- Provision of transportation of equipment from Japan to Nepal, provision of spare parts, supervision by Japanese experts during installation and commissioning of the plants, and training of Nepali engineers for O & M of equipment.

It is expected that by implementation of the Grant Aid there will be positive social and economic development of the area through sustained tourism industry and will contribute for environmental conservation of the Lake.

12. Findings of the Study

The findings and preparation of programs under the Master Plan for integrated environmental conservation of Phewa Lake are presented in the following paragraphs.

12.1 Hardware Components

- **Water Quality Management and Sewage Treatment Plan Component:** A series of Lake water quality testing and testing of inflow load from streams, canal and drain discharging into the Lake were carried out by the Study. Available previous test results were also collected and analysed. The data were used for generating simulation model of the Lake in various cases relating to existing condition and condition in future after technical interventions (refer **Fig. 10**). The Fig. 10 presents the existing TN, TP, COD and Chl-a level in the Lake water, and simulation results after installation of HMGN requested types of equipment and construction of diversion sewerage system alternatives respectively. All these results manifest emergency need of technical intervention for checking further deterioration of Lake water quality and save its aesthetic and commercial value. It has also been identified that the socio-economic standard and quality of life of the people from both rural and urban watershed area of the Lake, sustainable development of tourism industry around the Lake, and the environmental conservation of the Lake are very closely inter-related. Each are dependent on each other. Thus, to safeguard the aesthetic value of the Lake and in the process develop socio-economic and quality of life of people through sustainable tourism development, the management of water quality of the Lake is identified as 'Prime Necessity'.

It has also been identified that discharge of highly polluted Phirke Khola, Seti Canal and open storm-water drains in to the Lake, and seepage from open bottomed septic tanks are the main source of pollution causing Lake water degradation. To restrict the on-going pollution, HMGN requested Grant Aid as well as other viable alternative options are analysed by the Study. Such analysis are based on performance, efficiency, sustainability, duration of operation, durability, socio-economic benefits to the local communities, level of skill available in Nepal for future O & M, capacity of HMGN for replacement of equipments after completion of their working life etc. Comparative table on qualitative and quantitative characteristic of different alternatives is presented in following **Table 6** and **7** respectively.

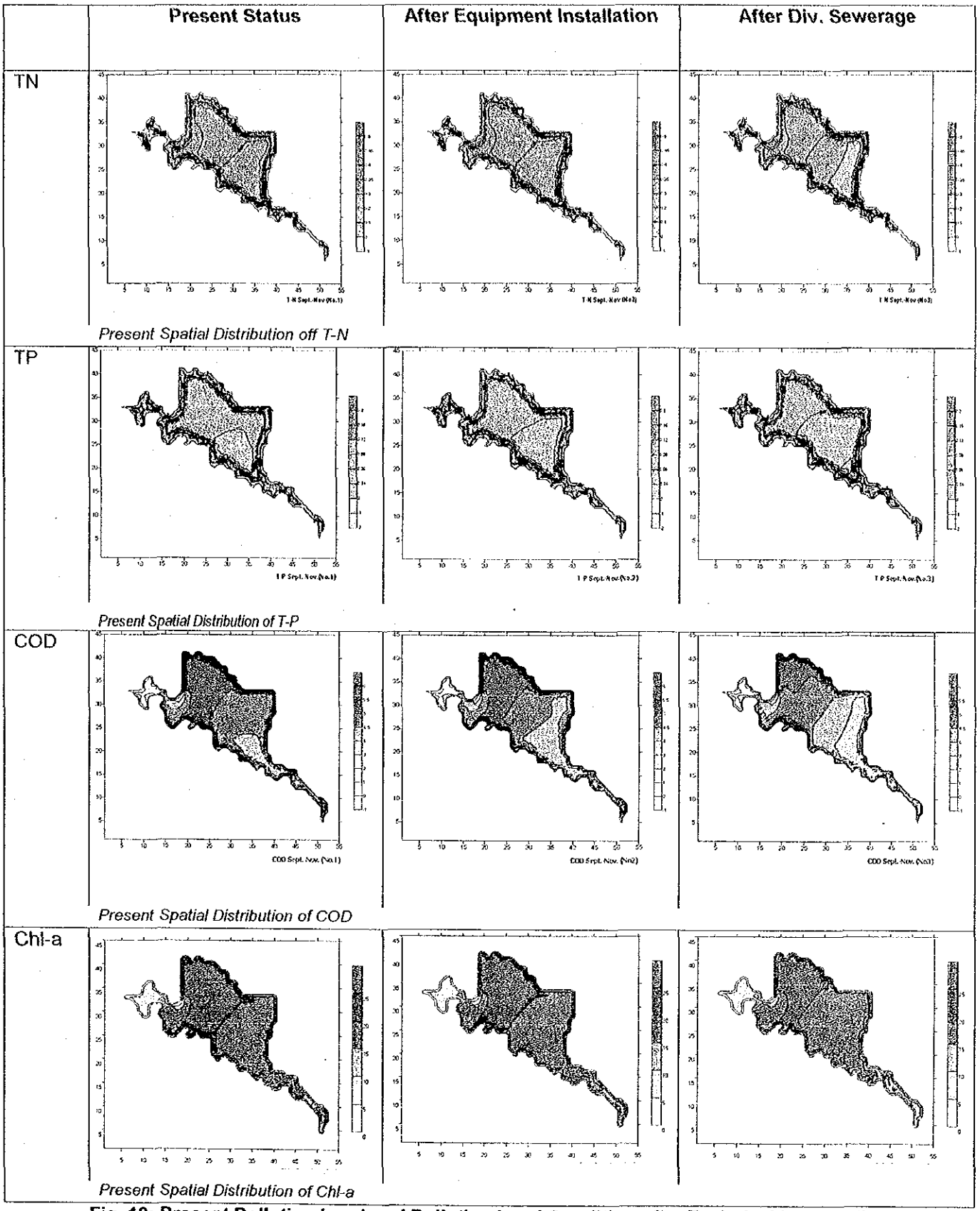
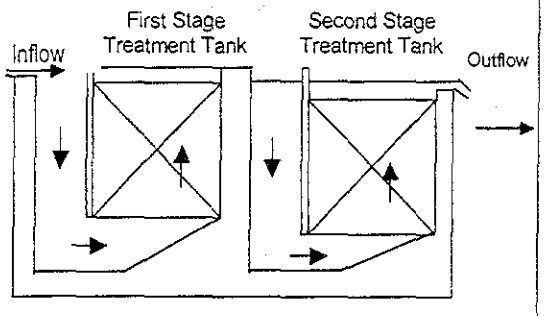
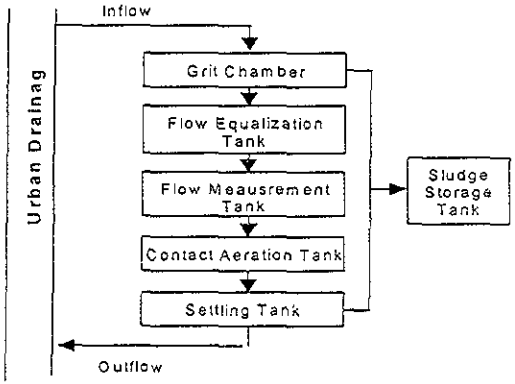
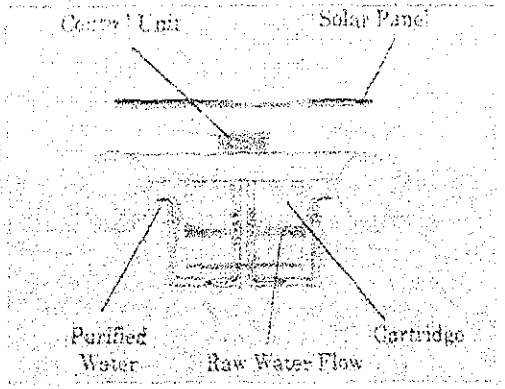
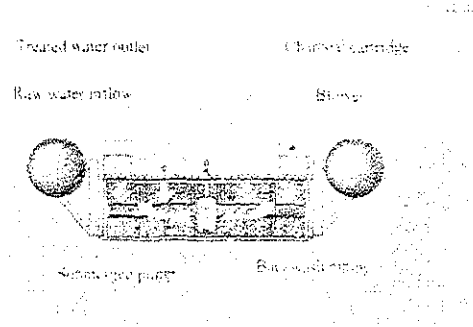


Fig. 10: Present Pollution Load and Pollution Load Condition after Technical Intervention

Table 6: Qualitative Comparison Table for Sewage Treatment Systems

SN	System Type	Operation System	Removal Ratio (%)					Advantage	Disadvantage
			BOD	COD	SS	TN	TP		
A. HMGN Requested Grant Aid from GOJ									
1	3 numbers of small prefab type of sewage treatment plant (See Fig. II-2.2)	Up-flowing contact oxidation system. Works on river water with BOD ≤ 20 mg.	40		70-75	15-20		▪ Removal ratio of daily wastewater is fair except runoff load from rain water ▪ Assembling of treatment plant is easy ▪ Can start working within a year 	▪ O/M cost is fair ▪ Repair and maintenance cannot be done by local skill ▪ The period of durability is short (< 10 years), and replacement is not assured ▪ Removal of pollution load is influenced by rainwater ▪ Mechanical trouble of plant at any stage will cause complete failure of overall project, and Phewa Lake will be back to its polluted condition ▪ Land acquisition is necessary, and difficult ▪ Past performance of such plants is not much known in developing countries ▪ Existing pollution from open bottomed septic tanks at lakeshore areas will continue.
		Contact aeration system. Used for urban Drain wastewater with BOD>20mg	75		67	15-20			▪ O/M cost is fair ▪ Repair and maintenance cannot be done by local skill ▪ The period of durability is short (< 10 years), and replacement is not assured ▪ Removal of pollution load is influenced by rainwater ▪ Mechanical trouble of plant at any stage will cause complete failure of overall project, and Phewa Lake will be back to its polluted condition ▪ Land acquisition is necessary, and difficult ▪ Past performance of such plants is not much known in developing countries ▪ Existing pollution from open bottomed septic tanks at lakeshore areas will continue.

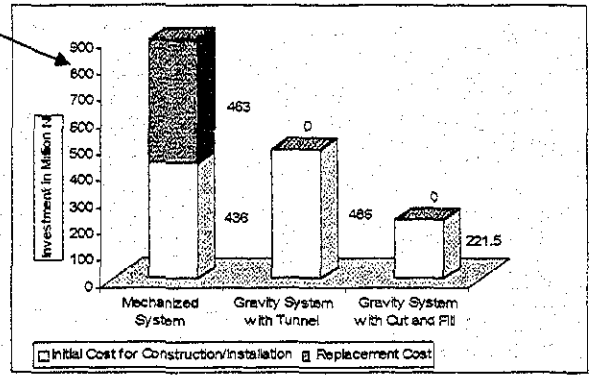
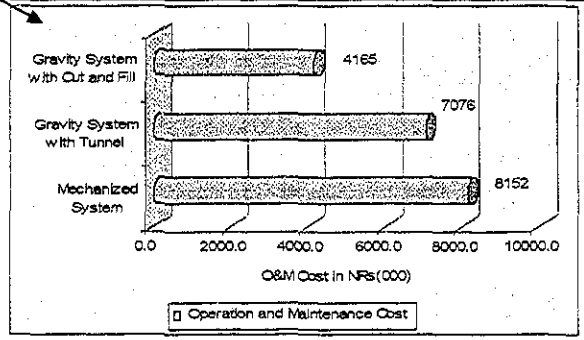
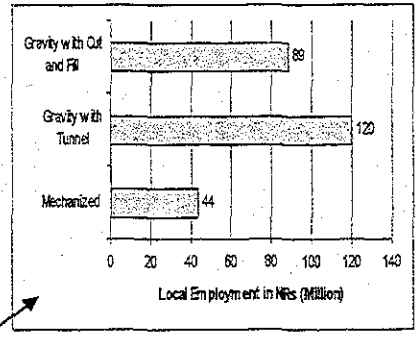
SN	System Type	Operation System	Removal Ratio (%)					Advantage	Disadvantage
			BOD	COD	SS	TN	TP		
2	25 nos. of Lake water purification system	Floating type Lake water purification system. - Raw water down flows into the cartridge from the upper side of the charcoal purifier - Purification and decomposition take place by food chain - The treated water is collected in the collection tube - Treated water discharged into the lake in a horizontal flow by the submerged pump. - A diffuser attached to the side supplies the dissolved oxygen		40				▪ No space is required for installation of the equipment (except for the space of the control panel) ▪ Low maintenance and management cost, low running cost by employing compact type high performance submerged pump and blower. ▪ No sludge treatment, no removing of sludge to outside the system, no sludge treatment cost ▪ Fully automatic operation. Attached with an automatic back washing function that requires no routine operation. ▪ High performance coal purification ▪ Excellent purifying performance with the use of filter material made of charcoal. ▪ Timber for thinning is the original source of charcoal. 	▪ The period of durability is short (<10 years), and replacement is not assured ▪ Life of solar battery is only 4 years, but the solar panel it used only on day time may not require the battery ▪ Removal of pollution load is possible only in small area (20 m diameter only). ▪ Mechanical trouble of plant will cause complete failure of overall project, and Phewa Lake back to its polluted condition ▪ Past performance of such plants are not known in developing countries. ▪ 25 numbers of floating equipment on Lake surface will diminish aesthetic beauty of Lake 

SN	System Type	Operation System	Removal Ratio (%)					Advantage	Disadvantage
B. Other Alternatives									
1.	Gravity sewerage system	Trunk Sewer (5088 m total with tunnel 1286 m and dia =1.2 m) Tunnel cascade type aeration treatment Plant before discharging in the Phusre Khola.	100	100	100	100	100	▪ Removal ratio of daily wastewater is 100% except a part of runoff load from rain water ▪ Removal of pollution load influenced by rainwater is fairly possible. ▪ O/M cost is relatively cheap ▪ little requirement of maintenance, which is easy ▪ The period of durability of the system is long (more than 25 years) ▪ System has minimum trouble as no mechanical devices are installed ▪ Land acquisition is not necessary in most of the places because sewer line will be below existing roads ▪ Past performance of such system are encouraging in developing countries like Nepal ▪ Local skill available in the country ▪ Large amount of benefit of construction cost goes to local people and local construction material industry ▪ Tunnel construction will assist in this essential area of technology transfer in hilly country like Nepal.	▪ Construction period is longer (min 2 years) ▪ Land acquisition is necessary in some locations (minimal) ▪ Traffic has to be diverted from by-pass roads during construction (available) ▪ Short-term impact on business along the Lakeside during construction ▪ Construction related impacts, which can be mitigated
	Modified gravity sewerage system	Trunk sewer + lifting pump + cascade type aeration treatment plant before discharging in the Phusre Khola.	100	100	100	100	100	▪ Lifting pump assist in elevating the sewage and maintain gravity flow, and thus expensive option of tunnel construction is not needed ▪ Removal ratio of daily wastewater is 100% except a part of runoff load from rain water ▪ Removal of pollution load influenced by rainwater is fairly possible. ▪ The period of durability of the system is long (more than 25 years for sewer system and 10 years for mechanical pump)	▪ Construction duration is long (min 2 years) ▪ Land acquisition is necessary for some locations. ▪ Past performance of such mechanical pumps are not very encouraging in developing countries. ▪ Construction work requires special attention ▪ The period of durability is short for pump (10 years) ▪ OMM is relatively difficult ▪ O&M cost is relatively expensive and not sustainable ▪ Trouble in lifting mechanism is possible, failure will allow the sewage in the Lake again.

SN	System Type	Operation System	Removal Ratio (%)					Advantage	Disadvantage
	Gravity system including treatment plant	Sewer line +treatment plant. Allow treated water in the Lake.	75	75	75	60	60	▪ Removal ratio of daily wastewater is good except a part of runoff load from rain water ▪ Removal of pollution load influenced by rainwater is fairly possible. ▪ Removal ratio of pollution from lake water is fair	▪ O/M cost is expensive ▪ OMM is difficult ▪ Period of equipment durability is short (less than 10 years) ▪ Construction work is difficult than diversion canal system plan (1 and 2) due to mechanised treatment plant ▪ Social conflict possible due to odor nuisance ▪ Land acquisition is necessary

***Note**: The removal ratio presented in the above table are the efficiency of the equipment or structure themselves. It does not mean the total removal of pollution from the entire Lake waterbody.*

Table 7: Quantitative Comparison Table for Sewage Treatment Systems and Sediment Removal System

S.No.	Description	HMGN Requested Grant Aid Prefab Type Treatment Plant and Floating Type Lake Water Purification System	Alternative Option Gravity type Sewerage System	
			With Tunnel	With Cut & Cover
1.	**Water Quality Management Plan**			
a.	Total cost	436 million NRs. (5.6 million US $)	486 million NRs. (6 million US $)	221.5 million NRs. (2.8 million US $)
				
b.	Comparision of cost considering O&M cost	*8.1 million NRs.*	*6.6 million NRs.*	*1.8 million NRs.*
				
c.	Local employment generation scenario	44 million NRs.	120 million NRs.	89 million NRs.

- Based on qualitative analysis, diversion sewerage system has been identified as the best solution as it attains more than 90 % pollution removal ratio in comparison to other alternatives.
- The qualitative and quantitative analysis suggest Diversion Sewerage System with Cut and Fill Option as the most suitable option. However, considering the difficulties in construction, risk involved in excavating more than 5 m depth in city area, and nature of material to be excavated, **Gravity Sewerage System with Tunnel** (length: 5088 m; refer **Fig. 11**) alternative appears becomes the most suitable and appropriate one.

  The simulation study has revealed a problem of pollution load at the portion of the Lake between Khapaundi and Gaira Chautara due to stagnant water without flow. This problem can be minimized by channelizing fresh water of Harpan Khola during low flow period by construction of a small canal with gate. This will clean the stagnant water by mixing of fresh water as well as inducing mixing and flow of water.

  The water quality management plan component has envisaged to construct 4 numbers of laundry platform along the Lakeshore. The wastewater with soap and detergent will be discharged into the proposed sewerage system, thus restricting it to enter in Lake water.

- **Watershed Management Plan Component:**
  - *Environmental Conservation Oriented Sustainable Agriculture Development*
  - *Watershed Erosion and Sedimentation Reduction Program*

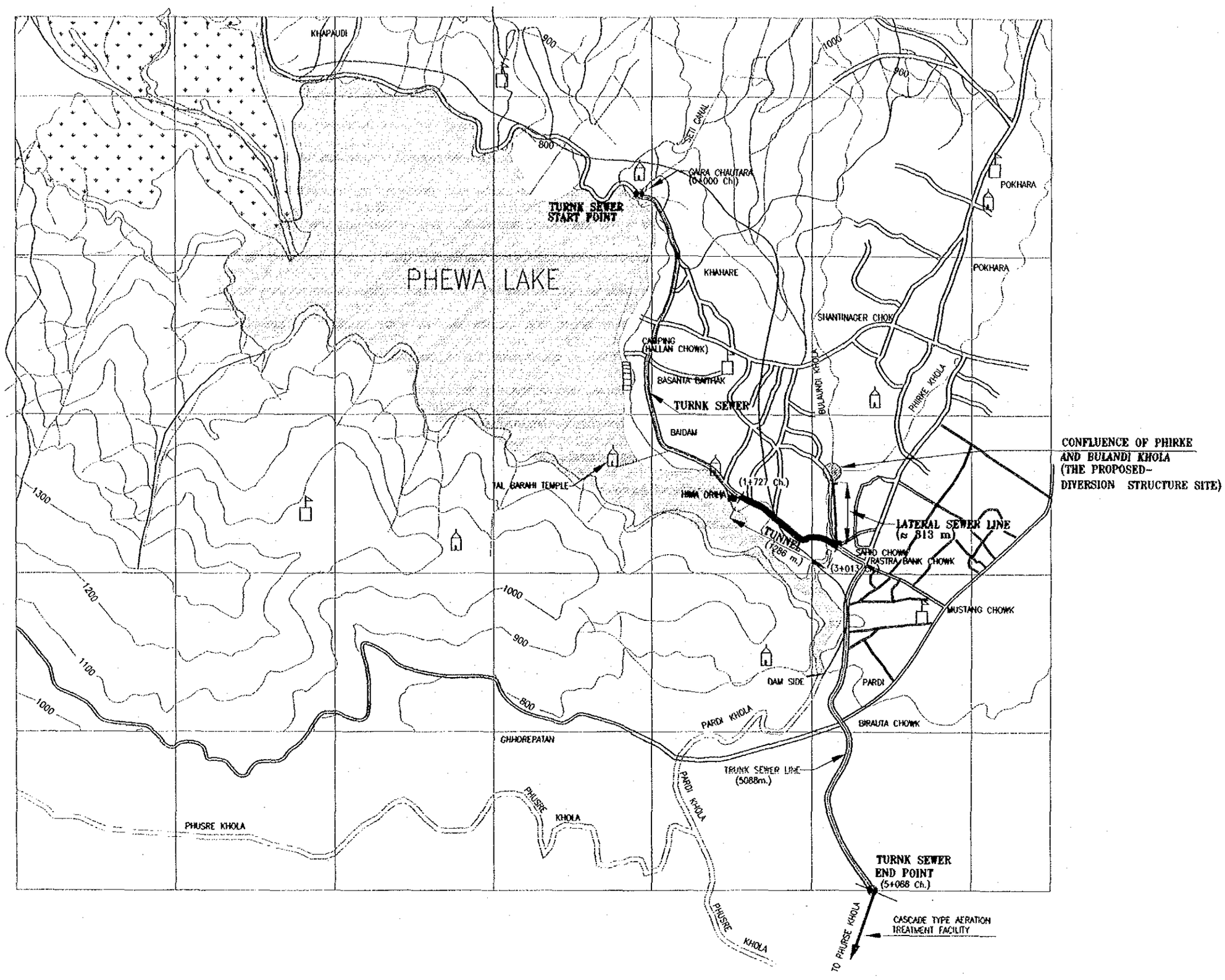
The priority projects envisaged in this component are (i) restrict flow of sediment into the Lake by construction of 250 m x 250 m x 2 m size of sediment trap at the mouth of Harpan Khola. Estimation of the sediment trap is calculated based on yearly sediment load even after implementation of effective watershed conservation plan, which will reduce only 20% of present rate of sediment load; (ii) yearly removal of sediment from delta formed by Harpan khola. Excavator (back hoe), front end loader, bulldozer and trippers will be used to excavate and dispose sediment from the sediment trap and delta of Harpan Khola in Seti River each year; (iii) hydraulic flushing of sediment from sediment trap to Phushre Khola through tunnel (iv) construction of riperian buffer strip around Lakeshore.

- **Monitoring Plan Component:**

  Monitoring plan, schedule, and methods has been prepared and responsible agencies identified for undertaking routine and periodic monitoring of Lake water quality, river pollution load, and watershed erosion and Lake sedimentation rate. It has also been proposed that the existing laboratory at Begnas of Fisheries Research Center, NARC, established under Japanese funding should be re-strengthened and used in cooperation with Phewa Lake Environment Conservation Committee for carrying out regular and periodic monitoring of Lake and river water quality.

- **Ecosystem Conservation Plan Component:**
  - *Land use planning and buffer zonation along Lakeshore*
  - *Conservation of threatened habitat and aquatic biodiversity*
  - *Wetland protection*
  - *Control through utilization of water hyacinth*
  - *Constructed wetland at Phewa Phant (delta)*

  The priority projects envisaged in this component are (i) Lakeshore's wise use project; (ii) Conservation and sustainable utilization of biodiversity; (iii) Fish conservation and fisheries development program; (iv) constructed wetland project.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	THE DEVELPOMENT STUDY ON THE ENVIRONMENTAL CONSERVATION OF PHEWA LAKE POKHARA NEPAL	DRAWING TITLE: LAYOUT MAP OF PROPOSED SEWERAGE SYSTEM				SCALE 0 250 500 750 1000 1250m	SILT Consultants (P.) Ltd. Baneswor,Kathmandu,Nepal P.O Box: 2724 Fax: 977-1-473573 Phone: 473573, 470866, 487598, 495163 E-mail:silt@mos.com.np Web:www.silt.com.np	Fig. No. 11 Page No. 27

- **Solid Waste Management Plan Component:**
  - *Solid waste collection from point of generation and transport to final disposal site in urban area*
  - *Reduce-Recycle-Reuse principle through environmental education*
  - *Composting, briquette making, handmade paper, bio-gas for energy etc. particularly in rural areas*

  A model solid waste management project in Ward No. 6 of PSMC has been prepared, which can be replicated in other areas. Public-private partnership modality has been suggested for managing waste, as private sector will be more efficient, regular and committed. They will charge for the services on monthly basis from the service-receiving households.

- **Tourism Development Plan Component:**
  - *Buffer zone creation with Lakeside footpath (refer **Fig 12**).*
  - *Landscape in Lakeside area*
  - *Upgrading of Lake Side Community Road*
  - *Eco-tourism with development of picnic spot, tourist trails, village tourism with loan to upgrade houses into lodges, establishment of botanical garden and aquarium to display exotic species of fishes found in the Lake, Phewa festivals, international lake seminar, culture exchange programs, water tournament etc.*

  The priority projects envisaged in this component is eco-tourism development in the rural area of the watershed, buffer-strip around the Lake as promenade, Lakeside community road, Phewa festival etc. to increase numbers of tourists as well as to prolong their stay.

12.2 Software Components

- **Environmental Education and Community Empowerment Program:**
  - ***Environmental Education***

    The **general objective** of the Environmental Education Program will be to promote responsible, committed and action-oriented awareness among the local community, to strengthen their capacities for sustainable environmental improvements and management of the Phewa Lake and its watershed areas.

    The **specific objectives** of the Environmental Education Program is to facilitate and enable the communities and stakeholders to:
    - Carry out *Participatory Situation Assessment* for the current environmental condition and trends and its current and potential consequences.
    - Design and Conduct Environmental Education through participatory and behavioral environmental education
    - Develop Participatory Environmental Rules and Action Management Plan (PERAMP)
    - Set-up a strong, efficient, appropriate and sustainable operational institution and its capacity building through properly designed and well targeted training and support programs.
    - Continue Implementation of Environmental Education and Improvement Initiatives and undertake participatory monitoring, follow-up and evaluation system of environmental education and improvement initiatives.

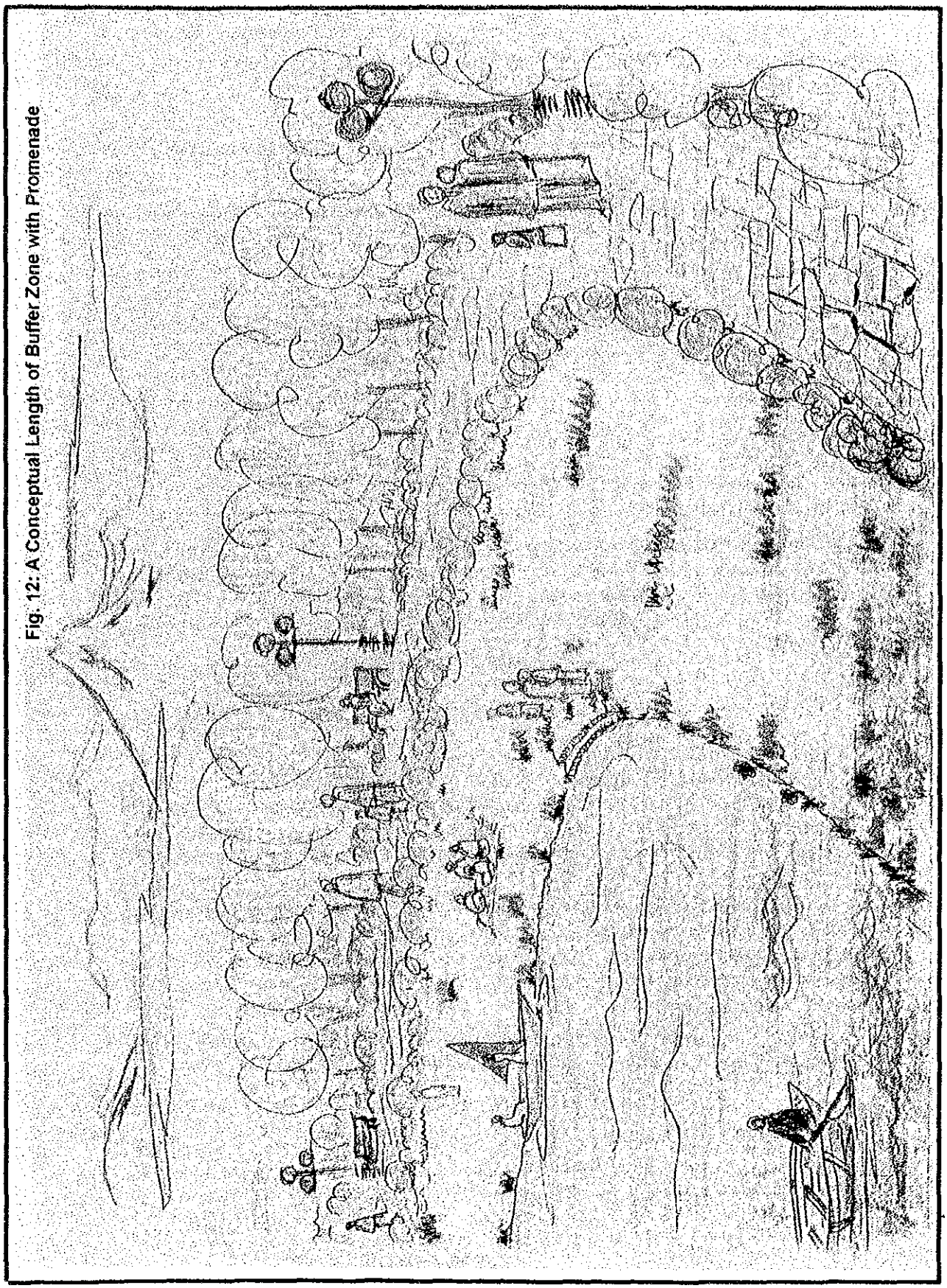


Fig. 12: A Conceptual Length of Buffer Zone with Promenade

- ***Community Empowerment***

  The overall goal of Community Empowerment Program will be to reduce poverty and improve the standard of living of poor communities through community-initiated sustainable social and economic development efforts leading to the environmental conservation of watershed areas of Phewa Lake. This will directly benefit people at the grassroots level that are poor and vulnerable.

  Program Components: The Community Empowerment Program will limit its focus to the following eight sectors:
  - Community Development;
  - Income Generation;
  - Environmental Health and Hygiene Education, and Support and Services;
  - Reproductive Health Initiatives;
  - Living Environment Improvement;
  - Children's Environment Improvement;
  - Women's Empowerment Improvement; and
  - Capacity Building

  The program requires more to be target-oriented than general welfare-oriented. The process will adopt the methods of mobilizing the community initiative rather than the project initiative.

  To the process of community empowerment, the social capital in the Phewa watershed area, which can be utilised, include the motivated people, societal institutions, willingness for community partnership, feeling of ownership, gender sensitivity, commitment of partnership, harmonized ethnic composition of communities, and specified occupations.

- **Organizational and Institutional Development Plan Component:**

- ***Establishment of Phewa Lake Environment Conservation Committee (PLECC)***

  To carry out and coordinate regular and routine plan, program, implementation and management of Lake conservation activities with a self sustainably and long-term perspective, it requires an institution as well as regular source of fund. Thus, to execute and coordinate all activities, coming under the hardware and software components of the proposed Master Plan, this Study has recommended restrengthening and restructuring of existing 'Phewa Lake Area Conservation Committee' (PLACC) as 'Phewa Lake Environment Conservation Committee' (PLECC), and set-up a Phewa Lake Environment Conservation Fund within this Committee. Justification of such Committee includes institutionalization of a long–term, self-sustaining organization through better collaborative management approach. The existing Phewa Lake Area Conservation Committee has heavy representation from HMGN, and lacks representation from VDCs, beneficiary communities and occupational groups, as well as the committee has remained quite inactive for considerable period of time. Thus newly restrengthened committee (PLECC) has been proposed by this Study.

- ***Institutionalize the Phewa Lake Environment Conservation Fund***

  The Fund will help in sustaining the conservation works and creating facilities for rendering services to cater need of visitors in a better way. The success of most conservation activities of Phewa Lake in future will be based upon efficient mobilization of this Fund. This Fund will give a sound base and sustainability to the conservation efforts.

It is proposed that tourist will be charged conservation fee to enter in Phewa Lake area. It has been estimated based on experience of national and international practices that per tourist will be charged with a rate of NRs. 200 (approx. US $ 3) per person per visit. The amount will be judiciously and transparently utilized for the development of rural and urban watershed areas of the Lake, which will contribute towards its sustained environmental conservation.

- ***Establishment of a Phewa Lake Conservation Center***

This institution, a wing of proposed Phewa Lake Environment Conservation Committee is defacto a link between the conservation activity and the people. Visibly, it will collect and disseminate information about the Lake, but the total effect will be generating interest and committal from the mass towards the Lake. It will inform the people about the bad and good in the Lake, bad and good treatment it is getting from the people. It will also collect view from the general mass about the Lake. In conclusion, it will act as a catalyst to sustain the conservation effort and get support from all the interested organizations and individuals, local or foreign. It will also promote the Lake and its conservation through activities as listed above under Tourism Development Plan Component. A conceptual elevation of the proposed center in given in **Fig 13.**

13. Prioritized Project and Cost

Table 8: Prioritized Project and Cost

SN	Component	Priority	Project Title	Cost (in million NRs.)	Remark	Total (NRs. million)
1	Water Quality and Sewage Management Plan	1	- Sewerage System Plan (with tunnel) - Laundry Washing Spots	486 5	Without Tunnel - 221 million NRs.	491
2	Environmental Education Plan	2	Environmental Education and Capacity Building	52		52
3	Watershed Management Plan	3	- Sustainable Agriculture Development - Soil Erosion and Sedimentation Reduction	38.5 40	Include Annual O&M Cost	78.5
4	Institutional Strengthening Plan	4	Phewa Lake Conservation Center	4.8	Does Not Include Operational Expenses	4.8
5	Ecosystem Conservation Plan	5	- Lakeshore Wise Use Project - Conservation and Sustainable Utilization of Bio-diversity - Fish Conservation and Fisheries Development - Constructed Wetland	1.1 3.4 8.5 0.9		13.9
6	Monitoring Plan	6	Monitoring of Lake Water Quality, Inflowing Rivers and Watershed Management	9.3	Includes Re-strengthening of FRC Lab of NARC/HMGN in Begnas	9.3
7	Tourism Development Plan	7	- Eco-tourism / Village Tourism - Lakeshore Planning and Beautification Project - Lake Side Community Road - Gaira Chautara – Thulakhet Road - Sarangkot – Naudanda Road	30 18 90 100	Does Not Include Land Acquisition Cost	238
8	Solid Waste Management Plan	8	Solid Waste Management System	-	To Be Carried Out Under Public Private Partnership	-
TOTAL						887.5

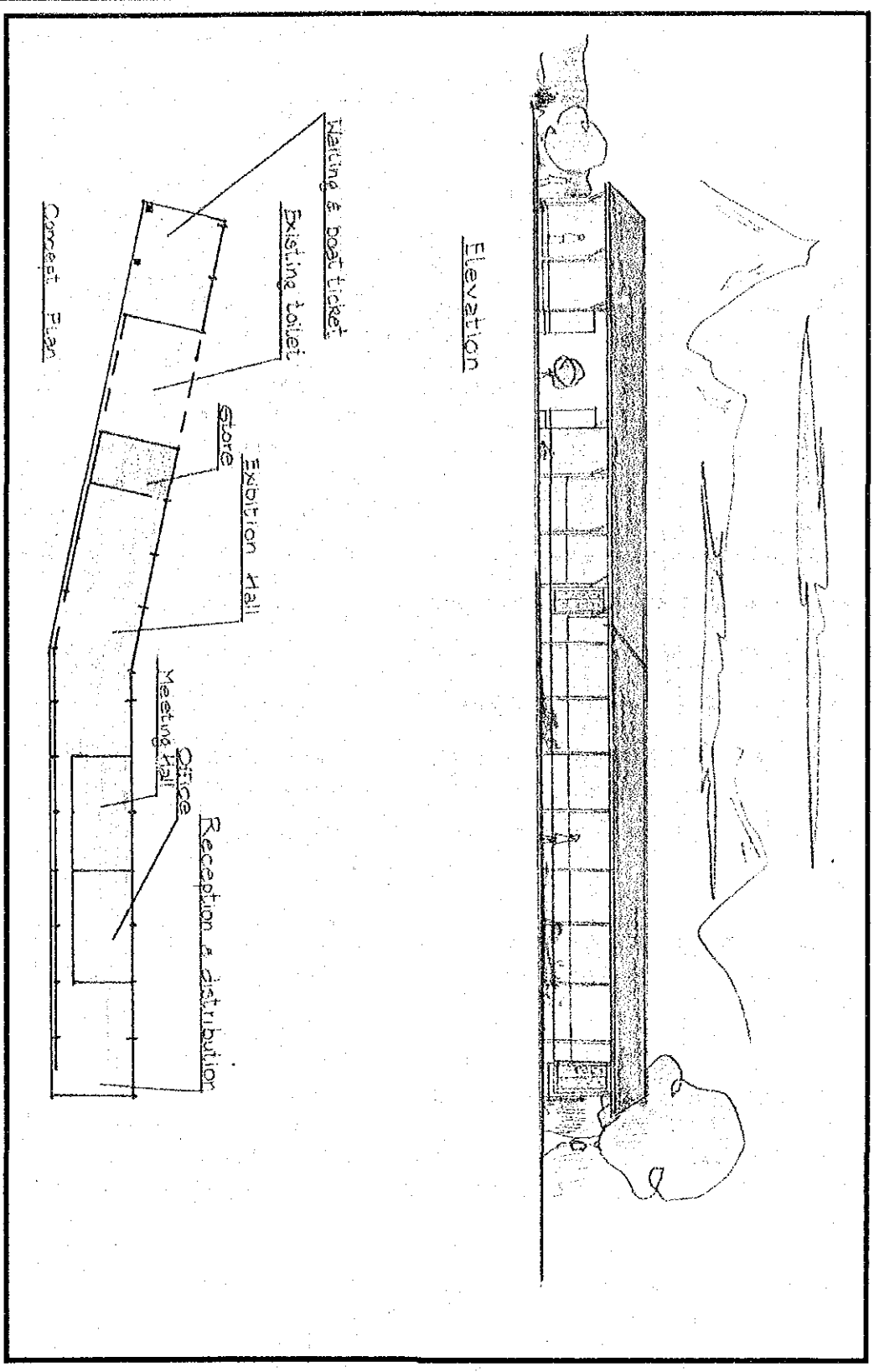


Fig.13: Conceptual Elevation of Phewa Lake Conservation Center

14. Implementation Schedule

Table 9: Implementation Schedule

S. No.	Master Plan Components	Priority Projects	Time Schedule				
			1st year	2nd Year	3rd year	4th Year	5th Year
1	Water Quality and Sewage Management Plan	- Sewerage System Plan (With Tunnel) - Laundry Washing Platforms					
2	Environmental Education Plan	Environmental Education and Capacity Building					
3	Watershed Management Plan	- Sustainable Agriculture Development - Soil Erosion and Sedimentation Reduction					
4	Institutional Plan	- Phewa Lake Environment Conservation Center - Phewa Lake Environment Conservation Fund - Phewa Lake Conservation Center					
5	Ecosystem Conservation Plan	- Lakeshore Wise Use Project - Conservation and Sustainable Utilization of Bio-diversity - Fish Conservation and Fisheries Development - Constructed Wetland					
3	Monitoring Plan	Monitoring of Lake Water Quality, Inflowing Rivers and Watershed Management					
7	Tourism Development Plan	- Eco-tourism / Village Tourism - Lakeshore Planning and Beautification Project - Lake Side Community Road - Gaira Chautara – Thulakhet Road - Sarangkot – Naudanda Road					
8	Solid Waste Management Plan	Solid Waste Management System					

15. Recommendations

(1) Water Quality Management and Construction of Sewerage System

- Qualitative and quantitative analysis by the Study and unanimous opinion in public hearing has indicated gravity type of diversion sewerage system with tunnel to be the most suitable alternative for Lake water quality management. Similarly, laundry washing platform at Lakeshore with provision of wastewater discharge in sewerage system is also recommended.

(2) Environmental Education and Community Empowerment

- Environmental awareness and community empowerment program, income generation activities, health and hygiene education, living environment improvements, women empowerment etc. through mobilizing local level NGOs/CBOs and occupational groups is necessary for long-term impact on sustainable environmental conservation of Phewa Lake.

(3) Organizational/Institutional Establishment

- Formation of Phewa Lake Environment Conservation Committee (refer **Fig. 14**)

- A unanimous support has been given during the public hearing for formation of a strong, and well represented Phewa Lake Environmental Conservation Committee with legal mandate.
- Budgetary support from HMGN will be needed

▪ Establishment of Phewa Lake Conservation Fund
- Establish fund from charging tourist as conservation fee before entering Phewa Lake area, and hoteliers and restaurants who are using natural capital of Phewa Lake for their commercial benefit. The fund will be exclusively used for environmental conservation activities of Phewa Lake.

▪ Establishment of Phewa Lake Conservation Center
- Construction of the Center
- System for collection and dissemination of information on Phewa Lake
- Organize Phewa festival, water sport competition, international seminar etc

(4) Watershed Management
- Sustainable agriculture development
- Watershed erosion and sedimentation reduction

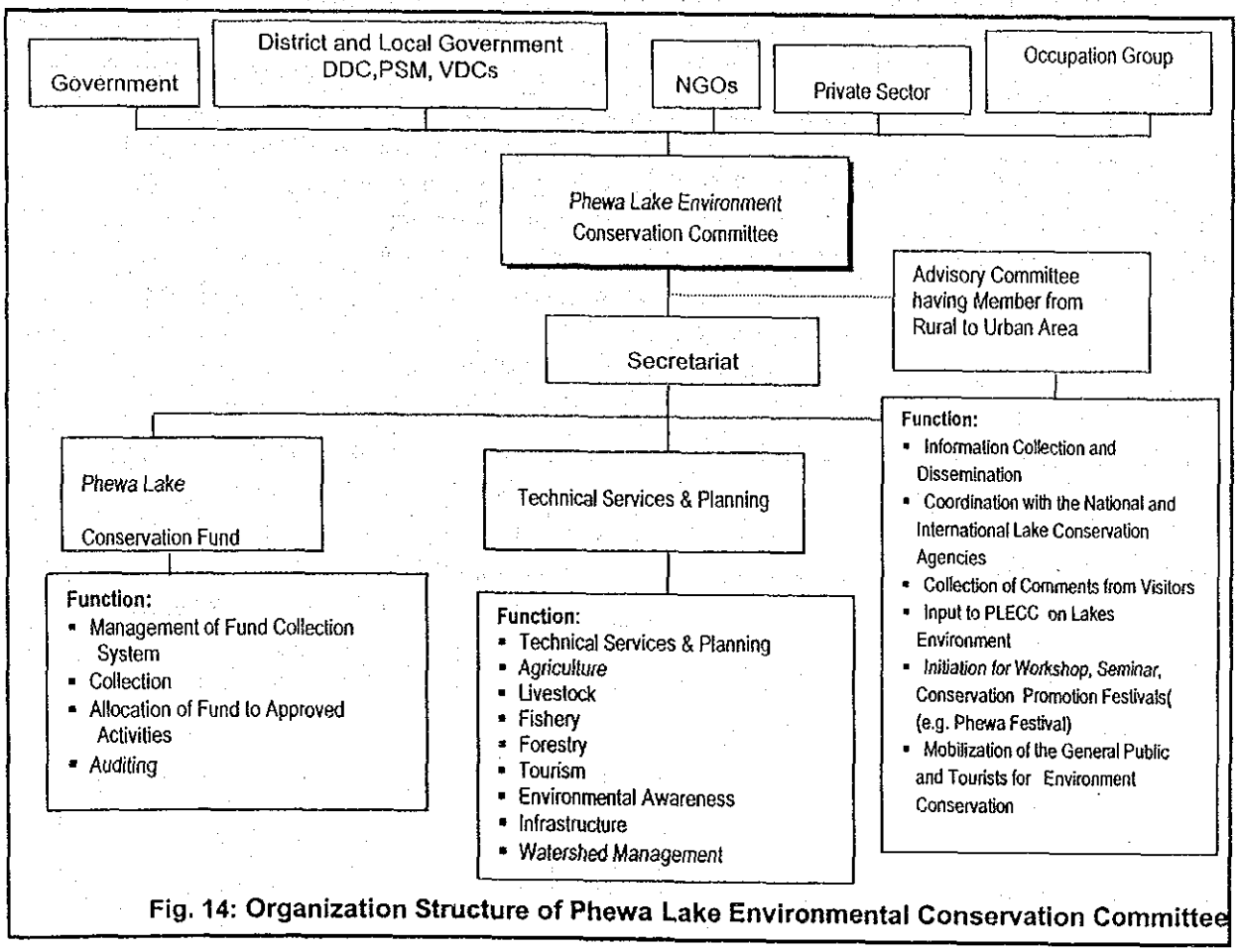


Fig. 14: Organization Structure of Phewa Lake Environmental Conservation Committee

- Prevent sedimentation of Lake by trapping sediment load at sediment trap and dispose it in Seti River by use of back hoe, front end loader, bulldozer and trippers
- Recover 20 ha area at delta edge of Phewa Phant to avoid division of Lake
- Riparian buffer strip around the Lake

(5) **Ecosystem Conservation**

- Protect bio-diversity
- Wise-use of Phewa Lakeshore
- Protection of wetland area and constructed wetland

(6) **Monitoring of Lake Water Quality, Hydrology and Watershed Erosion**

- Regular and periodic monitoring of Lake water quality and run off load from streams should be carried out
- Regular and periodic monitoring of landslide and soil erosion at watershed area should be carried out
- The water testing laboratory of Fisheries Research Center at Begnas should be strengthened and utilized in coordination with proposed Phewa Lake Environment Conservation Committee for regular and periodic monitoring of Phewa Lake water quality and run off load from streams.

(7) **Tourism Development**

- Increase number of tourists visiting Phewa Lake and prolong their stay by developing congenial environment, scenic beauty and cleanliness around the Phewa Lake area
- Develop promenade along buffer strip around the Phewa Lake
- Promote village tourism, eco-tourism
- Organize tourist pulling functions such as Phewa Festival, international seminar on lakes, culture exchange programs, international water sports competition etc.
- Strict implementation of Bylaws at Lakeside and Lakeshore areas.
- Develop trail, Lake side community roads etc.

(8) **Solid Waste Management**

- Door-to-Door solid waste collection system should be established at urban area under public-private partnership by collecting service charge from beneficiaries
- Waste purchase facility should be provided
- Composting, briquette making, handmade paper from waste, bio-gas etc. should be promoted in rural area.