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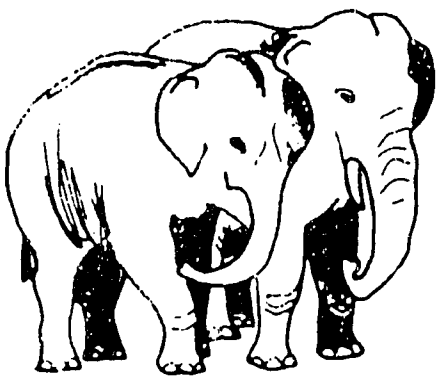

ENVIRONMENTAL ASSESSMENT

ACCELERATED MAHAWELI DEVELOPMENT PROGRAM

Funded by United States Agency for International Development

OCTOBER 1980

VOLUME I
MAIN REPORT

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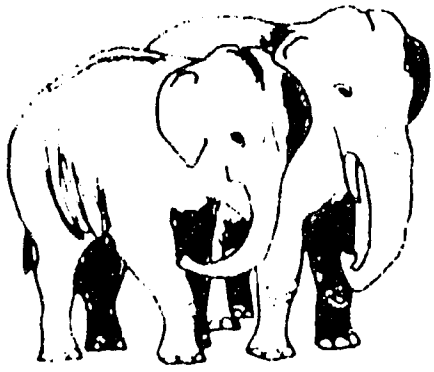
Ministry of Mahaweli Development



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VOLUME I
MAIN REPORT

TAMS TIPPETTS-ABBETT-McCARTHY-STRATTON
NEW YORK, NEW YORK

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Mr. N.G.P. Panditharatne
Director General
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Dear Sir:

ENVIRONMENTAL ASSESSMENT
FINAL REPORT

We are pleased to submit herewith our Final Report concerning the Environmental Assessment of the Accelerated Mahaweli Development Program.

In an assessment of this nature, a principal intent is to promote a balanced approach in the development of natural and human resources. For this reason, we have placed special emphasis upon formulating planning recommendations aimed at achieving optimal management of environmental resources within the context of the design and implementation of the Accelerated Program.

We have found a response to our project work from both the private and public sector which signifies the presence of a highly positive environmental consciousness in Sri Lanka. This was most exemplified in the cooperation and assistance we received and gratefully acknowledge from many agencies, institutions and individuals. We would like to express particular appreciation to Dr. Walter Abeygunewardena, General Manager of the Mahaweli Development Board for his assistance in the administration of our study and to Mr. Malcolm Jansen, Environmental Officer, who contributed significantly to all aspects of the assessment effort.

We believe that this assessment will be a useful contribution augmenting other aspects of the Accelerated Mahaweli Development Program, and we look forward to serving you again.

Respectfully submitted,

TIPPETTS-ABBETT-McCARTHY-STRATTON

Michael T. Sobczak

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1. INTRODUCTION

This report constitutes an executive summary of our Environmental Assessment of the proposed Accelerated Mahaweli Development Program. Detailed descriptions pertaining to the various environmental disciplines involved in the assessment are provided as a series of respective TOPIC REPORTS and a MAP ADDENDUM. This main report is a concise presentation of our findings, although certain aspects of our conclusions are necessarily integrated here and are not presented elsewhere.

As presently proposed, the Accelerated Mahaweli Development Program will generate major socioeconomic benefits. Approximately 175,000 families will find permanent employment in agricultural or agricultural-related activities. New and improved cultivation will produce more than 600,000 tons of rice and other crops annually and therefore meet the current import demand for rice as well as satisfy a major portion of future demands. In addition, the proposed reservoirs will substantially increase hydroelectric power output for the country.

Overall, adverse as well as beneficial impacts of the Accelerated Program on both the natural and human environments have been identified and evaluated in this report. Various measures have been suggested to either minimize potential detrimental impacts or to enhance the beneficial aspects of the proposed development. Particular emphasis has been given to providing recommendations for future environmental planning in order to promote effective management of the environmental resources which will affect, and be affected by, the Accelerated Program.

2. PROJECT DESCRIPTION

2.1 ALTERNATIVES FOR DEVELOPMENT

In Sri Lanka, the socioeconomic demands of an expanding population are generating basic needs for additional employment and increased agricultural production. Unemployment is presently estimated at more than one million people. Agricultural activities have continued to be insufficient to meet the food requirements of the growing population. Over the past several years, 250,000 to 500,000 tons of rice have been imported annually. In addition, substantial amounts of wheat, sugar, milk and other agricultural products must be imported each year.

Recognizing the difficulties imposed by these problems the Government has for more than 20 years sponsored a series of studies for the planning and promotion of socioeconomic development in the country. This planning effort has been conducted through the Government's own agencies and in collaboration with foreign assistance from a number of national and international sources. The latter have included the United States Operations Mission, the International Bank for Reconstruction and Development, the Food and Agricultural Organization of the United Nations, the United Nations Development Program and various foreign government aid programs. The basic premise of these studies was that the most effective means of improving the foreign exchange balance and nationwide socioeconomic conditions would be to increase local industrial and agricultural production.

To increase agricultural output it was concluded that the chief limiting factor was a reliable water supply. In addition, there is a comparatively small amount of land suitable for further agricultural development in the southwestern portion of the country, or the wet zone. On the other hand, in the northern and eastern dry zone, considerable land areas are available for cultivation. However, neither rainfall nor groundwater supplies are believed to be adequate to support a substantial program of additional cropping in the dry zone.

Consequently, in order to accomplish a major expansion of cultivated lands in this region and to obtain maximum production, it was concluded that new irrigation systems must be developed. A year round irrigation supply would also enhance the production of the existing dry zone irrigation systems. Thus, the planning for increased agricultural production in Sri Lanka has concentrated on providing additional irrigation to the dry zone; because of its size, the Mahaweli Ganga is the logical focus for this planning effort.

2.2 HISTORY OF THE MAHAWELI DEVELOPMENT PROGRAM

The diversion and use of the Mahaweli Ganga was originally carried out by the ancient inhabitants of the island. They diverted the Amban Ganga at Elahera and Angamedilla (Figure 1). In addition, irrigation systems were established throughout the dry zone using a series of man-made storage tanks. Many of these have been maintained or renovated and are currently operational.

The more recent studies concerning the diversion of the Mahaweli Ganga into the dry zone were initially conducted by the Irrigation Department. The resources of the Mahaweli Basin were studied by the Canada-Colombo Plan

Project and concurrently by the United States Operations Mission in the 1950's and early 1960's. As a result of these investigations, the Food and Agriculture Organization of the United Nations was subsequently requested to prepare a Master Plan for proposed developments of the Mahaweli Basin.

This Master Plan was completed in 1968 and included a scheme to provide irrigation from the Mahaweli Ganga which would enable the development of 360,000 hectares of new and existing agricultural lands in the northern, central and eastern portions of the dry zone. Additional hydropower facilities were also proposed. The entire project was to be constructed over a 30 year period.

The first project implemented under the Mahaweli Development Program was the Polgolla Diversion which was completed in 1976 with World Bank assistance. This project provides an irrigation supply for the cultivation of around 12,000 hectares of new land in System H. In addition, supplemental irrigation water is provided to the existing systems operating through the Minneriya, Kaudulla and Kantalai Tanks (Figure 1).

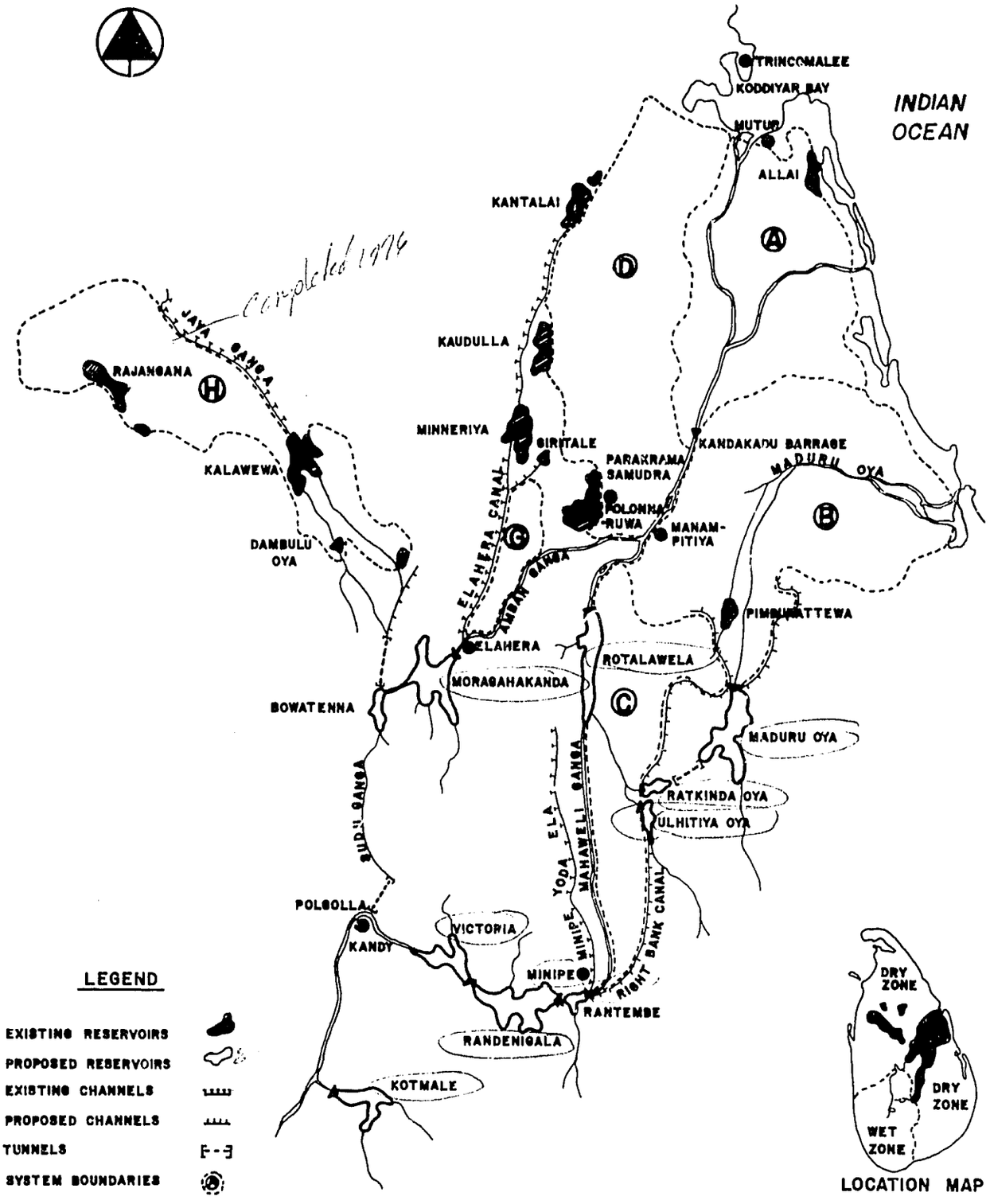
2.3 ACCELERATED MAHAWELI DEVELOPMENT PROGRAM

In 1977, the Government decided to accelerate the implementation of a major portion of the Mahaweli Development Program. It was proposed that the original 30 year completion period be reduced to five years. In this abbreviated time frame, it was envisioned that an Accelerated Program would become operational. The program would include the construction of storage and irrigation facilities sufficient to supply water for the cultivation of 128,000 hectares of new lands and for the upgrading of 32,000 hectares of existing agricultural lands in the irrigation systems designated as A, B, C and D (Figure 1).

The Accelerated Program comprises the proposed action which our Environmental Assessment addresses in this report. However, as planning progresses the actual components of the Accelerated Program are continuously being adjusted and modified. Information presented in this report concerning the various aspects of the proposed action is based upon the most recent data available. Consequently, the Accelerated Program (and the project area), for purposes of this report, is defined as consisting of the proposed Kotmale, Victoria, Randenigala, Ulhitiya Oya (including Ratkinda Oya) and Maduru Oya Reservoirs and their respective catchments as well as the proposed downstream irrigation Systems A, B, C and D. In addition, the development of the Rotalawela and Moragahakanda Reservoirs, which may become part of the Accelerated Program in the future, is also taken into consideration where applicable.

Implementation of the Accelerated Program is already in progress. Construction activities particularly at the Kotmale, Victoria and Maduru Oya Reservoirs are underway. In addition, logging and related land clearing operations are presently being conducted in a number of areas within the proposed irrigation systems. Recent indications are that the Accelerated Program may be developed in phases depending upon logistic and financial constraints.

It should be noted that not developing the Mahaweli region would have serious socioeconomic repercussions at the national as well as local levels. This would include a substantial loss in potential employment; the



ACCELERATED MAHAWELI DEVELOPMENT PROGRAM

FIGURE I

elimination of hydropower sources which are much needed to meet future energy requirements; and a significant restriction on the economic capacity of the country to balance imports for agricultural products. In addition, without implementation of the proposed program, it is likely that land clearing and utilization by shifting cultivation farmers would proceed in an uncontrolled fashion which would be highly detrimental to all environmental resources in much of the Mahaweli region.

2.3.1 Proposed Reservoirs and Related Structures

The locations of the proposed reservoirs and related structures for the Accelerated Program are presented in Figure 1. A summary of reservoir characteristics is given in Table 1. Under the Accelerated Program, the total live storage capacity of the major reservoirs is 2,555 million cubic meters. With full development of the Rotalawela and Moragahakanda Reservoirs, a total of more than 4,000 million cubic meters of water could be available for irrigation and power generation.

In addition to the proposed dams and reservoirs, the major canal (Minipe Right Bank Canal) and a tunnel will be constructed to divert water from the Mahaweli Ganga at Minipe to the Ulhitiya Oya and the Maduru Oya Reservoirs for irrigation of Systems B and C. Also, a barrage (Kandakadu Anicut) may be built in the Mahaweli Ganga near Manampitiya to divert Mahaweli water to System A.

2.3.2 Downstream Irrigation Systems

The areas which will be irrigated under the Accelerated Program are tabulated in Table 2. These data were compiled from the most recent estimates available based upon completed and ongoing feasibility studies for Systems A, B, C and D. Current projections are that when fully developed, the Accelerated Program will provide irrigation supplies for the cultivation of 80,800 hectares of new lands (mostly for paddy) and for the improvement of 14,350 hectares which are in existing irrigation schemes. These figures are lower than those initially envisioned (128,000 and 32,000 hectares, respectively), their reduction having been dictated by recent availability of more detailed soils and topography data.

The Implementation Strategy Study completed by NEDECO in 1979 indicated that in order to properly coordinate implementation, irrigation areas should be restricted to blocks of 5,000 hectares or less. Also, total construction aspects of a proposed irrigation block or area will take about three years, inclusive of initial clearing to land preparation prior to farmer settlement.

This report also pointed out a number of pertinent considerations for the establishment of implementation scenarios involving the irrigation systems. The natural river flow with regulation by storage in the Kotmale, Victoria and Maduru Oya Reservoirs will be more than sufficient for the requirements of power and irrigation of the Accelerated Program. The Kotmale Reservoir has sufficient storage for the irrigation of System D as well as for the additional requirements projected for System H, which has already been implemented (Figure 1). After the Minipe Right Bank Canal and its connection to the Maduru Oya Reservoir are completed, System B can be irrigated

from a combination of natural river flow, storage in the Maduru Oya Reservoir and a small portion of the Victoria Reservoir storage. System A can be totally irrigated from the Victoria Reservoir, while leaving it with a surplus irrigation potential of about 30,000 hectares. System C can be completely irrigated by natural river flow once the Minipe Right Bank Canal is operational. The construction of the Randenigala Reservoir would provide an additional storage to irrigate about 35,000 hectares of land. Consequently, following implementation of the complete Accelerated Program, there could be a surplus storage for potentially irrigating more than 60,000 hectares of land.

2.3.3 Settlements

The proposed settlement plan for the Accelerated Program includes the clustering of house lots into a hamlet which will be located not more than one to two kilometers from irrigated allotments. Each hamlet will be comprised of about 100 settler family units, each alloted 0.4 hectares (one acre) of upland as a house lot and vegetable garden and one hectare for paddy cultivation. About four or five hamlets will be consolidated into a village, and four village centers will form a township.

All the necessary infrastructure such as roads, schools, hospitals, etc. will be provided by the Government, and it is expected that the settlers will establish other facilities such as a shopping center, community centers, etc. through their own efforts.

In addition to the present inhabitants, the Accelerated Program area will accommodate a population of about one million people. This has been estimated on the following basis:

Farm Family Units Settled on New Lands		80,800
Non-farm Support Family Units		80,800
Farm or Support Family Units for Improved Lands		+ 14,350
		175,950
Average Family Unit Size		x 5
		879,750
Migrant Seasonal Labor		+ 40,400
	Total	920,150
	Say	1,000,000

TABLE 1
CHARACTERISTICS OF PROPOSED MAJOR RESERVOIRS

Reservoir	Height of Dam (m)	Approximate Surface Area at Full Storage Level (ha)	Net Storage Capacity (m cu-m)	Irrigation Potential (ha)
Kotmale	107	970	408	20,000
Victoria	110	2,270	690	53,000
Randenigala	93	2,750	860	35,000
Rantembe	43	-----	21	------
Ulhitiya Oya	26	2,270	146	------
Ratkinda Oya	25	-----	---	------
Maduru Oya	40	6,280	430	16,000
Rotalawela	78	15,000	850	------
Moragahakanda	72	4,050	686	20,000

TABLE 2

AREAS IRRIGATED IN THE ACCELERATED PROGRAM
(hectares)

	Amount of Existing Irrigation which will be Improved	New Rice Lands Cultivated	Other New Crop Lands Cultivated	Total (Improved Existing plus New Lands)
System A	3,500	14,000	------	17,500
System B	8,850*	25,800	5,500	40,150
System C	-----	19,550	------	19,550
System D	2,000	10,950	5,000	17,950
Totals	14,350	70,300	10,500	95,150

* Of this total 6,100 hectares is presently in rainfed crops or part of small tank irrigation systems. The difference of 2,750 hectares is the amount which will be affected by additional irrigation supply to the existing Pimburattewa, Punai and Vakaneri Schemes.

SOURCES: Most recent published feasibility studies and current (mid-June 1980) projections from on-going feasibility studies.

3. SUMMARY OF EXISTING CONDITIONS IN THE PROJECT AREA

3.1 TERRESTRIAL ENVIRONMENT

3.1.1 Climate

Climatic conditions in the project area are largely influenced by two annual monsoon seasons. From December to February, the area is generally under the dominance of the northeast monsoon, known as maha; the southwest monsoon, or yala, occurs from May to September.

The mean annual rainfall ranges from 1,650 millimeters in the downstream area where the proposed irrigation systems will be located, to 5,300 millimeters in the mountains which include the catchments of the proposed upcountry reservoirs (Kotmale, Victoria and Randenigala). This catchment area receives abundant rainfall during both monsoon seasons, but the downstream area receives significant rainfall only during the maha season.

Annual temperature variations are small (less than 5°C) throughout the project area. The mean annual temperature in the downstream area varies little from 27°C. Throughout the dry zone, including the proposed irrigation system areas, annual evapotranspiration rates normally exceed precipitation levels.

3.1.2 Land Use and Soils

Upper Catchment - Present land use maps for the upper catchment of the Mahaweli Ganga were prepared from 1979 aerial photography. These maps are presented in the MAP ADDENDUM.

The upper catchment may be described as having four major land use groups: intensively managed agricultural land, unmanaged agricultural land, forest, and unused or misused land. The intensively managed lands comprise 49% of the watershed area, of which two-thirds is under tea. About 14% is under some form of dry land agriculture; 14% is covered by forest or forest plantations; and 22% is unused or misused land - mostly scrub, chena, grassland and abandoned tea.

Over the past 25 years, the most notable changes in land use in the upper catchment have been:

- an increase in areas of towns from 1,000 to 4,000 hectares;
- the decrease of intensive agriculture from 87,000 to 63,000 hectares; and
- the reduction of the forest area by almost half.

In general, the catchment is characterized by steep slopes, three-fourths of the land having slopes of 21% to 40%. There are three major soil types in the upper catchment. The reddish brown latosols comprise 14% of the region, are good agricultural soils, and have the lowest erodability of the three major types. Red yellow podzolic soils make up 43% of the catchment and are used extensively for crops, mainly tea. These soils require anti-erosion measures on the steep slopes. Reddish brown earths also comprise 43% of the region but are too dry and erodible for agricultural use and might best be used for forestry.

Downstream Irrigation Systems - Present land use maps were also prepared from 1979 aerial photography for the downstream areas which will be occupied by the proposed irrigation systems. These maps were all compiled at a scale of 1:50,000 and are included in the MAP ADDENDUM. In addition, land classification maps were prepared for Systems A, B, C and D under a uniform classification system. These maps are also provided in the MAP ADDENDUM. Copies of the land use and land classification maps for both the upper catchment and the downstream areas can also be obtained from the Survey Department where originals are on file. Generalized land use and land classification maps for each of the four irrigation systems are presented as a series of plates and overlays at the end of this report.

The present land uses of Systems A, B, C and D are summarized in Table 3. System D is the most heavily cropped of the four systems. This is due to the existing irrigation systems associated with four major tanks - Kantalai, Kaudulla, Minneriya and Parakrama Samudra. Chena farming currently occupies about 23% of the total land area within the proposed irrigation systems. The amount of chena farming is believed to have increased substantially in the last few years due to a high influx of temporary settlers who are hoping to benefit from the proposed irrigation. The lands which are planned for new cultivation under the Accelerated Program are largely those which are presently forest, woodland, scrub or chena.

In this downstream area, the degradation of Pre-Cambrian rocks has resulted in the formation of a mature, mantled peneplain. This peneplain is broken by a number of prominent remnants of rock outcroppings and ridges, the most readily identifiable being Gunner's Quoin which rises more than 500 meters from the plain in System B.

The soil mantle overlying the peneplain is often thin (less than one meter in thickness). Over the degraded rocks, usually on slopes of 0-4% and rich in ferromagnesiums, shallow to moderately deep reddish brown sandy clay loam soils have developed. Moderately deep to shallow grey brown sandy soils have developed on nearly level slopes, overlying impermeable rock rich in quartz. The majority of the remaining soils include imperfectly and poorly drained lowland and alluvial soils as well as better drained soils along the Mahaweli Ganga and Maduru Oya floodplains.

During the intensive rainfall of the maha season, the imperfectly drained lowland and alluvial soils become exceedingly wet. Even much of the upland sandy, shallow soils remain water-logged throughout the monsoon season. Controlled drainage is a basic requirement to remove excess water during the maha. Application of irrigation water during the yala season must be carefully managed to avoid undesirable wetness presently associated with the maha season.

Land classification involves the assignment of capability ratings based on many factors including soil properties, topography, water requirements, crop type and costs. Standardized class ratings were applied to the four irrigation systems using the soils maps available. Briefly, the percentages of land suitable for upland crops and rice cultivation as well as that designated as non-arable for the systems are given in Table 4.

TABLE 3

PRESENT LAND USE IN THE PROPOSED IRRIGATION SYSTEM AREAS
(hectares)

Land Use	Downstream Irrigation Systems				
	System A	System B	System C	System D	Totals
Rice Land	10,000	23,000	6,000	44,000	83,000
Chena	26,000	39,000	22,000	9,800	96,800
Other Cropland	2,900	9,900	15,700	22,000	50,500
Pasture, Grasslands and Villus	10,600	10,700	500	3,400	25,200
Forest, Woodland and Scrub	40,800	62,000	24,200	26,000	153,000
Surface Waters	2,100	4,000	1,300	1,700	9,100
Other Lands	200	2,400	300	1,200	4,100
Totals	92,600	151,000	70,000	108,100	421,700

TABLE 4

SUMMARY OF LAND CLASSIFICATION OF THE PROPOSED IRRIGATION SYSTEM AREAS

System	Land Class (Percent of Area Surveyed)			
	Upland Crops	Rice Cultivation	Non-Arable	Other
A	34.1	54.4	10.1	1.4
B	14.2	36.0	44.5	5.3
C	24.6	41.6	33.2	0.6
D	27.1	60.9	12.0	---

3.1.3 Forestry

The total forested area of Sri Lanka is 1,675,000 hectares or 25% of the country; about 44% of the island was covered in forest in 1956. Of the present total, 681,000 hectares are designated as forest reserves, and 613,000 hectares are part of wildlife parks and reserves. About 90% of the natural forest cover in the country is currently found in the dry zone.

Currently, there are severe shortages of timber and fuelwood supplies. Imports of wood (mostly logs, sawnwood, veneer and plywood) have been increasing rapidly from less than Rs. 25 million in 1977 to more than Rs. 170 million in 1979.

Approximately 28% of the proposed irrigation systems in the Accelerated Program area are presently forested. The distribution of the forests and their respective timber and fuelwood volumes for the four irrigation systems are presented in Table 5.

The largest contiguous forest area remains in Systems A, B and C (see plates and overlays in back of this report). Compared to the other systems, System D forests have been heavily exploited. However, recent deforestation has generally been very rapid in the project area due to chena, illicit felling and spontaneous colonization by people hoping to get title to the land.

There were five forest reserves within the project area, but all have been released for development and have been largely cleared. The Somawathie Sanctuary, which effectively serves as both a wildlife and forest reserve, has been logged for the past three years by a contractor of the State Timber Corporation. The Corporation is now engaged in the removal of 30,000 hectares of forest in Systems B and C before the end of 1983.

The forest of the project area is described as a Tropical Dry, Mixed Evergreen Forest. It is a secondary growth which developed after about 1400 A.D. About 10 species, of a total of more than 90, dominate the forest canopy, with the most abundant being wira (Drypetes sepiaria). Forest types may be divided into high forest, riverine forests, villus (swamps) and dry scrub. The most diverse forests are found in the Somawathie Sanctuary. Also, one remnant of the original dry zone forest exists near Gunner's Quoin.

3.1.4 Wildlife

The project area is comprised of a variety of wildlife habitats such as villus, grasslands and numerous forest types. Several designated wildlife reserves are partly or wholly within the project area (Figure 2). The Somawathie Sanctuary, which covers 22,275 hectares, is completely contained within System A. The Nelugala Corridor, an officially declared elephant migratory route, extends south into System B from this sanctuary to the Maduru Oya. The Polonnaruwa and Seruwila - Allai Sanctuaries are partially within proposed Systems D and A, respectively. A major portion of the Veddikachchi Intermediate Zone is included within System D.

All of the above have been encroached upon significantly by settlements and/or various cultivation practices including chena. This is especially evident for the Veddikachchi Intermediate Zone, much of which is actually paddy

TABLE 5

EXTENT OF FORESTED AREAS AND THE TIMBER AND FUELWOOD VOLUMES IN THE ACCELERATED PROGRAM AREA

	Area (hectares)	Timber Volume (cubic meters)	Fuelwood Volume (cubic meters)
System A	34,700	92,000	826,000
System B	42,000	47,000	863,000
System C	23,000	103,000	828,000
System D	15,000	15,000	300,000
Totals	114,700	257,000	2,817,000

land associated with the Kaudulla Tank irrigation system. However, an "Intermediate Zone" is not considered to be a wildlife reserve in the strictest sense; areas so designated are those where licensed hunting is permitted. On the other hand, an area identified as a Jungle Corridor (like Nelugala) or as a Nature Reserve provides protection for wildlife while accommodating existing land rights; however, neither is developed for wildlife observation or related activities.

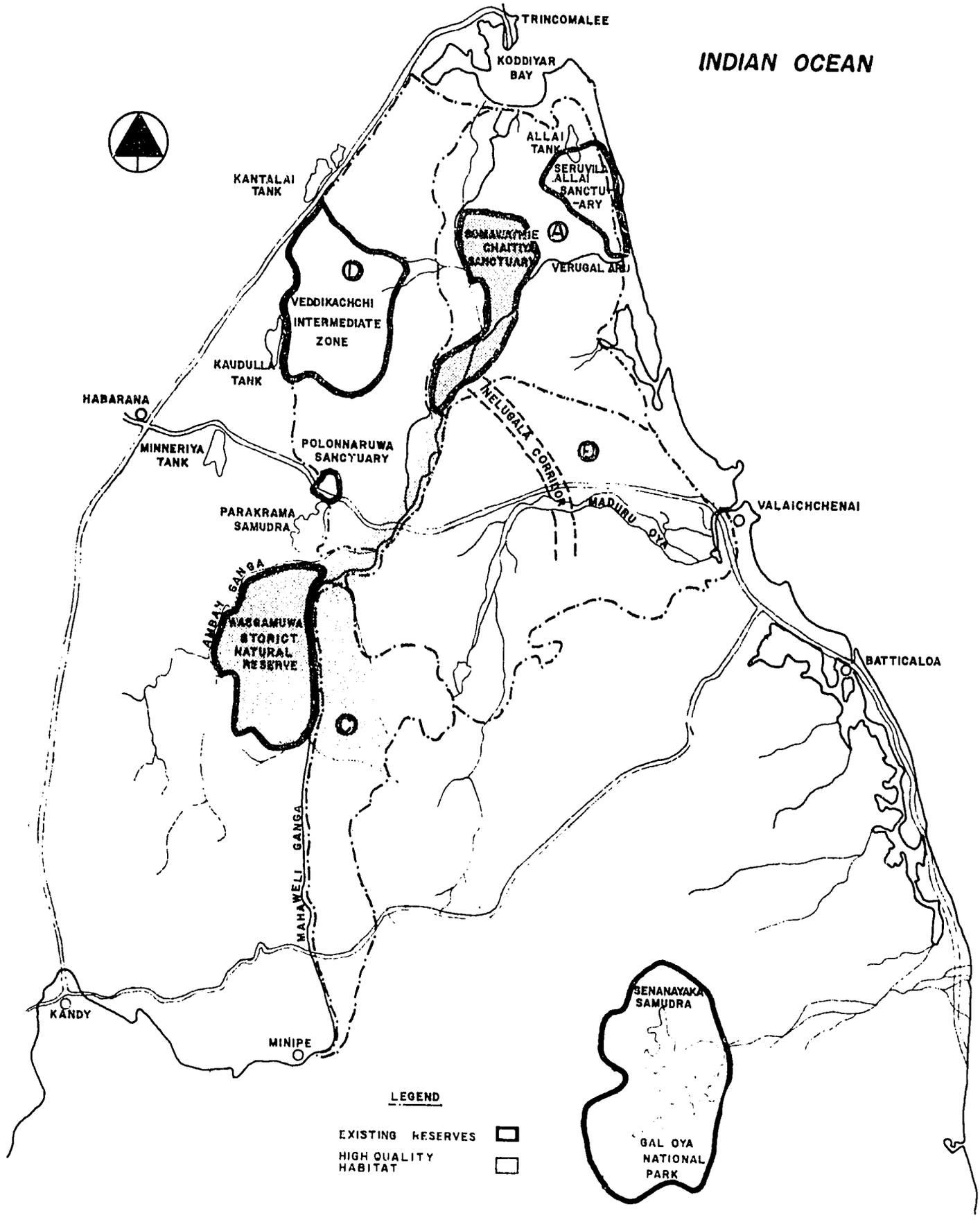
Immediately adjacent to the project area is the Wasgomuwa Strict Natural Reserve covering an area of about 29,000 hectares west of System C (Figure 2). A Strict Natural Reserve offers the greatest degree of wildlife protection; entry here is prohibited except by a special scientific research permit. National Parks similarly afford wildlife protection, but entry is allowed to observe wildlife upon payment of a fee. The closest national park to the project area is the Gal Oya National Park. It has an area in excess of 40,000 hectares and is located about 50 kilometers south of Systems B and C.

The diverse fauna inhabiting the Accelerated Program area includes seven endangered and two threatened animal species as designated by the International Union for Conservation of Nature and Natural Resources and the U.S. Fish and Wildlife Service (Table 6). These species are all found in other sections of Sri Lanka, and except for the toque macaque, purple-faced langur and the red-faced malkoha, are also distributed in other parts of the world. However, all nine species are generally considered to be threatened or endangered throughout their respective world distributions.

Within the project area, the bengal monitor has the most extensive distribution of the endangered/threatened species. The red-faced malkoha is confined to the riverine forest in the northern section of System C. The toque macaque and purple-faced langur are most commonly observed in riverine forests or near major tanks. Leopards appear to be relatively numerous in the northern sector of System C, although they are also present in several other areas. Similarly, elephants were recently observed to be very abundant in the northern part of System C and in the Somawathie Sanctuary. An estimated 800 elephants are believed to inhabit the project area and its immediate environs. The elephants have been observed to undertake seasonal movements generally related to grazing patterns and water requirements. In the dry season, elephants (and other wildlife) tend to congregate in the vicinity of perennial streams, tanks, at villu pools or in riverine forests. As surface waters rise with the onset of monsoon rains, they disperse and enter upland areas where they graze throughout the wet season.

The project area is also the natural habitat for a number of endemic animals, i.e. those found only in Sri Lanka and nowhere else in the world. These include eight species of fish, four amphibians, 19 reptiles, eight birds and three mammals. Moreover, 53 endemic plant species and 17 very rare plants have been identified as occurring within the project area.

In addition to the above, relatively common large mammal species known to occur in the project area include wild boar, deer and sambhur. Also, a majority of the 251 resident bird species found in Sri Lanka can be observed here. During the winter months, at least 75 more bird species migrate into the area from Europe and other north temperate regions.



WILDLIFE RESERVES
FIGURE 2

Data collected from recent field surveys and compiled from other available sources, indicate that an exceptional diversity of species and a particularly intensive level of wildlife activity, especially for endangered and endemic species, is identifiable for certain localities within the project area. These localities are categorized for purposes of this investigation as "high-quality wildlife habitats" and include:

- The Somawathie Sanctuary;
- The Mahaweli Ganga Floodplain between the Somawathie Sanctuary and the Wasgomuwa Strict Natural Reserve; and
- A section of the northern part of System C adjacent to the Wasgomuwa Strict Natural Reserve.

These "high-quality habitats" are shown on Figure 2. Note that the Wasgomuwa Reserve, although just outside the project area boundaries, would also be classified in this fashion. In addition, riverine forests are in general considered to be relatively significant wildlife habitats, especially for many endemic species.

TABLE 6

ENDANGERED AND THREATENED SPECIES FOUND IN THE ACCELERATED MAHAWELI PROGRAM AREA AND THEIR WORLD DISTRIBUTIONS

Species	Known Distribution	Portion of Range Where Endangered or Threatened
	Endangered	
Elephant	India, Burma, Laos, Thailand, Cambodia, Malaysia, Sri Lanka, Vietnam	Entire
Leopard	Africa, Asia	Entire
Red-faced malkoha*	Sri Lanka	Entire
Swamp Crocodile	Sri Lanka, Africa	Entire
Estuarine Crocodile	Sri Lanka, Malay Peninsula, Philippines, New Guinea, Australia, Fiji	Entire except New Guinea
Bengal Monitor	Iran, India, Burma, Afghanistan, Sri Lanka, Vietnam, Thailand, Malaysia	Entire
Python	Sri Lanka, India	Entire
	Threatened	
Purple-faced langur*	Sri Lanka	Entire
Toque Macaque*	Sri Lanka	Entire

* also an endemic species

3.2 AQUATIC ENVIRONMENT

3.2.1 Hydrology

The Mahaweli Ganga is the largest river in Sri Lanka. It originates in the hill country near Hatton and flows northeasterly, emptying into Koddiyar Bay near Trincomalee (Figure 1). The major tributary is the Amban Ganga which unites with the Mahaweli Ganga near Manampitiya. The Maduru Oya is a much smaller river which flows northerly and turns easterly adjacent to the east boundary of the Mahaweli Basin. It discharges to the Indian Ocean at Valaichchenai.

The mean annual flow of the Mahaweli Ganga at Manampitiya is approximately 8,300 million cubic meters; the Maduru Oya average at Welikanda is about 620 million cubic meters. Dry season flows are considerably less than those observed during the wet season. The geomorphology in the estuarine deltas of both the Mahaweli Ganga and the Maduru Oya indicates that the tidal influence in these areas is generally within six kilometers from the coast.

There are hundreds of irrigation tanks within the project area. They comprise a total surface area of more than 7,000 hectares. The major tanks are located adjacent to System D and include Kantalai, Minneriya, Kaudulla and Parakrama Samudra (Figure 1). Other relatively large irrigation tanks include those at Allai (System A), Horabora Wewa (System C) and at Pimburettawa and Vakaneri (System B). Most of the remaining tanks are relatively small and often dry out annually. Substantial surface waters in the project area are also associated with the villus (see below).

Groundwater data are limited for the project area. However, the potential for groundwater development in the region appears to be available only in the lower reaches and the delta of the Mahaweli Ganga, because the geological regime of that area is composed of alluvium and miocene limestone.

3.2.2 Water Quality

In general, the quality of the project area rivers, streams and tanks indicates that these waters are presently well suited for irrigation use. They are characterized by very low salinity and sodium absorption ratios. A few of the crop toxicity criteria are exceeded in occasional samples. Particularly high iron concentrations have been found in the Mahaweli Ganga and Maduru Oya, but not on a consistent basis.

Most of the groundwater sampled from project area wells also exhibits properties which classify it as suitable for irrigation use. However, several wells in System C and near the coast have very high salinity levels which would probably limit their use in most circumstances for irrigation.

The project area groundwater and surface waters are all suitable drinking water sources for livestock and are apparently suitable for swimming, bathing, clothes washing and other related domestic uses. However, the latter assumption and the quality of well waters for human consumption both require verification with coliform bacteria, metal toxicity and other testing. Some local water supplies are undoubtedly contaminated due to improper waste disposal or sanitation practices.

Surface waters generally exhibit qualities which are above standards normally associated with a healthy fish fauna. However, one notable point source of pollution is the result of poorly treated effluent being released into the Maduru Oya Estuary from a paper mill in Valaichchenai. In addition, although most of the persistent organochlorine pesticides have been replaced here by more readily degradable organophosphate types, the limited data reveal that chlorinated pesticide residues in project area waters may be very high. Further investigations are required to confirm the initial test results.

Most of the tanks in the project area may be characterized as highly productive or eutrophic systems. This is based upon high nutrient (phosphate) loadings and the readily observable extensive algae and aquatic weed growths.

3.2.3 Fisheries

There are about 60 species of fish found in the freshwaters of Sri Lanka; of these, there are 20 species valued as food fish. Tilapia, introduced in the 1950's, has increased inland catches significantly, and it normally comprises 50% to 90% of the catch by weight. However, higher prices are usually obtained for carps and catfishes.

More than 80% of Sri Lanka's inland fisheries catch, which was about 14,500 tons in 1979, is from irrigation tanks. Catch statistics, which are of varying reliability, indicate that yields range from about 20 kilograms/hectare/year in the deep up-country tanks to more than 500 for some of the shallow low-country ones. Average annual yields are estimated at around 180 kilograms/hectare. Many of the smaller tanks are fished at the subsistence level only, or have negligible production since they are emptied each year. Tank fishing is done from the shoreline or from non-motorized canoes and small rafts. The most common gear employed are gill nets and beach seines, which are often reportedly damaged due to interference from uncleared trees within the tank basins.

A number of villus also support full time fishing activities. Annual yields from the villus and the floodplains they are associated with are estimated at around 50 kilograms/hectare. The floodplains provide a valuable spawning and nursery ground for many fish species.

There are no commercial fisheries operations on the Mahaweli Ganga, Maduru Oya nor any other stream in the project area. Yields from subsistence level fishing from the rivers are probably about 5-10 kilograms/hectare annually. The total annual fish catch from project area fresh waters is approximately 1,850 tons.

Fishing activities are well developed in the estuarine portions of both the Maduru Oya and Mahaweli Ganga. These areas provide breeding and feeding grounds for shrimp and a number of economically valuable food fish species. Of the 1,300 fishing management units (boat, gear and crew) operating from Trincomalée, about 350 reportedly fish inshore waters, chiefly in Koddiyar Bay. Approximately 150 full time fishermen are active around the Valaichchenai estuarine area.

Fish farming in Sri Lanka is very limited with most efforts to date confined to experimentation or field trials.

The per capita consumption of fish in Sri Lanka has reportedly declined from 14.5 kilograms in 1972 to 11.4 kilograms in 1978. Fish and fish products constitute a principal source of protein for the rural population, and a major objective of a new five-year Master Plan sponsored by the Ministry of Fisheries is (in addition to raising overall catches) to increase per capita consumption to 20 kilograms. Other goals include improving incomes and standards of living for fishermen, many of whom are poor migrants and/or landless.

3.2.4 Wetlands

Villus - Villus are marshy areas which occur in association with the riverine floodplain, particularly along the lower sections of the Mahaweli Ganga. They usually occupy depressions between the natural river levees and adjacent upland areas. Villus consist of a pool which is more or less constantly filled with water and a marginal floodplain which is inundated only during the flood periods.

The volume of water entering a villu due to rainfed and surface runoff is generally balanced by the amount which is lost through seepage and evaporation. The main determinants of water inflow and outflow for the villus are the varying river stages. Most of the villus have direct connections to the Mahaweli Ganga or to its distributaries by means of small channels. During periods of low river flow, water drains out from the villus through these channels. The reverse occurs with increasing river levels.

There are more than 50 identified villus within the project area. The Mahaweli Ganga floodplain with its associated villus occupies a total area of about 12,800 hectares. Smaller villus are 10 to 25 hectares in size, while the largest cover 700 to 900 hectares.

The distribution of vegetation in the villus has a characteristic pattern whereby creeping, essentially terrestrial grasses at the outer margin gradually are replaced by more water tolerant species, and these in turn by truly aquatic plants. A number of villus are at times covered with the floating plant *Salvinia*.

Villus are highly productive biological communities. Grasses produced here are an important source of dry season grazing for both domesticated stock and wildlife. During the wet season, animals move from the inundated floodplain to feed on the upland or damana vegetation; they subsequently graze back into the villus as the dry season begins. The current livestock carrying capacity for the villus is effectively 1.0 Animal Unit per hectare. Thus, with 80% of the villu area exposed during drawdown making it accessible to grazing, the total carrying capacity for the project area villus is about 8,190 Animal Units per grazing period.

Villu habitats are very favorable for many wildlife species and high concentrations of birds and mammals are usually observed there. The Mahaweli Ganga floodplain provides nesting and feeding grounds for many migratory birds and is an important fish spawning ground. Consequently, this floodplain, as

mentioned previously, is considered to be a high-quality wildlife habitat.

Mangrove Swamps - Mangrove swamps occur in the coastal areas, extending inland with tidal intrusion. However, mangrove swamps in the project area have been substantially reduced due to clearing for settlements and from exploitation for fuelwood needs. Presently, less than 25% of the roughly 1,000 to 1,500 hectares observed 10 to 15 years ago remain in the region from Tambalgam Bay to Batticaloa.

3.2.5 Aquatic Vegetation

The more abundant aquatic weed species which presently occur in the project area include water hyacinths, floating ferns (*Salvinia*), water lettuce and cattails. The floating water hyacinth is very prolific and has already spread through the irrigation system associated with the Kaudulla Tank. *Salvinia* is widespread and frequently covers nearly the entire surface of small tanks and villus.

Rice fields with poor drainage frequently have a large variety of aquatic weeds. Large irrigation channels occasionally have weed problems, but small channels in many areas have heavy growths and must be regularly cleared by farmers.

3.3 HUMAN ENVIRONMENT

3.3.1 Social Profile

The project area is sparsely populated; a total census for all four proposed systems has not been conducted, although the overall population is probably on the order of 200,000 - with one-half of this population in settled areas of System D, 15% in the existing settlements of System C and the remaining 70,000 distributed throughout the four systems. There are several relatively large population centers at the periphery of the project area such as Trincomalee, Mutur, Polonnaruwa, Valaichchenai and Batticaloa. However, most of the residents within the boundaries of the proposed irrigation systems inhabit small villages or hamlets in which the main economic activity is farming.

The traditional or purana villages found in the region rely upon either rice crops produced below a village tank or upland crops grown in chena cultivation. The distinctive features of these villages are their self-sufficiency, their reliance on subsistence agriculture and their relative isolation. Villagers are considered to have legitimate title to the traditional village lands.

New villages in the area are of two principal types. One includes residents of government or private company settlement colonization schemes. The other is comprised of new residents who are considered illegal encroachers since most of the land in the project area is state owned and cannot be distributed to private ownership except by government decree.

System B - In a 1979 survey, the total population of System B was enumerated at 25,515, which includes 6,760 residents of the existing Pimburettawa irrigation scheme. The Sinhalese population accounts for about 65% of the total, followed by 25% Tamil and 8% Muslim. There are four reported aboriginal villages of the Veddah tribe in System B, but all have lost their original character.

The number of encroachers into System B is growing rapidly with more than 2,700 listed in the area in 1979. The number of legitimate landowners is only around 1,150, but there is a sizeable number of absentee landowners (around 2,300). About one-half of the families presently residing in System B have an income less than Rs. 3,000 per year. Another 25% earn between Rs. 3,000 and Rs. 6,000 annually. The average family size is 4.8.

System C - The total population of System C in the 1979 survey was 29,776; however, 78% of the people reside in the southern area which is already developed largely under three medium sized tank irrigation systems. As in System B, a large portion of the settled area is occupied by encroachers. The population of System C is made up almost entirely of Sinhalese. Nearly 70% of the households earn less than Rs. 3,600 per year.

Systems A and D - Detailed surveys of the populations of Systems A and D have not been conducted to date. However, a rough approximation would be about 30,000 current residents in System A and more than 100,000 in System D. The comparatively large population in System D is associated with the extensive irrigation systems presently operating from storage in the major tanks at Kantalai, Kaudulla, Minneriya and Parakrama Samudra.

3.3.2 Cultivation Practices/Pest Control

In traditional villages in the project area, farmers operate usually a 0.2 to 0.6 hectare plot of lowland below the village tank, a small rainfed homestead plot and an area of rainfed upland shifting chena cultivation. On the irrigated lowlands, rice farming is developed as a predominant monoculture, especially within the large tank systems. On some well drained parts of the lowlands, chillies, onions and vegetables are also grown.

Paddy yields in Sri Lanka from rainfed and irrigated sources average about 2.5 tons/hectare/year at present. The availability of water is a major factor affecting yield levels as well as cropping intensity. Where a reliable water supply is available, paddy yields are well above 3.0 tons/hectares, occasionally reaching 4.5 tons/hectare. Other limiting factors include shortages of draught power and farm labor which sometimes make it necessary to broadcast instead of transplant large areas and extends the period of land preparation and seeding.

On the rainfed homestead plots, various perennials and vegetables are grown along with bananas, pineapples, mangoes, papaya and other tropical fruits. The chena cultivation conducted focuses on annuals, mainly cereal and root crops. These include pulses, millets, vegetables, tobacco and often rainfed paddy. Most of the encroachers who have entered the project area in the past few years are subsisting on chena cultivation.

The most serious insect pest for rice in the project area is the brown planthopper. Other major insect pests include rice thrips and paddy bug. Sugarcane suffers considerable damage from shoot borers and smut.

In addition, the munia and rose ringed parakeets cause an estimated 5% loss to rice crops in the project area. Wild boar and elephants also are responsible for substantial crop losses. The Kantalai Sugar Corporation sustained annual losses of about 20% for a number of years due to elephant and wild boar activity. Elephants on a number of occasions have completely ruined rice crops of individual farmers living in the proximity of forested areas.

Control of mammal and bird pests is generally by means of surveillance, often day and night. Elephants and wild boars cause most damage in the evening hours, while birds attack the crops in daylight. When detected, the animals are frightened away by various means, including shooting. Most rural farmers have at least one shot gun or rifle which is kept loaded at all times. Rats, and even wild boars, are poisoned in some areas to reduce their numbers.

For the control of insect pests and diseases, the Agricultural Department and its Experiment Stations have published sound recommendations with clear instructions. Control methods have been varied including the use of resistant crop varieties, parasites, predators, cultural and mechanical practices and water management and manipulation. However, the control of insect pests, plant diseases and weeds is predominantly by means of pesticides, fungicides and herbicides.

3.3.3 Public Health

Four classes of infectious diseases dominate the admissions to government hospitals: diarrhoeal diseases, malaria, fevers of unknown origin

and infectious hepatitis. Diarrhoeal diseases include dysenteries, forms of gastroenteritis, cholera and worm infestation; and they affect 40% of all persons seeking treatment. These diseases also rank as the third leading cause of mortality behind heart disease and accidents/suicides.

The diarrhoeal diseases along with hepatitis, typhoid fever and related water-borne diseases are all closely associated with the presence or absence of adequate human waste disposal facilities and the provision of safe drinking water supplies. Currently more than 40% of rural housing units, including those in the project area, do not have a latrine of any kind, while about 45% have simple pit latrines. Similarly, more than 90% of the rural populace obtain drinking water from streams, tanks and mostly dug wells. Most of these supplies are poorly maintained and are contaminated with fecal wastes; thus, their use perpetuates a continued spread of the communicable water-borne diseases.

Of the vector diseases found in Sri Lanka, malaria is considered to be the primary concern with respect to the Accelerated Program. Malaria epidemics have devastated the country for centuries, apparently contributing to the collapse of ancient civilizations within the project area at Polonnaruwa. Basins of the Mahaweli Ganga, Amban Ganga and Maduru Oya are all within a notable region for malaria transmission.

However, attributed malaria deaths and overall incidence have declined over the past 20 years. The total number of malaria infection cases in 1979 was 48,000. The reduction of incidence in the last few years is probably due largely to the expanded activities of the country-wide Anti-Malaria Campaign.

Malaria in Sri Lanka is transmitted primarily by the mosquito species, Anopheles culicifacies. This species is a highly effective and dangerous vector. It breeds primarily in small sunlit pools formed within stream beds. DDT was used as an effective control against A. culicifacies until the 1950's when the species became resistant to this pesticide. Under the present intensive program, houses are sprayed with malathion, and chloroquin or amodiaquin therapy is offered to all infected persons.

Other vector diseases of particular concern for the project area would include dengue fever, hemorhhagic fever, encephalitis, chikungunya virus, scrub typhus and bed bugs. Filariasis (elephantitis) is prevalent primarily on the south-western coast of the country. Schistosomiasis is not presently found in Sri Lanka.

In the project area, there is presently one relatively large base hospital at Polonnaruwa, two district hospitals, a rural hospital and three peripheral units. The total number of hospital beds in these institutions is 480. Health care, including drugs, is free. In 1977, Sri Lanka had 1.14 doctors, 0.16 public health nurses and 1.3 midwives for every 10,000 people. In the project area, the availability of these types of staff is lower than throughout the rest of the country.

4. SUMMARY OF ENVIRONMENTAL IMPACTS

4.1 TERRESTRIAL ENVIRONMENT

4.1.1 Climate

Although evapotranspiration rates in the project area will be decreased due to the reduction in forest cover, this reduction will probably be exceeded by higher evaporation resulting from the increase in exposed surface water on proposed agricultural lands, especially paddy. The overall effect is likely to be a localized increase in thunderstorm activity which may be considered as a beneficial impact to some cultivated areas. However, a significant increase of the total annual rainfall for the entire project area is not expected; rainfall patterns will continue to be dominated by the seasonal monsoons.

4.1.2 Land Use and Soils

Upper Catchment - Erosion impacts in the upper catchment are not a direct result of the proposed Accelerated Program. However, potential impacts of erosion as they pertain to the program were investigated.

Annual soil losses range from 0.3 to 7.0 metric tons/hectare on slopes less than 20% for the well managed land use classes. On poorly managed land, it ranges from 21 to 570 tons/hectare. Land uses comprising either well managed agriculture or forest cover suffer the least erosion even on the more erodible soils and steep slopes. Heavy erosion occurs on all soils under scrub or abandoned tea. An acceptable rate of erosion has been suggested of 10 tons per hectare per annum.

The aggregate annual soil loss from the mapped portion of the catchment is estimated at 11.3 million tons per year. This represents a 4,800 hectare equivalent of annual productivity lost in the highly eroded portions of the catchment. The total net economic loss is estimated at Rs. 3.6 million per year.

With an estimated average annual sediment yield for the catchment of 300 cubic meters/square kilometer, the total suspended river sediment load would be 948,000 cubic meters. An added 10% for bed load would bring the total sediment level to a little more than one million cubic meters per year.

Compared with reservoir storage capacities, this sedimentation rate should not impair the effective operating life of either the Kotmale or Victoria Reservoirs at all for more than 50 years. Because of sediment entrapment in upstream reservoirs, the remaining reservoirs in the Accelerated Program are also unlikely to be significantly affected by sedimentation problems. However, if left unchecked, the rate of erosion will continue to increase and land usage in the upper catchment will steadily deteriorate.

Downstream Irrigation Systems - Changes in land use patterns which will occur in the irrigation system areas are depicted in a generalized form on the enclosed plates and overlays for the respective irrigation systems. A comparison of the arable areas shown on the red overlays with the present land use plates roughly delineates those lands planned for new cultivation as well as the existing cultivated areas which will be improved by the

Accelerated Program. Essentially all of the designated arable land not presently under cultivation will become newly developed irrigated paddy. These new irrigation systems will replace what is largely forests, scrubland or chena. This will result, in several localities, in a non-recoverable elimination of high-quality wildlife habitat. These conflict areas are shown in Figure 2 and are discussed in a succeeding section concerning project impacts on wildlife. A further reduction in high-quality wildlife habitat will occur due to decreased river flows and the subsequent conversion of about one-half of the floodplain villu area into a comparatively poor damana grazing area.

The suitability of the soil types found in the project area for irrigated agriculture is variable. Water use and percolation losses would be high with irrigated paddy on the reddish brown earths. Non-calcic brown soils have high infiltration rates and a low water holding capacity which restricts their use for paddy production. These two soil types will be used mainly for upland crops. On the other hand, low humic gley soils are excellent paddy soils, and most alluvial and solodized solonetz soils are suitable for irrigation under most circumstances, although adequate drainage is necessary to prevent waterlogging, or flood protection is required.

Erosion potential in the new areas proposed for irrigation should be relatively low due to the gradual slopes and limited rainfall there. Once under cultivation, the paddy lands will serve as an adequate deterrent to soil erosion. Upland cropping presents the highest risk for erosion losses; however, areas planned for upland crops are comparatively small.

Land clearing and leveling may reduce the organic matter content of the surface soils. Applied irrigation waters, especially if excessive, will further reduce soil nutrients due to leaching. Nitrate fertilizers will be necessary after the first few years of cultivation. Phosphorous supplements will probably be needed from the beginning, since the phosphorous content in the soils is presently very low.

The new arable areas slated for development within the project area are comprised of a mixture of land class types, including those highly suitable for paddy (1R), those moderately suitable for paddy (2R) as well as lands highly and moderately suitable for upland crops (1U and 2U). These land classes are variously distributed within the proposed irrigation areas, as shown by the percentages given in Table 7.

These figures are approximations based largely upon an extrapolation of the partial soils and land class information available for each system. However, they indicate that about 32,000 hectares or nearly 40% of all the new cultivation lands in the project area will be highly suitable (1R) for paddy cultivation. They will require low water application and minor economic inputs to obtain good yields. On the other hand, about one-third of the new areas will be on Class 2R land which necessitates higher economic expenditures to obtain acceptable yields.

4.1.3 Forestry

National forecasts for timber supply and consumption indicate the following trends:

- The demand for timber will almost double by the year 2000;
- A large increase in imports will occur during the next 10 years;

- There will be an accelerated depletion of dry zone forest; and
- The present plantations will come close to satisfying anticipated timber requirements at about the year 2000.

The latter pre-supposes that the plantations will be properly managed, and that encroachment can be controlled. In any event, the quantity of timber imports are expected to increase from 80,000 cubic meters in 1980 to over 200,000 cubic meters to meet the demands of major construction planned for about the next 10 years.

In addition to timber requirements, fuelwood needs are about 4.8 million cubic meters annually for the present population. This will increase accordingly with rising population at a rate of about 2% per year.

Three-fourths of the Accelerated Program area have already been denuded of forests. The State Timber Corporation is presently engaged in the removal of a significant portion of the remaining forested area. None of this clearing and felling is being done according to an organized schedule integrated with the agricultural development plans. A significant and unnecessary wastage of forest resources is likely to occur because of this.

The 114,700 hectares of forest remaining in the project area have an estimated 257,000 cubic meters of timber and 2,817,000 cubic meters of fuelwood. Timber requirements for the one million incoming settlers are estimated at 1.25 cubic meters per person. This would mean that there would be a deficit of about one million cubic meters even if all merchantable trees in the project area were harvested, sawn and used in the immediate vicinity of the settlements. Up to now, logs and sawn timber have been mostly shipped to Colombo.

The basic fuel sources used in rural areas are kerosene for lighting and some cooking, and fuelwood predominantly for cooking. It is assumed that this pattern will continue among new settlers in the project area. The total kerosene requirement for the new population is estimated at about 16.3 million liters per year, which is projected to have an economic cost of Rs. 153 million. This translates as an economic cost of Rs. 785 per family, although with the present subsidy program the actual financial cost to each family would be about Rs. 360.

The one million settlers will have a fuelwood requirement of about 570,000 cubic meters annually. Consequently, the project area can yield about five years of this need, again assuming all fuelwood trees in the project area were harvested. However, only a part of the fuelwood in the project area could be realistically available for settler use because of its relation to the proposed settlements and the need to maintain forests in reserves, in riverine areas, etc. Therefore, the existing forests can probably supply fuelwood needs for only two or three years.

The current financial cost to a family for average fuelwood needs is about Rs. 178 per year. The only acceptable energy substitute for fuelwood is kerosene. However, to fully meet cooking needs, the equivalent calorific substitute of kerosene for fuelwood would necessitate an increased cost per family of about Rs. 1,210 per year. It is apparent that this energy source replacement will result in excessive fuel bills, probably beyond the ability of many settlers to obtain full requirements without subsidization.

TABLE 7

PERCENTAGE OF LANDS CLASSIFIED FOR PADDY AND UPLAND CROPS

Systems	New Cultivation Areas (Hectares)	Land Class (%)			
		1R	2R	1U	2U
A	14,000	67	16	7	5
B	31,300	30	40	15	15
C	19,550	25	40	10	25
D	15,950	50	20	25	5

4.1.4 Wildlife

Implementation of the Accelerated Program will result in the replacement of more than 80,000 hectares of mostly undeveloped land with agricultural or related development schemes. Consequently, there will be a significant reduction of natural wildlife habitats and a concomitant unavoidable loss of large numbers of animals and plants presently in the project area.

Furthermore, only a very small proportion of the animals currently inhabiting areas proposed for development could be accommodated in either adjacent natural habitats (even if enriched) or in captive populations. Initially, as projects are actually implemented, many animals will be displaced and move into the surrounding regions. However, most of these areas already contain population densities at, or approaching, full carrying capacities. Additional displaced animals entering these surrounding habitats will cause overcrowded conditions there which may result in physical habitat destruction (particularly by elephants) and an over-exploitation of food supplies. Because of this, most of the displaced animals would probably not be successfully relocated to the surrounding habitats.

Modification of natural ecosystems will result in a decrease of present carrying capacities for most wildlife species, and a subsequent decrease in their populations. This will include an unavoidable reduction of population levels for most endemic species and probably for all of the endangered/threatened species found in the project area.

Endemic species, which occupy well defined and relatively narrow ecological niches or ranges, are particularly sensitive to environmental perturbations such as habitat alteration. The loss of riverine forests would have especially serious detrimental effects on endemic populations.

Endangered species already face extinction; any loss of individuals or habitats for these species further reduces their viability. For example, although about one-half of the present elephant population in the project area could be accommodated in existing and proposed reserves, the remainder even if some are captured for domestic use, will be removed from the natural breeding population. In addition, pocketing or isolation of elephants and other animals could contribute further to the decline of respective species viability. The red-faced malkoha, the purple-faced langur and the toque macaque are endemic species as well as endangered or threatened. Therefore, the adverse impacts of a decrease in population for any of these species could be considered even more significant than for the other endangered species.

Other fauna which will be adversely affected by habitat changes will include those with a dependence upon floodplain villus. The decreased size of these habitats will particularly affect a number of resident waterfowl species as well as some migrant birds and herbivores which rely on the villus for dry season grazing. Also, the proposed land use changes for the project area will result in the creation of barriers and the isolation of some wildlife habitats. This will disrupt the emigration and immigration patterns of many species. Animals that seasonally migrate or are shy (e.g. sambhur, wild boar, spotted deer, muntjac), and species which are almost totally dependent on trees and forests (e.g. purple-faced langur, porcupine, giant squirrel, flying squirrel) will be

the most seriously affected by agricultural barriers. The prevention of emigration and immigration for one of these species limits its accessibility to the overall species gene pool which eventually decreases the species viability, with a resultant reduction of its population.

A few species which adapt readily to habitat change related to agricultural development such as rats, parakeets and munias will probably proliferate to such an extent that they would become serious agricultural pests within the project area. Other significant pest problems may arise due to the feeding and movements of wild boars, elephants and perhaps deer. In addition, pocketing of wildlife in small areas could increase the potential of serious injury to settlers from direct encounters with elephants. These impacts would be most pronounced in the "high-quality wildlife habitats" which are slated for agricultural development.

Specific high-quality habitats which are presently being considered for cultivation schemes include an area of about 5,600 hectares in the northern part of the Somawathie Sanctuary and most of the northern section of System C. In addition, about one-half of the high-quality habitat in the Mahaweli Ganga floodplain will be lost due to reduced river flows. These impacts would result in irrevocable losses of relatively exceptional wildlife habitats.

Other sections of wildlife reserves in the project area which would conflict with planned cultivation include about 2,500 hectares of the Nelugala Corridor and a relatively large part of the Veddikachchi Intermediate Zone. However, reduction of this latter zone cannot be considered as especially significant since it affords no protection to wildlife species, and the area it covers is mostly under cultivation already.

On the other hand, the overall diminution of high-quality and related wildlife habitats is balanced to some extent by the committment of the Government to maintain the Wasgomuwa Strict Natural Reserve in its entirety. This reserve was originally scheduled for development as part of System E within the Mahaweli Development Program. Further, the Government has recently initiated plans to establish the proposed Maduru Oya National Park adjacent to Systems B and C.

It should be noted that without the development of the proposed projects, significant amounts of forested area are likely to be removed in any event by encroaching chena farmers. Without appropriate land use planning to balance human and natural environments and without proper surveillance and protection, this problem will undoubtedly escalate due to the heavy demands for agricultural land from the nation's growing population. Unless controlled, large segments of the project area natural wildlife habitats, including the high-quality ones, will probably be lost to encroaching farmers.

Finally, implementation of the extensive proposed program will essentially result in the confinement of a substantially large portion of the country's remaining natural wildlife populations within specifically designated wildlife reserves. This will necessitate the formulation and execution of a nationwide wildlife management program aimed at conserving and controlling wildlife populations. This in turn will require a substantial increase in the training, management and manpower capabilities of the existing Department of Wildlife Conservation.

4.2 AQUATIC ENVIRONMENT

4.2.1 Hydrology

Under the Accelerated Program, a large amount of the water diverted from the Mahaweli Ganga will be delivered to irrigation systems outside of the Mahaweli Basin. Of the remainder, only about 20% is likely to re-enter the Mahaweli as irrigation return flow. Overall, the volume of flow in the river will be reduced by about 50%. Wet as well as dry season flows are expected to decrease in the Mahaweli; however, future flows during the dry months should increase slightly in the Maduru Oya due to the planned transbasin diversion into System B.

Flood peaks in the Mahaweli Ganga will be considerably reduced by the surcharge storage in the new reservoirs. Similarly, the frequency of flood occurrence will be reduced as a result of controlled outfalls. However, these changes cannot be quantified until reservoir operation policies are finalized.

With the conversion of forests to agricultural land, the future surface runoff is expected to increase by a range of 10% to 20%. However, the effect on stream flows should not be significant, because the forested area to be cleared is relatively small in comparison with the total drainage area of the Mahaweli Basin. In addition, the increased runoff will be retained by rice paddies and eventually lost to evapotranspiration.

The reduction in downstream flows in the Mahaweli Ganga may cause an increase in the extent of the present tidal wedge. Increased salt concentrations from irrigation return flows may also contribute to a change in the salinity regime. This could be further complicated if groundwater in the delta area discharges into the river bed, causing reciprocal salt water intrusions into coastal acquifers. Salt water intrusion problems are not expected to occur in the Maduru Oya delta, since the river stage will be raised during the dry season, thus controlling the tidal wedge there.

The clearing of forests will result in a decrease of present transpiration rates, an increased accumulation of groundwater in the saturation zone and, consequently, a rise in the water table. Moreover, this relatively slight raising of the water table will be further enhanced by a significant rise due to irrigation. Infiltration rates are estimated to be far greater than the groundwater movement rates in Systems A, B, C and D. Thus, irrigation of the lands in the project area will necessitate the use of drainage channels to remove excess water from infiltration in order to prevent water-logging or salt accumulations in the crop root zone.

4.2.2 Water Quality

The quality of the initial irrigation supply sources, including the new proposed reservoirs, the upstream river sections and the existing major tanks, is expected to be highly suitable for irrigation purposes. Some degradation of the water quality in downstream tank systems such as Punai, Vakaneri and Allai may occur as return flows with accumulated salt levels enter these systems.

In a few localized areas water quality in return flows may deteriorate significantly, preventing their immediate reuse for irrigation. This may occur

where salt accumulates due to improper drainage or where sodic sub-soils exist which, when irrigated, release sodium into drainage waters. However, in most of the project area, adequate drainage and the flushing action of heavy monsoon rains should limit salt build-up in soils or high sodium concentration problems.

Generally, surface water and groundwater in the project area should be suitable for livestock drinking as well as for swimming, bathing, clothes washing and related domestic uses. However, the use of these waters for bathing or swimming and for human consumption will depend upon the provision of protected water supplies and adequate sanitation facilities. Without them, it is likely that contamination with human wastes will occur and thus increase the potential spread of water-borne diseases. It is unlikely that surface waters will be suitable as potable supplies, especially the irrigation return flows which may contain high levels of nitrates and pesticides. Wells located in the immediate vicinity of drainage canals may also be contaminated by these substances.

Project area waters receiving agricultural runoff may exhibit a substantial increase in pesticide levels which could be highly detrimental to fish and other aquatic life. The toxic effects of pesticides in an ecosystem are often magnified by the continuous accumulation of pesticide residues throughout a food chain.

All of the new proposed reservoirs are expected to undergo vertical thermal and chemical stratification, with reduced oxygen levels occurring in the bottom waters for some part of the year. The reservoirs will probably overturn one or more times annually, although the deep reservoirs including Kotmale, Victoria and Randenigala will not have the thorough surface to bottom mixing expected in the shallow, low-country reservoirs. The latter, due to increased nutrient availability through recycling and drawdown, should be highly productive, more so than the deep reservoirs.

Major existing tanks in the project area will not receive agricultural return flows which could affect production levels. Moreover, although the flushing rates of these tanks will increase significantly, they would be expected to remain relatively highly productive or eutrophic. Many smaller tanks and especially villus may receive substantial quantities of return flows which could increase eutrophic conditions, resulting in more extensive algae blooms and an overall deterioration of water quality.

The new reservoirs on the mainstream Mahaweli Ganga and Maduru Oya will act as effective nutrient traps limiting nutrient supplies that normally reach downstream estuaries. Conversely, return flows will at times increase certain nutrient levels in these areas. The net effect will be an alteration of the organic production and energy cycles in the estuarine systems. This may be further complicated by the paper mill pollution in the Maduru Oya delta. Normally, changes in the nutrient balance and cycling patterns in estuaries have a detrimental effect on fisheries and shrimp resources.

4.2.3 Fisheries

The formation of the proposed reservoirs will result in a local replacement of riverine ecosystems with lacustrine ones, and a subsequent elimination of some fish species and an enhancement of others. The predominant natural reservoir

food fish populations will be comprised of tilapia, banded etroplus, labeo, barbs, giant gourami, snake heads and catfishes, especially the freshwater shark. The mahsier and several other species will be eliminated from the river sections which will be impounded. This will include habitats in small, upland tributary streams which support some endemic fish species. In general, the loss of these specific local habitats would not be considered significant, since the endemic species affected also occur in large numbers in many other river basins in the country. Two endemic species, leaf lates and smooth breasted snake head will probably benefit by the project, since they prefer quiet waters of reservoirs and paddy fields.

The presence of a series of dams on the main river will also block upstream spawning migrations of the mahsier. This, combined with the inability of the mahsier to adapt to reservoir habitats, will probably result in a significant reduction in the population of this species within the Mahaweli Ganga. Other species which may be adversely affected by interference with migratory movements include eels, two species of barbs, the endemic mountain labeo and the freshwater shrimp Macrobrachium.

Potential fish yields calculated for the proposed reservoirs clearly indicate that the deep, up-country reservoirs are likely to be much less productive (20 to 30 kilograms/hectare/year) in terms of fish output than the shallower, low-country ones (100 to 300 kilograms/hectare). Yields from the reservoirs will greatly exceed existing river yields both on a unit and total area basis. The total net yield for the major proposed reservoirs is estimated at about 2,550 tons/year.

Project implementation will result in changes in the mean water levels for the four major tanks in System D. Parakrama Samudra will increase in size, but the other three will decrease with a net loss in potential fish yields of about 100 tons/year. Some smaller tank fisheries may be adversely effected due to a deterioration of water quality from agricultural return flows. Estuarine fisheries may be affected in a comparable fashion.

The reduction of floodplain and associated villu areas (see below) will result in a corresponding loss to fisheries resources. The total loss in terms of fish yield is estimated at 320 tons/year. A further non-quantifiable adverse impact would be the reduction of floodplain spawning and nursery grounds for a number of fish species which inhabit rivers, streams, backwaters, ponds and tanks of the entire Mahaweli Ganga system.

Overall, there will be a net increase in potential fish yields from project area waters of about 2,140 tons, or a gross economic benefit of about Rs. 8.6 million annually.

4.2.4 Wetlands

Lower river flows and the reduction in frequency and magnitude of floods will result in a substantial decrease in the areas of floodplain villus. Overall, about one-half of the total 12,800 hectares of villus will be more or less permanently lost (except during exceptional flood years), and much of the remaining villu areas will be inundated for shorter periods of time.

The change in exposure to inundation will be to such an extent in the peripheral parts of the villus that they will essentially lose their character as wetlands. The outer margin of the floodplain will undergo a shift from the present annual high-water content grasses to low-water content terrestrial grasses and eventually to perennial woody vegetation.

There will be a reduction in area for livestock grazing in the villus and a decrease in the villu carrying capacity from 1.0 to 0.75 Animal Units per hectare. The total carrying capacity for the project area villus will be decreased by more than 60%, to a level of 2,880 Animal Units per grazing period. In addition, the critical grazing period in the villu will be increased with a subsequent high risk of overgrazing. The outer margin of the floodplain which will no longer be inundated will become part of the damana or upland grazing area. However, the quality of this land for grazing will be considerably lowered from that in its previous wetland condition.

The impacts of the reduction of the villus on fisheries were discussed in the preceeding section. The loss in wildlife habitat will be significant, since the villus are presently a focus of high wildlife activity, especially for migratory waterfowl.

The decrease in floodplain villu area will result in a total loss in quantifiable economic benefits of about Rs. 5.7 million annually. This includes losses to fisheries, grazing and associated dairy production.

The limited mangrove swamps in the Maduru Oya and Mahaweli Ganga estuaries may be further exploited as a fuelwood source by the increased future population. The potential spread of mangroves is highly unlikely.

New wetlands may be formed in some localized areas, but extensive marshes or swamps are not expected to develop. Limited or temporary wetland conditions may arise where canal bunds or roads obstruct drainage, where irrigation canals pass through low lying areas enabling periodic flooding or due to an accumulation of seepage water. The total area of these new wetlands should not be substantial. Some wetland characteristics may develop in the drawdown zones of the major tanks, since water levels here may become more stabilized.

4.2.5 Aquatic Vegetation

Any of the new reservoirs, irrigation canals, drainage systems or paddy areas may be susceptible to aquatic weed infestation, chiefly from water hyacinth, floating ferns or cattails. Particular areas of concern would be where eutrophication may be increased due to the accumulation of nutrients from runoff or return flows. Consequently, small downstream tanks and villus, the lower part of the Mahaweli Ganga with its reduced flow, and the shallow Kandakadu Barrage are likely to experience a continued infestation of water weeds.

Dense growths of these plants can block reservoir penstocks, provide habitats for disease vectors, cause increased evapotranspiration losses, interfere with fishing and block canals, pumps and drainage channels in irrigation systems.

4.3 HUMAN ENVIRONMENT

4.3.1 Social Conditions

A major social impact of the Accelerated Program will involve the transition from small isolated village societies to production oriented large scale colonization schemes. Implicit in the model of transition is the modernization of rural society with the attendant loss of traditional values and social cohesion within small, kinship based villages.

The population in the project area will be increased by about one million people. Current project area residents who are over eighteen years of age and have an agricultural background will have priority in the resettlement planning. The principal social benefits will accrue to settler families who stand to gain land and irrigation waters; this is also the major benefit perceived by project area residents as well as potential settlers from other regions who are applying for allotments.

An important attitude prevailing among future settlers is that the one hectare paddy land allotment, irrigated for two full seasons, will represent an improvement from present landholding. However, planning calls for traditional inheritance and kinship roles to be abandoned with respect to the mechanisms for landholding and its acquisition. This may prove difficult to enforce; studies in System H indicate that alloted land was leased, mortgaged and given in tenancy to relatives within the first year of cultivation.

One of the major effects of the Accelerated Program will be the increased demand for agricultural labor. There is some expressed concern that there may be insufficient farm labor available within the project area. Agricultural labor shortages in other schemes have resulted in not transplanting on some farms and a reversion to broadcast seeding with a consequent yield reduction. A class of rural wage laborers, some perhaps as seasonal migrants, will be needed. Moreover, the welfare, housing, etc., for these laborers needs to be taken into consideration in settlement planning.

As in previous colonization schemes, the Accelerated Program will also face the problem of employment for the second generation of the farmer settler families. Some of these second generation offspring can be provided employment in non-farm sectors; however, not all of them can be accommodated in this manner. This may lead to fragmentation of paddy land and home plots or the further encroachment on undeveloped lands within or adjacent to irrigation blocks. Many of the present chena farmers in the area are second generation settlers from other schemes who have encroached land in order to be in a position of acceptance in the new program.

Project area residents are unaware of effects the Accelerated Program would have concerning reduced grazing areas or losses in timber or fuelwood supplies. Traditional villagers complain of crop damage due to wildlife. Many have guns and shoot at animals to drive them away; however, most feel it is not right to kill the animals. New settlers will undoubtedly use guns to scare encroaching animals, with a subsequent loss to the wildlife. Project area residents believe the Accelerated Program will bring better educational and health facilities and improved domestic water supplies, although there is no appreciation for the use of latrines. Perspective settlers usually have little

knowledge of the program or of the services they expect to find in the new settlement areas.

At the proposed reservoir sites, especially Victoria and Kotmale, a total of 25,000 to 30,000 residents will have to be relocated. The affected people have accepted the inevitability of relocation, but there is a general resentment and a sense of loss of ancestral homes for those who have experienced little geographic mobility over many generations. These people have a choice of moving to nearby tea estates or into the Mahaweli area, which would benefit smaller landholders. However, most are concerned about how they can support themselves in the period it will take to replace their lost tree crops and paddy.

Sri Lankan society has not yet achieved an integration among its various ethnic, religious and language groups. The three major groups are the Sinhalese (which comprise about 72% of the population), the Tamils (20%) and the Moors (6%). These groups maintain distinctly separate social customs and cultural traditions. Similarly, each group is very sensitive to potential colonization schemes in terms of the proportion of representation it will have in the development of new settlements. The potential problems relating to social integration and ethnic group balance as they pertain to settlement in the project area remain to be resolved by the Government.

4.3.2 Cultivation Practices/Pest Control

A major benefit of the Accelerated Program will be to increase agricultural output. The main focus will be on rice production. The single rice crop intensity presently achieved per year under rainfed conditions or small tank irrigation will be increased to obtain double cropping. Approximately eight tons per hectare of paddy will be produced from the two crops grown per year on the newly cultivated lands. Moreover, much of the existing irrigated paddy land will receive supplemental water to permit additional cropping intensity, essentially enabling a complete double crop to be produced annually. On homestead plots, various perennials and vegetables along with tree crops will be grown in a similar fashion to current practices.

One constraint to the high intensity rice monoculture envisioned will be the farm labor supply. Another problem will be pest control. Since there are no geographical barriers to prevent the movement of any known insect pest or plant disease, it is anticipated that the crops proposed for the project area will be susceptible to damage from the same pests found in other parts of the island. Intensity of pest activity for the new rice growing areas is expected to be manifested by an increase of brown plant hoppers and sheath blight. The appearance of a novel crop insect pest, although a possibility, is considered unlikely.

Extensive sections of wildlife habitat will be removed and thus eliminate a substantial amount of natural predator control. This, coupled with the increase in cultivated areas and the intensification through double cropping, will necessitate a significant increase in the use of insecticides, fungicides and herbicides. Additional import requirements for all pesticides would be about 115 tons of dusts, wettable powders and granules and 66,000 litres of liquid formulations.

Generally, even with pest management controls, farmers would probably sustain unavoidable crop losses of about 10% due to the combined effects of weeds, insects, diseases and rats. In addition, some areas planned for future cultivation will be located adjacent to, or in the vicinity of, natural habitats which support large populations of elephants, wild boar, deer and other potential wildlife pests to rice or sugarcane. High-quality wildlife habitat areas would be high risk zones for crop damage. Based upon previous damage records, a reasonable estimate of average crop loss in these zones would be about 20% due to physical wildlife damage and feeding. This would probably occur for a period of five years or so, until the larger wildlife pests could be killed or effectively driven out of the area.

Total crop losses from all types of pests on new rice lands in the project area over the first six years of crop production may amount to about Rs. 487 million. Crop losses due to wildlife alone are estimated at Rs. 133 million. Losses for respective systems taking into consideration the amount of high-quality habitat areas are estimated in Table 8.

4.3.3 Public Health

With the substantial increase in population which is anticipated in the project area, there will be an inevitable spread of a number of viral and parasitic water-borne communicable diseases. This will be exacerbated by the lack of basic health education combined with the cultural practices of the people. They would be expected to continue their present utilization of the same water supply for drinking, bathing and waste disposal which would be very conducive to the spread of gastroenteritis, hepatitis, dysentery and other water-borne diseases. This condition will be worsened if suitable water supply and sanitation facilities are not provided, or perhaps more importantly, not maintained.

TABLE 8

ESTIMATED CROP LOSSES DUE TO PESTS IN THE FOUR IRRIGATION SYSTEMS

System	Six Year Build-Up Percent of Potential Production under Full Development	Crop Loss (Rs. million)	Percent of Crop Loss due to Wildlife	Value of Crop Loss due to Wildlife (Rs. million)
A	60.94	128.81	30.56	39.36
B	48.59	175.97	24.81	43.66
C	35.56	99.75	34.64	34.55
D	57.42	81.97	19.35	15.86
	Totals	486.50		133.43

Reduced river flows and seepage from irrigation channels in the project area will enhance the formation of small pools which will increase the breeding potential of the principal malaria vector, Anopheles culicifacies. Malaria incidence will undoubtedly increase in the region. The present intensive control program involves the risk of producing malathion resistant A. culicifacies which could trigger an epidemic until new controls are devised. This vector has already developed resistance to malathion in India.

Among the other vector diseases, dengue fever, chikungunya virus, scrub typhus and bed bugs are all likely to spread in the project area. For the present, neither filariasis nor schistosomiasis would be expected to spread as a result of project implementation.

Rabies, tetanus, accidents and snake bites are also likely to increase, particularly in the early years of construction and clearing. Tetanus may be a serious problem for construction workers due to its prevalence in the project area soils. Existing health facilities in the Mahaweli region will, of course, be too limited to accommodate the health needs of the additional population.

Overall, dietary patterns and nutritional quality should improve for the incoming settlers due principally to increased food availability and an increased standard of living. However, one potentially serious problem may be an insufficient supply of animal protein to meet nutritional requirements for the general maintenance of good health. The supply of dairy products to the project area may be limited since the grazing area may be reduced. On the other hand, increased freshwater fish production could contribute significantly to this need for animal protein.

5. PROJECT BENEFITS VERSUS ADVERSE ENVIRONMENTAL IMPACTS

The Mahaweli Accelerated Program, as presently proposed, will generate several major socioeconomic benefits. About 175,000 families will be provided with permanent employment in agricultural or agricultural-related activities. New and improved cultivation will result in the annual production of more than 600,000 tons of rice and other crops. This will meet the current import demand for rice and contribute significantly to the rice demands of the future national population. In addition, the proposed reservoirs will substantially increase hydroelectric power output for the country.

To obtain these long-term benefits, a commitment of resources is required which will result in a number of adverse environmental impacts, some of which would in all likelihood be unavoidable. These would include the following:

- Due to clearing, as well as timber and fuelwood needs, a substantial portion of the present forest will be removed;
- There will be a loss of large numbers of animals and plants, many from the nine endangered and threatened species or the more than 90 endemic species;
- Carrying capacities and populations for most wildlife species in the project area will decrease. The viability of the endangered species will be further reduced;
- High-quality wildlife habitats comprising 5,600 hectares in the Somawathie Sanctuary and about 15,000 hectares in the northern part of System C will be eliminated;
- About 6,400 hectares of additional high-quality wildlife habitat will be lost in the Mahaweli Ganga floodplain villus. Breeding and feeding grounds for some fish species, waterfowl and migratory birds will be lost. Livestock grazing areas and carrying capacities will also be reduced here;
- The water table will rise considerably, necessitating the provision of drainage channels;
- Return flows will deteriorate the quality of receiving waters;
- Pesticide usage will be increased with the subsequent magnification of pesticides throughout natural food chains;
- Organic production and energy cycles in estuarine systems will be altered, with a detrimental effect on aquatic life;
- Fish migratory routes along rivers will be blocked;
- More than 25,000 people must be relocated from their homes in proposed reservoir sites;
- Crop losses of 10% will occur due to the combined effects of weeds, insects, diseases and rats; and
- Birds and large mammals will also cause crop damage, especially in high-quality habitat areas. Elephants may cause physical harm to settlers or their families.

Several significant, potentially adverse impacts related to the proposed Accelerated Program may in fact be avoidable or at least be mitigated considerably through implementation of recommendations such as those provided in this report (see following section). These would include the following impacts:

- The rate of erosion in the upper catchment will continue to increase, and land usage there will steadily deteriorate. This impact is not as a result of the Accelerated Program per se, but it could have negative effects on certain aspects of it;
- A few of the major existing tanks will have a net decrease in mean area which will reduce fish yields there;
- Aquatic weeds will spread through a number of areas;
- Second generation offspring of settlers will face local unemployment problems;
- There will be a spread of water-borne and vector diseases along with other health hazards in the project area; and
- Fuelwood and animal protein supplies for project area residents may be insufficient to meet future demands.

6. SUMMARY OF RECOMMENDED ACTIONS

This section consists of a series of recommended actions for mitigating or minimizing adverse environmental impacts of the proposed action and for enhancing beneficial aspects of the Accelerated Program. Generally, the major recommendations for the respective environmental sectors are summarized here; details are provided in the accompanying series of TOPIC REPORTS. In addition, a number of specific recommendations have been integrated to promote a planning effort aimed at maximizing environmental resources for both the natural and human environments. Recommendations are presented as action plans which include, where applicable, relative priority, schedule of implementation, coordinating Government agency or institutions and costs and benefits.

6.1 COORDINATING AGENCY FOR NATURAL RESOURCES

The formulation of policy guidelines and legislation for natural resource conservation is logically related to the establishment of an agency which will have executive and implementation powers. Under the present system of administration, coordination between conservation oriented departments is either lacking or non-existent. This is largely because these departments are isolated units which are attached to separate ministries.

As an overall general recommendation, it is suggested that a number of these scattered units be consolidated at the national level to form a Coordinating Agency for Natural Resources. Government agencies which should be considered for inclusion in this new coordination body would be the Department of Wildlife Conservation, the Forestry Department, the State Timber Corporation, the Soil Conservation Division and the Coast Conservation Division. New departments could be added to this Agency including Park Planning and Management, Wetlands, Air and Water Pollution, Conservation Education, etc. The framework for the new Agency has been recently established with the creation of the Natural Resources, Energy and Environmental Authority. However, this Authority focuses on energy programs and does not have enforcement power. It is suggested that an Environmental Protection Authority be established under the proposed Coordination Agency for Natural Resources to promulgate environmental safeguards and standards and have the power to ensure compliance with regulatory statutes.

6.2 WATERSHED MANAGEMENT - UPPER CATCHMENT

6.2.1 Soil Conservation Measures

Objective

In the upper catchment of the Mahaweli Ganga, extensive soil erosion is occurring due largely to past and present cultural practices. Future erosion of the catchment is expected to increase. To minimize losses to the productive base of the region, a series of conservation measures are required to establish ground cover and stabilize exposed slopes and poorly managed lands. In addition, the supply of forestry and agricultural products needs to be increased to meet demands in the region.

Recommended Actions

Forestry - The natural forests in the upper catchment have been reduced far below the minimum for the control of runoff. No further cutting of any natural forest in the catchment should be allowed. Similarly, protection planting is recommended on steep slopes abutting the present timber line, on ridges and mountain tops where possible, in steep ravines within tea estates, and along streams and rivers. Trees planted in these areas for erosion control should never be cut.

In addition, it is recommended that 2,000 hectares of upper catchment lands be annually planted as fuelwood plantations over the next decade. These plantations will serve both as soil conservation measures and as a supply of fuel to the region. The plantations should be relatively small and established close to consuming communities in order to limit high transportation costs. Yields from these plantations are estimated to be 140 cubic meters per hectare on a 10 year rotation basis.

It is further recommended that timber plantations be planted in the catchment at a rate of 3,000 hectares per year. Timber plantations must be planted in large contiguous areas in order to make them convenient for forest management. Also, lands chosen for timber cultivation should be fertile and not too seriously eroded.

Capital and recurrent costs estimated for both the proposed fuelwood and timber plantations in the upper catchment are as follows in rupees (Rs.)/ hectare:

CAPITAL COSTS	Fuelwood Plantations	Timber Plantations
Nurseries	155	202
Plantation surveys, land preparation, planting, etc.	2,039	2,064
Buildings	113	172
Vehicles	97	81
Equipment	10	15
Contingencies	100	150
TOTAL CAPITAL COSTS	2,514	3,008
RECURRENT COSTS (Average)	165	345

Consequently, total capital costs for a nine year planting program of fuelwood and timber plantations would be Rs. 45.3 million and Rs. 81.2 million, respectively. Maintenance and harvesting of fuelwood plantations will be done by local villagers with the assistance of Government extension workers. However, the timber plantations require a full complement of trained staff and equipment and will be maintained by the Forest Department. Harvesting of the timber requires an additional recurrent cost.

Over a 40 year period, the proposed fuelwood plantations would have net returns of Rs. 18,545 per hectare planted. Similarly, total returns for timber plantations would exceed Rs. 700,000 per hectare. Consequently, both types of plantations would generate very favorable economic benefits.

Agriculture - In conjunction with present activities of the Agricultural Diversification Division and the National Agricultural Diversification and Settlement Authority, it is recommended that 2,000 hectares of catchment land be annually redeveloped with crop diversification planting. This would be aimed primarily at rehabilitating abandoned and poorly managed tea lands. The mixed crops would include jak, breadfruit, cardamons, pepper, citrus, avocado, cacao, coffee and a number of spices. Capital investment costs are estimated at about Rs. 13,600 per hectare with net annual returns of Rs. 11,850 per hectare.

This crop diversification scheme combined with the proposed forest plantations would develop 63,000 hectares of upper catchment lands by 1990. The total capital costs would be about Rs. 370 million, while average annual undiscounted returns (over 40 years) would be about Rs. 59 million, although plantation returns would not be realized for a number of years. An added benefit in soil conservation savings after full implementation would be Rs. 3.6 million per year. The overall economic benefits in terms of present net worth would be Rs. 148,000 per unit developed.

Engineering Works - In conjunction with cultured controls, a variety of engineering works can be used to limit erosion and conserve soil. These include rip-rap, bench terracing, bunds, paved waterways, river bank stabilization, culverts, detention reservoirs and ponds, and check dams. Selection of sites and designs of appropriate control measures must be done for each specific problem locality. It is recommended that the Mahaweli Authority conduct a detailed ground survey of the catchment to identify these problem areas. A study of this nature can be integrated with the Master Plan discussed in the following section.

6.2.2 Redevelopment Institutions and Master Planning

Objective

At present, a large number of Government and international organizations are conducting watershed management related projects in the upper catchment and in adjacent upland areas. Also, there are over a dozen laws with clauses covering various aspects of soil conservation. In order to effectively coordinate conservation and development of the catchment, a single organization is necessary to control and manage the area as a unit.

Recommended Actions

It is recommended that a Mahaweli Catchment Redevelopment Law be enacted which would take precedent over related soil conservation laws, or that existing laws be sufficiently revised to make provision for the conservation of soil resources; for the prevention or mitigation of soil erosion, for the rehabilitation of unproductive lands; for the productive use of land for agriculture or forestry; and for the establishment of the Mahaweli Catchment Redevelopment Corporation.

This Corporation would prepare a Master Plan to be used as a basis for its activities and include:

- Specific areas for redevelopment;
- Appropriate conservation and development measures to be taken;
- Planning for settlements and infrastructure;
- Coordination of all public, private and foreign agencies or institutions working in the area; and
- Identification of surveys and projects required and sources of funding.

The Corporation should be based in Kandy and administered by a general manager appointed by a Board of Directors comprised of representatives from the Ministries of Agriculture, Plantations, Lands and Land Development and others. Besides developing and updating the Master Plan, the Corporation will conduct public information campaigns, develop an effective extension service and establish a marketing organization. The activities of the Corporation would be performed within existing Government agency structure where applicable.

The actual redevelopment program should take into consideration the present activities already in progress and apportion an additional 7,000 hectares a year for forest plantations and crop diversification as discussed in the previous section. It is suggested that the catchment be divided into six regions according to their priority for redevelopment. The first two regions are catchments of tributaries to the proposed Victoria Reservoir. Regions 3, 4 and 5 are upstream along the main channel of the Mahaweli Ganga. Region 6 contains the catchment of the Kotmale Oya.

6.3 FORESTRY MANAGEMENT AND PLANNING

6.3.1 Control Plan for Clearing Operations

Objective

Present logging and clearing operations are inadequately controlled. They are being conducted without a coordinated plan defining the areas specifically designated for agricultural development or settlements. In order to prevent an unnecessary elimination of forests and associated wildlife habitats, an increase in soil erosion and a wastage of forestry resources, an organized clearing plan and schedule should be formulated and implemented as soon as possible.

Recommended Actions

It is recommended that all cutting and clearing of forested areas be postponed until the new irrigation systems and settlements along with their respective implementation schedules are more adequately defined. No further cutting within the Somawathie Sanctuary should be done until it is definitely established that this area will be developed.

It is recommended that an immediate study be conducted in order to develop a control plan for clearing operations in the project area. The scope of work for this study would include the following:

- Outline all forested regions of the project area on present land use maps. The maps suggested for this are the 1:20,000 land use maps prepared as part of this Environmental Assessment. These maps were based upon 1979 aerial photography, and originals are on file at the Survey Department;
- Superimpose the areas planned for agricultural development and settlements on the 1:20,000 maps and delineate boundaries for the limit of cutting. Village sites should be left forested to provide fuelwood, building materials and shade trees. Information concerning planned cultivation and settlement areas must be provided by the Mahaweli Authority, Mahaweli Development Board, Irrigation Department and the consultants' final feasibility studies for the four irrigation systems;
- Survey the boundary lines in the field and mark them by painting all border trees;
- Develop a priority program for cutting which will be integrated with scheduled settlement implementation;
- Provide maps suitable for field use in determining which areas should not be cut and advise the State Timber Corporation accordingly; and
- Establish a monitoring system to detect non-compliance.

It is recommended that a forester/land use planner prepare and assemble the required maps, develop cutting priorities, supervise field surveys and boundary marking and establish the monitoring required. The level of effort for the forester/land use planner would be about eight person-months. The study would cost, including salaries, per diem, travel, vehicles and equipment, about Rs. 1.3 million. The level of effort and costs could be reduced accordingly if a smaller portion of the project area is selected as a priority for development.

The above study would be conducted in cooperation and with the assistance of the Mahaweli Development Board (MDB). The MDB would supply draftsmen, a field survey team, office space and materials, jeeps and paint sprayers. The MDB will implement the clearing plan, direct activities of the State Timber Corporation and other logging contractors and conduct the monitoring program.

6.3.2 Establishment of Fuelwood Plantations

Objective

Even with controlled selective harvesting of the remaining timber in the project area, fuelwood supplies for the increased future population will only be sufficient for a few years. Substitution of fuelwood with kerosene is not believed to be a feasible alternative to meet energy demands because of escalating costs. Consequently, a sustainable fuelwood supply will be a basic need for settlers in the project area.

Recommended Actions

To meet the estimated annual requirement of roughly 570,000 cubic meters of firewood, it is recommended that fuelwood plantations be developed within a short distance from planned settlements. The plantations should be planted with fast growing trees, such as eucalyptus or ipl-ipl, capable of producing 140 cubic meters/hectare on a five year harvest rotation. The initial plantings needed to meet the demand by 1990 would cover a total area of 20,000 hectares. The hectarage required per settlement would be derived according to the size of the respective settlement population, based upon a usage of 2.8 cubic meters of firewood per family per year.

The plantations should be established as soon as possible after village sites have been determined. Priority planting should commence on lands already denuded. The coordinating agency would be the MDB in association with the Forestry Department.

It is recommended that the Government provide the seedlings and the initial land preparation for the plantations. Actual planting, maintenance, guarding and harvesting would be done by the villagers with extension personnel supervising.

Capital costs for this program are estimated at about Rs. 1,400 per hectare or Rs. 28 million for total planting. These costs are summarized as follows:

COST ITEM	Rs./ha.
Nursery (seeds and seed beds, land preparation, etc.)	354
Survey and demarcation of plantations	158
Plot marking, soil preparation, fertilizer	711
Buildings	44
Vehicles and Equipment	68
Contingencies	66
TOTAL	1,401

Recurrent costs including seeds, operations, maintenance and salaries are estimated at Rs. 1,019 per hectare of plantation developed.

The present net worth of the program (at a 10% discount rate) is Rs. 40,235 per hectare. The net annual returns of the collective village plantations following the sixth year of operations would be Rs. 27.7 million. In addition, there would be an annual savings of Rs. 242 million which would be the amount required to substitute kerosene for fuelwood demands. Intangible benefits which may accrue from the plantations would include some selective harvesting for housing timber, or surplus fuelwood which could be sold or converted to charcoal.

6.3.3 National Forestry Programs

Objective

The demand for timber, fuelwood and related wood products will increase substantially in Sri Lanka within the next 10 to 20 years. To effectively meet this demand, all production activities related to the forestry sector must be developed to their fullest extent. Consequently, consideration should be given to expanding and further integrating the present national forestry related institutional and management capabilities.

Recommended Actions

In order to supervise and manage the exploitation of the remaining forest resources and manage new forest plantations, it is recommended that a National Forest Authority be established combining the functions of the Forest Department, the State Timber Corporation and other wood based corporations. This will enable close coordination in the assessment, planting and actual harvesting of the forest resources.

The new Forest Authority should be comprised of a number of divisions including those specifically designated for administration, research, public education and extension. A Forest Management Division would be responsible for forest and plantation surveys and for preparing annual schedules for planting, thinning and final cuts and for allocating the various products to consuming centers. A Community Forestry Division would develop a system of local village forest programs to supply fuelwood and other forest products for use and for sale. Divisions for Forest Operations and Timber Utilization would carry out final cuttings and coordinate handling and processing, respectively. In addition, a Plans and Project Preparation Division of the Authority should be responsible for coordinating funding activities and implementing and modifying a National Forest Sector Master Plan.

This Master Plan should be prepared to coordinate all activities connected with the production, manufacture and marketing of forest products. The plan should cover all aspects of the size and location of proposed plantations, species used, rotation ages and silviculture treatment. The plan would also identify types of new industries required to meet market requirements for quality and grading specifications of products. The plan should include soil

conservation programs and a monitoring system for fuelwood requirements and related forestry product marketing.

To provide a basis for the formulation of the Master Plan, it is recommended that the following studies be undertaken:

- Forest and plantation inventory;
- Census of forest related industries and specific energy and fuelwood requirements;
- Forest products market demand study;
- Feasibility studies to provide supplies of pulpwood and logs for paper and plywood production; and
- Feasibility studies for new sawmills and the development of the charcoal industry.

Finally, the anticipated increase in all forest related activities requires an immediate need to increase the number of trained forestry personnel. The existing Government funded China Bay Ranger School should be expanded to accommodate a larger enrollment. Presently, the school trains 15 forest guards annually and plans to provide a two-year course for 40 forest rangers. However, this will be insufficient for projected demands in the next five years of more than 200 rangers and 350 forest guards. An immediate suggestion is that 45 rangers be given a two year course, but in two stages each three years apart. The number of forest guards trained should be doubled and given a six month intensive course, returning after three years to complete the remaining half year of updated courses. In any event, staff and facilities at the school must be increased to meet future demands for trained personnel.

6.4 WILDLIFE CONSERVATION AND MANAGEMENT

6.4.1 Expansion and Development of Wildlife Reserves

Objective

The development of new lands for cultivation can only proceed at the expense of natural habitats and their associated fauna and flora. However, social values derived from cultural and spiritual traditions in Sri Lanka indicate a need to balance development goals with wildlife conservation. Because of this, and considering the rich and unique wildlife inhabiting the project area, it is recommended that all reasonable means of conserving animal and plant species affected by the Accelerated Program be incorporated into the development scenarios.

An immediate response to the actual loss of animal life would appear to be a program aimed at moving the animals to suitable habitats in surrounding areas. This would involve capturing and translocating individual animals or driving them into neighboring wildlife reserves which could be enriched to increase their carrying capacities. In addition, this program would reduce pocketing, thus decreasing potential crop damage to farmers located adjacent to remaining natural habitats. To the extent possible, this program is endorsed.

However, this approach is a shortsighted one. Very few animals would actually benefit. Existing reserves (even if enriched) and captive populations can accommodate an insignificant number of those animals which will be displaced. Overall, while it is advisable to implement the above program in order to save some individual endangered animals and to limit crop losses, it is not a long term solution for sustaining wildlife species, especially endangered and endemic ones.

The most feasible means of conserving the largest number of wildlife species is by providing as much contiguous natural habitat as possible. This is particularly true for the wide ranging endangered species such as leopards and elephants. Therefore, it is recommended that the emphasis on wildlife conservation be focused upon the expansion and legal protection of present wildlife reserves and the establishment of others where possible.

Recommended Actions

In the selection of areas for wildlife reserves, it is recommended that priority be given to those regions which have been identified as "high-quality wildlife habitats" (Figure 2). However, preservation of all of the high-quality habitat areas would in some cases preclude proposed agricultural development on lands highly suitable for cultivation. Furthermore, this approach would significantly reduce the size of some of the proposed irrigation schemes to a level which would in all likelihood render entire irrigation systems economically and technically unfeasible. This would have a very negative effect on solving critical problems facing Sri Lanka in the areas of employment, food production and related human needs. Therefore, while a decision to maintain all of the high-quality habitat areas would be favorable from the point of view of wildlife conservation, it would not be appropriate as a balanced recommended view when the human environment is also taken into consideration, especially since it is apparent that substantial land areas are available and suitable for wildlife reserves which

would not present land use conflicts with future agricultural development.

However, because of the importance of the high-quality habitats for the conservation of endemic and endangered species, it is recommended that as much of these areas as possible be fully protected in appropriate wildlife reserves. It is also recommended that any planned clearing of high-quality habitats be delayed until feasibility studies pertaining to these areas are completed and reviewed, and it is then concluded that clearing is absolutely necessary for the continuation of the program.

Finally, to in part compensate for the loss of high-quality and other wildlife habitats in the Mahaweli area, it is recommended that large contiguous reserves be established in and around the project area. Area specific recommendations in this regard are presented and evaluated in the following sections.

Somawathie National Park - The Somawathie Sanctuary is unique in many respects and is considered an especially high-quality wildlife habitat. It contains the highest density of elephants found anywhere in Sri Lanka, and this type of alluvial floodplain habitat represents the arena in which much of the evolution of the Asiatic elephant took place.

It is recommended that the Somawathie Sanctuary be expanded (see overlays) primarily to the east and west in areas not planned for cultivation, and that its status be elevated to that of a National Park. The improved status will provide full protection of fauna and flora, prevent permanent settlement within the boundaries, and allow tourism development. A westward expansion will enable a link to be formed between the Somawathie and the Hurulu National Park (see below).

The expansion of Somawathie to the east and west will only partially balance the loss of the northern portion of the reserve to agricultural development. The specific 5,600 hectare area of the present sanctuary which is being planned for cultivation is well forested and is a significant wet season grazing habitat for elephants and other large herbivores. The annual costs associated with foregoing development of these 5,600 hectares would be about Rs. 107 million attributable to potential crop and homestead income returns. Not developing this region would provide some economic returns in terms of savings of infrastructure and savings to crop losses and some tourism benefits. However, it is clear that preserving this section of the Somawathie would not be justifiable on a strictly economic basis.

However, technical and economic feasibility for developing this region has not yet been firmly established. Consequently, the possibility of preserving this area may arise, and if so, it is strongly recommended that the area along with other forested portions in the northern part of System A be incorporated into the Somawathie Park. In the meantime, clearing or other construction activities in this area should be strictly prohibited.

Mahaweli Ganga Conservation Park - It is recommended that the high-quality habitat identified as the floodplain villu area between the Somawathie Sanctuary and the Wasgomuwa Strict Natural Reserve be designated as the Mahaweli Ganga Conservation Park. (A Conservation Park would be managed as a National Park, yet allow for existing development.) Gunner's Quoin and its immediate surroundings should also be included in this park. Although this area will be

reduced due to decreased river flows in the future, it will still constitute a high-quality habitat, especially for migratory birds and many endemic species. Protection of the floodplain from further development would not result in a conflict with any cultivation plans of the Accelerated Program. Most of the large villu areas which would be included in the Conservation Park are located along the right bank of the river.

Wasgomuwa National Park - Wasgomuwa and its environs comprise a somewhat unique wildlife area in Sri Lanka that includes eight of the nine endangered/threatened vertebrate species within a single faunal complement. The faunal richness of this area is enhanced by the availability of riverine forests (along the Mahaweli Ganga) which are the preferred habitat of many endemic species.

Taking into consideration the habitat requirements of endemics and the welfare of endangered species, Wasgomuwa and its environs are considered to be a high-quality habitat. In this regard, the Government's decision to preserve the present Wasgomuwa Reserve for wildlife conservation instead of developing it for agricultural use is very beneficial for wildlife and is endorsed. Preservation of the reserve to a certain degree offsets some of the losses of other high-quality habitats which will result with implementation of the Accelerated Program.

It is recommended that the present reserve status of Wasgomuwa be transferred to that of a National Park in order to ensure more active protection of the area and to stimulate more public participation and concern for conservation in the area. It is further recommended that the new park be extended to the northeast to allow for a natural merger with the Mahaweli Ganga Conservation Park along the river floodplain. In addition, it is also recommended that other areas adjacent to the present Wasgomuwa Reserve boundaries to the north and west and southwest be designated as appropriate wildlife reserves, perhaps as a Conservation Park.

Ideally, in terms of wildlife conservation, the high-quality habitat region in the northern part of System C (Figure 2) should also be included within an expanded Wasgomuwa National Park. On the other hand, not developing this area would result in a conflict with the proposed cultivation of more than 8,000 hectares of land and a corresponding loss of potential crop and homestead income returns of about Rs. 162 million per year. Furthermore, without this development, the feasibility of implementing both Systems C and B may be questionable, since the two systems share the costs of construction for delivery and irrigation infrastructure (some of which is already being built).

This would have a significantly adverse effect in terms of the socio-economic requirements of the country, and considering Government commitments to preserve other high-quality habitats as well as the opportunities to substantially expand wildlife reserves in general, it is suggested that the development of this specific area to meet human needs is preferential to its maintenance for wildlife conservation. In this regard, it should be noted that this area is very likely to be considerably encroached upon in the immediate future before any reasonable protective measures could be initiated.

A few additional mitigation measures can be evaluated with respect to the development of the northern portion of System C. One is a Jungle Corridor requested by the Department of Wildlife Conservation along the Kuda Oya to allow for animal movements between the Wasgomuwa and the Maduru Oya National Park.

This proposed Kudu Oya corridor would displace about 3,000 hectares of paddy plus 1,700 of settlement in System C as proposed in the Accelerated Program. The capital costs for developing the corridor would be about Rs. 3.9 million, and recurrent costs are about Rs. 100,000. The opportunity cost of agricultural production foregone would be around Rs. 54 million per year. The corridor could not be justified on the basis of quantifiable costs and returns. In addition, the reduction of the total high-quality habitat to the corridor size would benefit a few more far ranging species, such as elephants, but would not allow substantial gene flow between reserves for all of the relatively unusual fauna and flora. Also, the corridor would pass through an area of intensive agricultural activities; the actual prevention of encroachment into what is suitable land for cultivation would in the long term be very difficult. Thus, for many reasons, the proposed corridor does not appear to be practical nor feasible.

Finally, a mitigation measure which is feasible and would particularly benefit endemic fauna in the region, would be to include the riverine forests and rocky outcrops bordering the Mahaweli Ganga in System C within the Wasgomuwa National Park. The park could extend into System C in some places for perhaps several kilometers due to the dendritic nature of the proposed cropping patterns.

Hurulu National Park and Kaudulla Reserve - It is recommended that the Hurulu National Park be established by connecting the Hurulu-Anaolundawa Man and Biosphere Reserves with the Naval Headworks Sanctuary through the broad patch of forest on the western side of Kantalai Tank (see overlay of System D). Establishment of this park should not prove difficult, since a large proportion of it already exists as protected areas.

In order to allow for continuity of fauna and flora between the proposed Hurulu Park and the Minneriya-Giritale Sanctuary, a second wildlife reserve is recommended near the Kaudulla Tank.

Maduru Oya National Park - The Department of Wildlife Conservation has proposed and recently received approval for the establishment of the Maduru Oya National Park in the catchment of Maduru, Ratkinda and Ulhitiya Oyas. This is highly endorsed with two major additional recommendations.

It is recommended that the eastern and northeastern boundary be extended to include a substantial portion of the Omunugala Forest Reserve.

Second, it is proposed that the area forming the upper catchments of Rambukkan, Maha, Maduru and Ulhitiya Oyas be established as a wildlife reserve. This would effectively merge the Gal Oya and proposed Maduru Oya parks as one extensive wildlife reserve. This area between the two parks could be designated as a Conservation Park. This recommendation is largely derived from and supports findings of the present investigations by the Canadian International Development Agency as part of the Lower Uva Regional Planning Study.

Nelugala Corridor - The Nelugala Corridor was established in order to protect one of the known paths of intensive elephant movement to and from the riverine forests of the Maduru Oya. However, the present corridor is neither patrolled nor maintained.

An estimate of the capital cost to fully develop the corridor which would involve enrichment, guard housing, jeeps and buffer zones is about

Rs. 16 million. Maintenance of the corridor would result in an annual opportunity cost of crops foregone of probably about Rs. 40 million. The corridor could not be justified on an economic basis.

In any event, substantial portions of the present corridor have already been converted to cropland and settlements. Encroachment pressure in the corridor is expected to further increase, especially after project implementation. The corridor would then, as with the proposed corridor in System C, be bounded by intensive agricultural activity. Protection from encroachment would become increasingly difficult, especially as second generation families would be seeking any available land suitable for crops. Consequently, the corridor may prove effective in the short term, but over a long period its maintenance is probably not feasible.

It is recommended that the corridor be maintained at least as a temporary measure. Its permanence may not be so essential since a trade-off may be possible by further extending the Somawathie into the east. It is suggested that this area be investigated in detail to determine if enrichment or other measures could be implemented to provide suitable wet season grazing habitat as a replacement for the Nelugala Corridor. A study of this nature would involve a range management specialist, wildlife management/ecological expertise and perhaps a water resources engineer. The study could be coordinated by the Department of Wildlife Conservation. Wet and dry season surveys should be made of vegetation and animal movements in the region and specific enrichment recommendations should be made including their costs and designs. A study of this nature would cost about Rs. 1.6 million.

An additional compensation which could be considered would be the preservation of the northern part of the Somawathie which is now planned for development. Preservation of this area, and perhaps some other forested areas north of Somawathie, may be a suitable exchange of wet season grazing habitats for that of the corridor.

Riverine Forests - It is recommended that riverine forests along all major project area rivers and streams be maintained for a distance of at least 200 meters on either side of their respective main channels. These forests will provide bank stabilization, serve as windbreaks and also provide favorable habitat for various wildlife species, especially some of the endemic ones. Forested areas surrounding tanks and reservoirs should also be preserved.

Management of Wildlife Reserves - A number of generalized recommendations can be made for managing the new proposed reserves and parks. For example, buffer zones should be established at the periphery of the reserves where specific conflicts may arise due to crop damage by wildlife. These zones can be comprised of a combination of grazing land and fuelwood plantations and should extend at least one kilometer between the reserve and areas of intensive agriculture.

Each of the National Parks (Somawathie, Wasgomuwa, Hurula and Maduru Oya) should have an administration center with sufficient trained personnel to handle tourist inflow and management responsibilities. These centers should include four-wheel drive vehicles, a vehicle maintenance unit, living quarters, basic research and laboratory facilities, and radio communications.

Guard posts should be established at reserve peripheries as soon as the new park and reserve boundaries are finalized. Guard post personnel would be responsible for patrolling the reserves to prevent poaching or encroachment activities. Each guard post would be responsible for an area of about 75 square kilometers.

6.4.2 National Wildlife Programs

Objective

Implementation of the Accelerated Program and other development schemes will in the near future result in an almost complete confinement of Sri Lanka's wildlife populations within specified reserves. Wildlife management must be developed within this context in order for the conservation of the diverse flora and fauna on the island to be successful. National planning of reserves is needed as well as a substantial increase in trained wildlife management personnel.

Recommended Actions

National Wildlife Conservation Policy - The Ministry of State has recently established a committee which is mandated with formulating national wildlife conservation policy. This planning approach is highly endorsed in this report.

However, the terms of reference for the designated committee appear to be limited and pertain only to areas that should be declared, redefined, revised or improved as wildlife reserves. It is advised that this committee be requested to include in its terms of reference the following:

- An evaluation of the new legal measures that are being formulated to strengthen the existing wildlife conservation laws;
- Recommendations for the integration of the wildlife conservation policy with national development programs;
- A Master Plan for a national system of wildlife reserves; and
- Details for revamping and expanding the Department of Wildlife Conservation.

It is hoped that the guidelines and recommendations provided in this report would prove useful in the formulation of the National Policy.

Expansion of Administration and Management - An enlarged wildlife reserve system will automatically require an expansion of the administrative and management capacity of the Department of Wildlife Conservation. It is recommended that the Director of this department be supported by five Deputy Directors responsible respectively for:

- General administration;
- Wildlife management and field research;
- Veterinary research;
- Park planning; and
- Law enforcement.

Overall, the present upper level staff of seven should be increased to at least 27 in order to effectively manage future programs. However, sufficiently

qualified personnel for these positions are lacking. Consequently, it is recommended that suitable candidates be recruited and sent abroad as soon as possible for training. The regional administrative capacity should be expanded to four fully operational offices. These regional offices should be provided with:

- Secretarial and drafting staff, supplies and equipment;
- Living quarters;
- Four-wheel drive vehicles;
- Vehicle and equipment maintenance units; and
- Tractors or bulldozers for construction work as well as equipment for capturing and transporting wildlife.

Wildlife Training Institute - It is further recommended that a Wildlife Management and Training Institute be established to train basic and mid-level staff in wildlife ecology, wildlife management and conservation policies. In addition, the Institute should provide research facilities, assist in translocation when necessary, and monitor wildlife habitats and populations. The curriculum would include subjects such as principles of wildlife management, enforcement, equipment use and maintenance. The institute is envisioned as a complex with facilities designed for training, research, administration, laboratory work, documentation and living quarters.

National Wildlife Management and Park Planning Team - It is also recommended that a National Wildlife Management and Park Planning Team be assembled to plan and coordinate the development of the reserve system on an island-wide basis. The team should be comprised of expatriate and qualified Sri Lankan professionals in the fields of wildlife management and ecology, park planning and engineering, veterinary science and range management. The team would be set up under the Department of Wildlife Conservation and would have a scope of work to include the following:

- Prepare a Master Plan for the wildlife reserves in the country;
- Integrate this plan with proposed agricultural developments;
- Recommend infrastructure development and management for tourism in the reserve system;
- Develop wildlife management policies for selected species;
- Initiate a monitoring program using aircraft and ground survey crews with a particular goal of establishing the status of internationally endangered species and Sri Lankan endemic forms;
- Develop the technical capacity and guidelines to capture and transport selected species of wildlife whenever necessary; and
- Identify research needs and specific studies required along with suitable funding sources.

This program should be implemented as soon as possible and have a duration of about three years. Results from this program would form the basis for all future wildlife management planning in the country.

Project Area Park Design Planning Study - Proposed park and related wildlife reserve boundaries in and around the project area should be established, at least on a preliminary basis, as soon as possible through coordination between the Mahaweli Authority and the Department of Wildlife Conservation. Once this is accomplished, it is recommended that a specific study be conducted for planning

the development of the reserve system west of the Kaudulla and Kantalai Tanks, the Hurulu National Park, the Somawathie National Park, the Wasgomuwa National Park, the Maduru Oya National Park and the Mahaweli Ganga Conservation Park. The scope of work for this study would include the following:

- Delineate park boundaries on 1:20,000 or larger scale land use maps;
- Identify specific potential conflict areas where intensive agriculture would border a park. Detailed buffer zones for these areas would then be proposed;
- Conduct detailed habitat/vegetation analyses in order to recommend specific localities for habitat enrichment and to provide estimated carrying capacities for larger mammals, especially elephants, in the respective parks;
- Recommend population management and related techniques for particular species as needed;
- Design infrastructure needs for park administration, tourism development and related management;
- Recommend staffing requirements, maintenance schedules and monitoring for each park; and
- Estimate costs and benefits for each park development.

It is recommended that this study be conducted through the auspices of the Department of Wildlife Conservation and be developed as part of national park policies. The study personnel could include a park planner (12 person months), a range management specialist (eight person months) and an economist (four person months), all of whom should have experience with park management in tropical countries. The proposed study would last about one year and cost approximately Rs. 4 million.

6.5 WETLANDS AND AQUATIC WEED CONTROL

6.5.1 Conservation of Wetlands

Objective

Both freshwater and brackish water wetlands are highly productive and relatively unique ecosystems. They provide benefits to man as well as for fisheries and wildlife in general. Unfortunately, wetland areas will be unavoidably diminished as a result of the Accelerated Program. However, every effort should be made where possible to preserve extant wetlands and to minimize potentially detrimental modifications which may occur in these sensitive systems.

Recommended Actions

It is recommended that the remaining villus and mangrove swamps be preserved to the greatest extent possible. In the estuarine areas, cutting or clearing of mangrove swamp lands for conversion to other uses should be strictly prohibited. Also, new bridge crossings over tidal streams should be constructed in a manner which will not impede tidal exchange.

Preservation of the major villus would be enhanced with the declaration of the Mahaweli Ganga floodplain between the Somawathie and Wasgomuwa Reserves as a Conservation Park. This will restrict future development in the floodplain while providing for continued grazing and fishing activities and maintaining existing settlements.

In some instances, limited preservation of a villu may be possible by regulating the inflow or the outflow water volumes. This could be accomplished by constructing weirs or barrages at outlet streams or by directing return flows or a river meander into a villu. However, engineering works required for this type of regulation would be very costly and would only result in partial control of villu pools, while most of the floodplain margins associated with the pools would not be benefited. In addition, the routing of return flows into a villu may not be desirable, since this would increase potential eutrophication rates. On the other hand, applying irrigation runoff in a controlled manner may be possible in order to improve the pasture conditions of the floodplain margins.

In general, the feasibility of implementing any means of controlling water balance in the floodplain is unlikely except perhaps for a few of the larger villus. It is suggested that possible flow regulation for the villus be investigated following project implementation when actual water balance requirements for selected villus can be determined. Also, the added effect of transbasin diversion schemes must be taken into consideration before control structure specifications can be defined.

Few new wetland areas are anticipated as a result of the Accelerated Program. Undoubtedly, some will occur in localized natural depressions where return flows may accumulate. In many cases these areas will enhance aquatic weed proliferation or provide favorable breeding habitats for mosquito vectors. These unproductive wetlands should be drained or filled where possible. However, with the future increased needs for animal protein supplies and draught power, consideration should be given to utilizing these small new wetlands for duck raising, fish ponds or fulfilling water requirements of water buffaloes.

6.5.2 Removal of Aquatic Vegetation

Objective

The potential for the spread of a number of aquatic weeds throughout the project area is relatively high. Dense growths of this vegetation can interfere with turbine operations, limit transportation, interfere with the use of fishing gear and, of particular significance, block canals and drainage channels. Thus, various measures to control and remove these weeds should be considered.

Recommended Actions

It is recommended that preparations be made at the village and hamlet level to provide farmers or laborers the means necessary for removing dense aquatic weed infestations. For example, early detection of the presence of a potential weed problem by extension workers or the farmers themselves will greatly facilitate control operations. Also, recognition that certain weeds, especially water hyacinth, can reproduce and spread vegetatively may limit careless deposition of the plants once removed. It is recommended that agricultural extension workers be trained to enable them to implement appropriate control and removal strategies as various weed problems arise.

In canals and channels, herbicide application is often the most efficient means to kill aquatic weeds. In addition, herbicides such as 2, 4-D, Amine and Diquat can be used without harmful effects in other aquatic organisms. However, herbicides are becoming increasingly expensive, and while plants are effectively killed, often they must then be physically removed to prevent the blockage of water flows.

Biological control methods can also prove effective in some cases to limit weed proliferation. One form of this type of control is to seed water with a competing species such as Azolla. This plant can be introduced to provide nitrogen to paddy fields while simultaneously serving as an effective competitor to undesirable weeds. Shading with trees along canals also can limit weed growth. Another means of control is through the introduction of various herbivorous animals which will naturally graze on aquatic vegetation. A few fish species and ducks or geese are among the more effective herbivores for controlling aquatic plants.

Physical removal is often the only practical means of weed control. However, since physical removal requires substantial labor, it is best applied in areas that are chronically infested. Mechanical removal is not recommended at present due to the high fuel and maintenance costs.

6.5.3 Utilization of Aquatic Vegetation

Objective

Aquatic vegetation can be harvested for a number of useful purposes; this would simultaneously serve as a control measure. With the likelihood of increased aquatic weed infestations in the project area, all possible uses of these plants should be examined.

Recommended Actions

One recommended use for aquatic vegetation would be as a direct or processed animal feed. Dewatering is usually necessary, but partially dewatered aquatic plants have been used to make a palatable, digestible and nutritious silage readily acceptable by cattle and sheep.

Aquatic weeds can also be used as green manure through direct application as a surface mulch or plowed under in shallow troughs. Further, the plants are a useful component of compost which, when applied, increases soil fertility, improves yields and enhances soil quality. Successful composting of water hyacinths has been accomplished in Sri Lanka by the Home Gardens Unit of the Department of Agriculture. This compost was composed of chopped water hyacinth mixed with kitchen refuse, ash, earth and cow manure. It was sold under the brand name of "Garbage Gems".

Aquatic vegetation can be used solely, or in combination with organic matter, for the production of biogas. The high moisture content of the aquatic plants is an advantage in this process, since it is needed for fermentation. Finally, a number of the aquatic plants found in Sri Lanka can be exploited as a food source.

In general, the more feasible uses of aquatic plants would appear to be the low level technology approaches for the production of supplemental animal feeds and mulch or compost. It is recommended that training in the processes required for aquatic weed utilization be implemented as an integral part of the agricultural extension services. Furthermore, research and demonstration projects need to be implemented to promote the harvest, or in fact cultivation, of aquatic vegetation.

6.6 FISHERIES DEVELOPMENT

6.6.1 Fisheries Development for Proposed Reservoirs

Objective

Potential fish yields from the proposed reservoirs will be substantial. However, in order to fully capitalize upon this potential resource, several planning measures should be taken into consideration.

Recommended Actions

It is recommended that planning for fisheries development of the new reservoirs be conducted with the aim of promoting small-scale fishery operations, comparable to those on the existing major tanks. This would involve the use of small fishery management units, consisting of a single fisherman with perhaps an assistant operating from non-motorized canoes and using primarily gill nets along with handlines, cast nets, beach seines or traps where they are applicable.

This type of fishery is labor intensive and attracts more individuals, since input costs and maintenance are low. Small-scale operations are well suited to effect maximum exploitation of the fishery resources on what will be relatively small sized reservoir areas. Collection gear, however, can be modified, with new gears introduced to harvest the different fish stocks. It is recommended that gear selectivity studies be initiated once the reservoirs are operational in order to determine the most appropriate gill net mesh size, the best trap designs, etc.

Subsidy and extension programs will also be needed to fully develop fisheries potential on the new lakes. These could be provided by extending the programs of the Ministry of Fisheries recent Master Plan to the proposed reservoirs.

Provisions for the settlement of fishermen and their families near the reservoirs will also be required. The plan initiated by the MDB for establishing permanent fishing settlements in which fishermen are alloted a small plot of land for cultivation should be extended to the Accelerated Program area. In addition, the welfare program proposed in the new Master Plan for coastal fishermen should be extended to inland fishermen as well. This would involve the provision of housing, latrines, wells and associated infrastructure.

It is essential that much of the woody vegetation be removed from all of the proposed reservoirs if effective fishing of the natural fish stocks is to take place. However, to enhance natural fish productivity in the reservoirs, especially for the deep up-country ones, it is advisable to permit small tracts of forests to remain in selected areas of the reservoir basins. Approximately 20-25% of the inshore drawdown zone vegetation could be maintained. However, it should be subdivided into small blocks of five to ten hectares, which are separated by open water (where vegetation has been removed) zones of one-half kilometer, or more. The remaining vegetation blocks should be about 100 to 200 meters from the shore. The inshore area between the beaches and the banks should be cleared as completely as possible. During any clearing, it is unnecessary to actually remove or burn all of the vegetation and other debris from the site.

Instead, it is advisable to form large brush piles where possible as part of the vegetation blocks which would be left.

A clearing pattern of this nature will permit utilization of all types of fishing gear with minimal risk of damage and, simultaneously, provide a feeding and nursery area to replenish natural fish stocks. Clearing patterns should be mapped and coordinated with contract cutting for each reservoir. Modifications suggested here for establishing brush piles, etc., can be easily incorporated into present MDB plans for clearing reservoir vegetation.

While indigenous fish populations are likely to contribute a sizeable portion of the reservoir yields, it is likely that other species will have to be introduced in order to maximize outputs. The most likely candidate for stocking in the new reservoirs is the common tilapia species, Tilapia mossambica, which is already prevalent in many of the freshwater areas of Sri Lanka. The MDB in collaboration with the Ministry of Fisheries is planning to produce tilapia fingerlings to stock in the Accelerated Program area.

It is suggested that consideration be given to the fact that Tilapia mossambica is a prolific breeder in Sri Lankan waters and that repeated stocking of the species into tanks and reservoirs may be unnecessary, since its own reproductive potential may be sufficient to maintain high populations in the reservoirs. Thus, Tilapia mossambica could be introduced into the proposed reservoirs in order to allow the establishment of self-sustaining populations, while other species would be considered for annual stocking and restocking programs. An additional potential concern with this species is that it may over-populate a water body and subsequently cause stunting of growth rates. However, since the species is well distributed in the country, it is likely that it would appear in any event within the new reservoirs. Even though it may then stunt at some time, the species could still be valuable at a small size - currently, many small sized fish are marketable, especially smoked or dried.

Other species which may be suitable for stocking in the low-country reservoirs would include native fishes such as labeo, olive barb, snake heads and catfishes. Exotic species which could be considered are other tilapia species, banded etroplus, Indian carps and Chinese carps. In the deeper up-country reservoirs, common carps and crucian carps may be preferable for stocking.

At the present time, it is not recommended that fish ladders or comparable conveyances be installed as part of the new dams to permit upstream fish passage. There are few species adversely affected by blockage of migration routes; and none of these species are of exceptional economic value. If further study warranted by-pass devices, it is likely that they could be installed after the dams are constructed.

6.6.2 Development of Aquaculture

Objective

The total potential fish yield from capture fisheries operations from new reservoirs and existing project area water bodies is estimated at 5,410 tons per year. However, the nutritional and market demand for fish and fish products in the region will greatly exceed this amount. For instance,

to meet the present per capita consumption levels for the increased population in the project area, about 11,400 tons of fish would have to be harvested annually. Moreover, around 20,000 tons would be required to meet the Ministry of Fisheries' goals for increasing per capita consumption in rural populations.

Consequently, even assuming that potential yields could be fully realized, it is evident that the capture fisheries sector will not provide a sufficient amount of fish products to meet future project area demands. Thus, additional sources of fish production will be necessary.

Recommended Actions

A program to investigate aquacultural potential within the project area is highly recommended if future fish product demands for the region are to be met. A series of pilot projects should be implemented to determine the most feasible fish farming techniques which can be used for the area. Some suggestions in this regard are made in the following sections.

Production of harvestable fish in floating cages has been successful in other parts of Asia and may be highly feasible for the shallow major tanks and new reservoirs in the project area. Some preliminary favorable cage culture trials using tilapia have been conducted by the Colombo University Campus in cooperation with the Ministry of Fisheries. Additional applied research support is needed however to expand these studies. Further trials with cages are advisable using different species and testing the adaptability of the cages to various environments including tanks, rivers, backwaters and villus.

Somewhat similar to cage culture, the use of a fixed pen enclosure constructed of bamboo and nets may also be a very feasible means of raising fish in the project area. Fish pens in several Asian countries have been highly productive with annual yields usually averaging about 2000 kilograms/hectare, and levels of 5000 are not uncommon. This type of aquaculture could contribute significantly to regional fish demands, and a study of the technical and economic feasibility of pen culture is recommended. The study should involve the construction of two one-hectare pens in a coastal lagoon and a major tank, respectively. The Ministry of Fisheries could provide pen construction materials and fingerlings for stocking (milkfish should be the principal species in the lagoon pen), fish culturalists, support staff and equipment. This pilot project could be conducted for at least one full year under the direction of a fisheries biologist familiar with all aspects of pen culture in Asia. The fisheries biologist should direct initial construction and stocking, monitor progress and coordinate harvesting. His total level of effort would be about five person-months, with an estimated cost of about Rs. 800,000.

Other fish farming related activities which require additional research include polyculture and integrated farming. Polyculture involves the raising of a combination of various species in a single system. Some polyculture research has been planned by the Ministry of Fisheries involving tilapia, Chinese carps, Indian carps and common carp. It is recommended that this be extended to include an examination of a combination of the different tilapia species with various predators (snake heads and catfish) to test stunting control. Other species to be considered would include banded etroplus, common labeo and other native species.

Integrated farming practices may be highly amenable to certain areas which could accommodate a combined poultry and fish raising system. This would involve maintaining chicken or duck flocks around ponds or small tanks which are stocked with fish. A similar level of effort pilot study to that suggested for pen culture is recommended to demonstrate the feasibility of an integrated farming system to local communities in the project area. In this case, however, the coordinating government agency should be the Department of Agriculture, with technical support from the Ministry of Fisheries. As in the pen culture study, a specialist in integrated farming systems should assist in the initiation of the project and monitor its progress.

6.6.3 Seasonal Tank Program

Objective

Generally, most aquacultural practices require relatively high level technological inputs, especially suitable training, to be successful. Implementation of these types of fish culture programs will require research and field trials or pilot studies before more broad application can be adopted. A more immediate program to substantially increase project area fish yields using a low level technological approach is needed.

Recommended Actions

An examination of 1979 aerial photography indicates that there are approximately 4,000 hectares of small, seasonal tanks in Systems A, B, C and D. Most of these tanks are less than 10 hectares in surface area. It is proposed that these tanks be annually stocked with fingerlings and serve as rearing areas until harvestable sizes are attained.

The tanks would be stocked near the end of the wet season when water levels are high. Stocking density would be about 5,000 fingerlings per hectare, using a mixture of fish species.

The fish will be harvested using traditional non-motorized canoes, gill nets and seines after about eight or nine months. It may be possible to selectively harvest faster growing individuals at an earlier stage in the rearing period by using large mesh sized nets which would allow smaller fish to escape and continue growing.

The tanks will be upgraded with the addition of nets or screens to prevent escape through the release outlets. Also, some vegetation clearance and bund repair may be necessary. The Government's program to renovate many small tanks in the dry zone would bear much of the costs of dredging where necessary.

In order to provide the roughly 20 million fingerlings needed to annually stock the tanks, it is proposed that a jar hatchery be constructed in a centrally located position in the project area. A new hatchery is recommended, since the facilities necessary to produce the desired fingerlings are fairly substantial. These would include a hatchery building, staff quarters, laboratory, garage and office. There would be six brood stock holding ponds, with a total area of about 3.0 hectares, and about 15 hectares of nursery and rearing runways.

Hatchery operations would be administered through the Inland Fisheries Development Division of the Ministry of Fisheries. There are a number of existing staff members sufficiently trained to conduct the necessary technical operations of the hatchery, although some further training may be needed for assistant aquaculturalists and field assistants. Expatriate supervision may also be required.

The capital costs for this entire seasonal tank program, including the hatchery and tank upgrading, would be approximately Rs. 31 million. Recurrent costs are estimated at roughly Rs. 8 million per annum.

The program would provide employment for over 1,300 fishermen with a net return to them of about Rs. 8,200 annually. Even though cost and yield estimates (from the hatchery and the tanks) are conservative, the internal rate of return for the program would be about 25%.

The program when fully implemented would result in a significant additional fish yield of at least 4,000 tons/year for the project area. Combined with the capture fisheries yields, the inland waters could produce close to 28% of the animal protein requirements for the future population. The net economic benefits resulting from potential yields for future project area waters and from proposed fisheries development projects are Rs. 22.8 million after 1988. There is strong economic justification for a concerted fisheries development program.

6.7 WATER AND SOIL MANAGEMENT - DOWNSTREAM DEVELOPMENT

6.7.1 Effective Water Use for Irrigation

Objective

Improper water usage may cause a number of adverse effects which should be prevented or minimized. Many of these potential problems are associated with an excessive application of irrigation waters. This can cause a loss of soil nutrients due to increased leaching, create potential drainage problems or lead to the formation of pools which become weed infested and/or provide a breeding habitat for mosquito vectors. On the other hand, regulation of water use can produce important beneficial effects.

Recommended Actions

It is recommended that a management program be emphasized which will control and regulate the application of irrigation water effectively. The on farm water management project established by USAID for System H should be extended to the Accelerated Program. The program should include the installation of accurate flow measurement facilities, provide for adequate monitoring and develop administrative capabilities for increased manpower and irrigation training. This type of program should be conducted at the local Government level, with the close coordination of the agricultural extension services.

Some general factors should be taken into consideration regarding the planning of a water management program. It is unlikely that effective water use can be achieved if water is provided to an area before a complete distribution and/or drainage system is developed. Since adequate drainage systems will be required for all four irrigation systems, they should be installed simultaneously with the construction of reservoirs and canals, and not be delayed until after irrigation waters are being delivered.

It should be emphasized that once farmers become accustomed to applying a certain amount of water, even if it is excessive, it will be difficult for them to accept new application rates. Thus, appropriate application rates must be defined for specific areas and clearly understood by the prospective farmers prior to cultivation activities. This can be accomplished through the Irrigation Department and the extension services.

Soil salinity, permeability and perhaps even occasional toxicity problems may occur due to the quality of the irrigation or reuse water in some localized cultivation areas. Yield reductions which result from these kinds of problems can be minimized by altering cultivation or irrigation practices. This could include some of the following:

- Improved drainage of surface and sub-surface waters;
- Use of more salt tolerant crops;
- Improvement of the slope or level of land to allow for more uniform water application;
- Determination of leaching requirements and use of extra water for adequate leaching;
- Alteration of seeding patterns, fertilizer application, etc.;
- Change or blend water supplies; and

- Addition of chemicals such as gypsum, sulphuric acid and sulphur dioxide to the soil or the irrigation water to improve the sodium to calcium ratio.

These recommendations can be implemented on a case by case basis at specific localities.

6.7.2 Erosion Control Practices

Objective

On a large scale, erosion problems in the proposed irrigation system areas should be controlled by the presence of bunded paddy fields. However, potential localized erosion problems should be taken into consideration during land clearing and preparation, along rivers and streams and for those upland areas planned for cultivation.

Recommended Actions

Before major land clearing takes place, the contractors should be given a standard set of procedures to follow to reduce the possible loss of topsoil and to minimize erosion after clearing. Certain conservation practices should be observed and incorporated in land clearing, rough leveling and preliminary cultivation operations to assure protective land use:

- Where bulldozers are used for forest clearance, windrows of tree trunks and brush should be formed along the contours;
- Scraping of topsoil should be minimized;
- Where ripping of heavy tree cover is necessary, a single pass should be made along the contour, and cross ripping should be done to only extricate large stumps;
- The use of heavy desk harrows is recommended for clearing light forest and regrowth. Trash mixed in with the topsoil forms an erosion resistant surface layer and helps to retain the nutrient level of the soil;
- The closure of gulleys should commence at the gulley head and proceed down slope; and
- Plowing and harrowing should be done in long runs along the contour.

On upland areas, contour plantings and terracing should be initiated from the very beginning with properly spaced bunds to retain and distribute the runoff without causing erosion. Final design of bunds in general should carefully consider the types of soils and topography. Major bunds should be oriented along the contour while smaller bunds should be for water distribution only. Bunds constructed of erosion resistant soils can be smaller than the normal design size, but bunds of erodible soils such as reddish brown earths must be larger than usual. Bund support can be enhanced with proper vegetative plantings, such as the small indigenous tree Sisbania sisba, which also provides fuelwood.

Similarly, in order to stabilize the banks of rivers and streams and to provide shade to inhibit mosquito breeding and the growth of water weeds, a 200 meter wide forested strip on both sides of the main river and stream

channels is recommended. This will require a total of 5,100 hectares for System A, 5,600 hectares for System B, 2,800 hectares for System C and 1,500 hectares for System D. The total area is 15,000 hectares. These riverine forests also provide important natural habitats for many endemic wildlife species in the project area. Shelterbelts are also recommended to be planted along roads or canals wherever possible, or along natural ridges where orientation is as nearly as possible at right angles to prevailing winds. The areas slated for land clearing and preparation can be roughly delineated by the borders established in the forest clearing program recommended in a previous section. It is envisioned that site specific canal preparation will be determined by the Mahaweli Authority in conjunction with engineering consultants. However, additional provision should be made to monitor land preparation procedures to ensure adequate soil conservation. This should be done through combined efforts of the Soil Conservation Division of the Department of Agriculture and consultant soil conservation engineers. The level of effort for this monitoring will be dependent upon the clearing schedules which must be finalized by the Mahaweli Authority. In any event, the present Soil Conservation Division is understaffed and ill equipped. It is recommended that this Division be reorganized with new vehicles and equipment and especially with an increase in trained professional staff.

6.7.3 Pesticide Usage and Limiting the Spread of Pests

Objective

All possible methods of pest control should be properly employed to reduce crop damage and simultaneously to limit the potential magnification of toxic pesticides throughout aquatic and terrestrial ecosystems.

Recommended Actions

An integrated pest management approach should be adopted to minimize potential pest problems. This would include surveys of crop damage, pest monitoring and identification, establishment of chemical control needs, expanded research programs and an improvement of extension services.

The best means of minimizing the potentially adverse impacts of pesticides is to develop sound application procedures to ensure their most effective usage. Economic thresholds above which treatment should be initiated should be developed for each of the specific potential insect pests and for each proposed crop, especially for paddy. Correct chemical applications must be made at the appropriate times without excessive use.

The expertise is available in Sri Lanka to determine the most appropriate method of chemical control. The methodology and application rates, etc. have in fact already been developed in many cases. However, further funding is needed to establish updated programs. Most importantly, adequately trained extension workers are required to properly advise the farmers, who in turn should receive as much education as possible regarding pesticide usage prior to settling in the project area. For example, the use of insecticides on an as needed basis should be emphasized instead of application on a strictly fixed schedule.

In addition, the present trend toward increased use of organophosphate and carbamate pesticides in place of organochlorine forms should

be further encouraged by means of public information programs. Similarly, policy and guidelines for handling and usage of pesticides need to be emphasized at the farm level.

In general, the state of the art of pest insect control in Sri Lanka is quite advanced. There is a good knowledge of methods of management of destructive insect pests on the major crops. However, the few highly qualified entomologists and other researchers need more funding support for the provision of a field staff to conduct insect population monitoring and other pest studies to determine economic thresholds. For example, specific data from cultivated portions of the project area should be collected and analyzed to determine potential pest species and allow for the preparation of control measures prior to project implementation.

Chemical controls may also be the best means of limiting rat populations in paddy areas. For the larger wildlife species, especially elephants, the most effective means of minimizing crop damage would be to remove them from the area prior to cultivation. This will not be entirely possible, however, and substantial crop damage may occur in some areas as discussed in previous sections. To offset these losses, it is recommended that a subsidy program be considered for farmers who incur significant economic losses to wildlife encroachment.

6.7.4 Monitoring Programs

Objective

Monitoring in many cases is often the only means whereby soil and water quality problems may be adequately identified in order to permit the formulation of sound mitigating measures for the prevention of potentially serious adverse impacts. Monitoring is essential to locate improper use sources or significant accumulation sites for various agro-chemicals. This will enable the correct application rates or procedures to be enacted.

Recommended Actions

It is recommended that a multi-purpose water and soils monitoring program be implemented for the project area. The collection and analysis of samples should be integrated where possible with various monitoring systems or surveys involving groundwater studies, salinity intrusion, sedimentation, pest management control, irrigation usage, potable and related domestic supplies, protection of aquatic resources, livestock usage and soils.

Salinity Intrusion Survey - It is recommended that a salinity intrusion study be made of the existing tidal range in both the lower Mahaweli Ganga and the Maduru Oya estuaries. The purpose of this study would be to determine the present tidal characteristics as a basis for predicting possible changes in tidal extent due to alteration of river flows. An increased saline intrusion may result in eventual contamination of surrounding groundwater supplies and perhaps cause salinity problems in crop root zones. The study would enable the derivation of a conservation flow level needed to control tidal intrusion.

Data collection for this study should include an analysis of tidal currents, river profiles and cross sections, and salinity concentrations.

Tides should be measured simultaneously at several sections along the rivers as far upstream as possible so that the limit of estuarial conditions can be established. The upstream river flows should be measured at existing or provisional gauging stations during the same period.

The elevations of about 20 cross sections along the rivers will be needed for this program. These cross-sectional elevations can be obtained by means of echosound or other conventional methods.

Salinity measurements should be made every two months throughout a period of one year. Each time, observations should be made for at least two consecutive days. Samples need to be collected in a depth profile along an axis of the lower river beds at high and low water slack periods, for both spring and neap tides, and for various freshwater discharges.

This survey can be conducted under the supervision of an oceanographer/coastal engineer for a period of about four person-months to supervise the initiation of the survey and to develop the analysis of the sampling results. The total funding would amount to about Rs. 800,000. The study can be coordinated through the Coast Conservation Division of the Ministry of Fisheries. The Government should supply vehicles, motorized boats (purchased or rented), fuel and two field assistants. The latter could be selected from graduate students at one of the national universities.

Water Quality Monitoring - Overall, background or baseline samples should be collected for analysis a minimum of twice annually to represent dry and wet seasons at stations selected at both surface and groundwater sites in the project area. Background parameters for analysis should include temperature, pH, dissolved oxygen, major anions and cations, conductivity, nutrient salts, heavy metals, pesticides and coliform bacteria.

As part of the background monitoring, detailed surveys should be made of the existing irrigation systems in the project area. Dry and wet season samples should be collected at irrigation tank inflow and outflow points and in the canal and drainage waters. Existing systems should be selected for sampling which will enable the anticipation of problems related to water usage and return flows in all four proposed systems.

Once new cultivation programs are underway, monitoring should be made of irrigation supplies and return flows to identify potential salinity, sodium or toxicity problems. Specific attention should be given to iron analysis, since iron values have been occasionally very high. These problems can then be ameliorated by changes in various irrigation or management practices to improve crop yields. Also, proper fertilizer and pesticide application rates and techniques can be investigated.

For potable and domestic water supplies, fecal coliform samples should be collected for analysis from a well in each village center on a quarterly basis. The samples must be preserved in cold storage during transport and should be analyzed within 24 hours following collection. Other parameters which should be analyzed on an annual basis for potable supplies include nitrates, organochlorine pesticides and a number of potentially toxic metals.

For the protection of aquatic resources, dry and wet season samples in all surface waters should be analyzed for temperature, pH, dissolved oxygen,

conductivity and pesticides. Pesticide analyses should be extended in the dry season to include flesh samples of fish, shrimp, crabs and fish-eating birds to determine the extent of pesticide accumulation in the tissues of these animals.

The monitoring program should also investigate downstream reservoir releases to determine the need for the installation of reaeration devices. Nutrient analyses should be conducted and productivity evaluated for the proposed reservoirs in order to determine the need for nutrient enrichment of these water bodies.

An initial survey for potentially toxic substances for livestock is recommended. This would also indicate the suitability of various surface waters for wildlife consumption.

Soils Monitoring - The critical parameters for soils monitoring will be salinity and exchangeable sodium percentage of lower river area soils and agricultural areas adjacent to Mahaweli and Maduru Oya channels affected by salt water intrusion. In areas where large amounts of pesticides are being used, drainage waters as well as soils and plant material will need to be monitored for level of contamination. Levels of deficiencies for the major nutrient elements (nitrogen, phosphorous and potassium) will need to be established for new agricultural lands for both upland crops and paddy.

Nutrient deficiency level samples should be taken annually on first priority over each of the present producing land areas starting as soon as possible. These should be repeated when new lands begin to be brought into production and then twice a year, for deficiency level samples, pesticide agricultural products and soil contamination samples.

Laboratory Facilities and Manpower - At present, there is no government agency which is conducting a water quality sampling or monitoring program in the project area. However, a well equipped laboratory with a highly qualified technical staff is presently operating at the Central Agricultural Research Center in Peradeniya. Soils samples are also analyzed here and at the Land Use Division soils laboratory in Colombo.

It is recommended that an integrated water quality and soils monitoring program be directed from the center in Peradeniya for the project area, with backups for soils analysis provided by the Land Use Division in Colombo. This would require an expansion of the existing facilities, the provision of some additional equipment and vehicles and an increase in lab technicians and other staff.

An estimate of additional materials and manpower and respective costs for combined soils and water monitoring would include the following:

Investment Items		Costs (Rs.)
Expansion of facilities		140,000
New equipment		350,000
Vehicles		480,000
	TOTAL Rs.	970,000

Additional Manpower		Annual Salaries
12 Laboratory Technicians		72,000
8 Field Officers		40,000
4 Drivers		18,000
4 Maintenance/Clerical		18,000
	TOTAL	Rs. 148,000

It is proposed that water and soils samples be collected simultaneously in the field by local agricultural extension officers. These samples would be sent to district offices and collected there for transport to Peradeniya. A short training program would be necessary for the extension officers to familarize them with sample collection and preservation procedures.

6.8 HEALTH CARE AND SANITATION PLANNING

6.8.1 Water Supply and Sanitation Facilities

Objective

The provision of an adequate supply of safe, potable water is a major precondition for achieving a healthy community. Statistics and field surveys indicate that diseases attributable to contaminated water supplies are grossly straining the health-care delivery system, suppressing productivity, and decreasing human morale. Access to safe drinking water and the use of basic sanitary facilities are the simplest and most effective means of controlling the incidence and spread of the principal water-borne viral and parasitic diseases including gastroenteritis and diarrhoeal diseases, cholera, typhoid, dysentery and hepatitis.

Recommended Actions

An immediate survey is required to determine the groundwater (for domestic use) availability in the project area and its proximity to proposed settlement schemes. At present, there has been no water demand forecast made in relation to potential yields from acquifers.

As a guideline, a consumption level for rural areas should be approximately 75 litres per day capita. Estimates for planning rural centers should be based upon a level of about 200 litres per person daily.

The scope of work for the required survey could include the following:

- Inventory of the existing wells in the project area;
- Establish acquifer capacity profiles;
- Estimate and map acquifer capacities in relation to proposed settlements;
- Develop forecasts for local community water requirements;
- Recommend well locations; and
- Initiate a groundwater monitoring program.

This project could be coordinated by the Ministry of Local Government, Housing and Construction or the National Water Supply and Drainage Board. Settlement information can be provided by the Mahaweli Authority. A sufficiently detailed survey would take about one year and could commence as soon as possible. The survey would be coordinated by a consultant team comprised of a hydrogeologist and a sanitary engineer with a combined level of effort of 20 person-months. The Government could supply a survey crew, vehicles, office and field equipment and field accommodations. The study should cost about Rs. 3.2 million.

It is recommended that standpipes be used to supply domestic use water in commercial or government centers, while adequately protected wells be constructed in the more rural hamlets and villages. The wells should have the following features:

- An impervious apron with drains which exclude surface water from entering the well;
- A concrete watertight seal for three meters below ground level;

- Provision of pumps or rope and bucket that limit user accessibility and contact with actual well water; and
- Provision of chlorination as needed when a disease focus is identified locally.

Wells should be located in areas which would prevent potential drainage from liquid wastes and privies. Actual well sites should be selected based upon availability of groundwater and by coordinating with local community needs. At least one well for every five families should be installed; one for each family would in fact be preferable. The capital costs of providing water supplies for the Accelerated Program are roughly estimated as follows:

Rural Areas (wells) at Rs. 60/person	30 million
Rural Centers (standpipes) at Rs. 550/person	275 million
TOTAL Rs.	305 million

Recurrent operations and maintenance costs plus contingencies would be about 10% to 20% of the total capital cost.

Similarly, every village house and commercial establishment should be provided with sanitary facilities for the disposal of human wastes. In hamlets, the general latrine type which would be recommended would include the following features:

- A housing structure;
- A concrete floor slab;
- Tamped earth mounded around the privy for drainage and fly seal;
- Impervious floor base to prevent larvae emergence;
- A pit lined with cut tree limbs and soil cement base; and
- A pit volume sufficient to last four or five years.

The latrines should be located preferably below water supply drainage catchments. They should be more than six meters from dwellings and more than 30 from wells. Roughly, each latrine would have a capital cost of about Rs. 1,000; the total cost for the project area would consequently be around Rs. 175 million.

Suitable drinking water supplies and sanitary facilities should also be provided for both temporary and permanent construction camps in the project area. Wells can be quickly dug for adequate water supplies. Temporary latrines should be at least three meters deep and provided with hand washing facilities.

6.8.2 Control of Malaria and Mosquito Vectors

Objective

The Accelerated Program has a high potential for increasing the incidence of malaria and other diseases carried by mosquito vectors. This can be minimized with modification to the present control program and the implementation of water level management procedures.

Recommended Actions

The present Sri Lankan Anti-Malaria Campaign is a highly effective organization which is well administered and has a competent and energetic

technical staff. The chemical spraying program and related malaria control activities should be well suited to the needs of the Accelerated Program. A few general recommendations can be made concerning the overall campaign. Firstly, the goals of the present time-limited control program should be reformulated for indefinite continuance. Further, in order to conserve the effectiveness of malathion, a new spray strategy should be devised that focuses upon threatened outbreaks and upon regions where transmission is readily broken.

The existing malaria surveillance system, upon which control and withdrawal of spraying is based, should be modified to develop parasitological monitoring of blood samples from infants between two months and three years of age. Young children do not consume sufficient anti-malarials to mask malaria and thus escape detection as do older people. Also, a different method of studying blood samples should be considered to limit the effects of dirt contamination.

From a logistics standpoint, it is recommended that the Anti-Malaria Campaign develop solutions to several pressing problems, especially prior to a major expansion into the Accelerated Program area. These include:

- Provision of additional vehicles and motorcycles;
- Improvement of transport facilities and procurement of spare parts;
- Reorganization of storage facilities;
- Proper disposal of malathion and containers; and
- Improvement of sprayer nozzles and provision of proper hose extensions.

Research needs of the campaign include the following:

- Ecological and life history data of mosquito vectors;
- Longevity and transmission effectiveness of potential vectors; and
- Insecticide susceptibility of the vectors especially with respect to the degree of resistance to malathion.

With the threatened loss of anti-malaria chemicals, water management policies should be formulated to minimize breeding habitats for mosquitoes. The present monitoring of pool formation in stream beds and subsequent larvacide application by the campaign should be extended to the Accelerated Program area.

Flow regulations in river beds may be a logical technique for flushing out isolated pools to prevent a rapid increase in mosquito populations. In order to accomplish this, a minimum flow depth of 0.2 meters is required within the river channel. For the Mahaweli Ganga, flushing once a week for a two hour period would require a volume of 172,800 cubic meters per month. There should be more than sufficient reservoir storage in most years to permit this weekly flushing. Alternatively, a conservation flow of 10 cumecs as suggested by the Hydrology Division of the Irrigation Department would also limit pool formation, while simultaneously conserving the riverine habitat for aquatic life.

Other means of limiting the formation of small, shallow pools should also be implemented throughout the project area. Reservoir basins could be prepared enabling all marginal ponds or depressions to drain into the main lake during drawdown. Irrigation canals and drains should be designed to facilitate high flow velocities and prevent pooling, but at the same time to

limit overflowing and seepage accumulation. Also, all borrow pits, abandoned ditches or wells and other unused excavations should be filled. Finally, villages and other rural centers should be located away from rivers and lakes, and on the leeward side of prevailing winds. This will limit areas of mosquitoes to human contacts. A distance of 1.5 kilometers from potential breeding areas is recommended where possible.

6.8.3 Control of Other Diseases and Health Hazards

Objective

A number of preventative measures should be considered to limit various disease and related problems in the project area.

Recommended Actions

Plans to extend the Anti-Filariasis Campaign to include the project area should be re-evaluated, taking into consideration the actual effectiveness of the program and the need for filariasis control in the region. The present program may well not be needed in the Accelerated Program area.

The effect of residual insecticides upon bed bugs should be further investigated. The possible resistance to pesticide application should interfere with anti-malaria activities.

It is recommended that at least all construction workers be immunized against tetanus prior to the commencement of work. Polio immunizations should also be given. Rabies serum should be kept in stock along with snake bit serum throughout the project area. In addition, anti-venom for cobras, kraits and Russell's vipers should be made locally available.

6.8.4 Comprehensive Health Planning

Objective

At present, sufficient priority regarding the provision of health care facilities or preventative health programs is needed in the overall planning for the Accelerated Program. A comprehensive planning approach is needed to integrate the development and operations of health care services for the project area.

Recommended Actions

A basis for health care and related facilities planning was established in a set of recent proposals by the Ministry of Health concerning the Accelerated Program. These included general recommendations for the provision of water supplies and sanitation, medical screening of settlers, development of monitoring programs and the upgrading of the health management system. In addition, specific recommendations were made for the provision of health care services and facilities as follows:

- A midwife and two or three volunteer health workers recruited from among the settlers serving every five hamlets or 3,000 population;
- A Central Dispensary serving every five villages or 15,000 population;

- A Peripheral Unit with 48 beds, clinic room, and ambulance to serve 60 to 70,000;
- A District Hospital with 90 beds, ambulance, and jeep, for every block of 100,000 to 150,000 people;
- Referral facilities; and
- Special facilities, including Ayurvedic Dispensaries and one Ayurvedic Hospital.

The development phasing for these specific facilities was projected for the next five years, and general locations were identified for the installation of the facilities. Details at this level were provided for Systems A, B and C. Comparable planning for System D is still required.

In general, the Ministry of Health's proposals are endorsed in that they provide an initial framework from which comprehensive health planning can be evolved for future implementation.

In addition, an essential feature of broad health planning is the development of adequate surveillance systems. A coordinated monitoring program should be devised with respect to existing manpower and equipment, with one of the major objectives being to significantly increase the speed of reporting and for distributing survey results. A regular system for collecting sera from project area residents should be instituted. These samples would serve as a basic surveillance system for various viral and rickettsial diseases in addition to malaria. In particular, the screen should include Japanese encephalitis virus, dengue, scrub typhus and epidemic typhus. This type of integrated surveillance would be very beneficial in conserving manpower and increasing the efficient use of equipment. It plus the existing Anti-Malaria Campaign surveillance system and the UNEP Health Effects Monitoring program should be combined as a single health monitoring program for the comprehensive health plan.

6.9 SOCIAL CONSIDERATIONS

6.9.1 Regional Planning and Socioeconomic Studies

Objective

The planning for the Accelerated Mahaweli Development Program has, perhaps by necessity, been predominantly oriented towards designing the physical aspects of the Program such as the dams and irrigation systems. Although the Mahaweli Economic Agency (MEA) has responsibility for settlement issues and has established a precedent for assigning separate priority to social concerns, the major concern of the MEA is agricultural production. In order to firmly establish the importance of social concerns for the success of the program, to promote a regional perspective for social planning and to provide the capabilities for regional and socioeconomic studies, it is recommended that the MEA set up a Regional Planning and Socioeconomic Studies Unit.

Recommended Actions

The staff of the Regional Planning and Socioeconomic Studies Unit should be comprised of highly qualified specialists in the fields of regional and urban planning, natural resources and development economics, resettlement planning, social science and demography. The Director of the unit should have sufficient status so that he can work effectively with other officers of the MEA, the Mahaweli Development Board and the Land Use Division in order to contribute to the physical planning aspects and in order to be able to implement social programs.

One of the first tasks of this planning unit should be to design the settler orientation program which is recommended in the following section. The planning unit should devise a method of monitoring the results of the program to insure that it is successfully carried out, and that it is responsive to the needs of the settlers. The orientation program will be a useful way of obtaining socioeconomic information about the settlers, their backgrounds, values and needs.

At the same time, the planning unit could be reviewing existing plans for housing, schools, health facilities and infrastructure for the settlements. It is necessary to carefully scrutinize these plans from a social science viewpoint and also with the needs of the settlers in mind. If provisions are not adequate or poorly designed, the planning unit will have to work quickly to incorporate improved designs. Of special concern are potable water supply, latrines, adequate woodlots and grazing areas close to the settlements and the availability of infrastructure. Details of requirements for these concerns are specified in the recommendations for forestry, public health and land use planning. Not only the design but the timing of construction of settlements and infrastructure is important so that facilities will be ready when the settlers move into the hamlets and villages (see also Control Plan for Clearing Operations).

From a social viewpoint a critical issue of development is that of social integration of the settlements. In order to confront this sensitive issue before it produces conflicts, the planning unit should review the current plans for dealing with social integration, clearly define the problem and identify alternative methods to minimize conflicts engendered by the project. At this

stage, it will be necessary to work closely with the Government to resolve the issues and to implement the selected method of dealing with the social integration issue.

For long term regional planning it is essential that the planning unit accurately determine and map the population of the region (including urban areas on the periphery of the project area), location of hamlets, villages and urban areas, population trends, ethnic distribution, existing land use, employment and unemployment, economic base and existing infrastructure. In conjunction with other departments, the unit should then develop projections of population, land use, employment, infrastructure and natural resource requirements.

With these trends the regional planning unit can identify future problem areas such as inadequate or misplaced infrastructure; shortfalls in fuelwood, grazing lands, agricultural inputs and labor; and unemployment. The unit will then be able to work with other agencies to correct these problems before they become critical.

A number of special studies are required in order to adequately provide for the social needs of the Accelerated Mahaweli Development Program. A partial list is presented below:

- A study of the relationship between urban areas around the project area and the villages within the project area to determine their relationships in terms of employment, provision of agricultural inputs and outputs and provision of services, so that the needs of the whole region can be integrated and solved on a regional basis;
- A study of the fishermen, their status, housing and infrastructure needs so that provision can be made for their welfare. (It is essential to realize that the fishermen will produce an important segment of the protein requirements of the region, and therefore their welfare is not only important from a social viewpoint, but also as a crucial part of dietary needs);
- In a similar fashion, a study of agricultural laborers, their population and needs so that adequate provision can be made for this segment of the labor force; and
- A study of alternative development schemes for the Kotmale and Victoria reservoir areas which will become a significant tourist attraction if it is carefully planned.

In addition to these special studies, the planning unit should carry out a series of monitoring programs in order to keep Program management aware of the success of implementing the settlements and agricultural programs, and to identify problem areas. Of primary importance for monitoring are:

- Initial settlement problems, conflicts, deficiencies, etc.;
- Social integration problems;
- Quality of life (i.e. using class cultural indicators as defined by the United Nations Research Institute for Social Development);
- Stages of growth as indicated for example by the ratio of farm to non-farm labor, supply and demand for agricultural lands, etc.; and
- Indebtedness of settlers, reasons for indebtedness.

In conjunction with these monitoring programs the planning unit should document changes in population, ethnic distribution, employment and infrastructure.

6.9.2 Settler Orientation Program

Objective

Adopting to a new way of life, in a strange location with a more intensive agriculture will generate a great deal of stress among the settlers, especially since it is apparent that they have little knowledge of the program or its implications for their lives. In order to minimize this stress and also to increase the chances of a successful implementation of the resettlement, it is recommended that the orientation program being planned by the Mahaweli Economic Agency (MEA) be expanded substantially and that it be carefully designed as to its contents, staffing and timing.

Recommended Actions

It is recommended that a complete orientation program be developed including the formulation of an appropriate curricula, scheduling for initial and subsequent programs, the training of suitable teaching staffs, and the preparation of specific materials such as visual aids for presentation as well as the preparation of specific pamphlets, leaflets, etc. in appropriate languages for distribution to the settlers.

Within the MEA, the Regional Planning and Socioeconomic Studies Unit should be responsible for designing the orientation program and monitoring the results so that the program can be improved as the Accelerated Program progresses. Since resettlement is a specialized issue of social planning, it is recommended that the MEA hire a resettlement expert for the regional planning unit or at least retain the services of a consultant to aid in the design of the orientation program. However, it is important for the MEA regional planning staff to undertake the major portion of the design work.

A first task in developing an orientation program is to determine the schedule and extent of the implementation of blocks of new or improved irrigation and to identify groups of settlers. If blocks of 3,000 to 5,000 hectares of irrigated lands are brought onto line at one time, then from 3,000 to 5,000 families would have to be settled within a short period of time. If there are 300 to 500 families in a village, this translates to six to ten villages. If a minimum of one community development worker teaches one village, then from six to ten community development workers will be required along with a coordinator and support staff.

The orientation program should be designed as a series of short courses lasting one or two weeks and presented two to three months prior to resettlement. Each session should be short with a clear objective. A suggested series of topics is shown below:

- Introduction and overview of the orientation program to acquaint the settlers with the community development worker, what they will learn and an overview of the Accelerated Mahaweli Development Program;

- Familiarization with the location of the villages, the layout of the village, water supply, infrastructure, fields and discussion of what items the Government will supply, what the settlers should bring with them, and what they will have to build;
- Overview of what life will be like in the village covering items such as the number of people in the village, the type and intensity of farming, the schools and health facilities, village government, availability of fuelwood, grazing and stores, and emphasizing aspects of their life which will be different;
- Public health issues concerning the importance of public health due to more crowded conditions and therefore the need for latrines, maintaining clean water supplies, disease control, discussion of poisonous snakes and methods of treating snake bites;
- Introduction to improved agricultural practices, the implications of more intensive agriculture, efficient water management, soil conservation, care and use of fuelwood lots and grazing areas and pest management (further courses on these subjects should be carried out by an agricultural extension agent as recommended below);
- An introductory discussion of credit and family budgeting; and
- A discussion of services that will be available after they are settled such as agriculture extension, public health education and other Government services and how to obtain the services.

The development of this program would require specific expertise in orientation and educational training and would probably take about one year or more to properly complete. However, initial training and orientation for the settlers could begin as soon as specific modules of the program are developed. The cost of developing the program would probably be on the order of Rs. 3.2 million.

6.9.3 Agricultural Extension

Objective

In order to implement agricultural practices necessary for the intensive cultivation of paddy and upland crops as well as to supply the credit required to minimize indebtedness, it is recommended that the agricultural extension program be expanded. The training of more than 80,000 farmers is an extensive undertaking for which the present agricultural extension program is inadequate.

Recommended Actions

A joint effort of the MEA and the Ministry of Agriculture is required to expand the extension program to an ultimate size of approximately 40 agents, or roughly one for every township (i.e. 2,000 families). The staff can be established on a phased basis to coincide with the implementation of blocks of irrigated areas. In addition, an expanded extension administration and support staff will be needed as well as sufficient vehicles, teaching materials, etc. The recent recommendation to train extension workers abroad is endorsed and should be implemented quickly so that agents will acquire additional training before the Accelerated Program reaches production.

The primary task of the agents will be to give instruction concerning:

- Effective water use management and problems involved with ineffective use of water;
- Soil conservation practices;
- Management of woodlots;
- Management of grazing lands to prevent overgrazing;
- Pest management and use of pesticides; and
- Effective agricultural practices for increased production.

At the same time, the agents should monitor agricultural conditions such as conflicts with wildlife, excessive crop damage by pests and signs of soil salinity and nutrient deficiencies. In this way, the Ministry and the MEA will be aware of difficulties in production before they become critical. The agents should also ensure that soil testing and other monitoring programs are being carried out and their results used to correct deficiencies (see recommendations on Water and Soil Management).

Current studies have shown that lack of credit during the first five years of settlement is a major stumbling block for the development of a solvent group of small farmers. Therefore the extension agent for each township, in conjunction with the MEA and its Regional Planning and Socioeconomic Studies Unit which monitors credit, should make available credit to the settlers. The MEA should establish criteria for extension of credit and a program of accounting for receipt and disposal of funds.

6.10 LAND USE PLANNING

6.10.1 Recommended Land Use Plan

Objective

The Accelerated Mahaweli Development Program is the major agricultural development of Sri Lanka and its aims are to enable Sri Lanka to become self-sufficient in rice production as well as other agricultural products and to create employment. The Government is seeking to obtain other objectives such as the conservation of wildlife and forest areas which at times appear to be in conflict with the objectives of agricultural development which entails clearing of forests and destruction of wildlife habitat. The assessment of the environmental impacts of the Accelerated Program and a careful consideration of the land use conflicts has led to an outline of a recommended land use plan for the four irrigation systems and their environs. The objective of the recommended land use scheme is to allow a maximum of agricultural development with a minimal elimination of high-quality wildlife habitat areas and without excessive destruction of forest areas which are essential not only from a conservation viewpoint but also for timber and fuelwood supplies.

Recommended Actions

At the back of this report is a series of plates and overlays showing the existing land use, land classification and recommended land use(s) for each of the four proposed irrigation systems. The recommendations for land use were derived from a study of existing land use and land classification maps developed in this study at a scale of 1:50,000 (see MAP ADDENDUM). The areas proposed for irrigation were studied in relation to potential conflicts with high-quality wildlife habitats or valuable forest areas. The recommended land use plan, then, was derived by trying to maximize the amount of irrigable land for development without a significant destruction of high-quality habitat or forest areas and also considering the suitability of land for agriculture, settlements and other uses. The resulting recommendations are a compromise between the objectives of future development and conservation; forest and wildlife habitat are recommended for development, but on the other hand other areas, some of which surround the project area have been recommended in this report for National Parks, as explained above in the wildlife recommendations.

The area shown as new cropland in the northeastern part of System A is the segment called A/D and is discussed below under the recommended land use plan for System D. The area between segment A/D and System A new cropland is proposed for grazing, since this area is a suitable location and of sufficient size for the large breeding herds which are required to maintain cattle production.

Additional grazing and/or forest area is set aside to the east of Somawathie National Park. This area is Class 3 or marginal land for agriculture and would be most productive as grazing land and forest. Appropriate portions of this area could serve as expansion areas for the National Park. Also, the area to the west of the Somawathie is recommended as a possible extension of Somawathie National Park.

The recommended land use plan for System B involves a network comprised of a temporary jungle corridor, riverine forest and a conservation park.

It is recommended that the Nelugala Corridor be temporarily maintained, and suitable wet season grazing areas be identified before converting it for agricultural use. The Conservation Park extends along the floodplain of the Mahaweli Ganga to protect that significant wildlife habitat and to minimize erosion from areas close to the river. Not shown on the map is a band 200 meters wide on either side of the Maduru Oya of riverine forest which serves to protect the areas close to the river. Details of costs and benefits as they pertain to these land uses are discussed above under wildlife recommendations.

To maintain as much as possible of the existing forest in the northern part of System B, the area is recommended for forest and cropland; cropland should only be located on arable portions of land as shown on the land classification overlay. The area surrounding the southern extension of the Nelugala Corridor is recommended for forest only because these lands are predominantly non-arable. The remaining areas of System B are proposed for cropland and settlement, which is consistent with existing land use and the consultant's feasibility plan.

The northern area of System C is proposed as cropland and forest, forest in the non-arable areas and cropland for the arable areas. The mid portion of System C is recommended as cropland and settlements which is consistent with the feasibility report. The lower portion is proposed for cropland on the arable portions, with reforestation of the non-arable lands. It is recommended that the riverine forests and rocky outcrops bordering the Mahaweli Ganga be included with the Wasgomuwa National Park to the extent possible.

The plan for System D is to develop new cropland as planned in the feasibility report. Almost the entire area of System D is suggested for cropland, except a narrow band which could provide a wildlife linkage between the Somawathie and Hurulu National Parks.

6.10.2 Detailed Mapping of Non-Arable Lands and Associated Studies

Objective

Part of the difficulty of carrying out land use planning in the project area is the lack of soils data or existing land use and topographic maps at a uniform scale and based upon uniform criteria. Furthermore, areas designated as Class 6 or non-arable have not been mapped as to their suitability for forest, woodlot, grazing land or settlements. This lack of uniformity and detail makes it difficult to identify possible shortages of woodlot and grazing areas around potential settlement sites. The objective of the detailed mapping is to provide a basis for rational planning of settlement areas and their needs, such as woodlots and grazing areas. The objective of completing uniform mapping within the project area and for any future feasibility studies is to enable planners to make consistent decisions on the suitability of areas for development, to be able to make uniform comparisons of economic feasibility based on land classification and to expedite land use planning by having a uniform set of maps.

Recommended Actions

As explained in detail in TOPIC REPORT B: LAND USE AND SOILS, it is recommended that a set of uniform scales be defined so that maps of any theme (i.e. soils, topography, land classification) can be used without having to account for different scales. It is further recommended that the soils classifications be converted to the scheme defined in Soil Taxonomy. This conversion is currently being undertaken by the Land Use Division. It is recommended that land classification studies use the methodology of the U.S. Bureau of Reclamation as modified and defined in TOPIC REPORT B.

For the detailed mapping of non-arable lands, the methodology employed by the U.S. Soil Conservation Service which designated non-arable areas as Classes V through VIII should be used to prepare detailed maps of the project area. This methodology is also explained in detail in TOPIC REPORT B.

Having mapped all of the non-arable areas as to their suitability for grazing, forest and settlements, there are two tasks which should be carried out simultaneously and with constant coordination; a grazing feasibility study and the establishment of fuelwood plantations (see Forestry Recommendations). Both studies would require information concerning the location and population of existing villages and the most up-to-date estimate of the proposed location of settlements. This data would be plotted on overlays of the detailed Class 6 maps. The grazing study then would identify suitable areas for grazing. Special attention would be given to the villu areas and estimates should be made on a villu by villu basis concerning the impact of reduced river flow on the size of the respective villus. The mapping of grazing areas would be carried out in conjunction with the woodlot plantation study in order to resolve potential conflicts.

After mapping the extent of grazing areas, grazing capacities would be calculated for the areas, taking into consideration the changes in villu carrying capacity and duration of grazing. This information on capacity as well as village and settlement locations and information of village requirements for cattle, will provide the basis for identifying areas where there are deficiencies in grazing capacities. Alternative locations for settlements or alternative grazing areas can then be recommended. The results of the grazing study should be incorporated into the development plans and the grazing areas monitored by agricultural extension agents to ensure that the grazing plan is implemented.

The level of effort for the detailed mapping of non-arable lands of the Accelerated Program area would be approximately 12 person-months for a land use planner and four person-months for a soil scientist. Assuming materials, transportation and support staff are provided by the Government, the cost of detailed mapping would be roughly Rs. 2.6 million.

The grazing study would require approximately eight person-months for a livestock management expert/range scientist. The added cost of this study would be about Rs. 1.3 million.

7. IMPLEMENTATION PRIORITY FOR RECOMMENDED ACTIONS

The recommended actions, studies and programs are grouped into four categories of priority for implementation as shown below. The most urgent actions or programs are listed in the FIRST PRIORITY category. Because of irrevocable actions already underway (e.g. clearing by the State Timber Corporation) or because of the long lead times required, the programs in the first priority group should be implemented between September and December, 1980. An immediate decision should be made concerning the overall land use for the project area (i.e. designation of areas for wildlife reserves, forests, croplands, etc.). The other FIRST PRIORITY programs entail the control of clearing operations and the establishment of critical planning units such as health planning and regional and socioeconomic planning.

The second category, or SECOND PRIORITY programs and studies, although important, are not contingent upon irrevocable outside actions and therefore can be implemented anytime between September 1980 and July 1981. However, the programs and planning studies in this group must be well underway or completed prior to settlement and implementation of new irrigation projects, because the results of these plans are critical to the success of the Accelerated Mahaweli Development Program. In this group are programs for standardization of mapping, detailed mapping of non-arable lands, settlement and infrastructure planning, fuelwood and grazing plans, water supply and sanitation facilities, fisheries development, park design and the expansion of the settler orientation program. The detailed mapping of non-arable lands is a critical study, since these maps are required to carry out settlement, fuelwood and grazing plans.

Programs which do not need to be implemented until just prior to settlement or the initiation of new irrigation schemes comprise a third level of priority. Among these are the implementation of the expanded settler orientation program, agricultural extension (including credit programs), control of malaria and other diseases, pesticide usage and control of spread of pests, monitoring programs and some related regional planning studies.

The final group, although not of the lowest priority, include large scale programs or actions which because of their national scope or general nature require long term implementation scenarios. However, these actions should be initiated within the next year so that their overall planning efforts can have an impact on long term developments.

Details of these recommended actions as well as their costs and benefits where appropriate are given in the preceeding Recommended Actions section. The prioritized categories are listed below.

FIRST PRIORITY

To Be Implemented Between September and December, 1980

1. Act on Land Use Recommendations to Designate Areas for Specific Land Use (i.e. wildlife reserves, forest croplands);

2. Control Plan for Clearing;

3. Soil Conservation Measures for Upper Catchment and Downstream Areas (e.g. forest plantings, crop diversification, engineering works, clearing procedures);

4. Clearing Plan for Reservoirs for Fisheries Development;

5. Health Planning Unit to Initiate Comprehensive Health Planning;

6. Groundwater Availability Survey (for domestic use);

7. Regional Planning and Socioeconomic Studies Unit; and

8. Settler Orientation Program.

SECOND PRIORITY

To Be Implemented Between September 1980 and July 1981

1. Standardization of Mapping (standard scales for soils, topography, land use and land classification maps; standard land classification methodology of USBR);

2. Detailed Mapping of Non-Arable (Class 6) Land for Forest, Grazing and Settlement Planning (see studies below);

3. Coordination of Settlement and Infrastructure Planning by Regional Planning and Socioeconomic Studies Unit (see studies below);

4. Plan and Establish Fuelwood Plantations in Conjunction with Settlement Planning (requires detailed mapping of non-arable lands);

5. Map Grazing Areas and Establish Grazing Management Plan in Conjunction with Settlement and Fuelwood Planning (requires detailed mapping of non-arable lands);

6. Collect Baseline Data for Soil and Water Quality Monitoring Program;

7. Domestic Water Supply and Sanitation Facilities (in conjunction with settlement planning);

8. Seasonal Tank Program;

9. Plan for Fisheries Development;

10. Design and Expand Settler Orientation Program;

11. Park Design Planning Study; and

12. Redevelopment Institution for Master Planning in the Upper Catchment.

PROGRAMS OR ACTIONS TO BE IMPLEMENTED
JUST PRIOR TO SETTLEMENT

1. Agricultural Extension (including credit);

2. Water Supply and Sanitation Facilities;

3. Control of Malaria and Other Diseases;

4. Control of Pesticide Usage and Limitation of the Spread of Pests;

5. Program for Removal of Aquatic Vegetation;

6. Utilization of Aquatic Vegetation;

7. Continued Soil, Groundwater and Water Quality Monitoring; and

8. Regional Planning Studies and Socioeconomic Monitoring (e.g. indebtedness).

BROAD-SCALE PROGRAMS OR ACTIONS
TO BE IMPLEMENTED WITHIN THE NEXT YEAR

1. Ministry of Natural Resources;

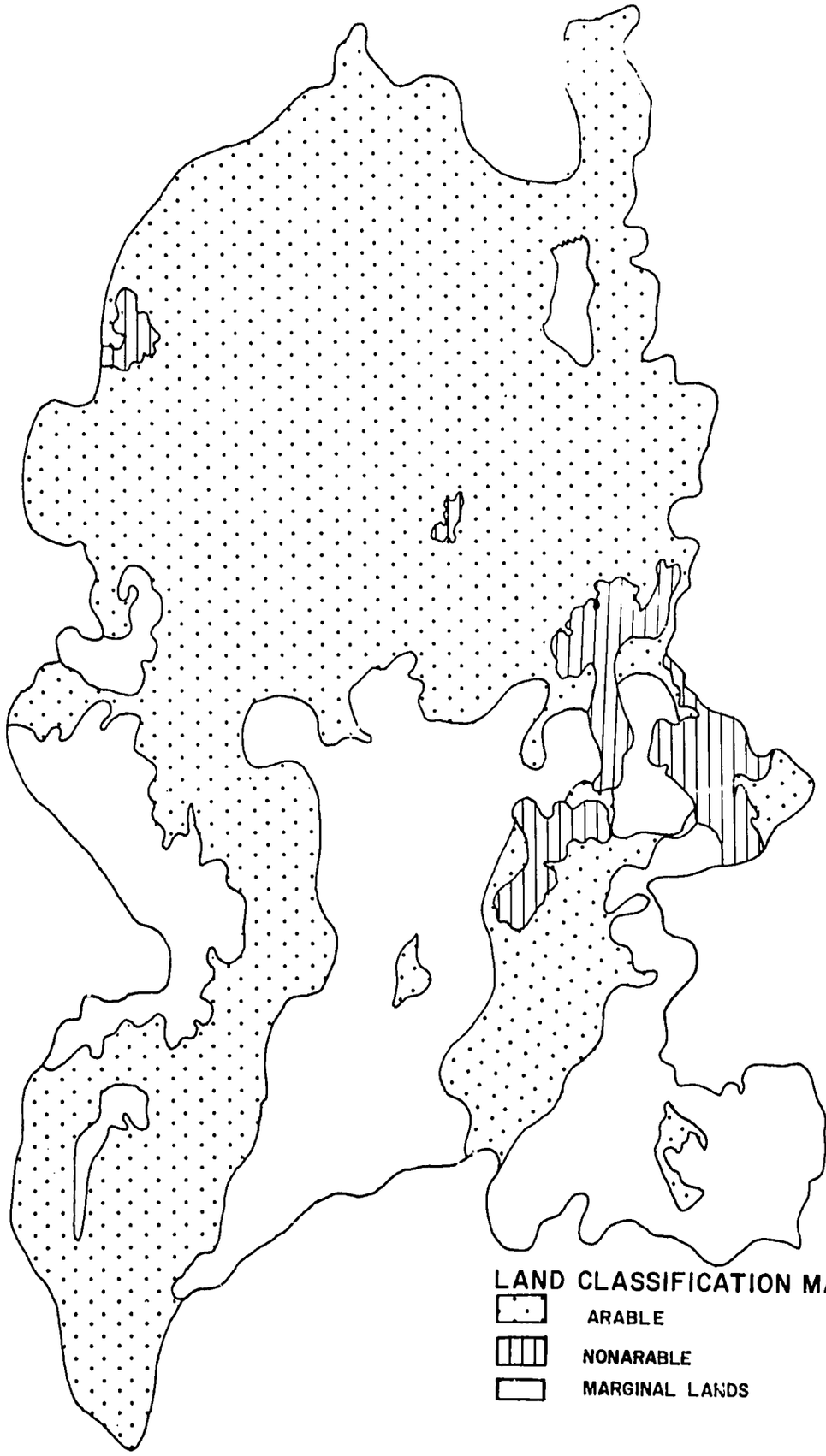
2. National Forestry Programs;

3. National Wildlife Programs;

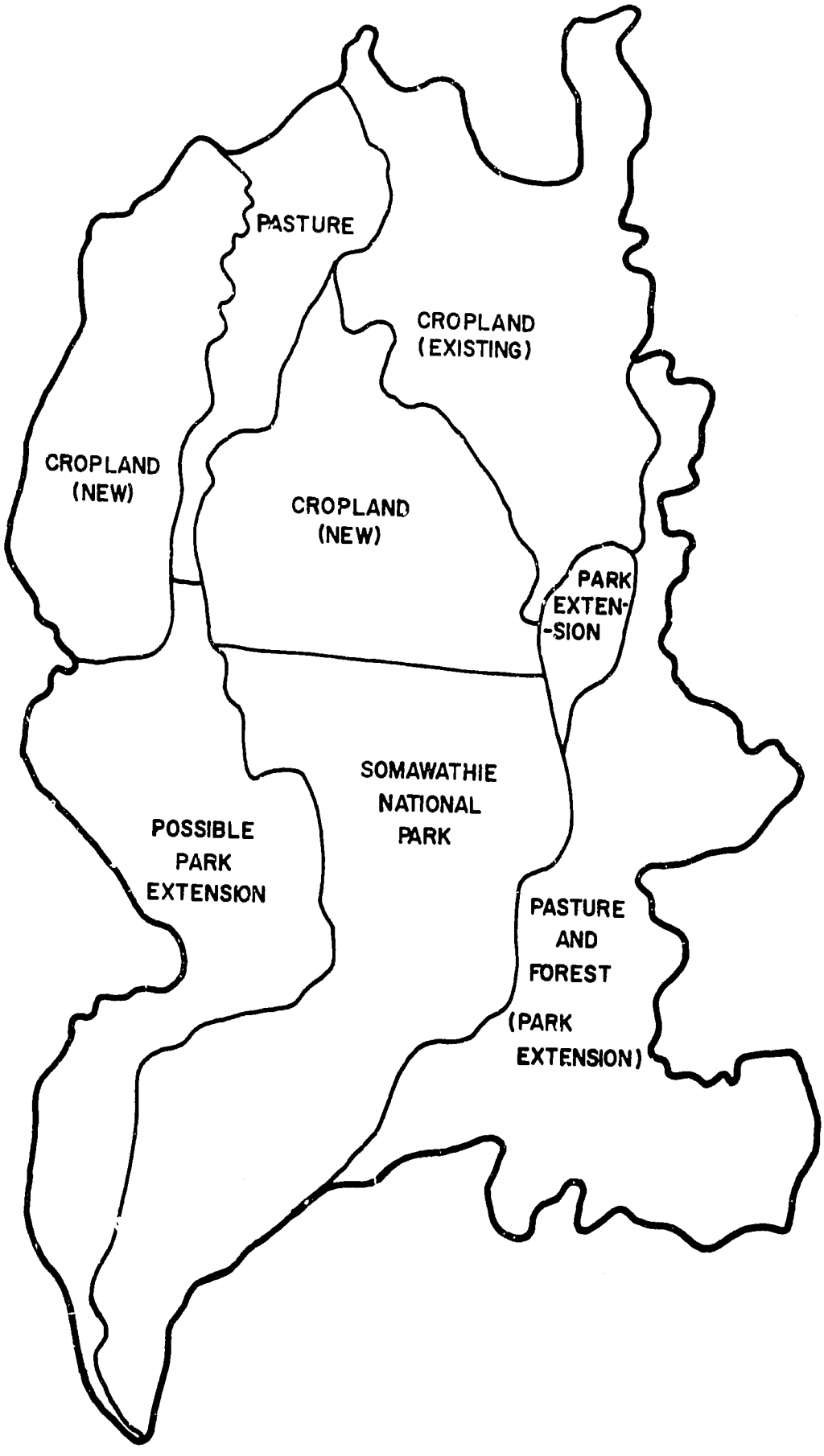
4. Comprehensive Health Planning;

5. Development of Aquaculture; and

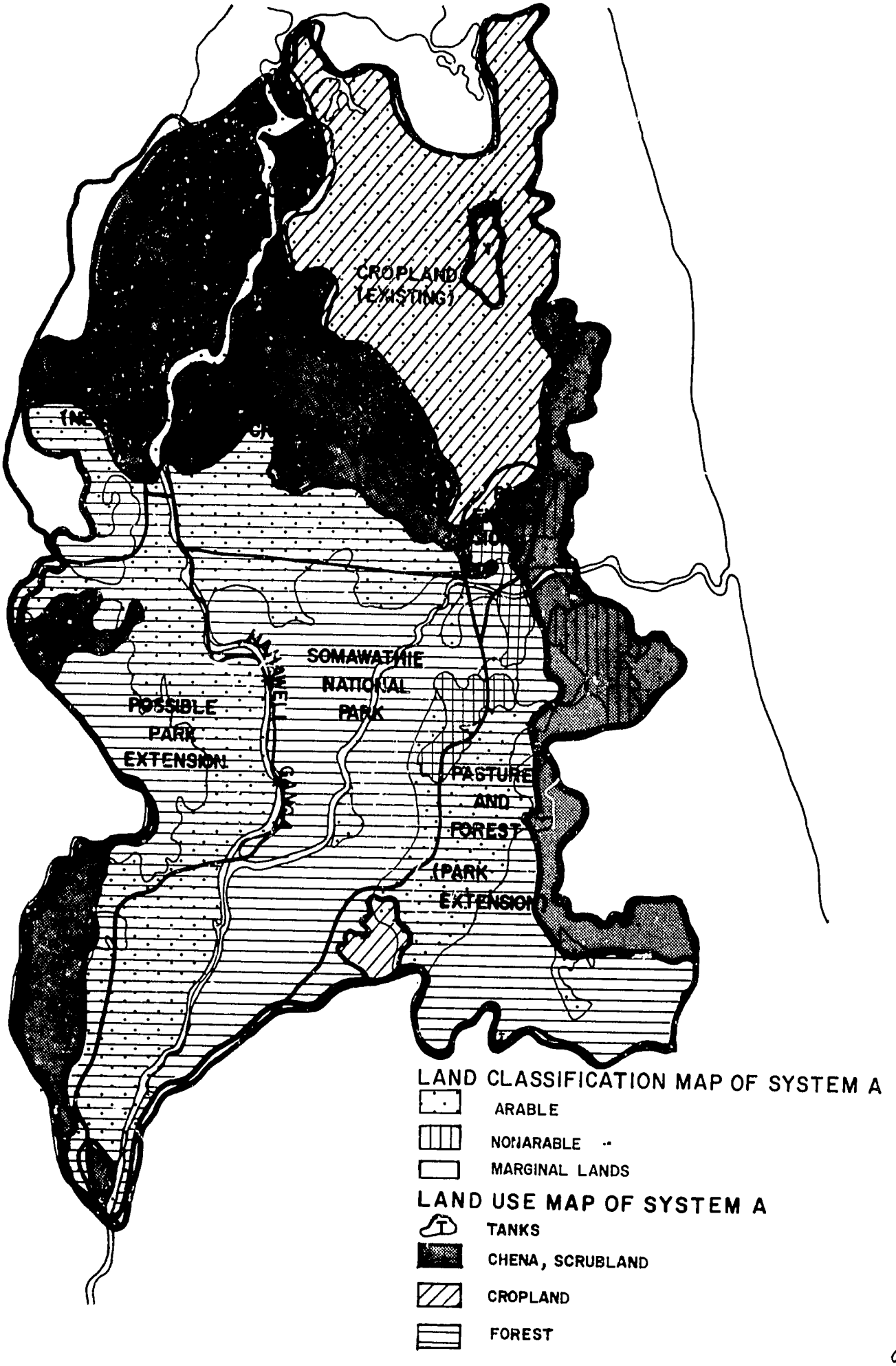
6. Conservation of Wetlands.

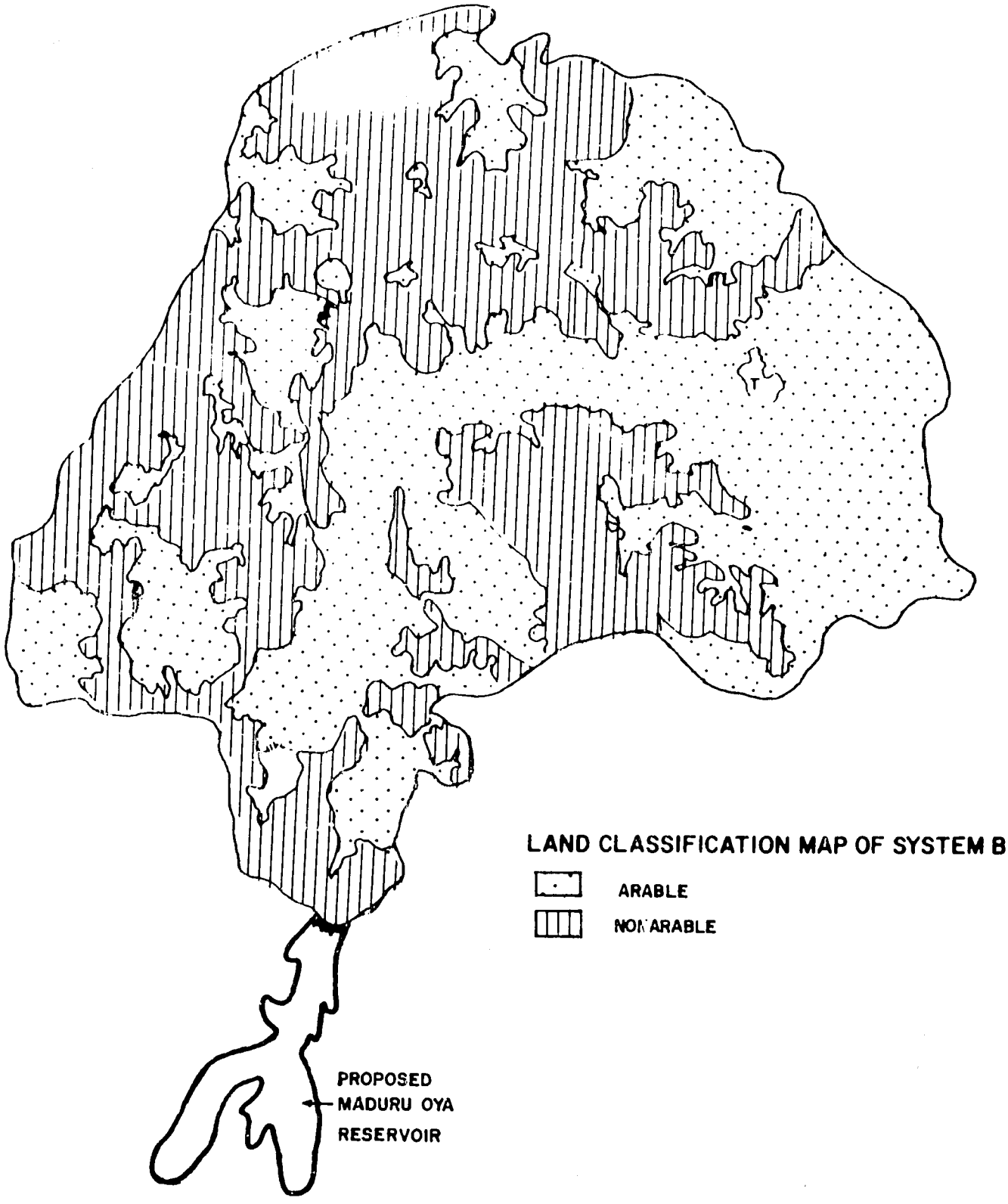

LAND CLASSIFICATION MAP OF SYSTEM A
ARABLE
NONARABLE
MARGINAL LANDS

RECOMMENDED LAND USE MAP OF SYSTEM A

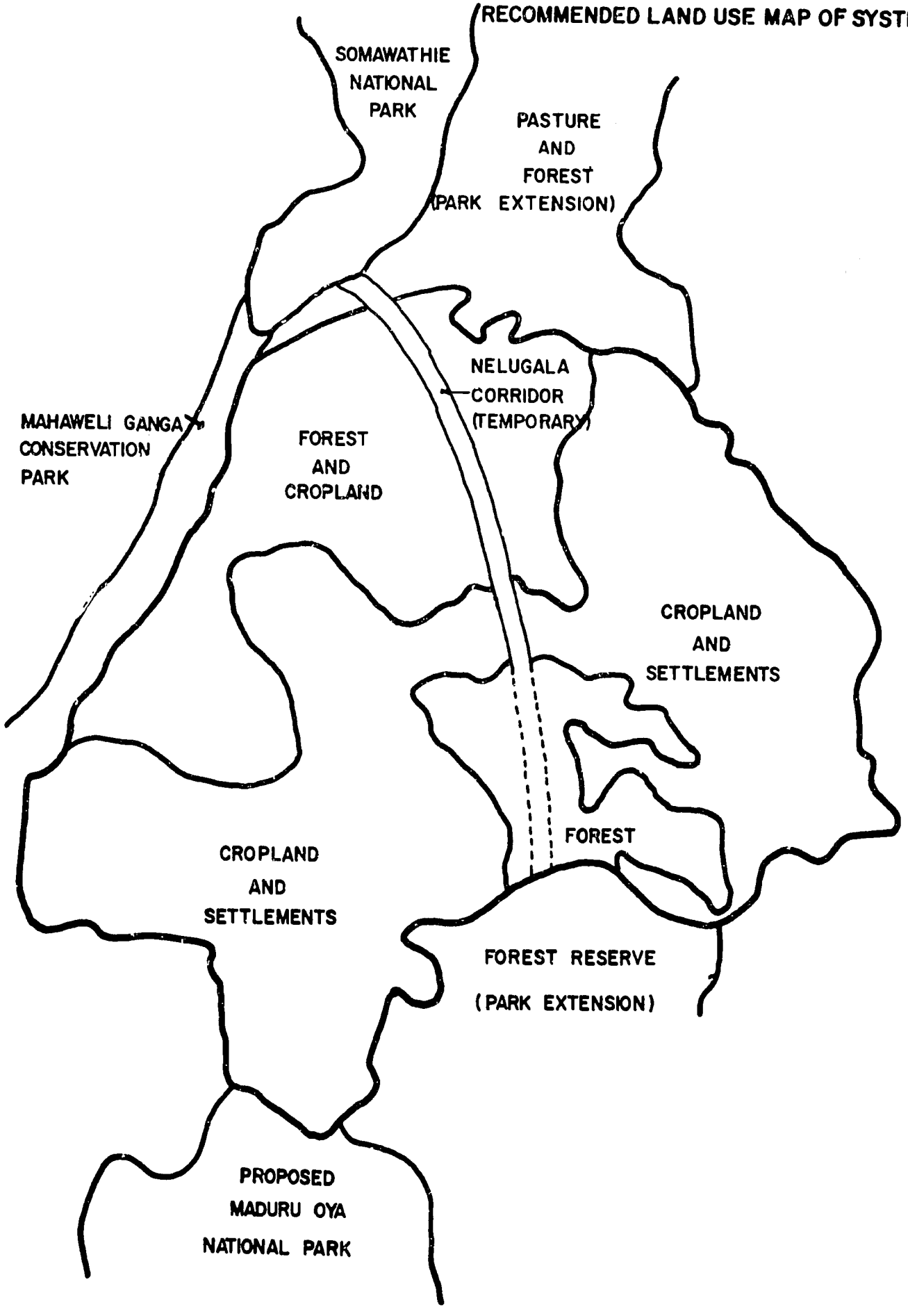


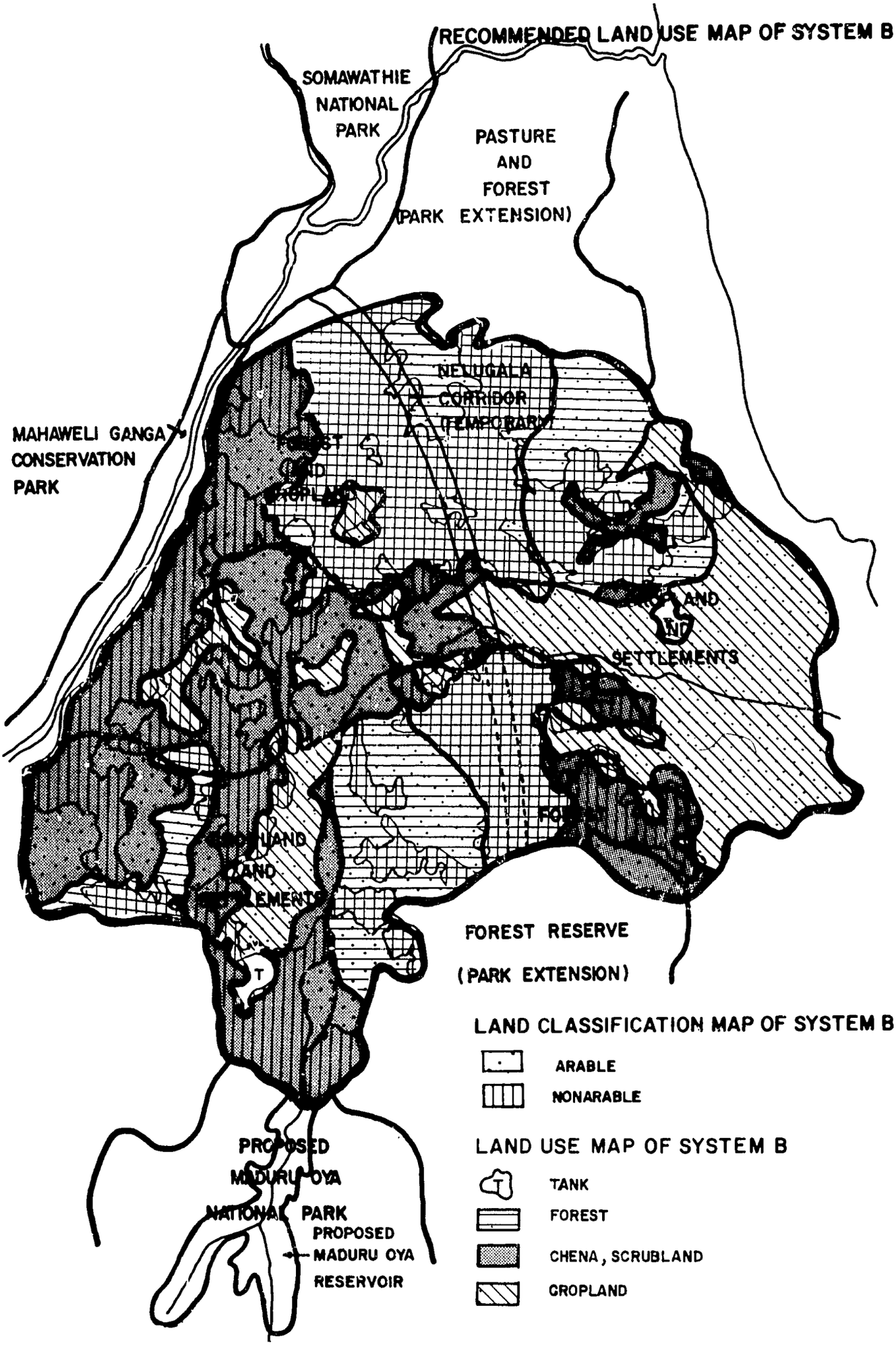
RECOMMENDED LAND USE MAP OF SYSTEM A

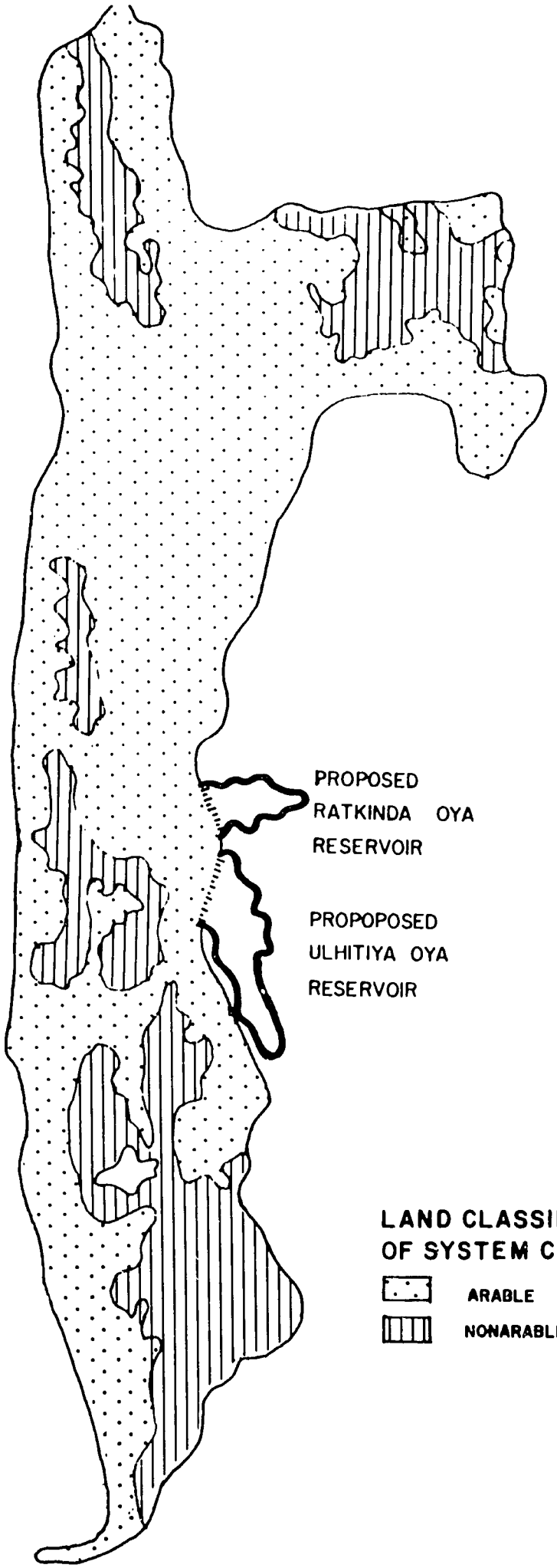



LAND CLASSIFICATION MAP OF SYSTEM B
ARABLE
NON ARABLE
PROPOSED
MADURU OYA
RESERVOIR

RECOMMENDED LAND USE MAP OF SYSTEM B




RECOMMENDED LAND USE MAP OF SYSTEM B
SOMAWATHIE NATIONAL PARK
PASTURE AND FOREST (PARK EXTENSION)
NELUGALA CORRIDOR (TEMPORARY)
MAHAWELI GANGA CONSERVATION PARK
SETTLEMENTS
FOREST RESERVE (PARK EXTENSION)
PROPOSED MADURU OYA NATIONAL PARK
PROPOSED MADURU OYA RESERVOIR
LAND CLASSIFICATION MAP OF SYSTEM B
ARABLE
NONARABLE
LAND USE MAP OF SYSTEM B
TANK
FOREST
CHENA, SCRUBLAND
CROPLAND

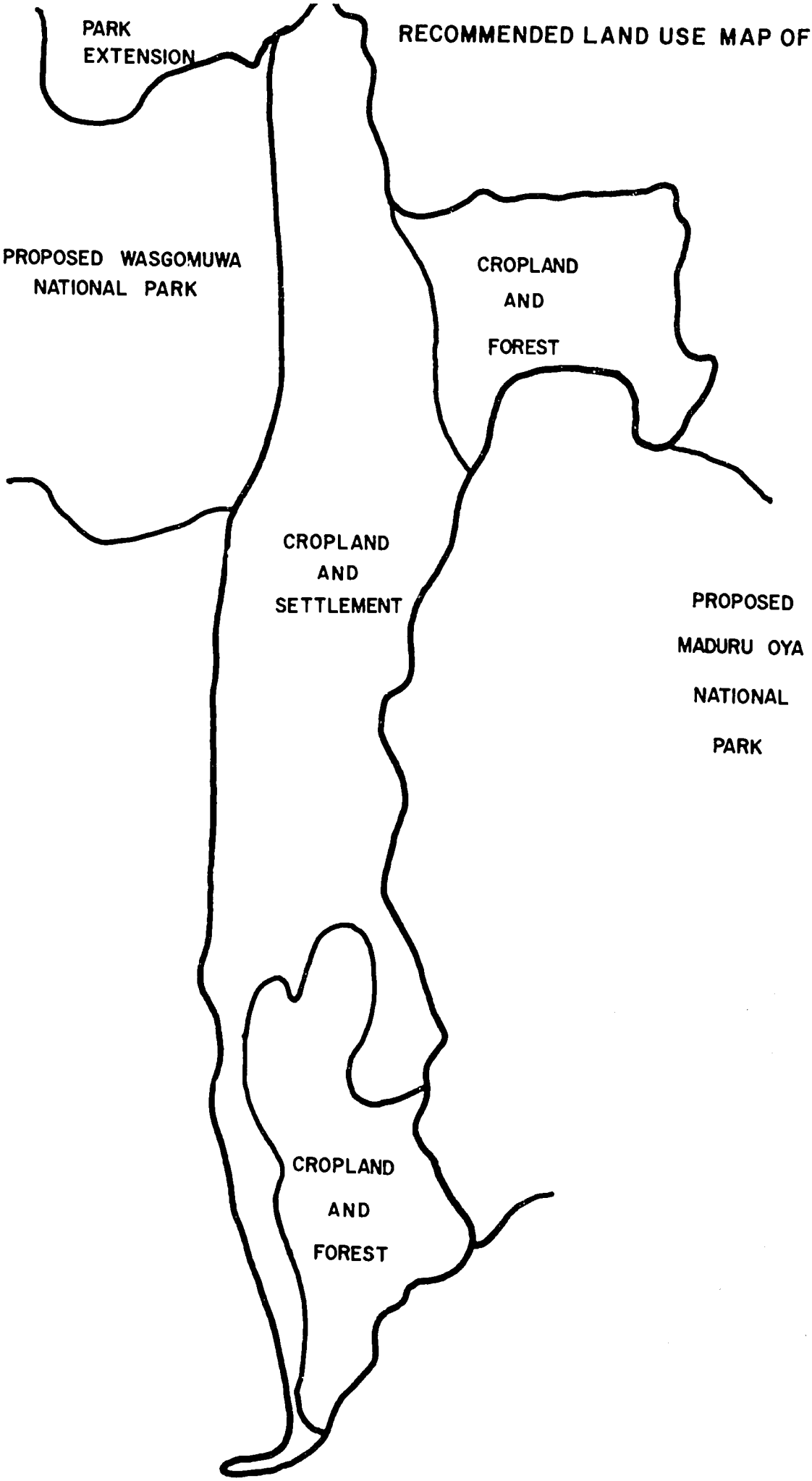


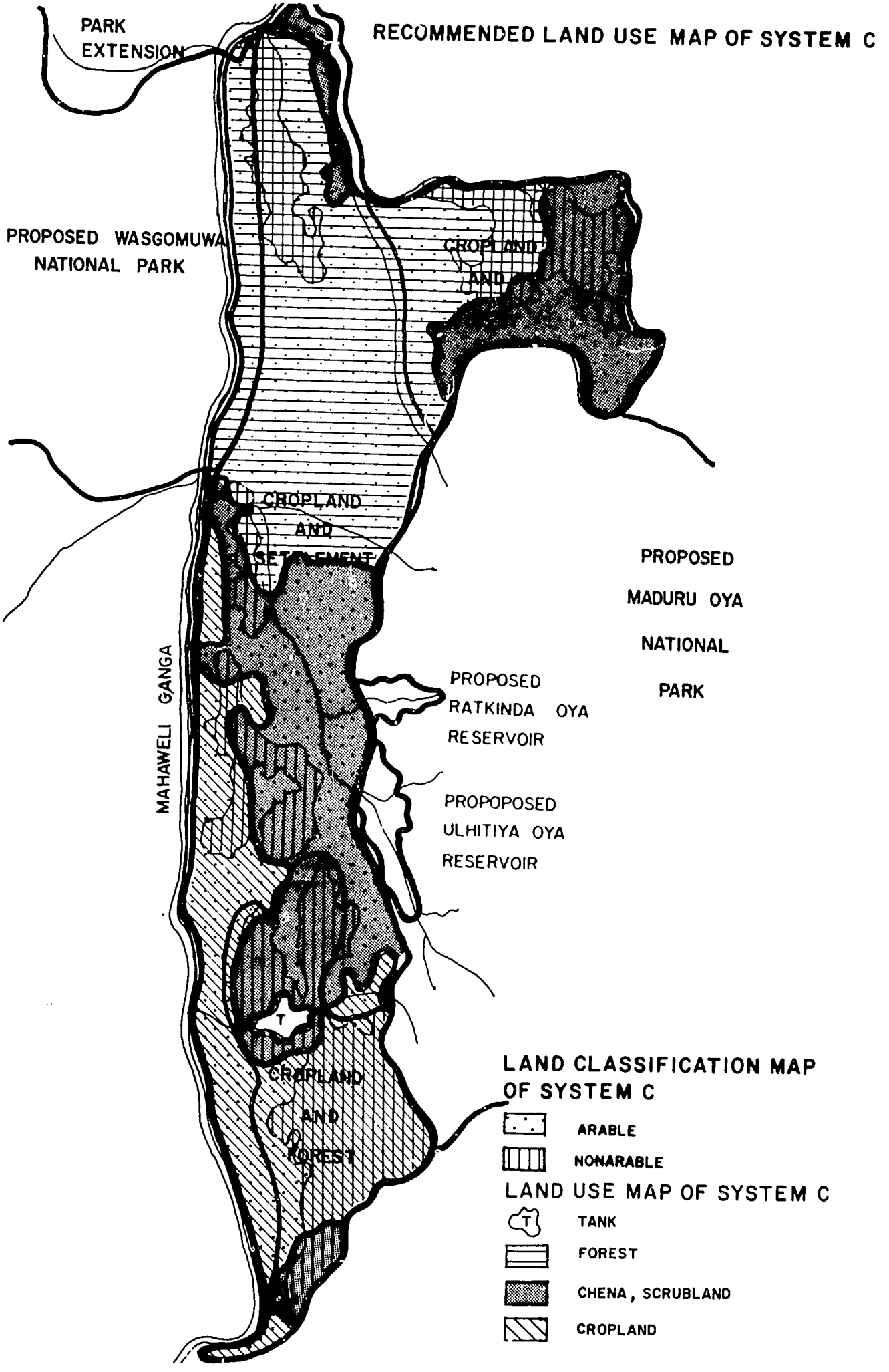
LAND CLASSIFICATION MAP OF SYSTEM C

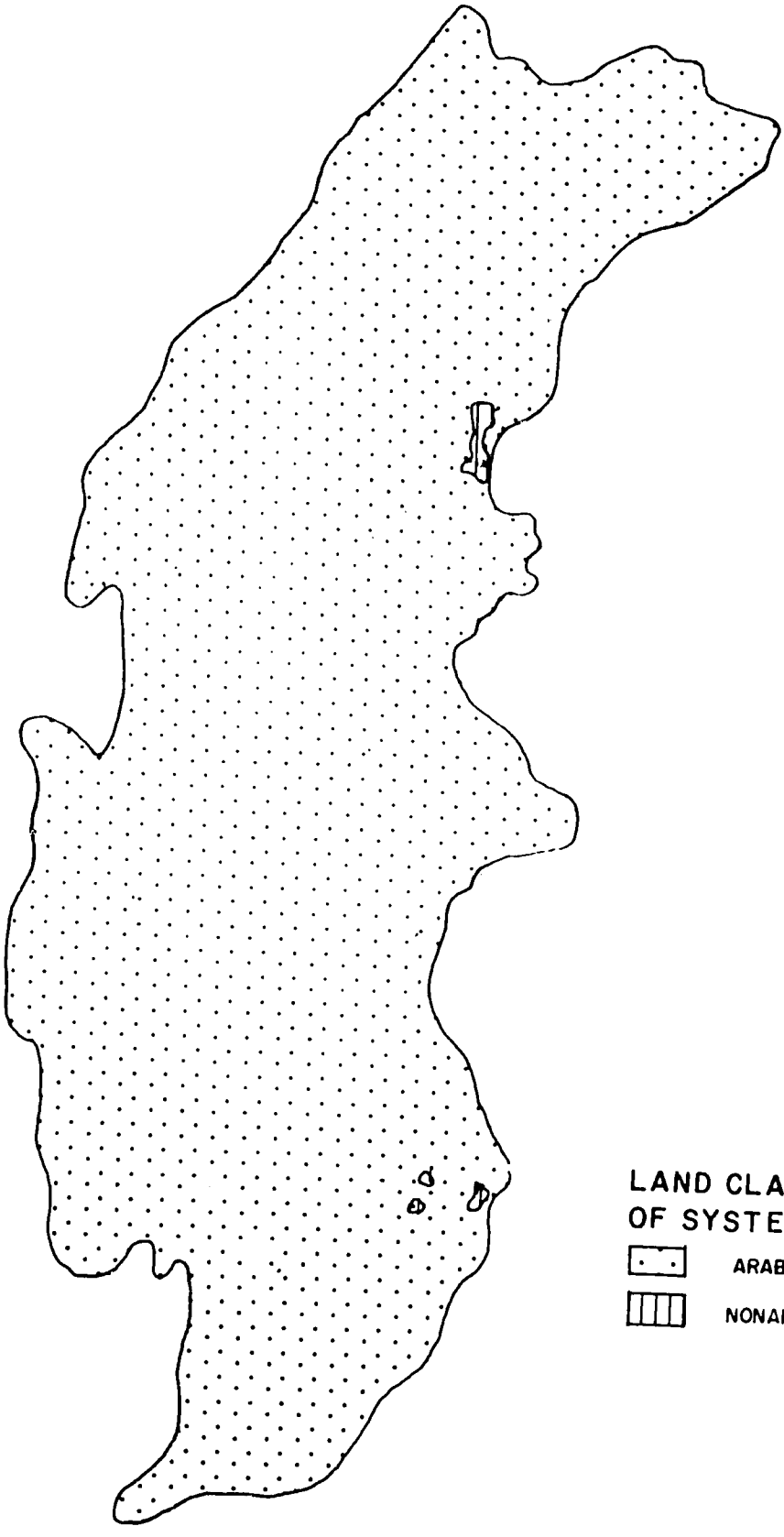
ARABLE

NONARABLE

RECOMMENDED LAND USE MAP OF SYSTEI




RECOMMENDED LAND USE MAP OF SYSTEM C
PARK EXTENSION
PROPOSED WASGOMUWA NATIONAL PARK
CROPLAND AND
CROPLAND AND SETTLEMENT
PROPOSED MADURU OYA NATIONAL PARK
MAHAWELI GANGA
PROPOSED RATKINDA OYA RESERVOIR
PROPOPOSED ULHITIYA OYA RESERVOIR
T
CROPLAND AND FOREST
LAND CLASSIFICATION MAP OF SYSTEM C
ARABLE
NONARABLE
LAND USE MAP OF SYSTEM C
TANK
FOREST
CHENA, SCRUBLAND
CROPLAND

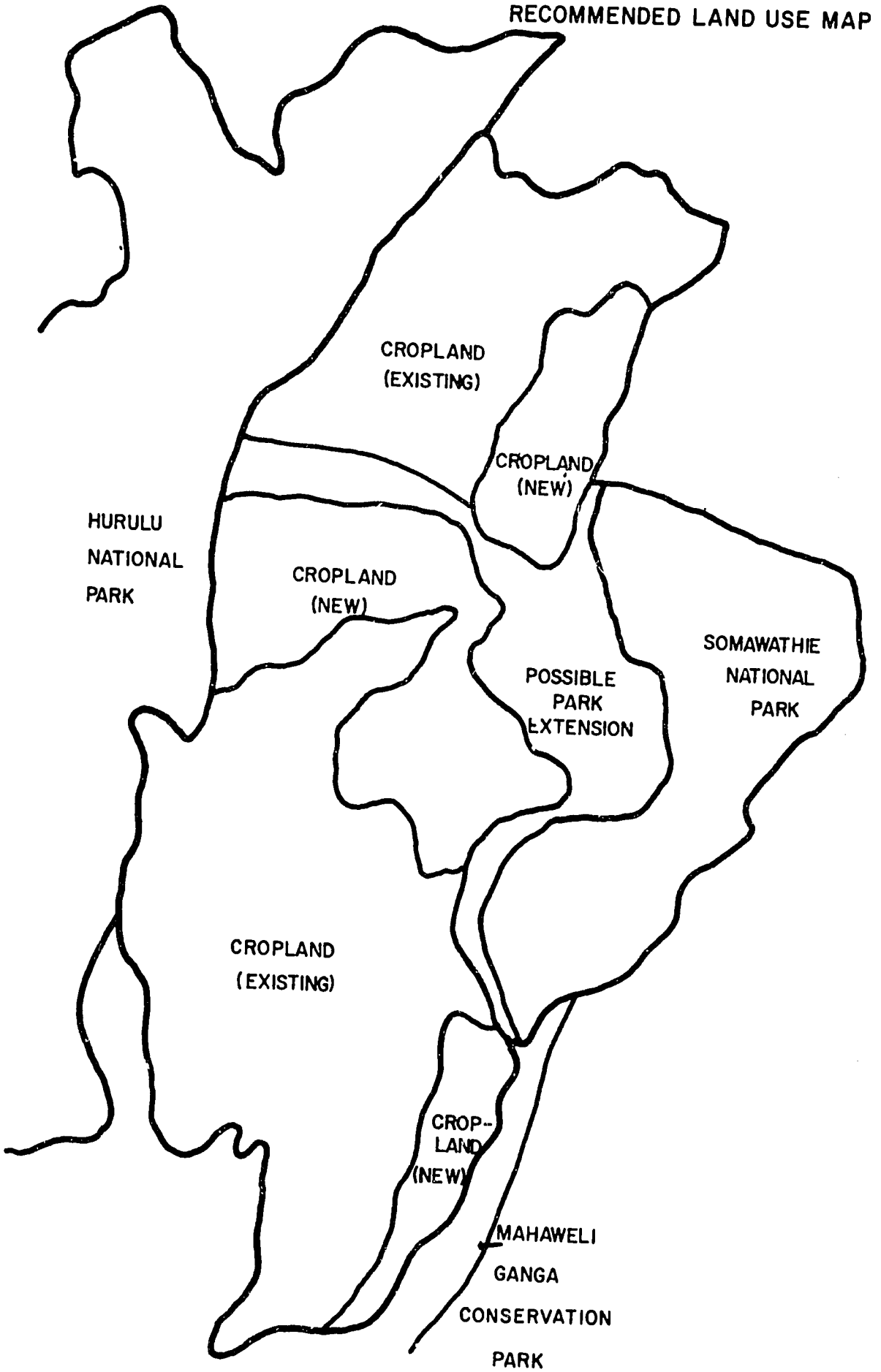
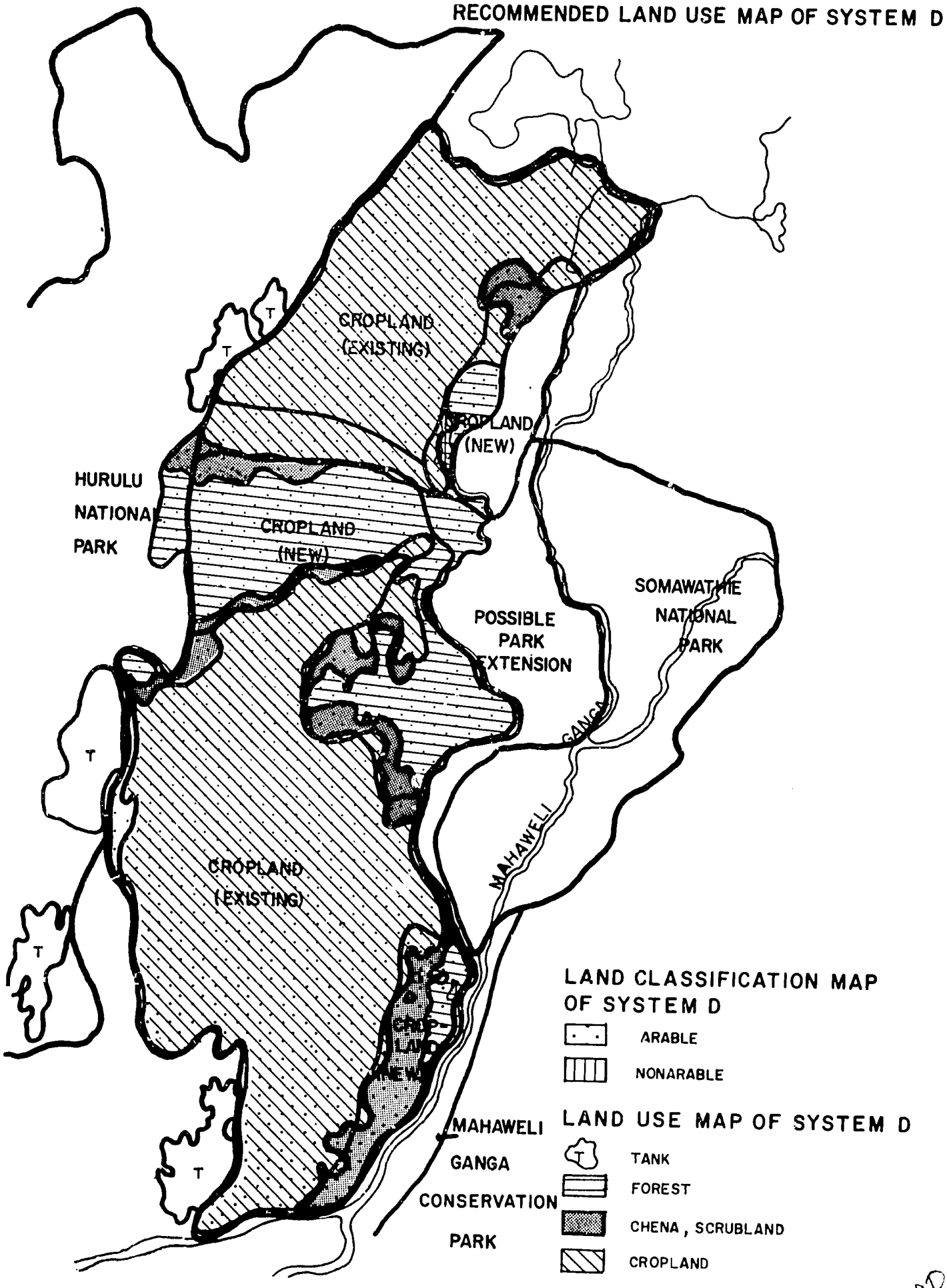


LAND CLASSIFICATION MAP
OF SYSTEM D

ARABLE

NONARABLE

RECOMMENDED LAND USE MAP OF SYSTEM D



RECOMMENDED LAND USE MAP OF SYSTEM D