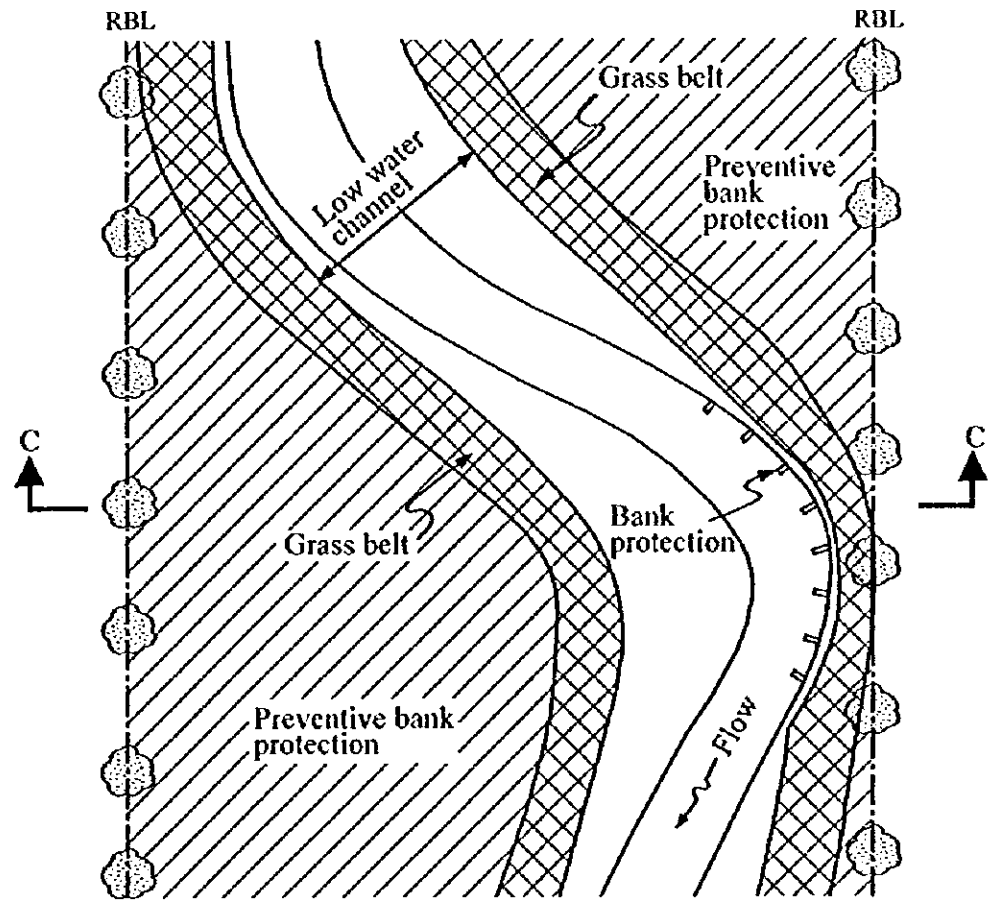
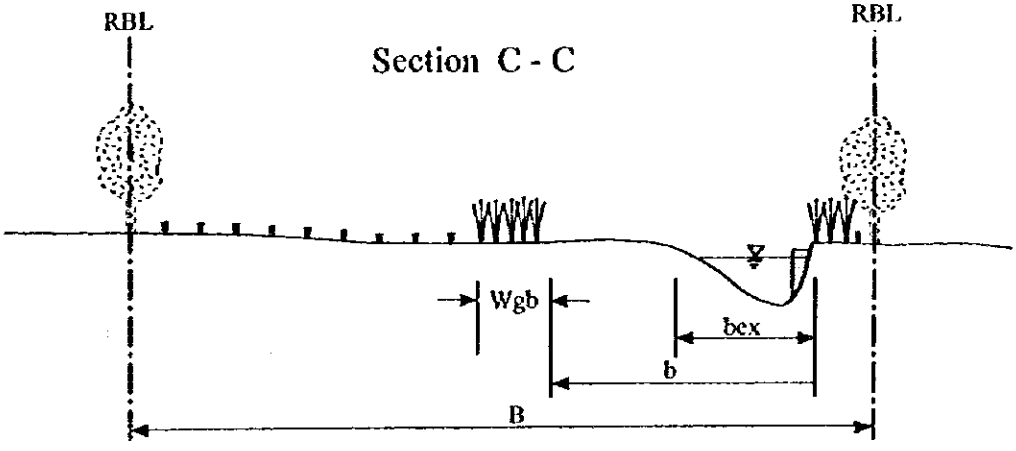
GRASS BELT ALONG LOW WATER CHANNEL





RBL : River boundary line
B : Width of river zone
Wgb : Width of grass belt
b : Width of low water channel
bex : Existing channel width

FOREST/GRASS BELT AND RIVER BOUNDARY LINE

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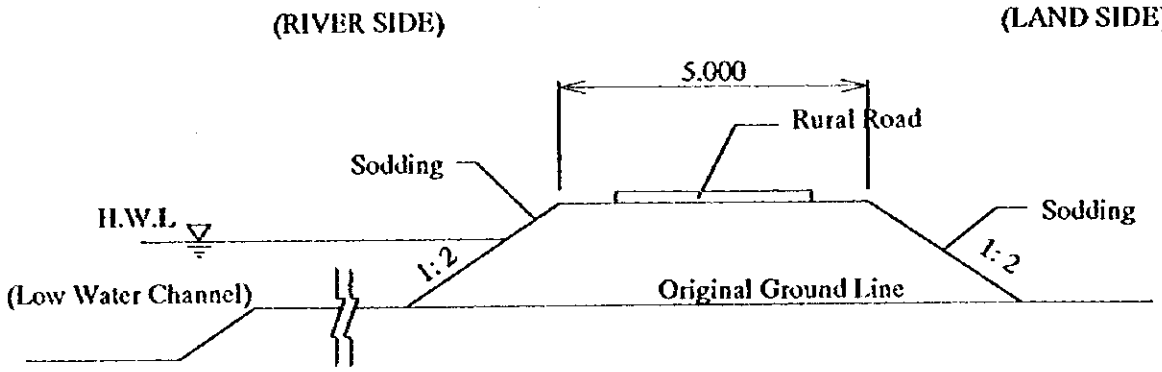
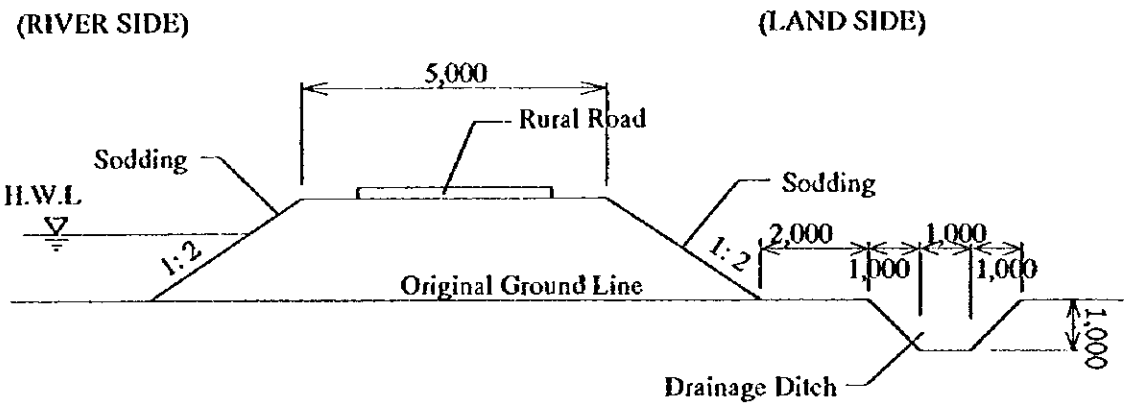
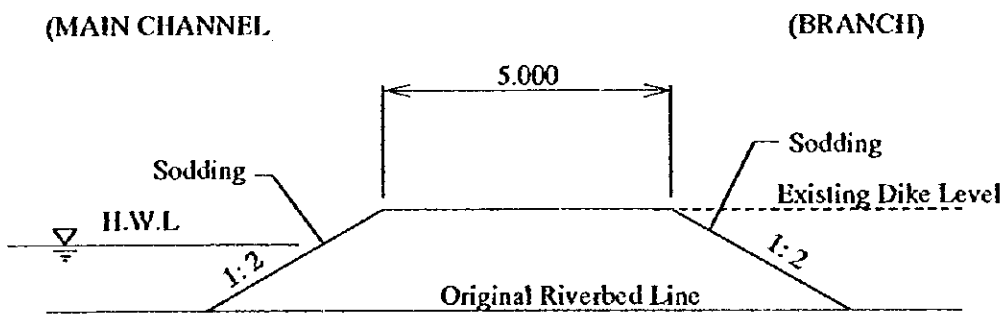
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL SECTION OF DIKE ROAD



TYPICAL SECTION OF RING DIKE



(unit:mm)

TYPICAL SECTION OF CLOSING DIKE

TYPICAL EARTH DIKE SECTIONS

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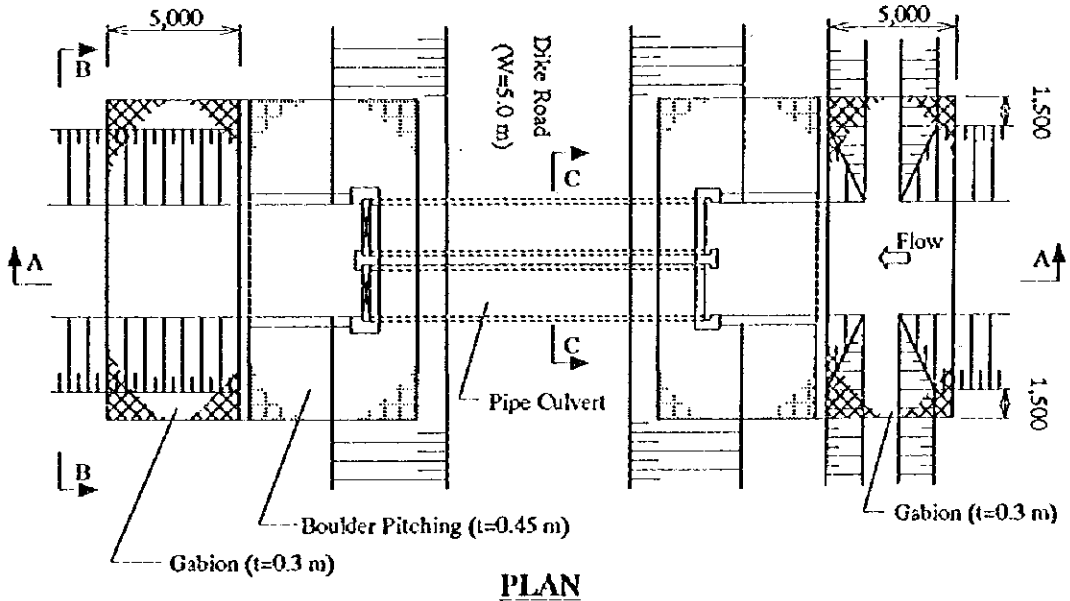
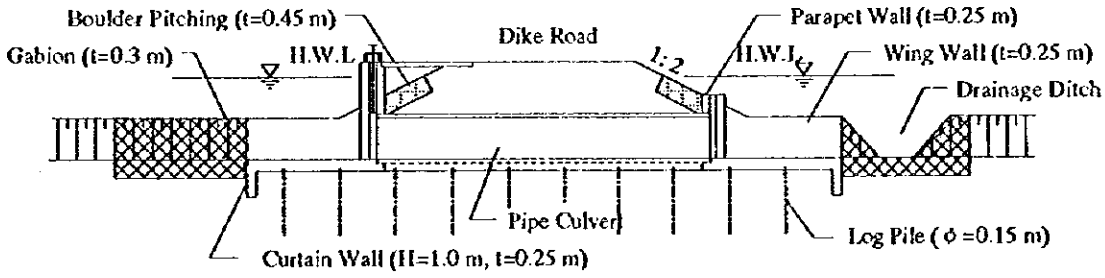
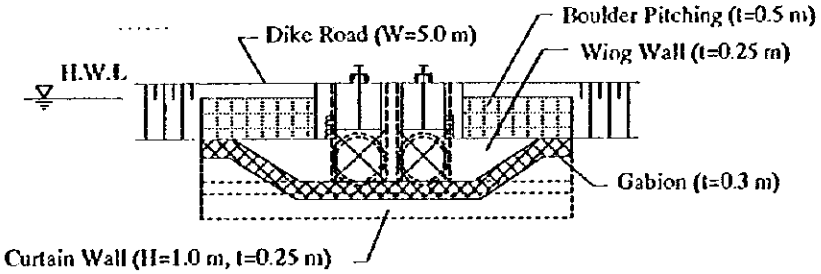
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN

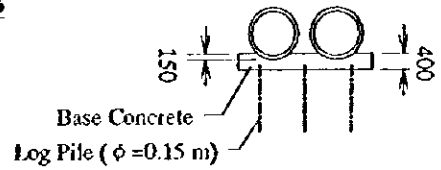


SECTION A-A



(unit: mm)

SECTION B-B



SECTION C-C

TYPICAL DESIGN OF SLUICE

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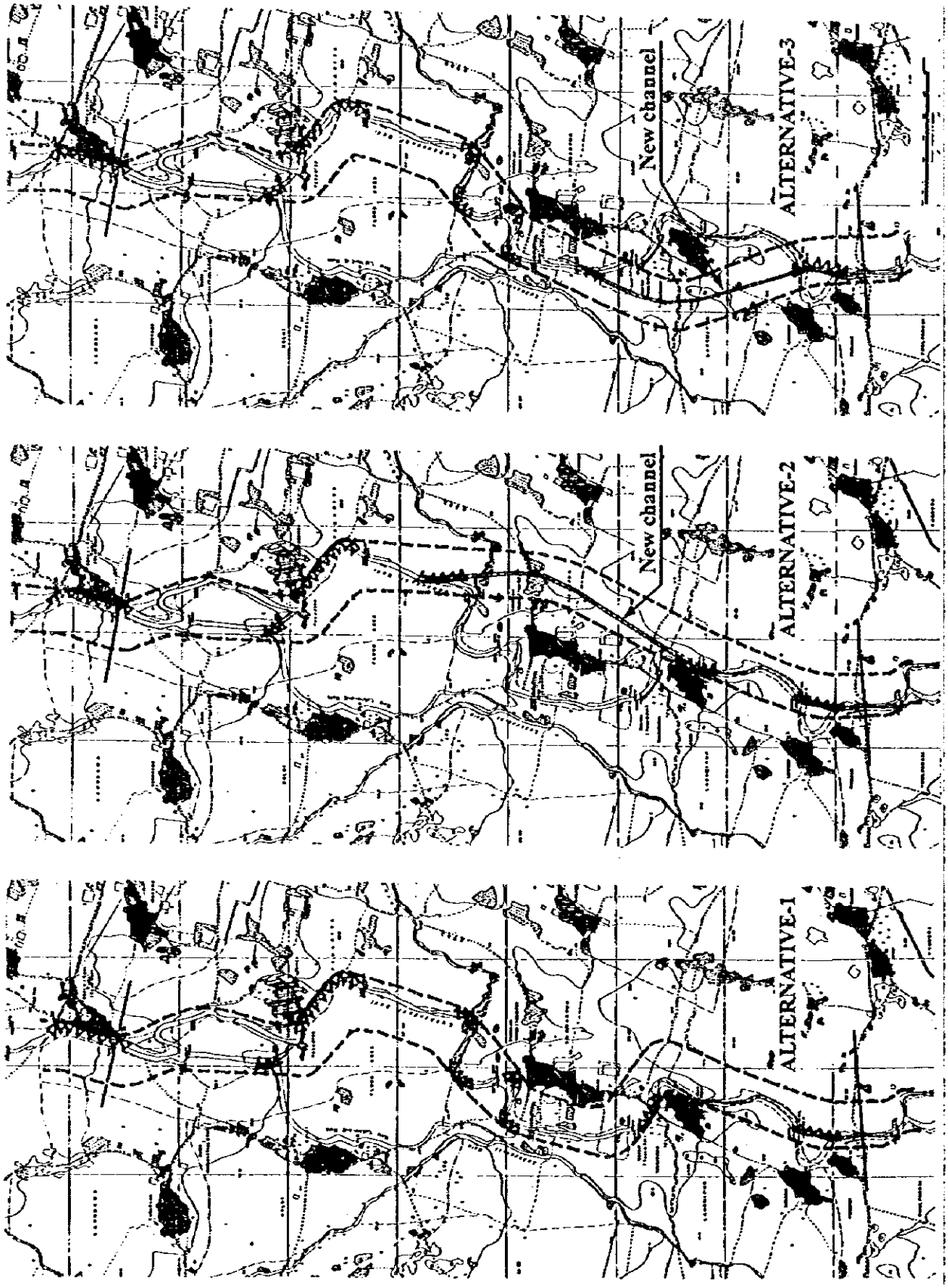
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



ROUTE OF LAKHANDEI RIVER
between Laksmipur and Belhi Villages

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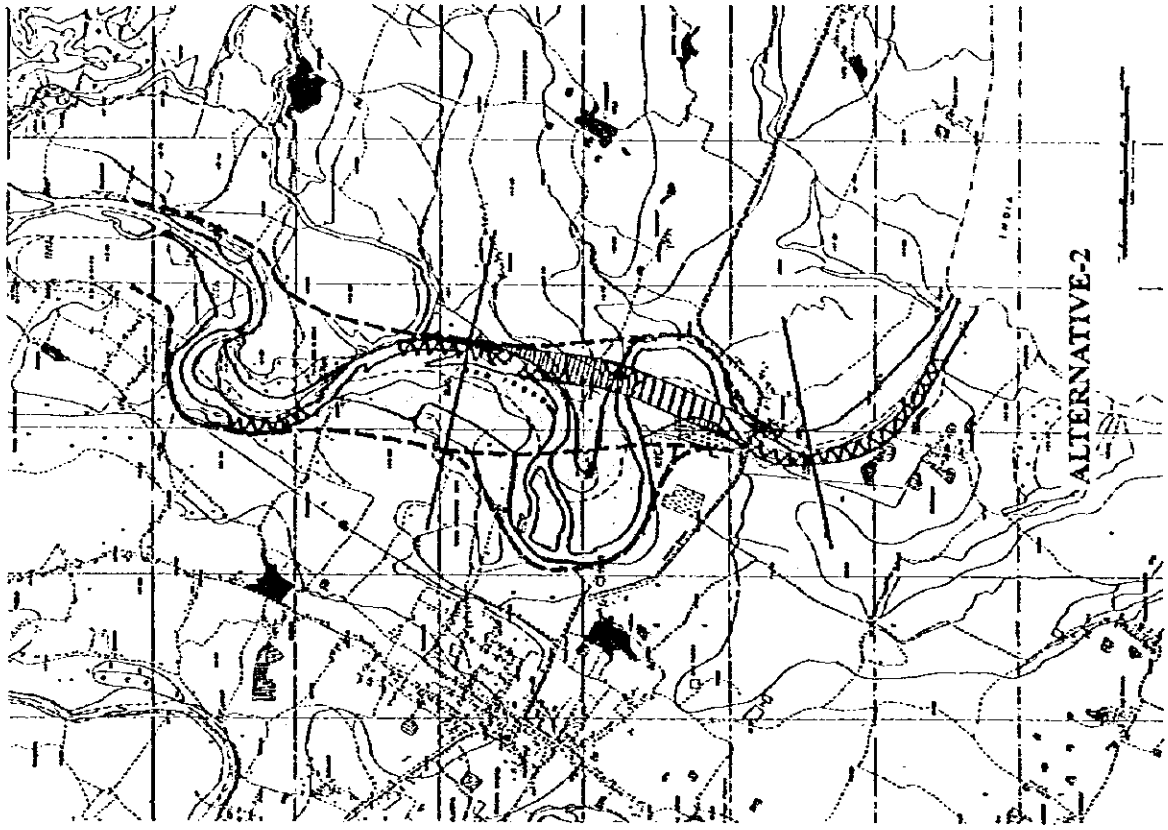
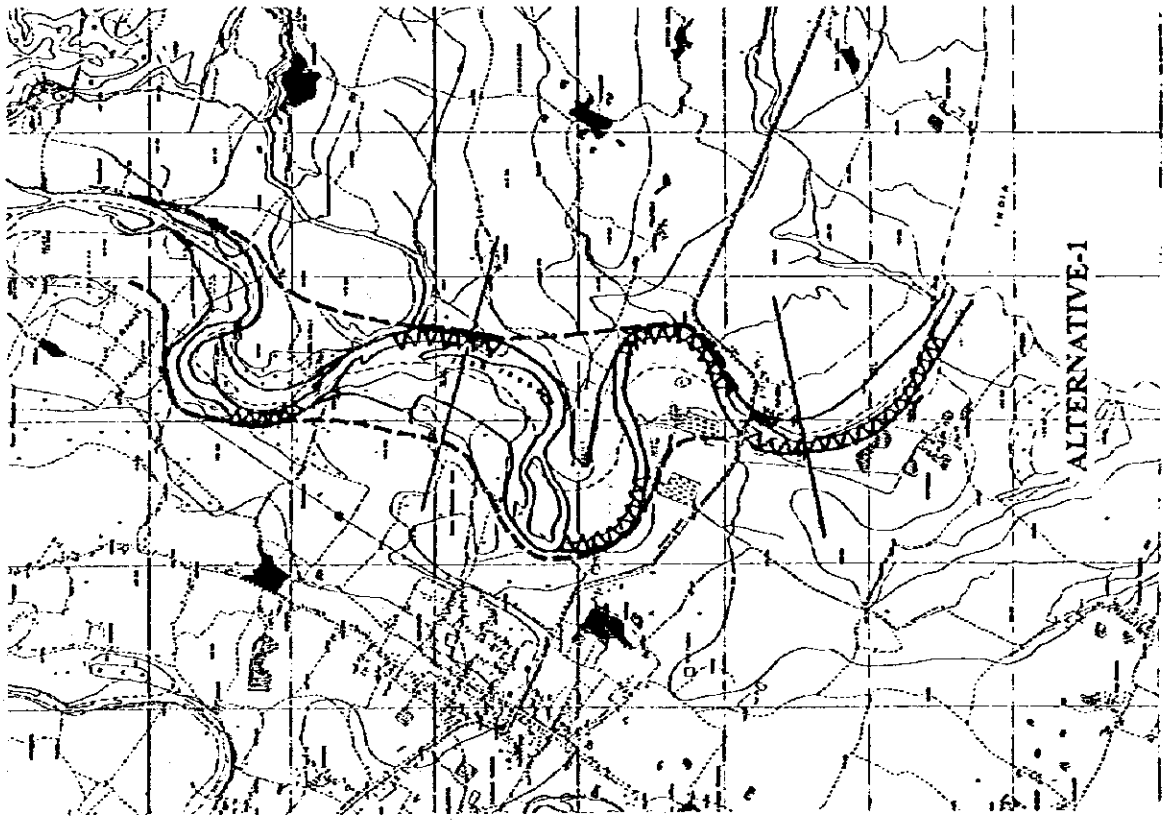
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY





Severe Meanderring of Babai River at Indrapur Bridge

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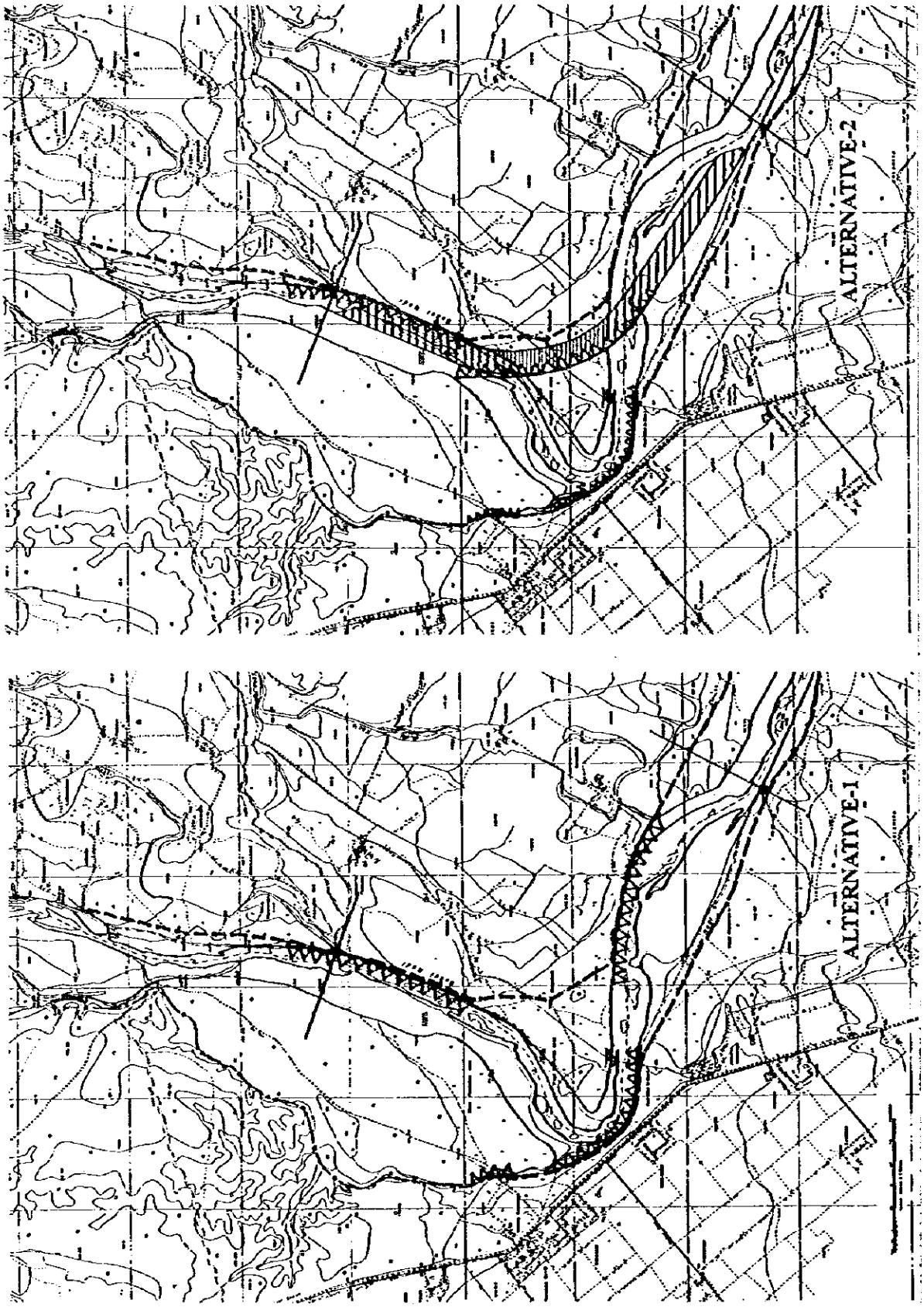
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



SHARP BEND OF BABAI RIVER
near Kusumbo Bazar

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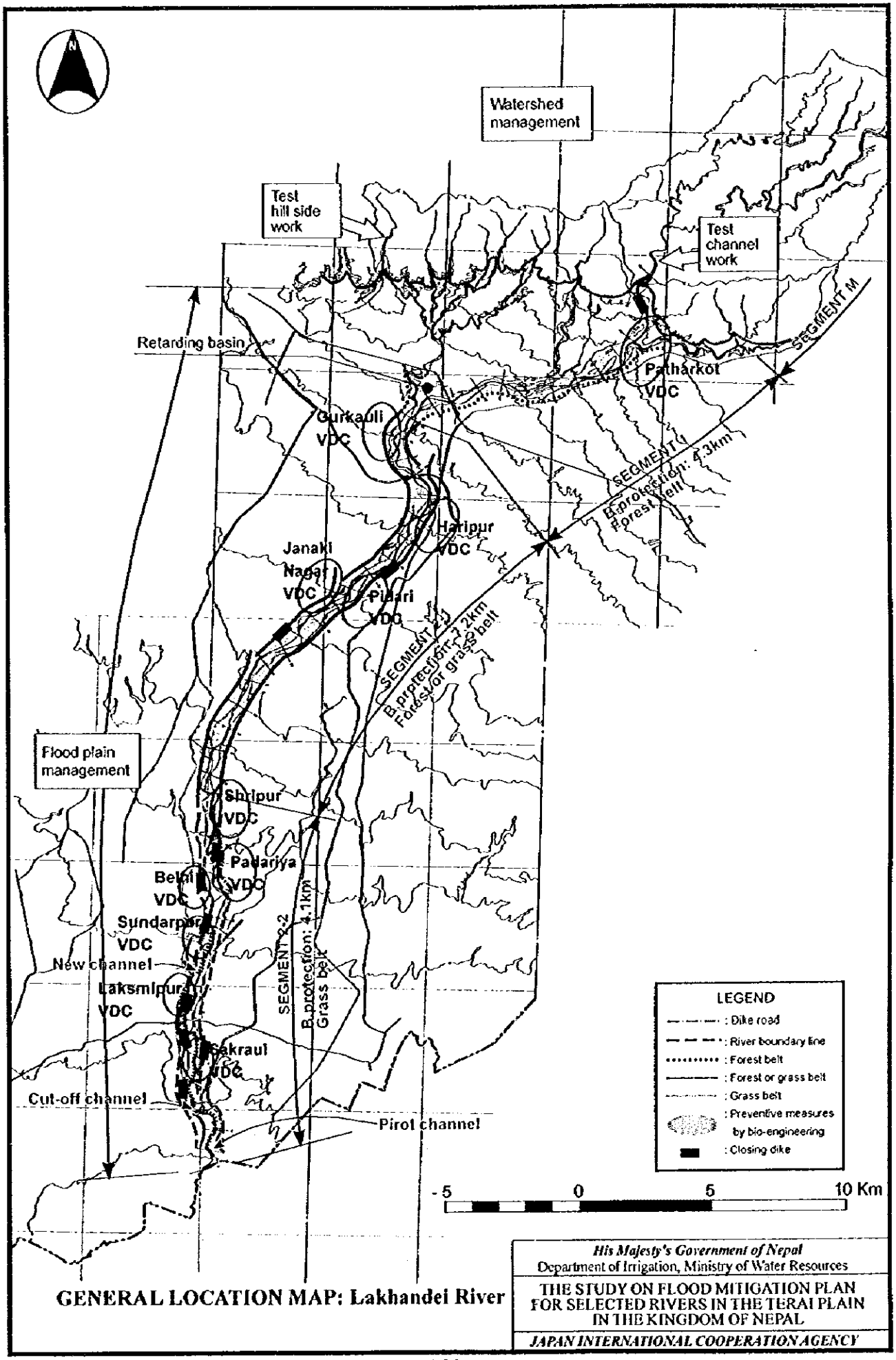
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



GENERAL LOCATION MAP: Lakhandei River

His Majesty's Government of Nepal
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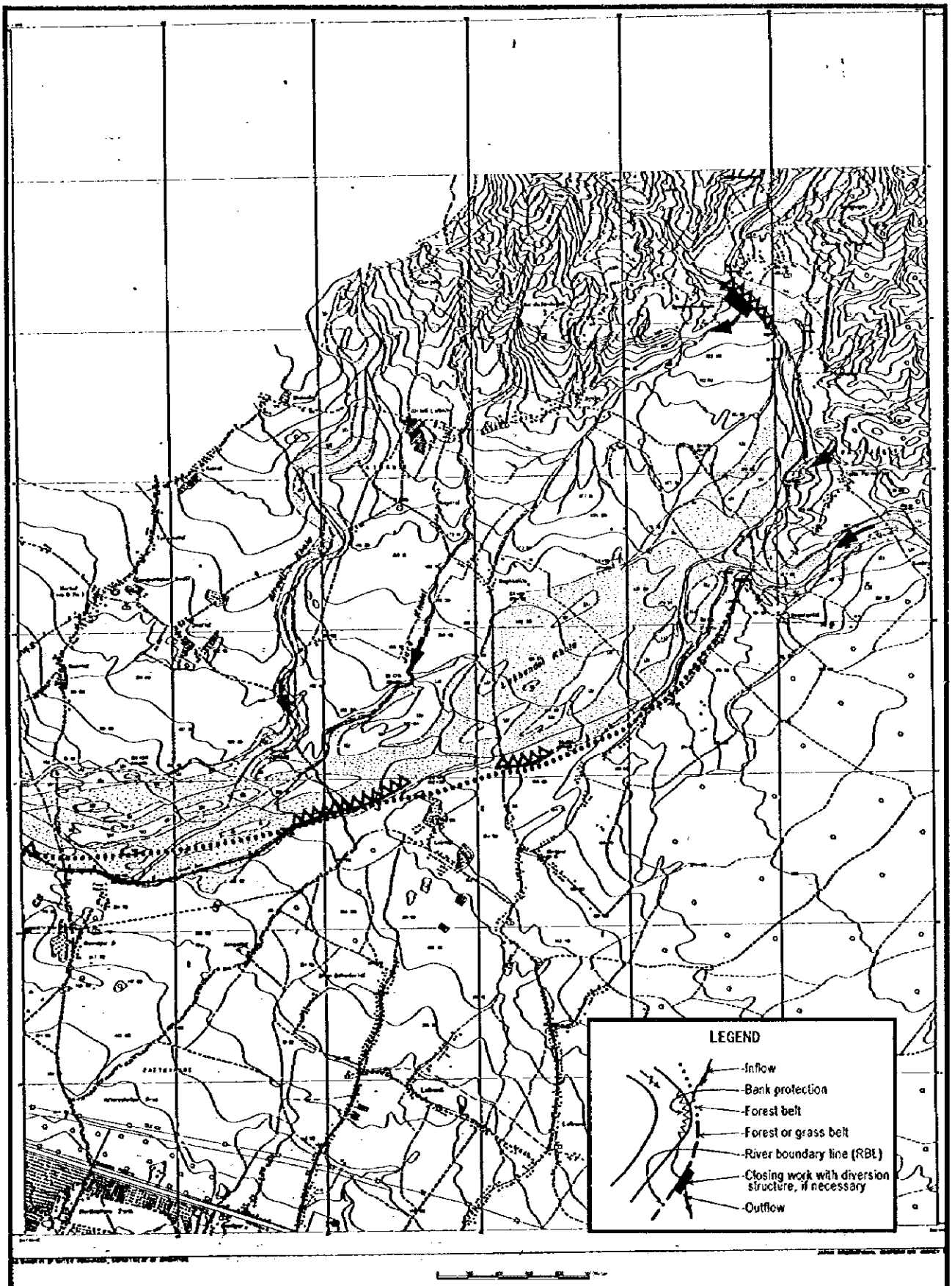
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY

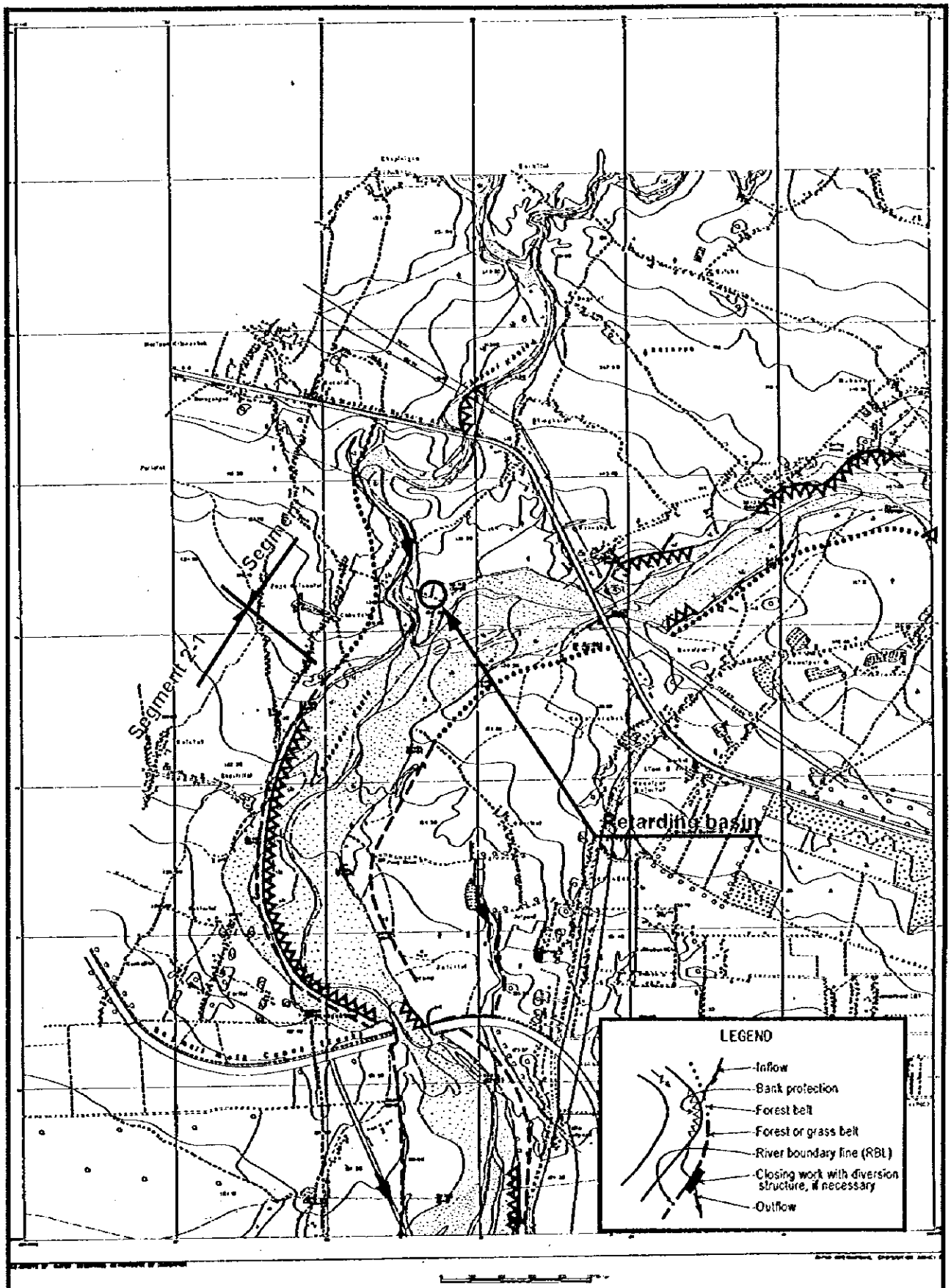


LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandei River (1/6)

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY

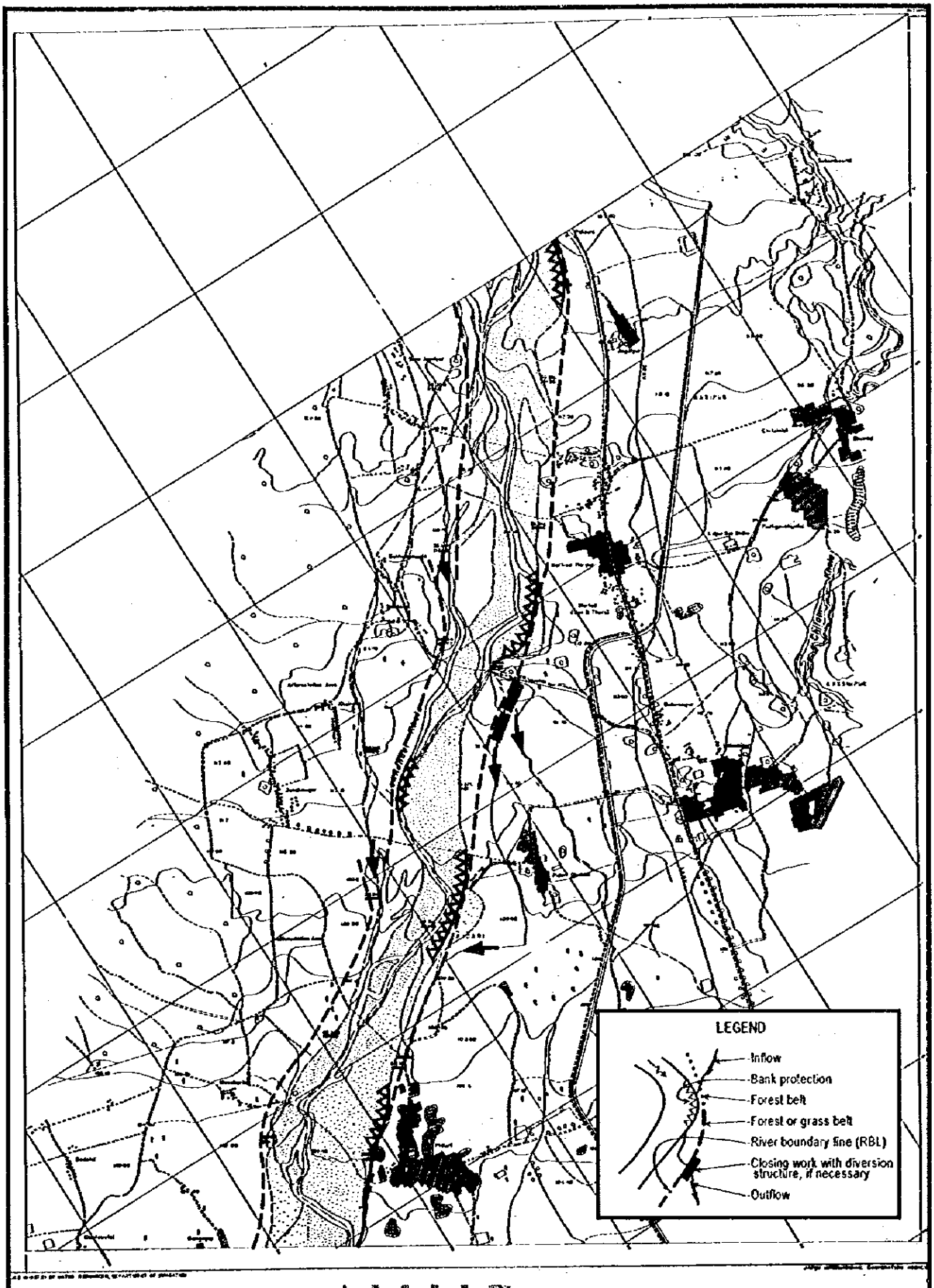


LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandehi River (2/6)

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY

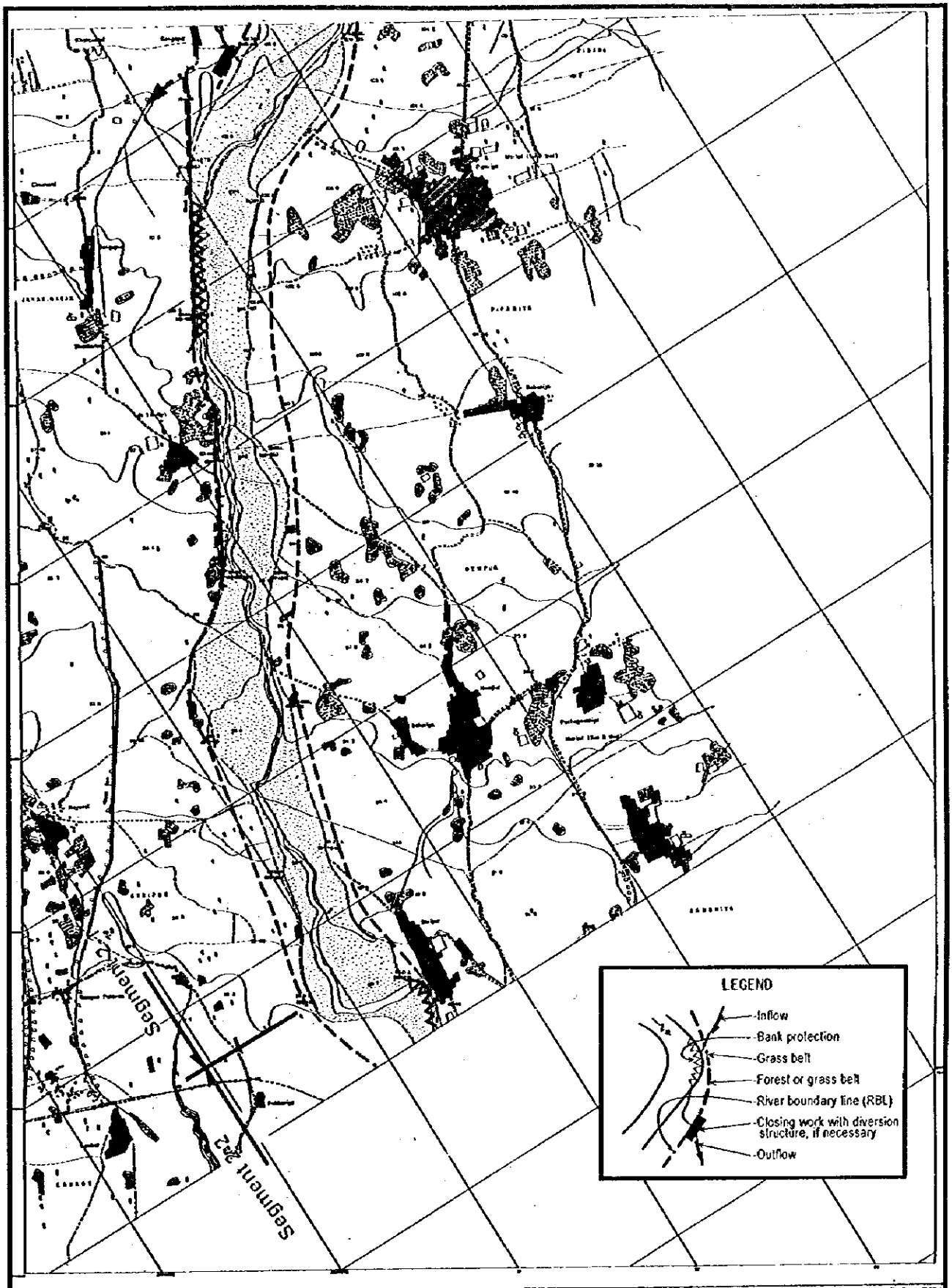


LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandei River(3/6)

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

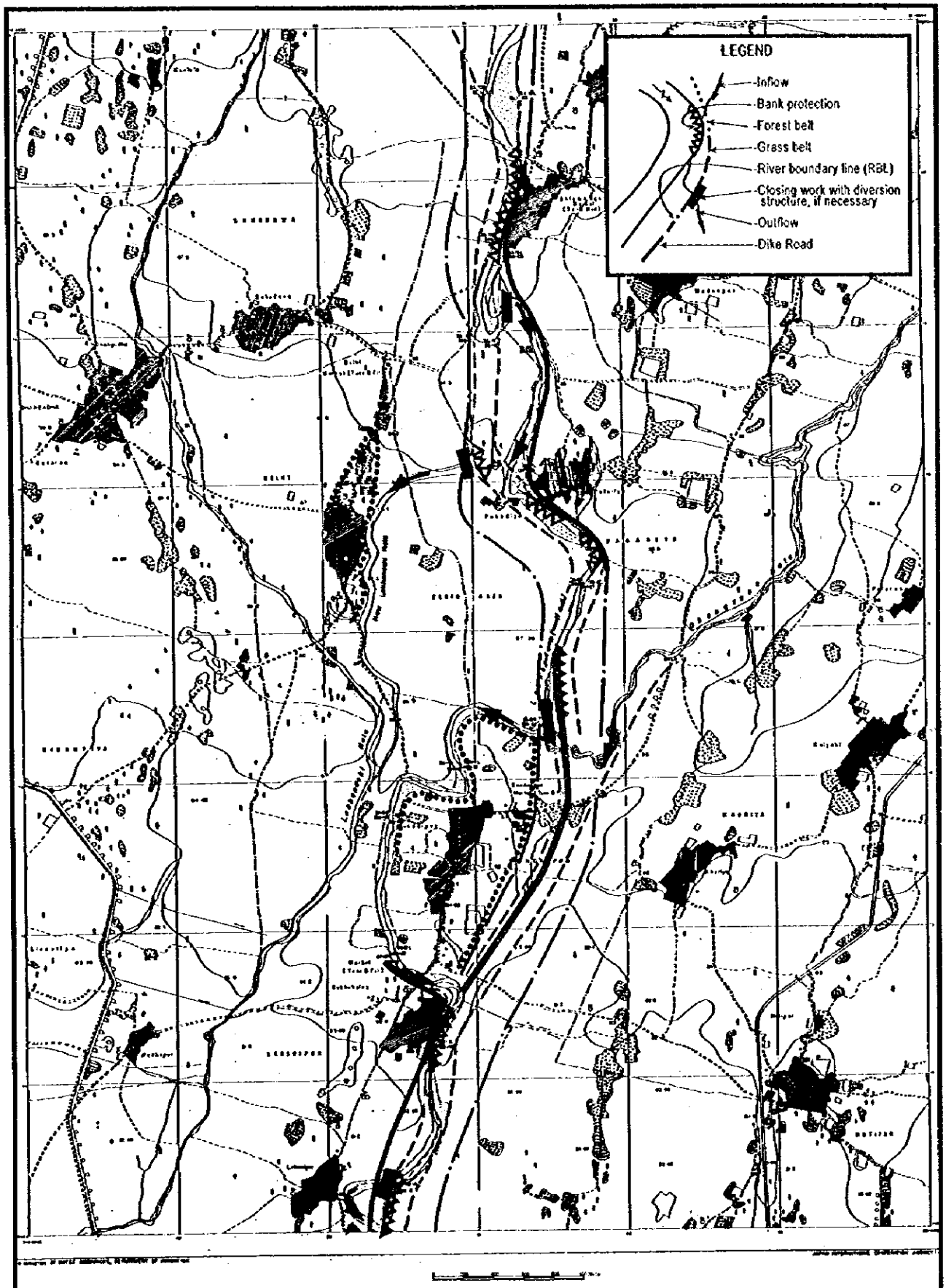
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY



LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandehi River (4/6)

His Majesty's Government of Nepal Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

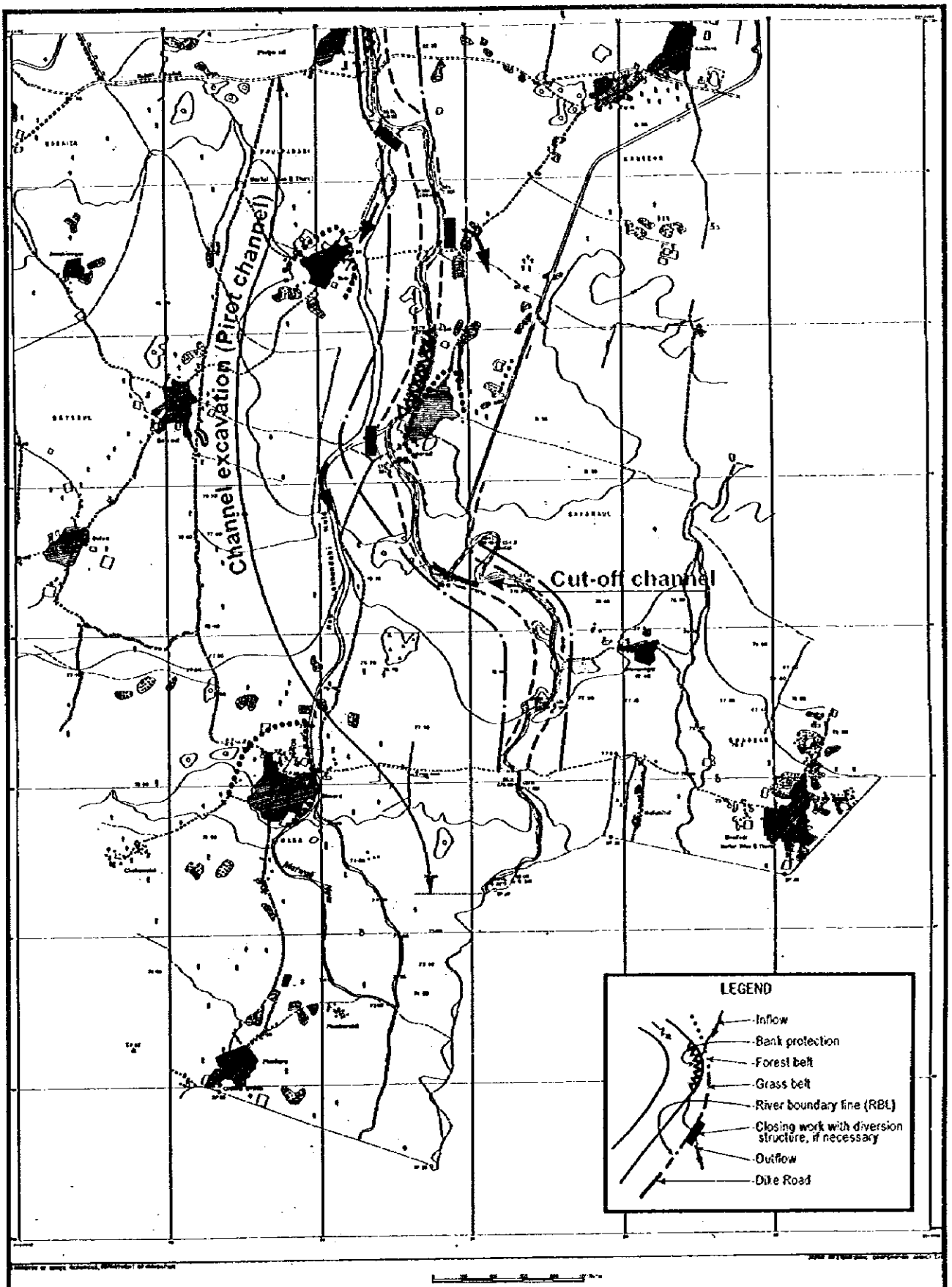


LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandei River (5/6)

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY



LAYOUT PLAN FOR FLOOD MITIGATION
Lakhandei River (6/6)

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY