



E1067
v1

Republic of Yemen

Ministry of Public Works and Highways
Rural Access Project Central Management Office (RAP CMO)

RURAL ACCESS PROGRAM

DRAFT
SECTORAL ENVIRONMENTAL ASSESSMENT
VOLUME 1



TECHNIPLAN

in collaboration with
SHEBA Engineering Services

Rome, October 2004

DRAFT
SECTORAL ENVIRONMENTAL ASSESSMENT (SEA)

Table of Contents

EXECUTIVE SUMMARY	2
CHAPTER 1. PROGRAM DESCRIPTION	6
1.1 OBJECTIVES	6
1.2 COMPONENTS AND PHASING	6
1.3 PROGRAM SCOPE.....	6
1.4 JUSTIFICATION FOR SECTORAL ENVIRONMENTAL ASSESSMENT AND POLICY FRAMEWORKS.....	7
1.5 OUTLINE OF SECTORAL ENVIRONMENTAL ASSESSMENT	8
CHAPTER 2. SECTORAL ENVIRONMENTAL ASSESSMENT PROCESS	10
2.1 DOCUMENTATION REVIEW	10
2.2 FIELD-BASED REVIEWS, MEETINGS AND CONSULTATIONS	10
CHAPTER 3. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK	13
3.1 GOVERNMENT FRAMEWORK	13
3.1.1 <i>Environmental Policy</i>	13
3.1.2 <i>Social Development Policy</i>	15
3.1.3 <i>Legal Framework</i>	17
3.1.4 <i>Environmental Institutions</i>	17
3.1.5 <i>International Conventions</i>	22
3.1.6 <i>Environmental Applications to the Road Sector</i>	23
3.2 WORLD BANK FRAMEWORK	23
3.2.1 <i>Safeguards Policy Framework</i>	23
CHAPTER 4. ENVIRONMENTAL BASELINE DATA	26
4.1 OVERVIEW.....	26
4.2 LAND RESOURCES.....	26
4.2.1 <i>The Resource and its Use</i>	26
4.2.2 <i>Physical Regions</i>	28
4.2.3 <i>Geology and Soils</i>	33
4.2.4 <i>Land Deterioration</i>	35
4.3 HYDROLOGY, WATER RESOURCES AND CLIMATE	38
4.3.1 <i>General Information</i>	38
4.3.2 <i>Rainfall</i>	38
4.3.3 <i>Other Climatic Factors</i>	40
4.3.4 <i>Notes for Project Development</i>	42
4.3.5 <i>Hydrology</i>	42
4.3.5.1 <i>Absorption and Run Off Zones</i>	42
4.3.5.2 <i>Principal Catchments</i>	42
4.3.6 <i>Water Resources</i>	47
4.3.7 <i>Water Quality</i>	51
4.4 BIOLOGICAL RESOURCES	53
4.4.1 <i>Introduction</i>	53
4.4.2 <i>Terrestrial Biodiversity</i>	53
4.4.3 <i>Coastal Biodiversity</i>	66
4.4.4 <i>Protected Areas (Declared and Proposed)</i>	69
4.4.5 <i>Agricultural Biodiversity</i>	74
4.5 AIR QUALITY AND NOISE.....	82
4.6 SOCIO-ECONOMIC AND CULTURAL.....	83
4.6.1 <i>Administrative Structure</i>	83
4.6.2 <i>Population</i>	84
4.6.3 <i>Education</i>	86

4.6.4	Health.....	89
4.6.5	Labor Force and Employment.....	90
4.6.6	History and Culture.....	92
4.6.7	Cultural Heritage.....	93
CHAPTER 5.	ENVIRONMENTAL IMPACTS.....	98
5.1	DESIGN/CONSTRUCTION PHASE.....	98
5.1.1	Land Resources.....	98
5.1.2	Hydrology and Water Resources.....	99
5.1.3	Air Quality and Noise.....	101
5.1.4	Biological Resources.....	101
5.1.5	Socio-Economic and Cultural Resources.....	102
5.2	OPERATIONS PHASE.....	104
5.2.1	Land Resources.....	104
5.2.2	Hydrology and Water Resources.....	105
5.2.3	Air Quality and Noise.....	105
5.2.4	Biological.....	106
5.2.5	Socio-Economic and Cultural.....	106
5.3	CUMULATIVE IMPACTS AND SECTOR-WIDE ISSUES.....	108
CHAPTER 6.	ANALYSIS OF ALTERNATIVES.....	110
6.1	PROGRAM OBJECTIVES AND ALTERNATIVE APPROACHES.....	110
6.1.1	Village-Level Multipurpose Alternative.....	110
6.1.2	Large-Scale Phase I.....	110
6.1.3	Large-Scale Stand Alone Project.....	111
6.1.4	Combined Intermediate & Village Access Alternative.....	111
6.1.5	“No-Project” Option.....	111
6.2	CONCLUSION.....	111
CHAPTER 7.	ENVIRONMENTAL MANAGEMENT PLAN (EMP).....	114
7.1	IMPACT MITIGATION DURING DESIGN/CONSTRUCTION PHASE.....	114
7.1.1	Land Resources.....	114
7.1.2	Hydrology and Water Resources.....	115
7.1.3	Air Quality and Noise.....	117
7.1.4	Biological Resources.....	117
7.1.5	Socio-Economic and Cultural Resources.....	118
7.2	MANAGEMENT OF IMPACTS DURING OPERATIONS PHASE.....	120
7.2.1	Land Resources.....	120
7.2.2	Hydrology and Water Resources.....	121
7.2.3	Air Quality and Noise.....	121
7.2.4	Biological Resources.....	122
7.2.5	Socio-Economic and Cultural.....	122
7.3	IMPLEMENTATION ARRANGEMENTS.....	123
7.3.1	Environmental and Social Management Process.....	123
7.3.2	Responsibilities and Procedures.....	124
7.3.3	Environmental Assessment Instruments.....	125
7.3.4	Environmental Monitoring.....	127
7.3.5	Costs of Mitigation.....	128
7.3.6	Compliance Monitoring.....	129
7.3.7	Institutional Strengthening.....	129
7.4	SUMMARY TABLES OF ENVIRONMENTAL MANAGEMENT PLAN.....	130
CHAPTER 8.	PUBLIC DISCLOSURE AND RECORD OF CONSULTATION.....	138
8.1	PUBLIC DISCLOSURE.....	138
8.1.1	Disclosure of Sectoral Environmental Assessment.....	138
8.1.2	Disclosure of Individual Category B Subprojects.....	138
8.1.3	Disclosure of Category A Subprojects.....	138
8.2	RECORD OF CONSULTATIONS.....	138
8.2.1	Summary of the field consultations carried out at local level.....	139
8.2.2	Approach.....	139

8.2.3	Issues Arising from Consultations.....	140
CHAPTER 9.	ENVIRONMENT ASSESSMENT INSTRUMENT FORMATS	144
9.1	SCREENING REPORT – TABLE OF CONTENTS.....	144
9.2	ENVIRONMENTAL CHECKLIST (SCREENING AND EMP).....	145
9.3	PUBLIC CONSULTATIONS FORMAT AND CHECKLIST.....	147
9.4	SOCIAL FRAMEWORK AGREEMENT.....	148
9.5	ENVIRONMENTAL ASSESSMENT REPORT – TABLE OF CONTENTS	152
ANNEX 1.	LIST OF SEA PREPARERS.....	155
ANNEX 2.	BIBLIOGRAPHY	156
ANNEX 3.	LIST OF PEOPLE AND ORGANIZATIONS CONTACTED	158
ANNEX 4.	MINUTES OF CONSULTATIONS	161

Index of Tables

TABLE 3.1.	ENVIRONMENT & SUSTAINABLE INVESTMENT PROGRAM 2003-08 - PROGRAM AREAS AND ACTIONS.....	14
TABLE 3.2.	GOVERNMENT POLICY STATEMENTS, STRATEGIES AND PROGRAMS RELEVANT FOR THE ENVIRONMENTAL SECTOR	15
TABLE 3.3.	INDICATIVE LIST OF YEMENI NGOS ACTIVE IN YEMEN	21
TABLE 3.5.	SAFEGUARD POLICIES TRIGGERED BY THE PROJECT	23
TABLE 4.1.	LAND RESOURCE IN YEMEN.....	26
TABLE 4.2.	UTILIZATION OF THE CULTIVABLE LAND.....	27
TABLE 4.3.	MAIN CROPS IN THE CULTIVATED AREA	27
TABLE 4.4.	FISHERIES PRODUCTION. ANNUAL CAPTURE (TONS).....	27
TABLE 4.5.	FISHERIES PRODUCTION. ANNUAL VALUE (US\$)	27
TABLE 4.6.	INDUSTRIAL PRODUCTION OF MINING, OIL AND ELECTRICITY (US\$).....	28
TABLE 4.7.	TOP EXPORTS COMMODITIES(US\$)	28
TABLE 4.8.	PHYSICAL REGIONS OF YEMEN	28
TABLE 4.9.	NUMBER OF REGISTERED DOMESTIC AND INTERNATIONAL EARTHQUAKE EVENTS BY SITE DURING 2001	34
TABLE 4.10.	NUMBER OF REGISTERED DOMESTIC AND INTERNATIONAL EARTHQUAKE EVENTS BY RICHTER SCALE	34
TABLE 4.11.	LAND DETERIORATION IN YEMEN*.....	35
TABLE 4.12.	QUANTITY OF MONTHLY RAINFALL (MILLIMETRE) IN MAIN METEOROLOGY STATIONS DURING 2000	40
TABLE 4.13.	AVERAGE SURFACE FLOWS OF WADI CATCHMENTS IN YEMEN.....	46
TABLE 4.14.	WATER BALANCE IN YEMEN.....	48
	(SOURCE –BIODIVERISTY STRATEGY-EPA- 1999).....	48
TABLE 4.15.	CULTIVATED LAND IN YEMEN BY TYPE OF IRRIGATION (2001).....	49
TABLE 4.16.	CULTIVATED LAND IN YEMEN BY TYPE OF IRRIGATION	50
TABLE 4.17.	WATER QUALITY STANDARDS FOR AGRICULTURE (FAO-1996).....	52
TABLE 4.18.	DRINKING WATER QUALITY STANDARDS (WHO).....	52
TABLE 4.19.	PRELIMINARY RECORD OF ORDERS, FAMILIES, GENERA, AND SPECIES OF MAMMALS ..59	
TABLE 4.20.	EXTINCT AND ENDANGERED MAMMALS OF YEMEN (A PRELIMINARY ESTIMATION) ..60	
TABLE 4.21.	GLOBALLY THREATENED BIRDS FOUND IN YEMEN.....	61
TABLE 4.22.	ENDEMIC AND SEMI ENDEMIC BIRD SPECIES IN YEMEN	62
TABLE 4.23.	PRELIMINARY RECORDS OF ORDERS, FAMILIES, GENERA AND SPECIES OF THE CLASSES OF REPTILES AND AMPHIBIANS IN YEMEN	64
TABLE 4.24.	NUMBER OF LIZARD SPECIES AND THEIR FAMILIES, RECORDED IN YEMEN.	64
TABLE 4.25.	NUMBER OF SNAKE SPECIES, AND THEIR FAMILIES IN YEMEN.	64
TABLE 4.26.	PRELIMINARY RECORDS OF CLASSES, ORDERS, FAMILIES, GENERA AND SPECIES OF TERRESTRIAL ARTHROPODS IN YEMEN.....	65
TABLE 4.27.	PRELIMINARY RECORD OF ORDERS, FAMILIES, GENERA AND SPECIES OF THE CLASS ARACHNIDA.....	65
TABLE 4.28.	INVERTEBRATES OTHER THAN ARCHNIDA RECORDED FROM YEMEN	65

TABLE 4.29.	LIST OF ECOLOGICAL SENSITIVE AREAS IN YEMEN.....	69
TABLE 4.30.	GLOBALLY THREATENED AND REGIONALLY IMPORTANT BIRD SPECIES POPULATIONS FOUND IN ADEN WETLANDS	71
TABLE 4.31.	AREA AND PRODUCTION OF CROPS IN YEMEN BY GOVERNORATES - 2001	77
	SOURCE: MINISTRY OF AGRICULTURE-APRIL 2002	77
TABLE 4.32.	LIVESTOCK POPULATION AND DIVERSITY IN YEMEN IN 2001	79
TABLE 4.33.	LIVESTOCK POPULATION AND DIVERSITY IN YEMEN IN 2001 BY GOVERNORATE	79
TABLE 4.34.	SUMMARY OF YEMEN'S ADMINISTRATIVE STRUCTURE (CSO-2001).....	83
TABLE 4.35.	DETAILS OF ADMINISTRATIVE STRUCTURE OF YEMEN (CSO-2001).....	83
TABLE 4.36.	DETAIL ON POPULATION FORECAST AT 2001 BY GOVERNORATE	85
TABLE 4.37.	STUDENTS IN PRIMARY AND SECONDARY SCHOOLS IN YEMEN FOR THE YEAR 2000/2001	86
TABLE 4.38.	PRIMARY SCHOOL ENROLMENT RATE AND ADULT ILLITERACY IN YEMEN IN 1999	87
TABLE 4.39.	NUMBER OF SCHOOLS AND CLASSES IN THE PRIMARY AND SECONDARY EDUCATION SECTOR IN YEMEN IN 2001.....	88
TABLE 4.40.	NUMBER OF HEALTH SERVICES AND BEDS IN 2001	89
TABLE 4.41.	INFECTIOUS DISEASES REPORTED DURING 1999-2001 AND THEIR DISTRIBUTION BY GOVERNORATE	91
TABLE 6.1.	COMPARATIVE ASSESSMENT OF RURAL ACCESS PROGRAM ALTERNATIVES	112
TABLE A.2	SECTOR STAKEHOLDERS MET DURING THE SCOPING & CONSULTATION SESSIONS.....	161
	AT CENTRAL LEVEL	161

Index of Figures

FIGURE 4.1	PHYSICAL REGION OF YEMEN	32
FIGURE 4.2	LAND DEGRADATION MAP	37
FIGURE 4.3	AGRO-CLIMATIC ZONES AND RAINFALL DISTRIBUTION IN YEMEN	41
FIGURE 4.4	HYDROGEOLOGICAL PROVINCES IN YEMEN.....	44
FIGURE 4.5	LOCATION OF PROTECTED AREA.....	73
FIGURE 4.6	MAJOR FARMING SYSTEMS ZONES MAP OF YEMEN.....	78

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This Draft Sectoral Environmental Assessment (SEA) has been prepared for the Rural Access Program (RAP) under a contract signed between the Ministry of Public Works & Highways and Techniplan S.p.A., on 11th June 2003. It has been prepared in accordance with World Bank Operational Directive (OP) 4.01, *Environmental Assessment*.

Program Description. The overall purpose and long-term development objective of the RAP is an improved livelihood and reduced isolation for rural populations. To achieve this objective, the Program will improve planning and implementation of rural roads, thereby reducing a major obstacle to rural economic growth caused by poor access. The Program will be implemented in three phases:

- **Phase I** (August 2001 to April 2005) is setting up the institutional and technical foundation of rural road projects. The approach is being tested in 22 pilot clusters that consist of intermediary roads combined with adjacent tertiary or village-access roads. This phase also includes formulation of a National Highway Master Plan and Governorate Rural Accessibility Master Plans which provide the basis for selection of future rural road investments.
- **Phase II** (December 2005/2007) will tackle access problems mainly at intermediary road level, also covering related tertiary roads, while setting up a policy and organization framework for gradually moving to feeder networks.
- **Phase III** (2007/2011) will tackle the improvement of tertiary roads at District level, while continuing to support the development and management systems of intermediate networks.

The RAP will be implemented as a nation-wide program, covering all 20 Governorates of the country, and their 333 Districts. The Governorate Accessibility Master Plans developed in Phase I will provide the foundation for rational planning and prioritization for rural access investments, as well as decentralized institutional arrangements and financing for management and maintenance of the rural roads.

Environmental Screening Category. Phase I of the Program was placed in environmental category "B", since all civil works were limited to improvements on existing alignments and roads with major impacts were screened out. For Phases II and III, such cases are not excluded, such that project roads may be categorized as "A" or "B". For this reason, the remainder of the overall program has been placed in environmental category "A", to allow the possibility of roads with potential major impacts to be included.

Justification for SEA. Since the location of all roads to be improved is not yet known, a Sectoral Environmental Assessment approach has been selected. This approach provides for a general assessment of program impact, establishment of standard methods of mitigation to be adapted to individual projects and a procedural framework for implementing the environmental and social management process for all roads within the program. The SEA also provides the basis for an Environmental and Social Management Framework Agreement between the Government of Yemen and the World Bank.

Policy and Institutional Framework. Environmental Impact Assessment (EIA) in Yemen is enabled by the Environment Protection Law No 26 of 1995 (EPL). The provisions of this framework law are implemented through Executive Regulations (By-Law 148-2000), issued by a decree of the Council of Ministers. In October 2002, the Environmental Protection Authority (EPA) issued the "Environment & Sustainable Investment Program 2003-08" (ESIP), which constitutes the framework for the Government's environmental

policy of the next years. While the Government general environmental policy provides a broad framework for environmental management, there is as yet no environmental policy for the road sector.

Baseline Conditions. The physiographic characteristics of Yemen are very diverse and consist of high, steep mountains, escarpments, deserts, coastal plains and hundreds of wadis running between the mountains and through the coastal plains. Socatra is the largest of the 112 Yemeni islands scattered in the Red Sea. The majority of the population concentrates in the wadis and highland plateaus, performing agricultural activities, irrigating from the spates flow in the wadis in the rainy seasons, and from base flow and groundwater. The country is classified into five physical regions (Mountain Massif, Eastern Plateau, Desert Regions, Coastal Plans and Yemen Islands) and 16 sub-regions. There are 36 important ecological sensitive areas, two of which have been declared Protected Areas (Autma and Socotra); four were under declaration as at October 2003; and 30 proposed for declaration. Population density varies markedly across the country, ranging from 1 person per sq. km in the desert areas (such as Al-Mahrah Governorate) to 388 persons per sq. km in Ibb Governorate. Tribal tensions can be a source of social conflict in the selection and implementation of rural roads. Yemen is rich in cultural assets, which are scattered in urban and rural areas; however, there is currently no comprehensive inventory of cultural assets. The agricultural terracing system is widespread in the mountainous zones and is well known as an efficient method of water conservation.

Environmental Impacts. Rural roads have a range of potential positive and negative impacts, depending on their location within the country. Roads located in the escarpments are characterized by hairpin bends whereas in flat areas they follow rather straight alignments. These geometric features affect the volumes of earthworks and consequent impacts on the environment. Water harvesting along and even on the road surface is routine practice and is a major consideration in rural road design, as is cross-drainage, discharge to adjacent lands, flood protection and wadi hydrology. Slope stabilization is a key issue in vertical alignment design to avoid landslides in the mountainous zones. Traditionally, rural roads designs in Yemen have featured a roadbed of 8 meter width, with a road surface 6 meters wide and shoulders of 1.0 meter on each side. In the case of mountain roads, this design requires rather deep cuts into the mountainside to achieve the design width of the roadbed, leading to the erosion of exposed slope surfaces and often to slides of slopes onto the road. In addition, such road widths can lead to land taking through populated or agricultural areas, which is difficult to justify, given the volume of traffic on these roads. Narrower road widths provide more economically justified investments and reduce the need for land taking or excessive excavations. Consultations revealed an overwhelming desire for improved access and willingness to collaborate with the Program. Positive socio-economic impacts noted include reduced transport costs and travel time, improved comfort and safety, increased mobility, stimulus to economic development, improved community cohesion and intercommunity cooperation and improved accessibility to social services and marketes. Increased road accidents and adverse impacts on water gathering patterns were identified during women's consultations as particular areas of social concern. Over the life of the program, the RAP investments will cover about 1% of the entire network scattered among the 20 Governorates. Impacts are expected to be localized and it is therefore reasonable to assume a negligible risk of cumulative negative impacts.

Ennvironmental Management Plan (EMP). The EMP consists of standard mitigation measures to be adapted to each individual road and institutional arrangements for ensuring consistent implementation of the environmental and social management processes. Standard mitigation measures have been developed to address potential environmental impacts as they may occur during the design/construction and the operational (post-construction/maintenance) phases. An EMP Table provides an overall summary of impacts,

mitigation measures and monitoring responsibilities during implementation. The main mitigation measures include:

- **Improved and environmentally-sound technical designs, tested during Phase I** including: (i) narrower road design widths, “pinch points” and other measures to avoid excessive mountain cuts or land taking; (ii) slope stabilization measures; (iii) flood protection in the wadis, incorporation of water harvesting measures, and reduction of cross-drainage effects and discharge to adjacent lands, with particular attention to agricultural terraces, graveyards and other sensitive areas.
- **Measures related to the conduct of design/construction and maintenance works activities.** The main ones include: (i) careful selection, management and rehabilitation of investigation sites, site compounds, borrow areas and diversion roads; (ii) controlled disposal of materials and surplus fill; (iii) avoidance of groundwater pollution through appropriate storage and use of petroleum products, paving materials and other hazardous items; (iv) limitation of effects on biological resources through identification and mitigation of impacts on critical vegetation, fauna and natural habitats affected by the roads; (v) separate men and women’s consultations to avoid tribal conflicts, address potential permanent and temporary land acquisition needs, and address gender considerations; and (vi) cultural resource assessments, management plans and chance find procedures, as appropriate.
- **Social Framework Agreements (SFA)**, developed during Phase 1, as the mechanism for reaffirming public agreements to the environmental and social mitigation measures, as discussed in the public consultations. The SFA also provides a framework for addressing unforeseen environmental and social issues that may arise during implementation.
- **Policy Frameworks for Resettlement, Natural Habitats and Cultural Resources**, which will be triggered when appropriate issues are identified during screening or based on chance finds during implementation.

Implementation arrangements are based on a standard environmental and social management process developed during Phase 1. The process includes procedures and standard instruments for screening, categorization, environmental assessment, and project implementation. It also includes prior review and approval by RAP and the World Bank following the screening and the environmental assessment steps. Environmental contract clauses are incorporated as an explicit annex into RAP’s standard contract documents. Overall responsibility for the implementation of the above process will be with the RAP CMO, through its Environmental and Social Unit (E&SU). The Unit is fully operational with two qualified staff. However, in view of the increasing workload, this should be expanded to include at least four staff. Institutional strengthening should be carried out through: (i) increase of staff; (ii) training and in-house seminars at RAP CMO; and (iii) training sessions for engineering consultants and contractors. From a sector-wide perspective, the RAP is introducing an operational approach to systematically address environmental and social issues on rural roads. As RAP expands its operations and becomes “mainstreamed” within the Ministry of Public Works and Highways, these processes will serve as a model for addressing such issues in the road sector in general.

Public Disclosure. Consistent with procedures of the World Bank, the Government of Yemen will make this Draft SEA available to the public through: (i) the World Bank InfoShop; (ii) the RAP CMO, Sana’a and on the RAP CMO Website; (iii) the Ministry of Water and Environment and the EPA, Sana’a; and (iv) the RAP CMO Regional Offices. Annex 3 provides a record of public consultations carried out during the preparation of the SEA. Comments gathered during the disclosure of the Draft SEA will be incorporated into the Final Sectoral Environmental Assessment.

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

Chapter 1

PROGRAM DESCRIPTION

Chapter 1. PROGRAM DESCRIPTION

1.1 OBJECTIVES

The Rural Access Program (RAP) pursues the long-term goal of improving the livelihood and reducing the isolation of the rural population of Yemen. To achieve this goal, it is necessary to ensure the year-round access to markets, social services and administrative centers, especially in the remote areas where the large majority of the poor live. The Program, designed also to support the Government's decentralization process, will complement and enhance the ongoing community-based programs, such as IDA-supported Public Works Project and of the Social Fund for Development.

1.2 COMPONENTS AND PHASING

The RAP will be carried out in three phases:

- (i) **Phase I** (August 2001 to April 2005) is setting up the institutional and technical foundation of rural road projects. The approach is being tested in nineteen pilot clusters that consist of intermediary roads combined with adjacent tertiary or village-access roads. Designs and bid documents are also being prepared for the projects to be funded in the subsequent phase. This phase also includes formulation of a National Highway Master Plan and Governorate Rural Accessibility Master Plans which provide the basis for selection of future rural road investments.
- (ii) **Phase II** (December 2005/2007) will tackle access problems mainly at intermediary road level, also covering related tertiary roads, while setting up a policy and organization framework for gradually moving to feeder networks.
- (iii) **Phase III** (2007/2011) will tackle the improvement of tertiary roads at District level, while continuing to support the development and management systems of intermediate networks.

Phase II will have three components:

- (i) **Component 1 - Rural Roads**, which will finance access improvements on intermediate and village access roads.
- (ii) **Component 2 - Institutional Support and Capacity Building**, which will support management of the program, the establishment of at least five decentralized rural road management offices and training and technical assistance to local professionals in public and private sectors.
- (iii) **Component 3 - Road Maintenance**, which will support the Road Maintenance Fund through performance-based road maintenance and management contracts.

1.3 PROGRAM SCOPE

The RAP will be implemented as a nation-wide program, covering all 20 Governorates of the country, and their 333 Districts. The Governorate Accessibility Master Plans developed in Phase I will provide the foundation for rational planning and prioritization for rural access investments, as well as decentralized institutional arrangements and financing for management and maintenance of the rural roads. The RAP's annual programs in Phases II

and III will be determined based on these Master Plans. Under Phase I, a revised road classification system will be adopted by the Government, which will also apportion responsibility for the maintenance of Governorate and District level roads, in conjunction with the Decentralization Law.

As a national program, RAP will also receive other donor funding. In all cases, these programs will adopt RAP standard criteria and apply the procedures developed in Phase I for selection, design and implementation of rural roads, including the environmental and social management process. As at the writing of this SEA, estimated donor commitments are:

Agency	Type of financing	Expected Amount (US\$)	Likelihood
World Bank (IDA)	IDA credit	30	High
Arab Fund	Credit	90	High
European Union	Grant	12-15	High
USAID Food Aid Program	Grant	15-20	High
OPEC Fund	Credit	12	Medium
Islamic Development Bank	Credit	12-15	High

Rural roads constitute about 87% of the Yemen's entire road network, and, as of December 2002, totaled some 54,450 km. Because of RAP's programmatic nature, it is not possible to establish exactly how many kilometers will be improved and in what locations investments will be made under the program. However, based on the above financing assumptions, it is anticipated that RAP will improve roughly 2,000 - 3,000 km of Governorate and District level roads, representing less than 1 % of the entire network.

1.4 JUSTIFICATION FOR SECTORAL ENVIRONMENTAL ASSESSMENT AND POLICY FRAMEWORKS

Phase I of the Program was placed in environmental category "B", since all civil works were limited to improvements on existing alignments and roads with major impacts were screened out. For Phases II and III, such cases are not excluded, such that project roads may be categorized as "A" or "B". For this reason, the remainder of the overall program has been placed in environmental category "A", to allow the possibility of roads with potential major impacts to be included.

Since the location of all roads to be improved is not yet known, a Sectoral Environmental Assessment (SEA) approach has been selected. This approach provides for a general assessment of program impact, establishment of standard methods of mitigation to be adapted to individual projects and a procedural framework for implementing the environmental and social management process for all roads within the program. The SEA also provides the basis for an Environmental and Social Management Framework Agreement between the Government of Yemen and the World Bank.

Initial scoping of the program revealed that some roads financed under the program may involve various levels of land acquisition or resettlement, or impact on natural habitats or cultural resources. For such cases, three Policy Frameworks have been developed and are incorporated into the SEA – *Resettlement Policy Framework*, *Natural Habitats Policy Framework* and *Cultural Resources Framework*. Their application will be triggered if such conditions are identified during road project screening.

It should be noted that, for the most part, projects are expected to keep within existing alignments and the screening and design activities are geared towards avoiding or minimizing effects on land holdings and buildings, physical cultural resources or natural

habitats.

1.5 OUTLINE OF SECTORAL ENVIRONMENTAL ASSESSMENT

The SEA consists of the following:

Volume I – Main Report

- Executive Summary
- Chapter 1 : Program Description
- Chapter 2 : Environmental Assessment Process
- Chapter 3 : Policy, Legal and Institutional Framework
- Chapter 4 : Environmental Baseline Data
- Chapter 5 : Environmental Impacts
- Chapter 6 : Analysis of Alternatives
- Chapter 7 : Environmental Management Plan
- Chapter 8 : Public Disclosure and Consultation
- Chapter 9 : Environmental Assessment Instrument Formats
- Annex 1 : List off EA Preparers
- Annex 2 : Bibliography
- Annex 3 : List of People and Organizations Contacted
- Annex 4 : Minutes of Consultations

Volume II – Safeguard Policy Frameworks

- Chapter 1 : Resettlement Policy Framework
- Chapter 2 : Natural Habitats Policy Framework
- Chapter 3 : Cultural Resources Policy Framework

* * *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)

Draft Final Report

Chapter 2

SECTORAL ENVIRONMENTAL ASSESSMENT PROCESS

Chapter 2. SECTORAL ENVIRONMENTAL ASSESSMENT PROCESS

2.1 DOCUMENTATION REVIEW

Numerous documents and existing secondary data sources were consulted during the preparation of the SEA. This included:

- Review of road sector literature, focusing on the policy, legal and administrative framework of Yemen's rural road development;
- Review of national environmental policies and as they relate to the road sector, including, but not limited to:
 - National Environmental Action Plan, 1996
 - Environment & Sustainable Investment Program 2003-08
 - Biodiversity Strategy (1999, in process of approval in December 2003);
- Countrywide inventory of the resources that can potentially be affected by road projects during Phases II & III of the RAP Program;
- Major documents and studies – Yemen Statistical Yearbooks, SFD Database, Poverty Reduction Strategy Papers of the WB, etc.
- Evaluation of the environmental management systems including mitigation measures, already introduced by RAP CMO, including the review of the environmental reports prepared for a number of road projects implemented during Phase I of the Rural Access Program.

Annex B presents the bibliography of all documents consulted.

2.2 FIELD-BASED REVIEWS, MEETINGS AND CONSULTATIONS

Consultations were carried out with various sector stakeholders at national and local levels, to clarify their expectations and discuss their views on the environmental aspects of the RAP. At the central level these included:

- Environmental Protection Authority (EPA)
- Department of Natural Resources & Biological Environment of the Ministry of Water and Environment
- Rural Access Program (RAP), Environment and Social Unit (E&SU)
- Ministry of Public Works and Highways (MPW&H)
- Road Maintenance Fund (RMF)
- Social Protection Unit of the Social Fund for Development (SFD)
- Women Affairs Unit of the Environmental Protection Authority (EPA)
- Women Affairs and Women Administration Units of the Ministry of Social Affairs
- National Women Committee
- The International NGO Oxfam
- General Organization for Antiquities, Manuscripts and Museums (GOAMM) of the Ministry of Culture
- General Organization for Protection of Historical Cities (GOPHC) of the Ministry of Culture

- General Direction for International Cooperation of the Ministry of Planning and Development (MP&D),
- Ministry of Legal Affairs

Field-based reviews were carried out in four rural road project areas. Three locations involved ongoing projects being implemented under Phase I of the RAP Program. The fourth location involves a Ministry of Public Works & Highway Project completed in 1998.

- Thulah - Amran (July 2003)- RAP
- Khawlan Affar - Al Maghrabah (July2003)-RAP
- Akamat – Mudaykhirah (October 2003)-RAP
- Badan - Ibb (August 2003)- MOPW&H

These reviews included consultation at local level to solicit views and concerns regarding the proposed project. These included:

- Local authorities;
- Community leaders;
- Affected land owners;
- Women’s groups; and
- Contractors and consultants.

Chapter 8 summarizes the results of these consultations.

* * *

Rural Access Program (RAP) Sectoral Environmental Assessment (SEA) Draft Final Report
Chapter 3
POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

Chapter 3. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

3.1 GOVERNMENT FRAMEWORK

3.1.1 Environmental Policy

Since 1990, the Government of Yemen has established institutions and responsibilities for environmental management, joined international conventions and is currently developing sector legislation and procedures. A National Environmental Action Plan (NEAP) was adopted in 1995 and the Environmental Protection Law was enacted a year later. The NEAP established priority issues and actions in the main environmental fields such as:

- water resources;
- land resources;
- natural habitats; and
- waste management.

During the late 90's and in the beginning of the 2000's, the Government developed major strategies such as the Socotra Archipelago Master Plan and the Biodiversity, Ecotourism, Women and Environment strategies. Parallel to this, the public awareness and concern have grown, supported by the increased NGO activity and the media involvement in environmental issues.

Despite all above efforts, Yemen is facing serious environmental problems: a severe water crisis; arable land, forests and unique habitats are being lost; waste pollution is negatively affecting population health, poverty and development opportunities. It is clear that the country needs increased investments in sustainable environmental management. Conscious of this need, in October 2002, the Environmental Protection Authority (EPA)/MOTE issued the "Environment & Sustainable Investment Program 2003-08" (ESIP), which constitutes the framework for the Government's environmental policy of the next years.

The ESIP presents an outline strategy and priority interventions aimed at controlling and gradually reversing the above trend and at supporting the sustainable human development for the people of Yemen. The ESIP is planned to be implemented within the next 5 years and it focuses on 6 main areas of intervention, consistent with the Mandate and Resources of the Ministry of Tourism and Environment (from April 2003 Ministry of Water and Environment). These are:

1. Habitat and biodiversity conservation;
2. Sustainable land management;
3. Sustainable water management;
4. Sustainable waste management;
5. Sustainable climate change and energy management;
6. Institutional development/capacity building (as delivery mechanism for the Program).

Within each area of intervention there are several implementation actions within which particular important priority actions are identified (shown in bold letters the following table):

Table 3.1. Environment & Sustainable Investment Program 2003-08 - Program Areas and Actions

Program Area	Action	Budget (Mill US\$)
1 Habitat and Biodiversity Conservation	Socotra conservation and development program	12.0
	Protected area management; Village conservation	1.6
	Coastal zone management	0.8
	Eco-tourism	4.5
	Monitoring	0.5
	Botanical garden; Natural history museum	1.3
Total for Program Area 1		20.7
2 Sustainable Land Management	Support to traditional and environmentally sound land use practices	0.7
	Action program for forest restoration and desertification	1.6
	Improvement of maps for soil degradation and desertification	0.5
	Support to land registration	0.6
Total for Program Area 2		3.4
3 Sustainable Water Management	Pollution control for fresh water resources, water supply and water harvesting systems	1.0
	Support to the enhancement of water law and information system	0.1
	Support to the optimization of water use and securing additional water resources	0.2
	Awareness raising	0.2
Total for Program Area 3		1.5
4 Sustainable Waste Management	Development of a waste reduction, reuse and recycling program	0.5
	Management system for hazardous waste	0.2
	Emergency unit for environmental pollution	1.0
	Implementation of the solid waste management guidelines, e.g. landfills	0.5
	Promotion of solid waste management systems, legislation	0.1
	Awareness campaigns	0.2
Total for Program Area 4		2.5
5 Sustainable Energy Management	Promotion of renewable energies	1.0
	Development of and energy use and air quality strategy	1.0
	Development of a National Adaptation Strategy	2.6
	Establishment of an energy balance scenario	0.1
Awareness campaigns	0.2	
Total for Program Area 5		4.9
6 Institutional Development/Deliver	Policy development	0.5
	Legal affairs and law enforcement	0.5
	Information and monitoring	0.5
	Awareness raising and education	1.0

y Mechanisms	Community, NGO and gender participation	1.2
	Technology development	0.5
	Institutional and capacity building	0.6
	Total for Program Area 6	4.8
Total for priority actions		30.2
TOTAL FOR THE PROGRAM		37.8

The ESIP will be the main guiding document in support of the Ministry of Water and Environment's (previously Ministry of Environment) strategic approach in the coming years. It will also be the basis to establish dialogue with all Ministry's partners and donors and also to raise awareness among all stakeholders and GOY agencies on a wide range of environmental concerns in other investment areas.

The Government's general environmental policy is mainly embodied in the following documents:

Table 3.2. Government policy statements, strategies and programs relevant for the environmental sector

Statements, strategies and programs	Year
• National Environmental Action Plan	1996
• Environment & Sustainable Investment Program	2003-08
• Biodiversity Strategy (1999, in course of approval in December 2003)	1999-03
• Environmental Impact Assessment Policy for the Republic of Yemen (prepared by Euroconsult - Netherlands)	1997
• Yearly Reports on the State of Environment (by EPA)	yearly
• Evaluation of Future Development of the EIA System in Yemen (METAP)	2001

3.1.2 Social Development Policy

3.1.2.1 Policies and Programs

The Government, in cooperation with international funding agencies started a series of policies and programs aiming at ameliorating the socio-economic situation in Yemen: these can be summarized as follows:

- The Social Welfare Fund (SWF), an agency under the Ministry of Insurance and Social Affairs (MISA) which provides transfers to those unable to work and to members of the poorest sections of Yemeni society;
- The Public Works Project, run by the Ministry of Planning and Development (MOPD), which is designed to create short-term employment opportunities for those able to work;
- The Social Fund for Development (SFD), which seeks to provide support for long-term development opportunities for the poor.

3.1.2.2 Vision 2005

Through Vision 2005, the Government of Yemen identifies and supports the following actions:

- To develop and implement sustainable management and monitoring programs for water resources, land resources and agriculture, coastal zones, biodiversity and waste;
- To develop a desertification combating program;
- To provide energy substitutions;
- To use environment friendly technology and enhancement of renewable energy resources;
- To implement environmental impact assessment for projects;
- To increase public awareness in all environmental fields.

3.1.2.3 Poverty Reduction Strategy (PRS)

The PRS reflects the role of the environment for the living standard of the people in Yemen: the poor are primarily reliant on the environment for their livelihood. They are directly affected by the methods by which the environmental resources are exploited. While poverty does not necessarily lead to environmental deterioration, there are clear effects of poverty on the environmental situation of Yemen today. The Government has therefore decided that the following environmental policies are to be strengthened within the PRS:

- Enhance the technical capacities of relevant institutions to develop comprehensive environment and development projects and programs relying on community participation;
- Develop a legal framework;
- Institutional empowerment of local organizations;
- Carry out field studies to assess environmental conditions;
- Find incentives accompanying awareness campaigns;
- Provide job opportunities through environment projects;
- Undertake environment assessments of development projects;
- Finance projects that provide soft loans for the poor.

In spite of the emphasis given to environmental issues in the PRS, the budget allocated by the GOY does not allow significant environmental measures to be taken in support of poverty eradication. Out of the total planned spending of YR 446,384 Million for the period 2003-2005, environmental measures will only amount to some 0.8% of the PRS budget¹.

3.1.2.4 Gender Policies

Although Yemen's constitution declares equal rights and obligations for men and women, and makes discrimination on the basis of sex illegal, the government's capacity to enforce such laws is weak, mostly due to inadequacy of the administrative apparatus. New laws introduced since Yemeni unification provide women more security rights, yet without effective enforcement, these are virtually ineffectual. In 1997 the government adopted the Yemeni Women's National Strategy. Among the institutions established to work on women's issues is the Women National Committee. Its duties include; cooperating with local, regional and international organizations involved in women's projects, conducting studies relating to women, contributing to women's legal awareness, and holding workshops and conferences. Its effectiveness is hampered, however, by lack of adequate funding; absence of coordination at a national level; unavailability of data disaggregated by gender; and ambiguity of its goals.

¹ Source: "Environment and Sustainable development Investment Program 2003-2008" EPA, October 2002.

3.1.3 Legal Framework

EIA, in Yemen, is enabled by the Environment Protection Law No 26 of 1995 (EPL). The provisions of this framework law are implemented through Executive Regulations (By-Law 148-2000), issued by a decree of the Council of Ministers.

The Environment Protection Law consists of five chapters and 95 articles. The law's objectives are to protect the environment, to combat pollution, and to protect natural resources, society, human health, and living beings from activities that damage the environment. In addition, the law is designed to protect the national environment from activities practiced beyond the national boundaries and to implement international commitments ratified by the Republic of Yemen in relation to environmental protection, control of pollution, conservation of natural resources, and the protection of such globally important environmental elements as the ozone layer and climatic changes.

To avoid future adverse environmental effects, the law stipulates the incorporation of environmental considerations in economic development plans at all levels and stages of planning for all sectors. It also, requires the preparation of environmental assessment for all projects proposed by government, public, private, and cooperative agencies, and foreign companies. No licenses are to be issued for projects that degrade the environment. However, there is as yet no regulatory framework to support the implementation of the Environment Protection Law and the provision of undertaking environmental assessment for projects is not enforced.

The competent bodies for EIA defined in the EPL are those government bodies with powers under other legislation to approve development activities (e.g. line Ministries). The Environment Protection Council (EPC) was given the responsibility of coordinating the activities of the competent bodies, and providing advice to them. In 2001 the Government transformed the EPC into the Environmental Protection Authority (EPA).

Environmental standards and specifications have been prepared by the former EPC as annexes to the Executive Regulations, covering potable water quality, wastewater quality for agriculture, and ambient air quality, emissions, noise, biodiversity and protected areas. These include standard application forms intended for use by all relevant government bodies.

In addition to the EP law, several new laws related to the environment are in various stages of development. As at the writing of the SEA (October 2003) EPA was preparing a draft proposal for a by-law for the establishment of Protected Areas and reviewing the EPL in order to provide a more participative approach to the environment issues especially in encouraging the participation of NGOs.

More comprehensive general and sectoral guidelines on interpretation of the EP law and regulations have yet to be prepared.

Detailed reviews of the specific legal frameworks for Resettlement, Natural Habitats and Cultural Resources are presented in the *Resettlement Policy Framework*, *Natural Habitats Framework* and the *Cultural Resources Policy Framework*.

3.1.4 Environmental Institutions

3.1.4.1 Ministry of Water and Environment (MOWE)

The Ministry of Water and Environment was created after the election of April 2003. It has the responsibility for managing the water sector and coordinating the existing water agencies

(NWRA, NWSA, etc.), as well as oversight of ecological matters. The re-organization was still ongoing at the time of this report. According to interviews held in October 2003, the water sector of the Ministry will have branches in the Governorates. It is not sure whether this organization will be established also for the environment sector of the Ministry.

Previously, the Ministry of Tourism and Environment (MOTE), created in 2001 with the Republican Decree 329/2001-Article II, had the mandate to manage and organize tourism, with the aim of developing it into a prosperous industry and economic resource, while maintaining and protecting the environment.

3.1.4.2 Environmental Protection Authority (EPA)

EPA, established by Decree 329/2001, is the official and specialized governmental agency for environmental protection and natural resources conservation according to the EPL and other legislation in force, with statutory planning, licensing, monitoring and auditing functions. The headquarters of the Authority is in Sana'a and it has the authority to establish branches in the governorates if prescribed by a Decree from the Minister based on a proposal approved by the Minister of Civil Services and Insurance.

EPA derives from the Environment Protection Council (EPC), established in 1990 with the responsibility of coordinating the activities of the competent bodies and providing advice to them to manage and protect the environment. It was an official organ of the State under the Council of Ministers, which reported to the Council of Ministers on the implementation of the Environment Protection Law.

The aim of the EPA is to ensure that all planned investments in Yemen are sustainable and not in conflict with the long-term preservation of the country's national resources which are the very basis of its economic and human development.

Being a coordinating and consultative body, the EPC had practically no power in enforcing the EPL. Conscious of this fact the Government has taken additional steps to consolidate the administrative framework of the environmental sector by:

- creating the Ministry of Tourism & Environment (2001) and then the Ministry of Water and Environment (2003);
- transforming the EPC into the Environmental Protection Authority (EPA) (2001), as the official and specialized governmental agency for environmental protection and natural resources conservation according to the EPL and other laws in force in Yemen.

As at October 2003, there were EPA branches in Socotra and Aden (dealing with the free trade zone) and small branches in Makhalla, in Taiz and in Hodeidah. A new branch was being installed in Sayu'n (2 persons). At that time it was still not clear whether the territorial distribution of EPA would follow the same pattern foreseen for the Ministry (branches in each Governorate).

The EPA is lead by a Chairman and a Deputy Chairman managing 3 Directorates (Natural Resource; Control and Monitoring; Planning and Environmental Data) and 4 units (Climate Change; Ozone Unit; Women and Environment; Local Environment Issues). The Authority has also 2 departments: one for Legal Affairs and one for Awareness Raising, NGOs and Information.

In comparison with the former EPC (which had just a coordinating role) the new EPA has a clear mandate to implement the environmental legislation and to execute projects with the following objectives:

- Protect the environment and conserve of its balance and maintaining the ecosystems;
- Combat the different kinds of pollution and avoiding any damage or negative impacts of various development projects,
- Protect and develop the natural resources and conserve the life qualities in national environment from the damages coming from outside the national environment;
- Protect the society, human health and other organisms from the different non-environmentally activities;
- Eliminate air pollution and the impacts of climate changes.

The duties and attribution of the EPA to achieve its objectives are the following:

1. Propose and implement policies, strategies and plans for protecting the environment, its components, conserving its balance, its ecosystems, combat the different kinds of pollution and conserving the natural resources from degradation;
2. Prepare national emergency plans to face the natural disasters and pollution in coordination with concerned agencies;
3. Carry out environmental surveys and determine the areas, resources and species, which require the adoption of legal procedures for their conservation. Protect the fauna and flora, wild and marine birds according to the laws in force and monitor their application;
4. Prepare proposals for laws related to environment protection in coordination with MOTE and concerned agencies;
5. Follow up the implementation of established criteria and stipulations by public and private establishments and implement the procedures established by the EPL and other existing legislation in coordination with concerned agencies;
6. Prescribe principles, procedures and terms of environmental impact assessment and review EIA studies of public and private projects to give EPA opinion and monitor their implementation;
7. Prescribe national criteria to protect the environment from pollution, conserve the natural resources and monitor its implementation in coordination with concerned agencies;
8. Implement the international commitments related to environmental protection that has been ratified by the Republic of Yemen according to the existing legislation;
9. Collect the international, regional and national data and information related to the changes on environment and natural resource periodically in coordination with concerned agencies. Assess these data and information to be used in environmental planning and management;
10. Prepare regular reports on environmental status and main environmental indicators in the Republic of Yemen to be published periodically;
11. Propose protected areas and manage them in coordination with concerned agencies according to the existing legislation;
12. Prepare integrated plans for coastal zone management in coordination with concerned agencies;
13. Prepare and implement pilot project to protect the environment and conserve the natural resources;
14. Prepare and implement environmental awareness programs in coordination with concerned agencies;
15. Participate in preparing educational programs to introduce environmental protection concepts in curriculum for different levels in coordination with concerned agencies;
16. Follow up the implementation of international and regional conventions related to the environment in which Yemen has a part; prepare proposal of required laws and programs to be implemented as result of the signed conventions and submit regular reports in coordination with MOTE;

17. Prepare and implement pilot projects and mechanisms to encourage the different activities necessary for eliminating air pollution and the impacts of climate changes;
18. Provide technical consultation to the governmental organizations, public and private sectors in different environmental protection fields;
19. Any other activity assigned to the Authority to achieve its objectives.

3.1.4.3 Other Government Agencies and Local Authorities

Line ministries have no formal structure for administering EIA. They commission EIA studies at the request of funding agencies, from consultancies recommended by the funding agencies. EPA staff is informed of such studies and are invited to participate in meetings. Development proposals, which are not internationally funded, and not subject to funding bodies' EIA procedures, are handled more informally. When competent bodies consider that a project may have environmental impacts subject to the EP law, they request advice from EPA.

There is some experience of managing EIA or EMP for small projects in two organizations, the Social Fund for Development (SFD) and Ministry of Public Works and Highways (MOPW&H).

At present there is no formal role for Governorates or other levels of local government in the EIA process though local government can have a role in development planning, especially in initiating and implementing projects and in securing support through the Governor where appropriate.

Ministries and Government bodies, which may have direct or indirect relationship with RAP implementation, are listed here below:

Ministry of Public Works and Highways (MOPW&H): The Ministry has overall responsibility for planning, construction and maintenance of all roads in Yemen, except feeder roads (Ministry of Agriculture) and earth tracks which are maintained by the Ministry of Local Administration.

Road Maintenance Fund (RMF): The RMF was established (Law No. 22 of 1995) to improve the maintenance of roads and to enhance cost recovery in the road sector. An additional surcharge on the sale of petrol was introduced to provide on an annual financial basis.

Ministry of Local Administration (MOLA): The Ministry of Local Administration is responsible for local administration, including Governorates, district authorities, municipalities, and local councils. The Ministry is also responsible for maintaining earth tracks. The Ministry's role in the RAP will be through the contributions of the local councils in providing guidance for implementing the project's activities in their respective areas. Active involvement of governor's offices in projects site selection will also contribute towards the efficient implementation of the RAP and its EMP.

Ministry of Agriculture and Irrigation (MAI): The Ministry of Agriculture and Irrigation has overall responsibility in overseeing the irrigation sector. Irrigation consumes about 90% of the national available water resources.

National Water Resource Authority (NWRA): Established in 1995, the NWRA is charged with the responsibility of managing, developing, exploiting, and conserving the nation's water resources. NWRA is mandated to prepare basin plans and monitor water resources. The organization has very little enforcement powers in its fields of operation.

Ministry of Culture - General Organization for Antiquities, Museums and Manuscripts (GOAMM): The GOAMM is responsible for conserving cultural heritage, excavation for antiquities, and archaeological sites in addition to the enforcement of the antiquities law.

Ministry of Public Health (MOPH): The Ministry of Public Health (MOPH) - is responsible for the overall health sector in Yemen, including financing, planning, regulation, management, and provision of health services at all levels (specialized hospitals, district and rural hospitals, governorate hospitals, health centres and primary health care units). In principle, all Yemenis are eligible to receive health care in MOPH facilities either free of charge, if indigent, or by paying subsidized user charges for the better-off collected at the facility level. Yemen does not have a compulsory health insurance system. There is evidence, however, of the expanding role of the private sector and NGOs in the delivery of health services.

3.1.4.4 Non-Governmental Organizations (NGOs)

There is at present no official role of NGOs in EIA, except as organized for international funding bodies. There are however a large number of Yemeni NGOs that, in theory, may have a role to play in the EIA process. A list of NGOs that may be relevant to the Rural Roads Project is provided here after:

Table 3.3. Indicative List of Yemeni NGOs active in Yemen

NGO	Area of Activity
Association for Environmental Communicators	Specialized Society
Supporters of the Environment	Specialized Society
Yemeni Environment Protection Society	Increase awareness of environmental issues, coordinate with government and NGOs to implement environmental projects and to promote sustainable development practices especially in Rural areas.
Al Yemen Al Khadhra	Protection of the rural environment
Wildlife Protection Society	Specialized Society
Yemen Ornithological Society	Specialized Society
Urban Development Society	Specialized Society
Welfare Associations	CBOs. Welfare Associations have largely replaced local development associations as the main avenue for sponsoring rural development. Often reflect existing social structures and are marked by strong tribal affiliations
NGO Network for Women	To provide organizational structure for the coordination of work on women's issues and to provide input into development project planning.
Social Organization for Family Development	To provide training and health care to poor women and children
Yemeni Family Care	To provide maternal and child health services and

Association	increase awareness of family care services
Yemeni Women's Union	To improve situation of women, economically, socially and culturally and encourage participation in development

Source: Dorman, et al. 1996

Unfortunately, the reality is that few if any of these NGOs can be considered truly effective at present, or potentially, as key players in the EIA process or the implementation of a sector strategy in the future. There are a number of reasons for this.

First, and most importantly, many of the NGOs are in fact quasi-government agencies and therefore cannot be, and are not, viewed as independent bodies by the population. In effect any NGO operating effectively is perceived to do so only as a result of through government patronage. Secondly, and possibly partly as a result of the restrictions on the independence of NGOs imposed by the law, few NGOs have the ability to organize and manage to a level that suggests they could operate as an effective element in a sector strategy. Finally, the strength of Yemeni traditions and customs and in particular the powerful family, clan and tribal linkages and associated support mechanisms are not conducive to the development of pressure groups or support agencies that are 'unrelated' and independent.

Direct public participation in decision-making commonly takes place through established social mechanisms.

3.1.5 International Conventions

Yemen has international environmental law obligations that are directly related to its national environmental planning activities and concern both the marine and terrestrial habitats. Many of the global treaties were ratified by either the former YAR and/or by the former PDRY. According to the Unification Declaration, the international conventions ratified in this manner remain valid and are applicable to the whole nation.

Yemen is signatory of more than 20 international conventions on environmental issues. Those relevant for the rural road sector are indicated below:

Table 3.4. Environmental conventions ratified by the Government, containing provisions relevant for the rural access sector

Convention	Place & Date of Stipulation	Ratification date in Yemen
Biological Diversity	Rio de Janeiro, 1992	03/12/1995
World Cultural & Natural Heritage	Paris, 1972	07/01/1981
Civil Responsibility for Damage from Oil Pollution	Paris, 1969	04/06/1979

The Yemen Government is concerned about effective implementation and enforcement of international obligations in light of national financial and managerial constraints. Some conventions have not been signed by Yemen due to lack of funds. Ratification of other international environmental conventions has been slow for similar reasons. These include: (i) Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979); (ii) Convention on international Trade in Endangered Species of Wild Fauna and Flora - CITES, Washington, D.C. 1973); (iii) Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971).

Implementation of international treaty obligations invariably becomes the responsibility of a national agency. It appears that, in Yemen, the capacities of national agencies to deal with the technical complexities and reporting requirements of international agreements are not sufficient. For example, Yemen is a party to several international conventions dealing with the marine environment, but does not have sufficient capacity to enforce them. It is clear that the assignment of new responsibilities to an agency to implement international treaties should go parallel with technical and financial strengthening of the agency concerned.

3.1.6 Environmental Applications to the Road Sector

While the Government general environmental policy provides a broad framework for environmental management, there is as yet no environmental policy for the road sector which has left, until now, the sector agencies free to implement roads projects practically without EIA studies.

The current Government Policy in the road sector is mainly related to road maintenance and development materialized in the following projects and programs:

- The Rural Access Program (RAP) with the aim to improve livelihood for the rural population and reduce rural isolation.
- The creation of the Road Maintenance Fund (1995) with the aim to improve the maintenance of roads and to enhance cost recovery in the road sector.
- The Transport Rehabilitation Project -1995- (financed by the World Bank) with the objective is to undertake urgent rehabilitation needs in the roads and civil aviation sectors;

Other aspects related to the road sector policy are embodied in laws and regulations as follows:

- Construction Law No. 19/2002;
- Road safety Law No. 119/1976;
- Weights and Dimension of Transport Vehicles Law No. 23/1994 with its Executive Regulations no. 282/2002;
- The Road Maintenance Law (No.22/1995) with its two amendments n. 7 of 1997 and 27 of 2000.

The lack of a proper sectoral environmental policy leads to the fact that few EIAs for road schemes have been prepared and implemented. In the absence of sector-specific environmental regulatory mechanisms, the Rural Access Program has established an Environmental & Social Management Unit within its Central Management Office (CMO). Through this Unit, the Program has put in place a standard environmental and social management process, tested during Phase I.

3.2 WORLD BANK FRAMEWORK

3.2.1 Safeguards Policy Framework

The World Bank has defined the Environmental and Social Safeguard Policies for all Bank financed projects. The policies of particular relevance for Yemen's Rural Access Program are tabulated below.

Table 3.5. Safeguard Policies Triggered by the Project

	Policy	Reference	Applicability to RAP
1	Environmental assessment	OP / BP / GP 4.01	Yes
2	Natural habitats	OP / BP 4.04*	Yes
3	Pest management	OP 4.09	No
4	Cultural property	OPN 11.03, being revised as OP 4.11*	Yes
5	Involuntary resettlement	OB / BP 4.12*	Yes
6	Indigenous peoples	OD 4.20, being revised as OP 4.10	No
7	Forestry	OP / BP 4.36	No
8	Safety of dams	OP / BP 4.37	No
9	Projects in disputed areas	OP / BP / GP 7.60*	No
10	Projects on international waterways	OP / BP / GP 7.50	No

* These policies will be triggered only if significant issues are identified during individual project screening under the program. Agreed Policy Frameworks (see below) will then apply in the design and implementation of these individual projects.

Because the location of all project roads are not yet known over the ten-twelve year life of the program, safeguards policy compliance will be assured through a programmatic approach. In particular, an Environment and Social Management Process has been agreed and put in place for the identification, screening, implementation and monitoring of all project roads improved under the project. Environmental screening of individual projects could possibly trigger three safeguard policies: Involuntary Resettlement (OD 4.30); Natural Habitats (OP 4.04, BP 4.04, GP); and Cultural Property (OPN 11.03).

Accordingly, the Program's Environmental and Social Framework Agreement contains Policy Frameworks for these three policies, which would be applied when triggered.

* * *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

Chapter 4

ENVIRONMENTAL BASELINE DATA

Chapter 4. ENVIRONMENTAL BASELINE DATA

4.1 OVERVIEW

This chapter assembles, evaluates and presents the baseline data on environmental conditions relevant to the rural roads sector. The following general categories of conditions have been addressed:

- Land resources;
- Hydrology, water resources and climate;
- Biological;
- Air quality and noise;
- Socio-economic and cultural

4.2 LAND RESOURCES

4.2.1 The Resource and its Use

Yemen lies in the south-western part of the Arabian Peninsula between latitude 12° 40' to 19° 00' North, and 42° 30' to 53° 05' East longitude. The country covers an area of some 555,000 km² excluding Rub-Al-Khali, with about 2,000 km of coastline along the Red Sea and the Gulf of Aden. Its altitudinal range extends from sea level up to 3,760 m at Jabel Al-Nabi Shauib, the highest point in the Arabian Peninsula. Yemen is bordered by Saudi Arabia in the north, the Arabian Sea and the Gulf of Aden in the south, Oman in the east, and the Red Sea in the west. Lying in the south-west of the country is the Bab-Al-Mandab Strait which is divided by Mayoon Island into two parts that also controls the pass way to the strait. Socotra Island in the Arabian Sea is the largest Yemeni Island (3,650 km²) and lies some 510 km from the mainland coast. Besides Socotra more than 112 Yemeni islands are scattered in the Red Sea, the largest of which are: Kamaran, Great Hunish, Little Hunish, Zakar, Al-Zobair, Al-Tair, and other smaller islands.

4.2.1.1 Agriculture, Forestry and Fisheries

Three percent of the total area is cultivable (about 16,700 km²). Rangelands together with forest and woodlands comprise 40% of the area. This land is grazed by 5 million sheep, 4.4 million goats and 1.4 million cattle (Source CSO 2001 Statistical Yearbook.) Other land, mostly desert with limited use potential constitutes almost 57% of the total area. This area also includes roads and residential areas.

Table 4.1. Land Resource in Yemen
(Source NEAP, 1996 & CSO 1998 Statistical Yearbook)

Land Use	Area (km ²)	%
Total Cultivable Land	16,700	3
Rangelands, woodlands and forests	222,000	40
Desert, Roads and Residential	316,300	57
Total Yemen Area *	555,000	100

* Note: This figure does not coincide with the total area of the country taken into account by CSO in calculating the population density (about 455,000 km²). The Consultant measured the total Yemen area on the maps and the result is roughly 555,000 km². This is the figure that will be taken into account in this Study.

Out of the about 16,700 km² (1,670,000 hectares) of the cultivable land, 28,15 % is uncultivated as shown in the following table.

Table 4.2. Utilization of the cultivable land
(Source: CSO 2001 Statistical Yearbook)

Land Use	Area (ha)	%
Uncultivated	469.754	28,15
Cultivated		
- Rain irrigation	611.543	36,64
- Flood irrigation	143.892	8,62
<i>Groundwater irrigation</i>		
- Spring Irrigation	35.974	2,16
- Well Irrigation (tube well)	407.695	24,43
Total Cultivated	1.199.104	71,85
Total Cultivable Area	1.668.858	100,00

In 2001, about 55% of the total cultivated area was cropped with cereals. The second major crop was constituted by cash crops (about 17%) as shown in the following tables:

Table 4.3. Main crops in the cultivated area
(Source: Ministry of Agriculture-April 2002)

Crops in the Cultivated Area	Area (ha)	%
Cereals	657.871	54,86
Vegetable	67.376	5,62
Fruits	95.247	7,94
Pulses	52.679	4,39
Cash Crops	208.295	17,37
Fodders	117.636	9,81
Total Main Crops in Cultivated Area	1.199.104	100,00

In respect of fisheries, the following tables describe the main indicators of the industry in the last three years and give an idea of the exploitation of the marine resources in the country.

Table 4.4. Fisheries Production. Annual Capture (Tons)
(Source: Central Statistical Organization, Republic of Yemen)

Prod. Quant. Of Fisheries (Tons)	2000	2001	2002
Surface Water Fish	99,222	122,493	151,905
Deep Water Fish	8,559	7,792	19,591
Other Aquatic Catches	6,157	11,913	8,088

Table 4.5. Fisheries Production. Annual Value (US\$)
(Source: Central Statistical Organization, Republic of Yemen)

Prod. Value of Fisheries	2000	2001	2002
Surface Water Fish	78,926,705	105,789,205	155,357,386
Deep Water Fish	6,710,795	6,193,182	9,913,068

Other Aquatic Catches	8,275,000	23,922,727	22,977,273
Total	93,912,500	135,905,114	188,247,727

4.2.1.2 Mining

Yemen's oil output, which averaged 443,288 barrels per day (bbl/d) in 2002, provides the country's main source of hard currency revenue. The country contains proven oil reserves of 4 billion barrels. Reserves are concentrated in five areas: Marib-Jawf Block 18 (490 million barrels) in the north, East Shabwa Block 10A (180 million barrels) and Masila Block 14 (500 million barrels) in the south, and the Jannah Block 5 (345 million barrels) and Iyad Block 4 (135 million barrels) in central Yemen. The table below gives the details of the country's industrial production in the Oil, Mining and Electricity sectors in the period 2000-20002.

Table 4.6. Industrial Production of Mining, Oil and Electricity (US\$)
(Source: Central Statistical Organization, Republic of Yemen)

Industrial Production	2000	2001	2002
Mining & Quarrying	3,184,347,349	2,866,071,491	2,961,934,028
Oil and Gas	3,174,831,506	2,857,840,909	2,953,977,187
Electricity, Water & Gas	88,237,824	102,425,018	105,428,142

Table 4.7. Top Exports Commodities(US\$)
(Source: Central Statistical Organization, Republic of Yemen)

Top Exports Commodities	2000	2001	2002
Crude Petroleum	3,378,568,182	2,807,295,455	2,814,017,045
Cuttle Fish (Fresh)	9,875,000	12,085,227	9,522,727
Fresh Fish	9,607,955	36,573,864	72,920,455
Coffee not Roasted	11,125,000	11,130,682	10,068,182

4.2.2 Physical Regions

The physiographic characteristics of Yemen are very diverse and consist of high, steep mountains, escarpments, deserts, costal plains and hundreds of Wadis running between the mountains and through the costal plains. The majority of the population concentrates in the Wadis and Highland Plateaus, performing agricultural activities irrigating from the spates flow in the Wadis in the rainy seasons, and from base flow and groundwater. In addition, there are a number of islands scattered within the Red Sea and the Arabian Sea.

The description of the physical regions is important since the geometric characteristics of rural roads are governed by the geo-morphological and topographical characteristics of the area traversed. For example rural roads located in the escarpments are characterized by a multitude of hairpin bends whereas in flat areas they follow rather straight alignments. On turn, the geometric features control the volumes of earth works and therefore the impact on the environment.

The physical regions in Yemen are described employing the same categories utilized in the Land Degradation Project in Yemen and widely utilized by public agencies including RAP CMO². According to these studies, Yemen is classified into 5 physical regions and 16 sub regions as illustrated in the following table (see also *Figure 4.1*).

Table 4.8. Physical Regions of Yemen

² See the Environmental Report for Phase 1

Physical Regions	Sub-regions	Physical Regions	Sub-regions
Mountain Massif	1. Highland Plains	Desert Regions	9. Ramlat As Sabatayn
	2. Western Slopes		10. Rub Al Khali
	3. Eastern Slopes	Coastal Plains	11. Tihama Plains
	4. Southern Slopes		12. Tuban-Abyan Plains
Eastern Plateau	5. Northern Plateau Zone		13. Ahwar-Maifa'ah Plains
	6. Southern Plateau Zone		14. Eastern Coastal Plains
	7. Wadi Hadhramout	Yemen Islands	15. Socotra
	8. Al Ghaydah Basin		16. Kamaran and other Islands

4.2.2.1 The Mountain Massif

The Mountain Massif forms a complex that separates the Highland Plains from the eastern deserts of the Arabian shield and from the Tihama plains in the west. It is a volcanic region with elevations between 1000-3600 m above sea level parallel to the Red Sea Coast, characterized by mountainous terraces and temperate climate with monsoon rains. It includes parts of the Governorates of Sana'a, Dhamar, Taiz, Ibb, Hajjah and areas of Dale'a and Mukairas. Mean temperatures in this region range from 14-32 degrees centigrade while relative humidity ranges from 60-65%. Rainfall ranges from 100-1000 mm except in Ibb and Taiz area where the mean annual rainfall may range from 600-1000 mm.

Four sub-regions are identified within the Mountain Massifs:

- *The Highland Plains:* The sub-region extends from the southern limits of Taiz region through the central mountains to the North of Sa'dah. On turn, this sub-region can be classified into three parts: Northern, Central and Southern Highland Plains. It comprises a series of plains at elevation varying from 2,200 to 2,600 m asl. Rims surrounding the plateaus may rise up to 2,600-2,800 m asl. Within the plains, isolated volcanic peaks and typical mesa/butte structures are present. Extensive gravel fans are common.
- *The Western Slopes:* Which constitute the steep slopes of the foothills beyond the Tihama plain up to the crest of the western escarpment. They comprise a complex topography with extreme variations in relief over short distances. Lower slopes may be as low as few hundred meters and high points over 3,000 m including the highest peak in Yemen and in the Arabian Peninsula (Shouaib Mountain 3,666 m).
- *The Eastern Slopes:* The Eastern slopes lie between 3,000 m and 1,000 m but comprise a much more gentle topography. Changes in relief are generally far less extreme and the exacerbating effects of water-based erosion are relatively muted.
- *The Southern Slopes:* They extend from the Red Sea in the west to the borders of Oman in the east. They consist of groups of mountains, wadis and drains into the Arabian Sea.

Landform and physiographic features throughout the Mountain Massif present a particularly challenging environment for rural roads implementation. This will be reflected in the special measures necessary to build and protect roads on steep slopes, which may involve cuts into the mountainside and safety issues during construction and operational period.

4.2.2.2 The Eastern Plateau

The Eastern Plateau covers half of the country and borders the Arabian Shield along its northern and eastern margins. The area is characterized by an extensive thick sediment layer with slight almost uniform (1° dip) at the surface. It includes the Hadramout-Mahrah uplands and areas from Mareb, Aljouf, and Shabwah. The climate in this area is generally hot and dry in summer and cool in winter. Temperature ranges from 19-40 degrees centigrade and

Relative Humidity ranges from 40-60%.;while rainfall ranges from 60-100mm Elevations range from 1,200 to 1,800 m asl a the main water divides to sea level in the southern plateau zone and to 900 m to the north (towards the Rub Al Khali desert). The principal sub-regions are:

- *The Northern Plateau Zone:* towards the Rub Al Khali, the Plateau becomes wider and then it slopes gradually towards the desert. Its maximum elevation is 1,000 m.
- *The Southern Plateau Zone;*
- *The Wadi Hadramout Plateau:* The elevation ranges from 600m in the Wadi to 1600m in high watershed areas. The plateau slopes gently towards the north where it becomes heavily covered by alluvial sediments:
- *The Al Ghaydah Basin.*
- The relief in the Eastern Plateau is generally moderate to gentle though there are some localised areas of extreme relief associated with structural features (typically reflected in ravines or much broader features) that pose challenges to road construction.

4.2.2.3 The Desert Regions

This includes parts of the northern areas of the country extending to Al-Rub-al-Khali (The Empty Quarter). The climate in these regions is generally dry. Rainfall ranges from 5-10 mm and temperature ranges from 40-45 degrees centigrade in summer and may drop to 20 degrees centigrade in winter. The desert regions include:

- *The Ramlat As Sabatayn Desert:* it is a sand desert lying between Mountain Massif and the Eastern Plateau and has a maximum extent (E-W) of 350 km. Except on the extreme southern fringes, this area is almost devoid of vegetation and moisture.
- *The Rub Al Khali Desert* lies between the northern part of the Mountain Massif and the northern part of the Eastern Plateau. This is an extremely dry and inhospitable area that supports little economic activity.

Within the scarce desert vegetation are included some needle plants such as Aruq Al-Kuthaib, Zeiza, Mawared etc. Some seasonal wadis constitute the habitat for animal grazing and rearing for nomadic settlements. Few road projects are likely to be developed in the desert regions.

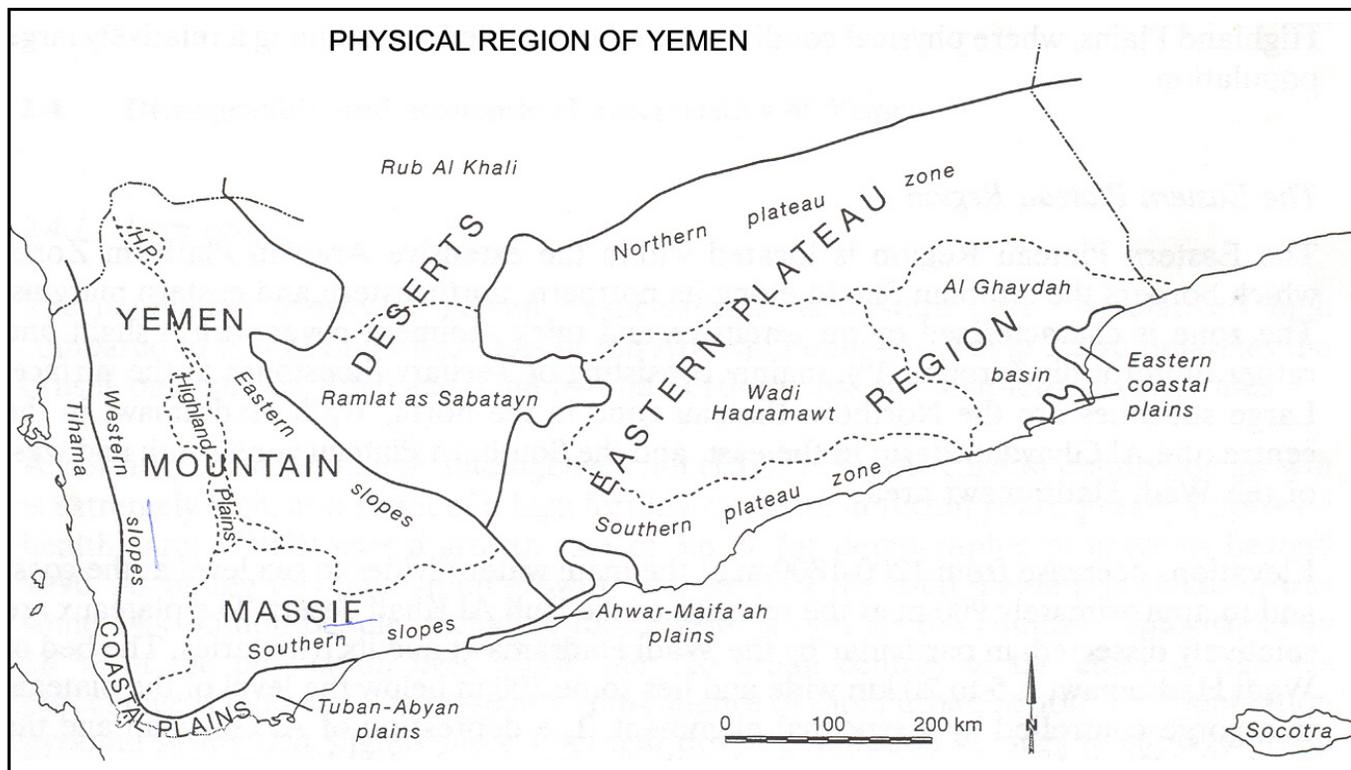
4.2.2.4 The Coastal Plains

This covers almost 16% of the land and stretches inland to about 65 Km. It covers the area of Tihama plain along the Red Sea to the Gulf of Aden and some stretches along the Arabian Sea to the boundaries of the Sultanate of Oman on the East. Rainfall in this area ranges from 70-100 mm and the mean temperature ranges from 25-35 degrees centigrade, while relative humidity ranges from 65-80%.

In broad terms, the Coastal Plains belong to the Western Arabian Rift System, which separates the Arabian from the African plates. They have been down faulted by as much as 2,000 metres and this has resulted in the accumulation of thick sequences of tertiary and quaternary sediments. Elevations are low, usually less than 300 metres and the surface is typically characterized by Aeolian and alluvial sediments, the latter often in the form of large outwash fans. Four areas can be found in the Coastal Plains:

- *The Tihama Plain:* The Tihama plain extends along the Red Sea up to the foot of the central mountains in the east with an elevation ranging from the sea level up to 250 m along the foothills;
- *The Tuban-Abyan Plains:* They extend from East to West starting by the Gulf of Aden and ending by the Arabian Sea below the southern slopes sub-region of the Mountain Massif. The elevation ranges from sea level up to 300m towards the inland.
- *The Ahwar Maifa'ah Plains* extend along the Arabian Sea coast from the southern slopes sub-region towards the southern plateau zone.
- *The Eastern Coastal Plains* are located near the Oman border just below the Al Ghaydah basin.

FIGURE 4.1 PHYSICAL REGION OF YEMEN



The movement of dunes is one of the primary environmental issues related to road development in the Coastal plains.

4.2.2.5 The Yemeni Islands

There are more than 112 small islands, which form part of the Republic of Yemen. Most of them are situated in the Red Sea and Arabian Sea and have their own distinctive climatic, environmental, geographical and natural characteristics. The most populated and famous are the Socotran Archipelago and Kamaran islands.

- Socotra is the biggest island and is famous for being the home of the dragon tree and span wood, some unique trees with significant medical and economic values;
- Kamaran is considered the major inhabited island with some wild animals;
- Mayoon Island has a strategic importance due to its location at the strait of Bab al Manadab.
- A number of other small islands are close to Socotra of which Abdul-Kori Island and al-Akhalween islands (Samha and Darsa) are the major ones.

4.2.3 Geology and Soils

The complex geologic setting of Yemen is the result of regional tectonic (continental drift) forces and events that not only controlled the deposition of sedimentary strata over geologic time, but the character of the present day landscape. These same forces are also responsible for the complicated geologic and hydro-geologic conditions in the Sana'a Basin.

The Arabian Peninsula comprises part of the East African Shield, an extensive region of Precambrian rocks. These rocks were leveled by erosion to a broad peneplain, and subsequently covered by younger marine and continental sediments during the Ordovician, Jurassic, and Cretaceous periods. During the late Cretaceous and early Tertiary, Arabian Peninsula and East Africa were uplifted by regional plate tectonic forces exposing the previously deposited sediments.

The continental plates began to break into separate blocks by a process known as rifting. Faults and other zones of weaknesses in the plates allowed the up welling and eruption of lava and volcanic pyroclastics that covered the new exposed sediment rocks. During the Tertiary, the rifting process continued causing the Arabian Peninsula to drift northeastward, pulling away from the East African plate. The rift valleys of the present day Red Sea and the Gulf of Aden opened between Ethiopia and Yemen. This same process also created the Kenya Rift Valley and caused extensive block faulting of the mountains of Yemen and Ethiopia. The resulting Horst (up thrown) and Graben (down thrown) block structure exhibits displacements of as much as 2 km. This faulting not only placed outcrops of the various basement and sedimentary rocks at different elevations in each mountain range, but also created the regional topographic features in Yemen. To further complicate the geologic setting of Yemen, granite and grandiorite intrusions occurred during the Late Tertiary, causing additional deformation and faulting of the surrounding country rock. Finally, a new phase of volcanism occurred during the Quaternary forming Volcanic Cones, tuff layers, and lava flows that are still visible in the Yemen countryside. As the Quaternary proceeded, these volcanic features were modified somewhat as erosive processes formed the principal drainage, creating terraces and alluvial plains. In the lowlands and eastern plateau areas, aeolian forces created vast dune fields and mobile sheets of sand that cover the Mesozoic sediments, granite intrusive, and basement rocks. Geologically, Yemen comprises successive deposition of sedimentary rock (Wajid sandstone, Kihlan series, Amran series, Tawilah

group and Medj-Zir series) on old Precambrian basement rock, widely covered by igneous rock known as the Trap series. Quaternary alluvium cover is present in lowlands along the wadis and basins, and in places recent volcanoes may be observed. Aeolian deposits cover the desert zone.

As would be expected with its proximity to the Red Sea Rift Fault system, Yemen is moderately seismically active. Number and intensity of local and international earthquakes registered by the National Centre of earthquake Monitoring in Dhamar are shown in the following tables:

Table 4.9. Number of Registered Domestic and International Earthquake Events by Site During 2001

(Source: National Centre of Earthquake monitoring at Dhamar published by the CSO 2001 Statistical Yearbook)

Event Site	Number of events	Event Site	Number of events
Ryeidah (Amrat)	10	Hais (Al-Hodidah)	13
Yerim (Ibb)	1	Haja	27
Aden	20	Dhamar	36
Sana'a	11	Al-Baida	53
Tweilah	34	Yafee+Al-Dhala	94
Al-Mokala	41	Al-Qafr	25
S.W. City of Taiz	38	De-sofal+Al-Oddain	38
Al-Anad (Lahej)	20	Red sea	33
Sada'ah	33	Aden Bay	621
Manakha (Sana'a)	1	International	72
Zabid	5	Total	1,226

Table 4.10. Number of Registered Domestic and International Earthquake Events by Richter Scale

(Source: National Center of Earthquake monitoring at Dhamar, published by the CSO 2001 Statistical Yearbook)

Location	Scale category	Number of events
International	Bigger than (5)	11
Domestic	5-4	38
	4-3	270
	3-2	539
	2-1	249
	Less than (1)	72
Unknown Magnitude		47
Total		1,226

The basic stratigraphy and lithology of Yemen is provided in Table 4.7 overleaf.

The country's soils are generally sandy to silty and loamy in coastal plains region, silty to loamy and clay loamy in the highland region, and low in nitrogen phosphorus, and organic matter. Soil erosion caused by run-off and/or winds is often serious. Sand and dust storms, which generally blast across the lowlands and highlands, promote soil erosion.

Factors of relevance to the RAP implementation can be summarized as follows:

- The region is relatively unstable, subject to frequent seismic events.
- Regional and sub regional geological structures are complex and there are numerous areas of extensive faulting and fracturing.
- Lithology generally poses few constraints to road construction. Difficulties would only be anticipated in case of drifting or mobile superficial dune type deposits on coastal plains and in some exposed hard rock areas, lava fields etc., which can make construction expensive.
- Favorable bedding conditions are not always present and when in combination with very steep terrain and adverse lithology poor bedding conditions will promote landslides / landslips even under relatively dry conditions.
- Soil conditions too are generally favorable with few if any extensive areas of expansive clays or others materials generally unsuited to road construction. Saline conditions may be problematic in some areas.
- Aggregates for road construction are widely found and sands and gravels are generally found in abundance. Shortages of either rock or gravel materials are therefore likely to be very localized.

4.2.4 Land Deterioration

Approximately 3,000 years ago, Yemeni farmers started clearing the hillsides and steep mountain slopes to increase the area of arable land. Terraces were constructed to conserve soil and water, to improve water use efficiency and to increase crop production. The hillsides terraces in Yemen constitute a national heritage and a monument to environmental sustainability and food security in past years. The farming systems schemes so designed were sustained until recently. Similarly, range management occurred in well-balanced operations. The social and economic changes occurred in Yemen in the last 30 years have resulted in changing farming and grazing practices and in rapidly expanding urban areas. This in turn, led to widespread soil erosion and sand encroachment, deforestation, agricultural and rangeland deterioration, and loss of farmland due to urban encroachment. Studies have shown that various deterioration processes, as indicated below, affect the cultivated and uncultivated lands.

Table 4.11. Land Deterioration in Yemen*

Type of Land Deterioration	Area (Ha)
Land deteriorated by salinization	3,372,000
Land deteriorated by wind erosion	6,197,000
Land deteriorated by water erosion	5,582,000
Land deteriorated by road construction	8,000
Total Deteriorated land	15,159,000

* Source. FAO - National Action Plan for Environment and Development (NAPED) - Policies and Guidelines. Compiled by FAO on the basis of information produced by UND Program YEM/92/TO-FAO Rome, 1995

The National Environmental Action Plan (1996) identifies the following concerns in land degradation :

- ③ Soil erosion;
- ③ Deforestation;
- ③ Agricultural and rangeland deterioration;
- ③ Loss of farmland due to urban encroachment and road construction

Soil Erosion. Although soil erosion occurs naturally and has been a major problem in Yemen since the dawn of civilization, the rate of erosion is increasing as a result of the removal of vegetation and unsustainable land-use and farming practices, particularly the development of large-scale irrigation schemes and deterioration of terraces due to inadequate maintenance. Sedimentation also is affecting reservoirs and diversion channels downstream. The areas most seriously affected by soil erosion are Anas, Bani Matter, Wadi Serbah, Hammam Ali, Wadi Afk, Raymah, Wadi Shiras, Wesab, and Wadi Bani. Although there are no quantitative data on the magnitude of soil erosion and the possible increase in erosion as a result of unsustainable land use practices, terrace erosion has emerged as priority resource management issue in Yemen. The collapse of the terrace system also forces rural population off the land and into the cities, which are already suffering from overcrowding.

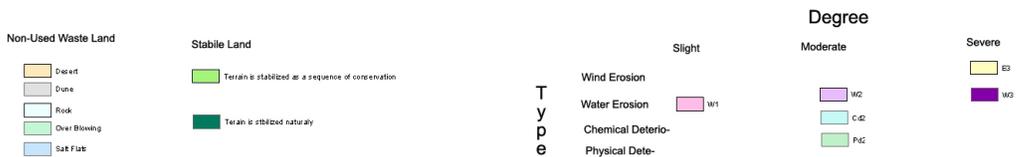
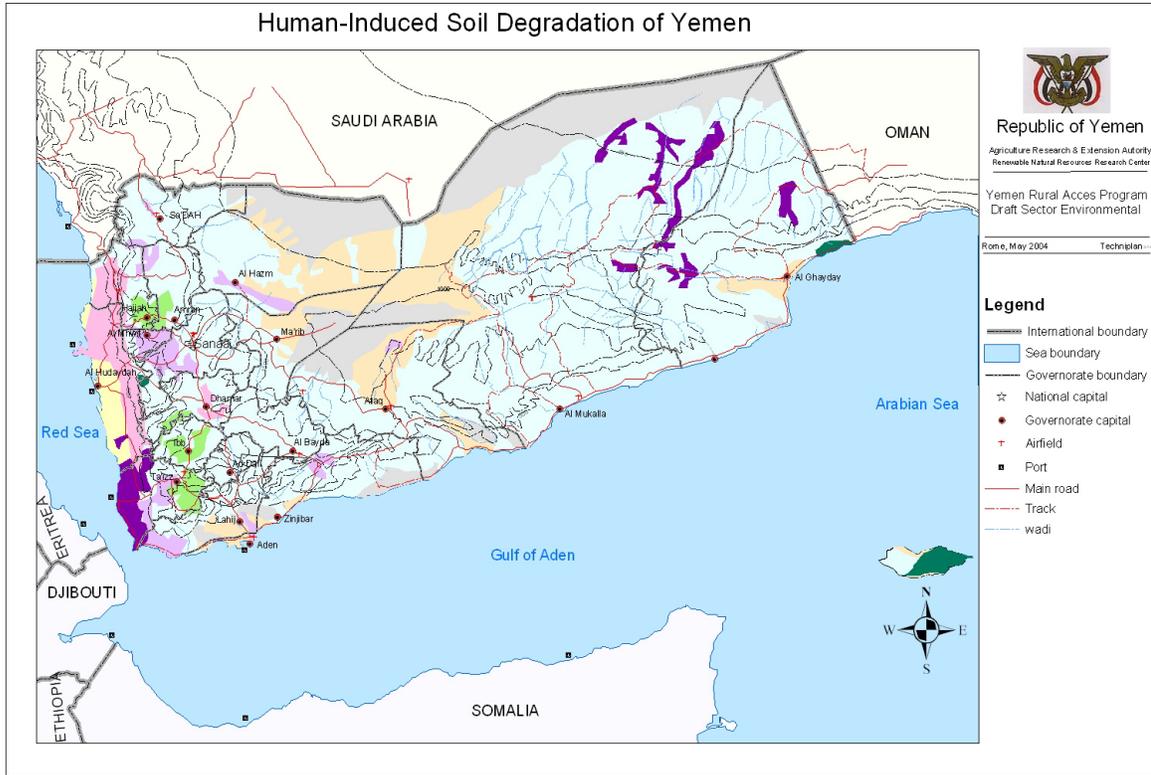
Deforestation. The natural wooded vegetation consisting of wadi and desert shrubs, savannah, and mountain trees has largely degenerated into open woodland or low scattered shrubs due to fuel wood consumption, stock grazing, and clearance for agriculture. Currently the forests are the country's principal source of domestic fuel and account for 90 percent of household energy consumption.

Agricultural and Range Land Deterioration. Information about agricultural and rangeland deterioration is largely inadequate. Currently, there is no basic information on land resources (e.g., arable land, range lands, terraces, sand dunes, soil and ground-cover characteristics), or inventory of national forest resources. In addition, there is no historic data on desertification (e.g., location and extension of sand dunes, movement patterns), on trends in the degradation of terraces (e.g., ownership, sizes, impacts on riparian farms and deltas in wadis, magnitude of soil erosion), or on forest conditions (e.g., location of forest cover). This lack of information is the principal constraint in developing the means for reversing land deterioration.

Loss of Farm Land due to Urban Encroachment and Road Construction. The area of cultivable lands and rangelands in the highlands is rapidly decreasing due to the expansion of cities, especially in the Sana'a area, including new buildings, industrial sites, and roads. In many cases, agricultural land is lost as a result of unplanned and uncontrolled urban expansion. In addition to the random physical expansion of urban areas, damage to lands occurs as a result of indiscriminate construction of roads and other infrastructures and disposal of waste soil.

A Land Degradation Map produced by the Agricultural Research Center of Dhamar (AREA) is attached overleaf as **Figure 4.2**.

FIGURE 4.2 LAND DEGRADATION MAP



4.3 HYDROLOGY, WATER RESOURCES AND CLIMATE

4.3.1 General Information

Yemen lies within the northern stretches of the tropical climatic zone and its border with the sub-tropical climatic zone. The extreme differences in elevation are largely responsible for the great variations in temperature and climate over the different regions of the country. Mean annual temperatures range from less than 15°C in the highland region to 30°C in the coastal plains region. Recorded temperatures may rise to 40°C during summer in the coastal plains region and to over 40 °C in the desert plateau region. However, the winter temperature may fall below freezing in the highlands. Relative humidity may range between the extremely dry 4% in Sana'a to the very high figures of 90-100% with intermediate figures between 16 and 60%.

The country can be broadly divided into three climatic zones:

- Arid tropical climate: This climate covers the coastal plains region and lower mountain slopes in the west and south, and is characterized by high temperatures and low precipitation ranging from 0 to 400 mm.
- Arid sub-tropical climate: This is a transitional climate between the tropical climate of the coastal plains region and the temperature climate of the highland region. Mean monthly temperature varies from 16°C to 28°C. Precipitation ranges from less than 100 mm to 600 mm. It covers the lower and upper mountain slopes and the eastern plateau region.
- Temperate climate: This covers the mountains ranging in altitude from 1,800 to 3,700 m asl. Mean monthly temperature in this climate ranges from 10°C to 18°C. Precipitation varies from 200 mm to more than 1,200 mm.

4.3.2 Rainfall

Rainfall is the basic water resource, and there are marked differences in the amount of rain received in various parts of the country. Rainfall varies from less than 50 mm in the coastal plains region and desert plateau region, to more than 1,200 mm in the western mountainous highland region. The highest and most consistent rainfall occurs in the southern highlands near Ibb/Taiz area. Rainfall is highly erratic in time, quantity, and location. It occurs in two periods, the first from March through May, and the second from July until September, which is the heaviest rainy season. Normally, there is little or no rain from November to February but there are exceptions in certain regions and years. In general, annual rainfall increases with distance from the Red Sea, reaching 150 mm in the Coastal Tihama Plain (Western coastal plain of the coastal plains region), and up to 300-400 mm on the foothills of the mountains. Again, the rainfall increases from south to north and in the western mountainous highlands. Then it decreases in the central highlands towards the capital, Sana'a where it averages to about 200 mm in the northern highlands, then, gradually increases from Sana'a towards Sa'dah.

The spatial pattern of annual rainfall varies from year to year due to the unavailability of long term records with the exception of few stations along the country. Most of which are located in the mountain massif region, Southern and Western Coastal plains and in the Wadi Hadhramout area.

Socotra and the sparsely populated mainland of Al Mahra have only one metrological station each and there are no monitoring stations in the vast desert areas. Hence it is not yet possible to produce a reasonable isohyetal map from the country. Nevertheless, Figure 4.1 was compiled to show the spatial pattern of average annual rainfall for the period of 1985 -1991.

4.3.2.1 Rainfall General Features

Rainfall in Yemen is generated by three meteorological phenomena:

- The Mediterranean Effect: In the winter months, (especially in December and January) the influx of polar air that follows the passage of a depression may trigger light rainfall. However, such events are infrequent occurring on average every 3-5 winter seasons.
- The Red Sea Convergence Zone (RSCZ): The RSCZ is caused by the rapid heating up of land surfaces (relative to sea warming) that gives rise to the generation of onshore winds that are then affected by the convection effects of the Western Slopes. As a consequence humid air masses are lifted and carried eastward to give rise to heavy, but short and highly localised, rainstorms. The RSCZ is at its most influential from March to May, and to less notable effect in the autumn.
- Monsoonal Inter-Tropical Convergence Zone (ITCZ): The Monsoonal ITCZ influences Yemen from July to September when warm dry air from the Arabian (and African) land masses to the North mixes with moist southerlies from the Indian Ocean. The rain producing effects of the ITCZ are most keenly felt on the Western and Southern Escarpments where the triggering orographic effects are most significant. The Eastern Escarpment receives relatively little in the way of rain from the influence of the ITCZ, though as the ITCZ moves north (before retreating south again) areas as far east and north as the Sana'a plain may receive.

4.3.2.2 Rainfall Distribution

The average annual rainfall ranges from less than 50 mm in the coastal areas and the deserts to 200-400 mm on the slopes of the highlands and more than 1 200 mm on the western slopes of the mountains. This demonstrates a clear pattern to the rainfall distribution and in particular the relationship between annual rainfall, relief and exposure to the RSCZ and the ITCZ.

Orographic effects also influence rainfall patterns strongly at the sub regional and local levels with very marked rain shadow effects evident over short distances. Similarly, individual rainfall events are typically convective in nature and quite limited in spatial extent. Even when large storm systems develop in the summer during periods of intensive air mass convergence, very significant variations in rainfall will occur over relatively short distances.

The rainfall data associated with agro-climatic zones are provided in *Figure 4.3* overleaf (Source. AREA- Dhamar).

4.3.2.3 Total Annual Rainfall

Variations in annual rainfall are significant but there are few stations with sufficient records available to provide for detailed assessment. Data for Aden suggest that:

- There is no significant long term trend identifiable;
- There are no well defined cycles of wet and dry year;
- Periods of high relative rainfall appear to have a greater variation relative to the mean than low rainfall periods.

Information from a wider data set (Riyan, Sana'a Shoub and Sana'a Airport, Taiz Town and Taiz Old Airport) seems to confirm the intuitive argument that annual rainfall variation is less in the wetter areas but nonetheless remains very significant.

Recent data (year 2000) on annual rainfall throughout the country are given in the table below:

Table 4.12. Quantity of monthly rainfall (millimetre) in main meteorology stations during 2000
(Source CSO 2001 Statistical yearbook)

Month	Stations									
	Ibb	Al-Hodeidah	Sa'ada	Mari b	Socotra	Sayoun	Al-Rayana	Taiz	Aden	Sana'a
Jan	0.0	1.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	117.4	0.0	42.1	0.0	0.0	0.0	0.0	138.8	0.0	0.0
May	117.0	0.0	29.7	0.5	0.0	0.0	0.5	58.2	0.0	3.2
Jun	123.5	0.0	0.0	0.0	0.0	0.0	0.0	103.3	0.0	0.0
Jul	182.9	0.0	1.6	0.0	0.0	0.0	0.0	112.2	0.0	4.5
Aug	244.3	83.6	4.0	6.4	0.0	2.1	0.0	143.3	1.2	48.7
Sep	125.9	55.2	1.9	2.5	0.0	0.5	0.0	149.2	0.7	0.1
Oct	53.9	16.5	0.0	0.0	26.0	14.5	5.0	134.0	2.4	0.0
Nov	41.7	0.0	6.0	18.4	7.1	0.0	11.6	21.3	1.8	7.4
Dec	0.0	0.0	1.0	0.0	98.0	0.0	1.0	0.5	0.0	0.0
Total	1,006.6	156.3	86.3	27.8	134.6	17.1	18.1	860.8	6.1	63.9

4.3.2.4 Rainfall Types and Intensity

Precipitation in Yemen generally occurs as rain though hail and mist are not uncommon. Snow may be observed in exceptional circumstances on the high peaks.

Rainfall tends to occur as a single storm event per day. Rain events are short, rarely extending beyond a few hours. Data on rainfall intensity is not well documented but TSHWC (Technical Secretariat of the High Water Council) take the view that variations in the duration and intensity of an event in different areas are not great. Their hypothesis is that annual rainfall totals are a function of the number of rain events rather than the duration and intensity of each event.

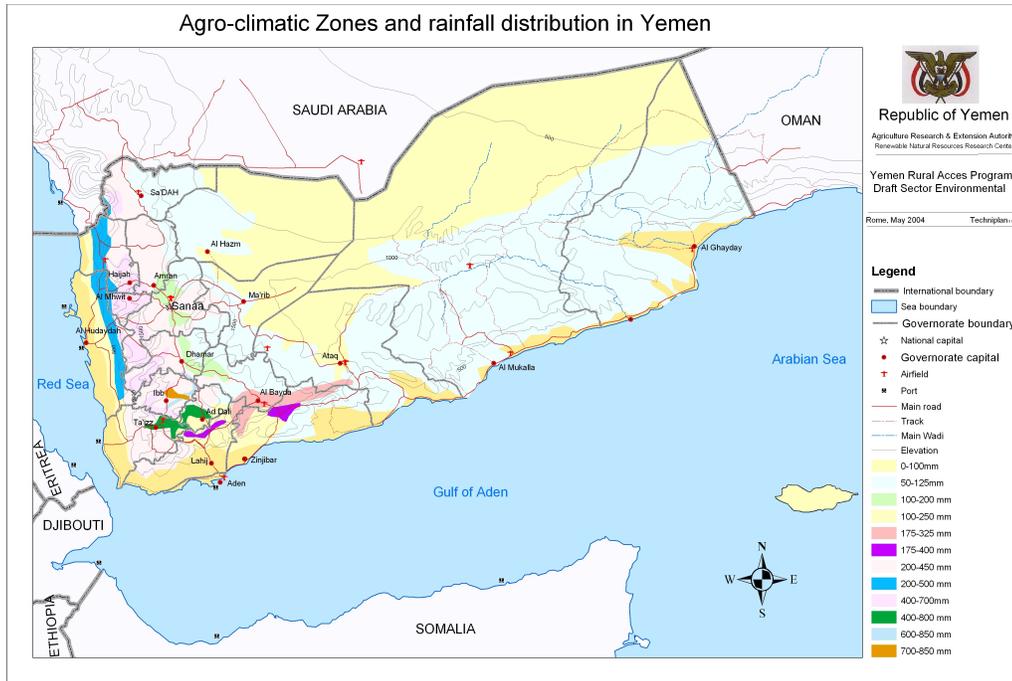
4.3.3 Other Climatic Factors

4.3.3.1 Temperature, Humidity and Wind

In the winter, highlands may experience frosts especially in Sana'a and Dhamar where temperatures fall below 0°C to -4 to -8. Such temperatures may not occur every year but they are not uncommon at higher elevations. High temperatures may reach 25° C with an average of 15° C. Figure 6 shows temperature versus elevation. High temperatures prevail in low lands all year round. The annual average temperature in the coastal plain of Tihama is 30.5° C, the maximum is 45° C and the minimum is 15.0° C. The annual sunshine duration was 2,760 hours during the year 1970 (7.6 hrs on average). The relative humidity ranges from 15% to 98% with an annual average of 65%. Eastern plateau experiences high temperatures of 32° C and as low as 18° C in winter.

Winds tend to be of low to moderate strength except during squall events where they tend to occur in a very short period and they are locally variable and affected by topography. Longer periods of high wind conditions may be experienced in some exposed mountain areas and on the coastal plains where sand storms are quite common.

FIGURE 4.3 AGRO-CLIMATIC ZONES AND RAINFALL DISTRIBUTION IN YEMEN



4.3.4 Notes for Project Development

Notes for project development within the RAP are as follows.

- While annual mean temperatures show no negative month it is common for temperatures to fall well below 0°C to -4 to -8 during winter months. Such temperatures may not occur every year but they are not uncommon at higher elevations;
- Rainfall intensities can be very high (though of short duration) and these combined with the small size of many mountain catchments will generate surface flows and possibly flash floods in extremely short time periods. Poor visibility is also likely to be a concern during storm events;
- The convection nature of the rainfall and orographic effects often generate the fast moving up and down drafts that produce damaging hail. These are noted in the Vegetation Mapping Project Report as being capable of destroying both planted and natural vegetation;
- In many highland areas poor visibility may occur from low cloud /mist cover;
- Winds in Yemen tend to be of low to moderate strength except during squall events These winds tend to be very short lived and extremely variable locally, often very markedly affected by topography;
- Longer periods of high wind conditions may be experienced in some exposed mountain areas and on the coastal plains where sandstorms are quite common.

4.3.5 Hydrology

4.3.5.1 Absorption and Run Off Zones

Yominco-TNO / DGV, in 1983, defined rainfall absorbing zones and run off producing zones in Yemen. In essence these zones define:

- Those areas with limited rainfall, limited relief and a relatively low energy environment that tend to be rainfall absorbing areas. For example the absorptive capacity of the Sana'a Plains is such that rainfall will only escape after rains of the most intense nature.
- Those areas with higher rainfall, greater changes in relief and higher energy environments that tend to produce run off.

However even in run off producing areas most wadis are ephemeral, running only in the period immediately after the heaviest rainfall. Even then surface flow is rapidly infiltrated into wadi beds recharging (at least initially) the alluvial groundwater system.

In some upper wadi catchments extensive terracing of hillsides has been undertaken to more effectively harvest the limited annual rainfall and to stabilize the soils. In catchments so affected surface flows are even further confined. Spate irrigation systems and other water harvesting techniques that seek to retard run are also widely utilized.

4.3.5.2 Principal Catchments

There are seventy-eight major wadi catchments basins in Yemen into which most of wadis drain from the physiographic zones described in § 4.1.1. These catchments are grouped into 4 main drainage basins: Red Sea Basin, Arabian Sea Basin, Gulf of Aden Basin and Ruba'a Al Khali Basin. The description of the 4 basins and their principal wadi catchments are provided here after. A Map showing the Hydrogeology of Yemen with principal catchments is shown in **Figure 4.4** overleaf.

Red Sea Basin: is dominated by three wadis: Sirdud, Siham and Mawr flowing to the west of the continental divide to the Red Sea across the Tihama

- **Wadi Sirdud:** Wadi Sirdud is narrow and confined in its upper reaches, (between 1800 and 2400m). The strong baseflow in this area originates from a number springs emerging in a steep gorge near Ayoun Sirdud and it is considered possible that these waters originate from the Sana'a plain in the Al Jawf catchment. Because the main wadi valley is very narrow, it has only limited potential for irrigation, the majority of water is allowed to infiltrate into the groundwater bodies in the foothills. Nevertheless, upstream of Ayoun Sirdud around Shibam, the entire 100 l/s baseflow is used for perennial irrigation. Despite relatively high rainfall (350 mm or so) no other wadi in the Sirdud catchment produces permanent baseflows. Catchment's area, annual run-off and baseflow of Wadi Sirdud are shown here after:

Catchment's area	2,700 km ²
Annual Run Off	82 Mm ³
Baseflow Portion	62%

- **Wadi Siham:** This catchment is important in the water supply of Hodeidah and much of the intensive agriculture found on the Tihama upstream of traditional flood diversion works. Little is known of headwater basal flows, or, their origins. Catchment's area, annual run-off and baseflow of Wadi Siham are shown here after:

Catchment's area	4,900 Km ²
Annual Run Off	73 Mm ³
Baseflow Portion	68%

- **Wadi Mawr:** Wadi Mawr has the largest Tihama catchment in Yemen, primarily because it is oriented north -south for a large section, rather than east - west. The northern catchments are fairly dry with rainfall of the order of 250 mm or less and topographic mapping tends to suggest that flows are confined to the wadi bed implying quite limited run off flows. The primary sources of flow are therefore thought to be the southern catchments, most notably, Wadi Akraf, Wadi Sharas and Wadi La'ah, with the latter two known to contribute permanent baseflows.

At present the system feeds a large traditional irrigation system on the Tihama that has recently undergone significant modernisation and upgrading. Recent works have also raised waters from springs, 1000 m or more, to feed villages located on mountaintops.

Catchment's area, annual run-off and baseflow of Wadi Mawr are shown here after.

Catchment's area	8,100 km ²
Annual Run Off	129 Mm ³
Baseflow Portion	67%

Arabian Sea Basin: The Arabian Sea Basin is complex. It includes the catchments of the wadis of the Al Ghaydah depression (Wadis Haghawat, Tinhalin, Al Jiza, Fauri and Idunut) and the Greater Hadramout system. In theory topographic conditions allow for rainfall on the Highland Plains near Sana'a to discharge to the Arabian Sea via Wadi Masila. In reality there is no possibility of such an event occurring as surface flow. Accordingly it is common to deal with the Hadramaut system as comprising a number of distinct units.

Primary wadis draining the highland areas are as follows:

- **Wadi Jawf:** The Wadi Jawf catchment comprises two major sub catchments, Wadi Al Kharid to the south, and Wadi Madhab to the north. Between the highland plains and Wadi Jawf itself are the eastern slopes of the Mountain Massif through which the main wadis of the Kharid catchment have cut numerous incised, narrow valleys. The larger tributaries have base flows; Wadi Kharid itself, downstream of spring sources at Samna, Wadi Attaf/ Wadi Hirran and Wadi Hibbash.

In the case of Wadi Kharid, supplementary waters (to spring flows) are rarely obtained from the Sana'a Plains and upstream catchments and thus, the effective catchment is relatively small. On this basis, SAWAS estimate the average annual catchment yield at 350 l/s varying substantially on an annual basis, but normally within the range 175 to 700 l/s. In addition, Jungfer suggests that the catchment area of the Sana'a Plain has been shrinking since the recent and subrecent morphogenesis, with the capture of flows in the headwaters of Wadi Siham and Wadi Sir.

Other surface flow is ephemeral. In some of the drier sections of the region, the efficiency of the terrace interception systems and light rainfall may mean that years may pass before a flow is recorded.

Catchment's area, annual run-off and baseflow of Wadi Jawf are shown here after:

Catchment's area	14,000 km ²
Annual Run Off	150 Mm ³
Baseflow Portion	31%

- **Wadi Adhanah:** Wadi Adhanah is the largest wadi in Yemen that has no permanent base flow. The catchment contains extensive run off absorbing zones on western and southern perimeters and, where the western watershed is less pronounced and the area receives higher rainfall up to 400 mm, agricultural development is intensive.

The only known major spring is in Wadi Hababib in Khawlan but even there surface flows are lost within a few kilometres. Recently the catchment has been dammed to provide water for the Marib Project to provide guaranteed water supplies to an agricultural area previously dependent on spate flows.

The run off producing elements of the lower Hadramout and other wadis are very dry and are dominated by bare rock surfaces or very shallow soils.

Catchment's area, annual run-off and baseflow of Wadi Adhanah are shown here after:

Catchment's area	12,600 km ²
Annual Run Off	100 Mm ³
Baseflow Portion	0%

Gulf of Aden Basin: There are 7 catchments in the Gulf of Aden Basin exceeding 1000 km². From east to west these are Wadi Huwayrah, Hajar, Maifa'h, Ahwar, Hassan, Bana and Tuban. These wadis drain the southern slopes of the Yemen Massif and have very similar characteristics to those draining to the Red Sea. However, these Catchments receive some of the highest rainfall in the country and this combined with the relatively shorter distance to the sea and the generally steeper slopes of the coastal plain make direct discharge to the sea much more common place than in the Red Sea catchment.

Rub Al Khali: Numerous wadis draining to the RAK dissect the northward facing slopes of the Mountain Massif and The Eastern Plateau. The most important are:

- Mountain Massif (West to East) - Najran, Atyfan, Khabb, Amrah and Ghummur.
- Eastern Plateau (West to East) - Hadi, Aywat As Sayar, Makhyar, Khadra Hardah, Qinab, Aywat, Harthuth, Rumah, Dahyah Ba'ut, Arabah, Rakhut, Mitan and Wadi Shihan.

In these Catchments flow is rare and water is rapidly evacuated to sandy areas of the interior where it recharges groundwater. Whether this eventually drains to the Arabian Gulf or is lost to evaporation in the depressions of Al Kidan and Al Mushruq Al Mutardiah is as yet uncertain. Green oases do occur for example in Wadi Najran.

4.3.5.3 Flow Characteristics

The available data for wadi catchments and surface flows have been summarized in Table 4.10 on next page.

Wadi beds are usually constituted by alluvial deposits and are sufficiently wide and long to enable significant losses due to:

- ③ Wetting of the alluvial material and subsequent evaporation and percolation to groundwater;
- ③ Infiltration through the bed material to form under-bed flow;
- ③ Evaporation from flooded banks and wadi terraces;
- ③ Diversion of the flow for irrigation or other water use.

Wadi floods are characterized by very rapid peaks and declines and between floods flows are either absent or comprise only very limited baseflows.

Table 4.13. Average Surface Flows of wadi Catchments in Yemen
(Source: Rypkove, V., 1999, "Water Resources Management Regions of Yemen")

Wadi Basins	Catchment Area (km ²)	Average Annual Surface Flow (Mm ³)
Sana'a Basin	3,200	11
Harad	1,700	35
Najran	4,400	30
Rasian	1,990	12
Mawza	1,600	29
Bana	6,200	170
Hassan	3,000	41
Ahwar	6,410	71
Mawr	8,100	129
Zabid	4,632	125
Surdud	2,700	82
Rima'a	2,750	99
Siham	4,900	73
Tuban	5,060	109.4
Al-Jawf	14,000	150
Jaza'a	15,000	60
Hadramout	46,075	161
Adhanah	12,600	100
Beyhan	3,000	21
Markhah	4,000	24

Mayfa'ah	9,900	54
----------	-------	----

Hydrographs for the most studied wadi in Yemen, Wadi Surdud, provide a profile with a rise in flow from a base of 0.5 to 1 m³/sec to values in excess of 100 m³ (possibly as high as 1000 m³) occurring in 15 minutes.

The initial flow is though to represent rainfall in the immediate area of the recording station. This recedes very rapidly to be succeeded by a second peak associated with rainfall in the upper reaches of the catchment, which is less pronounced, and more spread. Time lags between rainfall and flow are usually from 2 - 8 hours. This profile is not uncommon with most wadis that have been studied or monitored having flood regimes similar to Wadi Surdud. Flood rise times are uniformly very short (always less than 30 minutes) though recession times while generally quite short appear to be linked to catchment size, declining more rapidly the smaller the catchment. A similar pattern for example is also evident for the small Wadi, Qam Attah (catchment 100 km²) located to the west of Rada in the headwaters of Wadi Adhana. Notwithstanding the above, historical flow data for wadis in Yemen is scarce and that which is available is often compromised by the inadequacy of the database available.

4.3.5.4 Conclusions

The following broad conclusions are drawn with regard to hydrological considerations and RAP design.

- Destructive and relatively frequent flash flood events are common in virtually all mountainous areas of Yemen, in a few wadis of the Eastern slopes, across the coastal plain to the south of Taiz and west of Aden and on active outwash fans elsewhere on the Coastal Plain. Beyond these areas, the principal, risks should be factored into design
- In active hydrological areas there are major problems in design. Specifically the inadequacy of the flow database. For most wadis useable flow data is available. Where data is available is usually inadequate for design purposes and/or are in error. Historical flow data should therefore be used only with extreme caution.
- In many upper catchments, water management systems have so radically altered flow patterns that they determine the significance or otherwise of surface hydrology/run off as a design consideration. However in the absence of good flow monitoring data determining the impact of water management systems and thus design flows is extremely problematic.

In conclusion it can be argued that flow estimates derived for virtually any wadi reach in Yemen using empirical data can only be notional. Moreover any further time and effort spent refining such estimate is unlikely to produce more useful or accurate results.

4.3.6 Water Resources

4.3.6.1 General Information

Yemen's renewable fresh water is a finite and constant resource. Its availability per capita falls with as population grows and Yemen's population is growing fast. The availability per capita decreased from 1,098 m³ in 1955, to 460 m³ in 1990, to 137 m³ in 2002, and is expected to further decrease over time³. The key concerns regarding water availability identified in the NEAP (1996) include, inter alia:

³ *Population Action International: Population and Future of Renewable Water Supplies-Washington, 1993 and update 1995. Also based on information available from "Groundwater and Soil Conservation Project (GSCP).*

- Depletion of water resources due to over extraction of groundwater;
- Lack of water allocation and conservation systems;
- Inadequate water supply systems.

Although complete data on the nation and magnitude of the water crisis are not available, the basic trends constitute reason enough for concern. In Yemen's agriculture, water is of crucial importance. In most areas the rainfall is insufficient for rain fed agriculture. Only mountainous areas receive significant rainfall, which provides the water for agricultural areas, either through spate flows or indirectly through pumping from groundwater. Along wadis and in the lowlands, farming depends on surface water diversion and to a limited extent on conjunctive of surface and groundwater. Historically, farmers have built terraces, spate breakers, small dams, etc. to harness runoff water and increase groundwater recharge to a great extent. However, these facilities have deteriorated due to population migration to the cities and the Gulf countries and due to inadequate maintenance.

Surface water resources in Yemen have been estimated at 2,000 million m³/year, but this quantity corresponds to the runoff from major catchments and does not include the runoff produced within the smaller catchments.

Renewable groundwater resources have been estimated at 1.5 million m³/year, a large part probably coming from infiltration in the river beds. A major groundwater aquifer was recently discovered in the eastern part of the country with an estimated storage of 10 km³. This aquifer is still under study and it is not known whether the groundwater is rechargeable or whether it is all fossil water.

73.5% of the Yemeni population lives in rural areas (Source CSO 2001 Population Projections) within and in close proximity of wadis where water may be available. Irrigated agriculture provides most of the rural income. Irrigated agriculture covers an area of about 444,000 hectares. Agriculture as a whole accounts for about 20% of total GDP (about 85% of the value of crop production corresponding to some US\$ 600 million worth) and over 90% of water use. Irrigation efficiency is about 30 - 40% in the country.

Qat cultivation in Yemen has significantly expanded over the past two decades currently consuming 5.5% of arable land and accounts for approx. 20% of the total water use. The rapid expansion in the planting of qat trees is one of the major problems facing the agriculture sector. Official statistics about the scale and the trends of qat production are unavailable. However, several reports and studies indicate that the area used for qat production has nearly tripled over the past 20 years. Recent data shows that the total area planted in qat is estimated at approximately 80,000 ha. In the past, qat was grown on the hillsides and in a wide range of soil conditions, but recently qat is being planted in the irrigated valleys. The trend will seriously affect the availability of water in the future

In most areas, groundwater is being over exploited far beyond the safe levels of annual recharge. At an estimated 90% of water utilization by agriculture, most cities are running critically short of potable water supplies and if unchecked, the capital city Sana'a is due to run out of water from its traditional aquifers within the next 20 years. The water crisis is particularly acute in the western highland part of the country, where groundwater is the main source of water, aquifers are depleting some 1-4 meters per year, and water quality is degrading by wastewater discharge. It is also reported that parts of the coastal aquifers suffer from seawater intrusion. The balance of water resources in Yemen is tabulated here below:

Table 4.14. Water Balance in Yemen
(Source – Biodiveristy Strategy-EPA- 1999)

Supply Side Indicators	Demand Side Indicators
------------------------	------------------------

Rain water quantities	2.0 BCM	Demand for all sectors	2.9 BCM
Rain off from drainage	1.5	Pumping ground water	2.5 BCM
Renewable quantities	2.0 BCM	<i>For irrigation :</i>	
Non – conventional	n.a	Qat trees	800 BCM
		Population demand	Tripled by 2015
		Tube well	More than 45,000

The total dam capacity is estimated at 0.18 km³. In general, the dams are built for irrigation and domestic purposes, but at the same time they contribute to groundwater recharge. There are also many flood control dams, which are not intended to store water, but to divert the spate floods immediately to the adjacent irrigation network (spate irrigation).

4.3.6.2 Irrigation Systems

In most areas of Yemen rainfall reliability is a critical concern. This is reflected in the fact that little or no truly rain fed agriculture is practiced. In virtually all cases some form of rainfall supplementation occurs, be it tube-wells or hand dug wells systems or flood water harvesting. In 2001, the total cultivated area was 1,199,104 with different irrigation systems (Source: CSO-2001 Statistical Yearbook) as shown in the following table.

Table 4.15. Cultivated Land in Yemen by Type of Irrigation (2001)
Source CSO

Type of Irrigation	Area (ha)	%
Rainwater Harvesting	611,543	51.00
Floodwater Harvesting	143,892	12.00
<i>Ground Water Irrigation:</i>		
Spring Irrigation	35,974	3.00
Well Irrigation (Tube well)	407,695	34.00
Total Cultivated	1,199,104	100.00

Three main types of water collection are utilized for irrigation:

- Rain water harvesting: This is based on collecting and retaining (mainly through contour benching terracing) overland flow in zones where soils permit agriculture. The receiving zone is always smaller than the zone from which overland flow is produced, thus a multiplier effect is produced which permits agricultural production in low precipitation zones. The numerous mountain terraces, collect and retain rain and overland flow in a similar way in areas where natural slopes may be excessive, 12% or greater. The further implications for retention and soil stability and erosion have long been recognised and adequately countered by terrace systems. However, recent trends in agriculture have seen some fall off in the maintenance of terrace systems with potential serious long-term adverse impacts.
- Floodwater harvesting (or spate irrigation): Traditionally, farmers in the vicinity of wadis rely heavily on simple earth built diversion systems and irrigation networks. With small spates, these temporary embankments can be effective; with large spates, they are often swept away. In order to give better control of the spate flows, a series of public sector investments, involving the construction of permanent diversion weirs and canal distribution structures,

have been made in the main wadis since the early 1970s. Most of these systems, however, have experienced maintenance and water distribution problems because scheme designs have often conflicted with traditional water rights.

- Ground water irrigation: This comprises an area of about 444,000 ha, all irrigated from groundwater, of which about 408,000 ha from tube wells and 36,000 ha from spring water. In general, new, deeper tube wells replace those that have gone out of production because of declining water tables.

Overall irrigation efficiency is low, between 35 and 45%, depending on field levelling and the water conveyance system used. Sprinkler irrigation and micro-irrigation are found on a limited number of farms and in pilot projects, using water from tubewells and springs. Almost all irrigation is surface irrigation. Efficiency improvements, to say 60%, could be achieved by lining canals and installing pipe distribution for surface irrigation, and to over 80% by adopting sprinkler irrigation and micro-irrigation techniques.

According to the Constitution, flowing and underground water are defined as “res communis”. However, a landowner has “precedence” for water taken from a well on his land. In spring-irrigated areas water can be attached to land in the form of ‘turns’, which give rights to divert the canal into the field for a fixed period of time. The “turn” can however be detached from the land and sold or rented separately. This landowner “precedence” has permitted the private development of deep tube-well extraction, which is “in some ways in conflict with Islamic principles. Islamic and customary law has no precedent for dealing with a new technology that allows landowners to extract (and sell) an unlimited quantity of water from deep aquifers, and modern law has not yet regulated it either.

The distribution of the above data among the Governorates is shown in Table 4.13 below.

4.3.6.3 Summary

The significance of water harvesting to the economy of Yemen and to virtually all rural communities is such that they must be a primary consideration in road design programmes. In this context and given the difficulties associated with estimation of wadi flows it may be argued that placing the emphasis in design at the micro catchment level is probably the most sensible use of resources as failings at this level are more likely to generate severe adverse local impacts.

*Table 4.16. Cultivated Land in Yemen by Type of Irrigation
Distribution by Governorate (2001) - Source CSO*

Governorate (Muhafazat)		Cultivated Land by Type of Irrigation (ha)				
N	Name	Rain Water Harvesting	Flood Water Harvesting (Spate)	Groundwater irrigation		Total Cultivated (ha)
				Spring Irrigation	Well Irrigation (ha)	
1	Al-Beida	13,622	3,205	801	9,082	26,710
2	Al-Dhaleh	n/a	n/a	n/a	n/a	n/a
3	Al-Mahweet	14,738	3,468	867	9,826	28,899
4	Amran	n/a	n/a	n/a	n/a	n/a
5	Dhamar	49,678	11,689	2,922	33,119	97,408
6	Ibb	43,810	10,308	2,577	29,207	85,902
7	Sana'a	115,343	27,140	6,785	76,895	226,163
8	Sana'a City	n/a	n/a	n/a	n/a	n/a
9	Hajjah	31,355	7,378	1,844	20,903	61,480
10	Sa'adah	29,170	6,863	1,716	19,446	57,195
11	Taiz	35,661	8,391	2,098	23,774	69,924
12	Abyan	16,033	3,772	943	10,688	31,436
13	Aden	1,406	331	83	938	2,758
14	Al-Hodeidah	160,613	37,791	9,448	107,076	314,928
15	Laheg	11,144	2,622	656	7,429	21,851
16	Al-Jawf	24,903	5,860	1,465	16,602	48,830
17	Al-Mahrah	541	127	32	360	1,060
18	Hadramout	12,238	2,879	720	8,159	23,996
19	Mareb	46,363	10,909	2,727	30,908	90,907
20	Shabwah	4,925	1,159	290	3,283	9,657
Total		611,543	143,892	35,974	407,695	1,199,104

4.3.7 Water Quality

Water quality is deteriorating in Yemen. Shallow aquifers, especially in urban areas, are becoming polluted and coastal aquifers are subject to saline intrusion. The capacity to plan and implement appropriate responses to water resources problems is undermined by insufficient data. Data on water quality and saltwater intrusion are particularly weak. There are no national water quality standards, although WHO guidelines are generally applied to urban water supply monitoring and FAO standards for water used in agriculture.

Ground-water contamination is pervasive and poses a serious health threat for those dependent on water from private tankers and neighbourhood wells in urban areas. Water resources are contaminated primarily by industrial and residential waste, seepage of wastewater, low pressure, back siphonage, and cross connections. Consequently, many wells, especially those drawing water from shallow aquifers, are contaminated with viruses and bacteria, leaving large segments of the population vulnerable to waterborne diseases. In the poor neighbourhoods, inadequate environmental conditions have led to outbreaks of diseases such as cholera, bacterial dysentery, infectious hepatitis, salmonellosis and typhoid. It is estimated that about 70% of infant mortality is due to waterborne diseases (Source : NEAP-1996).

Surface water is fully exploited and essentially distributed in the upstream parts of watersheds, and only limited flows reach the sea. The immediate impacts include: decline in water quality from diminished dilution of pollutants, seasonal or continuous shortfall in supply of downstream users and increases in salinity in estuaries and other coastal areas.

The quality standards applicable for irrigation water (FAO) and for drinking water (WHO) are listed here below:

Table 4.17. Water Quality Standards for Agriculture (FAO-1996)

Parameters	FAO Standard
Na mg/l	<300
K mg/l	0-2
Mg mg/l	0-50
Ca mg/l	0-200
Cl mg/l	<400
HCO ₃ mg/l	<150
SO ₄ mg/l	0-200
NO ₃ mg/l	0-50
EC us/cm	1500

Table 4.18. Drinking Water Quality Standards (WHO)

Parameters	WHO Standards
EC us/cm	1500
pH	6.5-8.3
P mg/l	04-05
NO ₃ mg/l	0-50
Total Coliform MPN/100/ml	0
Faecal Coliform MPN/100 ml	0

4.4 BIOLOGICAL RESOURCES

4.4.1 Introduction

Yemen is very rich in flora and has a wide range of natural vegetation types, a mixture of species from East Africa, the Sahara-Arabia, and the Mediterranean. The vegetation coverage ranges from 9 to 43% and is dominated by grasses and dwarf shrubs, mainly the herbaceous *Andropogon spp*. Precise data on the status and number of rare and endangered plants in Yemen are not available, however, some 8 species (7 from the island of Soqatra are listed in the IUCN Red Book), plus some 19 additional species are considered endangered at the national level. Medicinal flora is not well documented in Yemen and research on the subject is limited, however, medicinal and aromatic plants are of great interest to rural Yemenis.

Yemen Fauna has a population of 71 recorded land mammal species including bats five species of gazelle have been recorded, four of which are believed to be almost extinct in the country. Other species are ibex, oryx, baboon, red fox, wolf, hyena and jackal. Amongst the most notable is the Arabian Leopard, which is considered endangered or already extinct and the cheetah, which has not been seen in the wild since 1963.

Yemen is very rich in bird life and more than 350 species have been recorded. The presence of a wide variety of habitats and strategic positioning at the transition of three geographic regions make the country an ideal stopover in the flight paths of migrant birds, notably birds of prey and waders.

The major threats to flora are cultivation and poor agricultural practices, wood cutting for timber, firewood and charcoal, over grazing, soil salination, wind erosion and expansion of villages and cities. The major threats to fauna are over hunting, killing of animals perceived as dangerous such as snakes, and destruction of habitats through deforestation and urbanization.

4.4.2 Terrestrial Biodiversity

4.4.2.1 Habitats and Floristics

The geographical position of Yemen and the diverse topographical features, which resulted in different ecosystem types, have given the country a great diversity of natural environments and a high level of biodiversity. Yemen is very rich in its flora and has a wide range of natural vegetation types. The vegetation of Yemen is a mixture of the East African Highlands, Sahara-Arabian regions, the Mediterranean regions and has its own endemic flora. The main natural habitats and vegetation areas⁴ in Yemen can be summarized as follows.

1) Coastal Plains: Seven vegetation types have been recognized in the coastal plains:

- a) *Avicennia marina* association: *Avicennia marina* forms mangrove swamps and occurs along the Red Sea coastal fringe, mainly north of the Wadi Siham outlet. Isolated swamps are also seen north at Yakhtol (southern Tihama) and around Bir Ali (west of al Mukalla). These mangroves serve to protect the coast from marine erosion, are valuable nursery area for fisheries and have many uses for man. Mangroves of Yemen are threatened by over-exploitation in Yemen. Occasionally other plants such as *Aeluropes lagopoides*, *Suaeda* spp. and others can occur in this association.

⁴ After Scholte, P.T., Al Khulaidi, A.A. & Kessler, J.J. (1991); Al Khulaidi, A.A. (1996); Al Khulaidi, A.A. & El-Ghuri, M. (1996).

b) *Suaeda fruticosa* shrubland: This habitat is found along flat areas on the coast, often on mud flats known locally as Sabakha and covers an area from shore line to about 5 km inland. *Suaeda fruticosa* and *Aeluropus lagopoides* are the most common species in this habitat. The following vegetation types have been found:

- *Halopyrum mucronatum-Suaeda fruticosa* type is a dwarf shrubland and grassland
- *Aeluropus lagopoides-Suaeda fruticosa* type is a grassland
- *Suaeda fruticosa-Odysea mucronata* type is a dwarf shrubland

c) Sandy plains covered by shrubland: Sandy plains cover most of the coastal area and may reach up to 5-20 km to 20-40 km inland. The vegetatin cover ranges between 6% to 27%. Many sandy hummocks covered by vegetation are found in numerous locations. Many vegetation types composed of shrubland, dwarf shrubland and grassland dominated by *Panicum turgidum*, *Suaeda fruticosa* and *Odysea mucronata* are found in this habitat.

d) Sand dunes area: This unit is a degraded form of the previous unit. The vegetation cover is very low (less than 5%). A sparse grassland dominated by *Odysea mucronata* and *Panicum turgidum* with Association of *Dipterygium glaucum*, occasionally *Leptedenia pyrotechnica*, *Acacia tortilis*, *Cassi sinna* and *Cassia italica* can be seen.

e) Gravelly plain areas: These plains are slightly undulating and intersected by wide and shallow wadis or depressions and numerous drainage lines where the dense vegetation is found. Most of these plains are concentrated in southern Tihama (south Wadi Zabid). Many vegetation types dominated by *Lasiurus scindicus*, *Sarcostemma* sp., *Acacia hamulosa*, *Panicum turgidum* and *Commiphora myrrh* and a number of associated species comprise the woodland, shrubland and grassland in this area. The vegetation cover ranges between 12 to 35%. Winds have removed the fine materials, resulting in extensive gravel plains. This habitat is the only part of coastal plains where some natural woody vegetation remains, and is an important source of fuelwood, forage for animals and bees, and a wood supply for construction.

f) *Acacia ehrenbergiana* woodland: This woodland is common in many parts of coastal plains such as wadis, depressions and alluvial fans. Associated species are *Ziziphus spina-christi*, *Panicum turgidum*, *Acacia tortilis* and others. A pure dense stand of *Acacia ehrenbergiana* can be seen in many sites. Most of this entire habitat is protected by owners who use it as a grazing reserve and for supplies of timber, fuelwood and forage for animals and bees. *Acacia ehrenbergiana* woodlands probably covered most of the gravelly plains of northern Tihama plain in the past, but due to human activities such as cultivation, cutting of fuelwood, grazing of domestic livestock and charcoal-making, these woodlands have all but disappeared.

g) *Ziziphus spina-christi* - *Dobera glabra* cultivated lands: These lands are located on plains near the Tihama foothills where scattered trees of *Dodera glabra* and *Ziziphus spina-christi* may be found. On fallow lands of this unit *Dactyloctenium scindicum*, may sometimes occur in dense cover. Cultivated fields provide the main source of forage for livestock, e.g. (sorghum stover and crop residues), but fallow lands (weeds) and harvested fields are also valuable grazing areas. The trees also provide shade and good forage for domestic animals. In general the vegetation of this area is characterized by the herbaceous species, which are valuable forage for livestock such as *Dactyloctenium scindicum*, *Eleusine floccifolia*, *Echinochloa colonum*, *Cynodon dactylon*, *Eragrostes ciliaris*, *Cyperus rubicundus* and *C. rotundus*.

A woodland dominated by *Salvadora persica* - *Tamarix aphylla* is found along wadis. The thickets of *Salvadora* and *Tamarix* are important sources for firewood, forage for

camels and are used as landmarks, fence and hedges and to protect fields adjacent to the wadis from flood erosion.

2) Low altitude mountains

The habitat is very rich in vegetation and important for grazing and firewood collecting. The tree and shrub cover are rich and form an important source of animal forage during dry seasons. For example trees like *Ziziphus spina-christi* and *Dobera glabra* and *Acacia tortilis* are regularly lopped to provide high quality fodder for livestock. Also there is a potential for developing the collection and marketing of *Commiphora* resin. In the past, Yemen was famous for myrrh produced from *Commiphora myrrha* and Balm of Gilled from *C. gileadensis*. Undisturbed reverie forest (e.g. Jabal Buraa) is among the richest habitats in Yemen, with many plants including a number of endemics which have a limited distribution on the Arabian peninsula..

The Huof area is very rich in vegetation and composed of forest dominated by *Anogeissus dhofarica*, *Dodonaea angustifolia* and *Jatropha dhofarica*. The area is rich in species which are endemic to Huf and Dhufar region. Among the important endemic plant species are: *Maytenus dhofarensis*, *Euphorbia smithii*, *Jatropha dhofarica*, *Anogeissus dhofarica* and *Commiphora foliacea*.

A shrubland dominated by *Anisotes trisulcus*, *Cassia italica*, *Acacia mellifera* and *Anisotes trisulcus* are found on dry slopes and foothills with and number of associated species. A forest and woodland dominated by *Trichilia emetica*, *Commiphora spp.* *Anogeissus dhofarica*, *Jatropha dhofarica* and *Euphorbia coneata* are found on rocky slopes, valleys and wadis such as Jabal Buraa, and Huf al Mahara with many associated species..

3) Medium altitude mountains

These mountains are very rich in vegetation and are one of the major habitats where succulent species are most conspicuous, such as the area around Taiz and east of Hammam Ali. A large part of the medium altitude mountains are covered by woodland and shrubland of *Acacia spp.* especially *Acacia mellifera*. Most of the valley bottoms are heavily cultivated, and almost all trees in these valleys are privately owned. The *Juniperus procera* forest in Jabal Eraf is very rich in vegetation and is considered to be the most important vegetation site known in Yemen. It has the highest number of endemic species after Socotra Island.

A woodland dominated by *Acacia asak*, *Euphorbia coneata*, *Cadia purpurea* and *Acacia mellifera* are found on the mountain slopes and hills. Forested areas dominated by *Juniperus procera* are found on moderately steep slopes of Jabal Eraf (al Maqatirah, Taiz) and Jabal Thogan (al Qabbaitah, Taiz), between 1350-1450m. There are many associated species, some of which have not yet been identified and could be new or endemic to Yemen or to the Arabian Peninsula.

A shrubland dominated by *Acalypha fruticosa*, *Euphorbia cactus*, *Euphorbia inarticulata*, *Euphorbia parciramulosa* is found on the slopes of mountains around Taiz, east of Madinat Ashsharq, near Hammam Ali and south Hajjah along with numerous associated species. Most valley bottoms of medium altitude mountains (between 1000-1400 m) are heavily cultivated. Here traditional agroforestry systems are practiced agricultural terraced fields. Trees grow around the edges and inside the fields to provide shade, forage and wood sources. The main trees are *Ficus vasta*, *F. sycomorus*, *F. palmata*, *F. cordata ssp. salicifolia*, *Trichilia emetica*, *Tamarindus indica*, with associated of *Acanthus arboreus*, *Carissa edulis*, *Jasimum grandiflorum* and others. Woodlands dominated by *Acacia etbaica* are found on plains, plateaus and at the base of mountains on moderately steep mountain slopes (between 1400-1800m).

4) High altitude mountains

Trees are very few at higher elevations and most of them are privately owned. Most high altitude mountain slopes are either terraced or appear bare from a distance. Dense perennial grasses grow in many areas in this habitat. The main source of fodder in cultivated areas is sorghum stover and forage crops like *Medicago sativa* (Alfa alfa). The *Acacia origena* woodland areas provide fuel wood and fodder for livestock in the dry season. The region has valuable and high quality of forage for livestock. A grassland or dwarf shrubland dominated by *Acanthus arboreus*, *Barleria proxima*, *Scabiosa columbaria* and *Pennisetum setacem* occur on the steep montane slopes and hills between 1900-2200m, such as east and south east Wadi Mauna (between Maaber and Madinat Ashsharq) and south east Hajjah, Jabal Saber (south Taiz) and Sumara. Woodlands dominated by *Acacia origena* are found near or on cultivated fields of wadis, plains and plateaus or slopes (e.g. Ibb, NE Atturba, Jabal Saber, and Jabal Sumara).

5) Highland plains

Grasses and dwarf shrubs dominate the vegetation of highland plains. The vegetation cover ranges between 9% and 43%. The plains have almost no trees, except on lower slopes and wadis, but these trees are mainly found as scattered or as small groups not more than 5% cover and mainly *Acacia origena*. The dwarf shrub cover is very low (< 10%) in general. Herbaceous cover is relatively high (about 50%) and is dominated by *Andropogon* spp., *Eragrostes pappos*, *Tetrapogon villosum*, *Cenchrus ciliaris*, and on fallow lands *Cynodon dactylon*, *Eragrostes papposa*, *Arisdida adscensionis* are common. Open woodlands dominated by *Acacia etbaica* are found on plains below 1500 m (e.g. Qa al Qaeda). Woodlands dominated by *Acacia origena* are found on mountain slopes and terraces (between 1,950 – 2,250 m).

6) Eastern and northeast mountains

The vegetation cover and forage production of most of areas between 1800-2600 m (east highland plains) is low, probably due to low rainfall and high degree of rock cover. Also this habitat is less cultivated than the montane plains. The characteristic species are *Lavandula pubescens* and *Euphorbia balsamifera*, both species a sign of over grazing. The high altitude regions >1800 m where the grass *Chrysopogon plumulosus* is dominant are the most important grazing areas. Shrub cover is also low, probably the result of intensive collecting of woody species for firewood. The herbaceous cover is high and is dominated by *Andropogon crossotos*, *Chrysopogon plumulosus* and *Tetrapogon villosum*. The high cover of *Euphorbia* spp. is also probably the result of wood cutting or may be due to poor environmental conditions. Trees in the region are privately owned by villages or individuals and occur in rocky areas in the northern and southern highland plains and wadis. Shrubland and dwarf shrubland cover most of the region and are dominated by *Lavandula pubescens*, *Helichrysum somaliense*, *Chrysopogon plumulosus*, *Kleinia odora* and *Psiadia arabica*. Open grasslands dominated by *Andropogon crossotos* occur on plains, hills and mountains around Rada at elevations up to 2600 m. An open woodland dominated by *Acacia nilotica*, *Cadia purpurea*, *Acacia oerfota* and *Commiphora myrrha* occurs on plains, mountains, wadis and hills adjacent to the desert and in the northeastern and southern part of al Baydha governorate, or in depressions at elevations between 1800 to 2000 m. Large trees such as *Brreonadia salicina*, *Trichilia emetica*, *Tamarix indica*, *Ficus* spp. and *Ziziphus spina-christi* characterize the Wadis.

7) Eastern desert

Most of the region consists of an aeolian sand dune plain in which fragments of tuffic basalt and scattered volcanic cones occur. Under these conditions the only plants which can survive are those which are able to absorb the water that has infiltrated deep into the soil, such as *Panicum turgidum* which is the dominant species of this habitat (the same case at the

coastal plains). Locally this plant forms pure stands of grassland. On saline soil near wadis the main species are halophytes such as *Desmostachya bipinnata*, *Suaeda aegyptiaca*, *Salsola imbricata* and *Tamarix aphylla*. The deposition of the alluvial materials adjacent to the wadi provides favorable conditions for sparse shrubs dominated by *Aerva javanica* and *Rhazia stricta*. This condition can be observed along the edges of wadis, but the vegetation gradually decreases as one moves from these edges to the gravely or sandy plains. In deep drainage lines that dissect the mountains or on wadis, a sparse woodland can be found, the dominant species here being *Acacia tortilis*, *Chrysopogon plumulosus* and *Aerva javanica*. *Acacia tortilis* provides excellent firewood and the leaves and pods are an important source of fodder for domestic animals during the dry season. Perennial grasses like *Pennisetum sp.*, *Panicum turgidum* and a dwarf shrub species are an important fodder for livestock in the rainy season. Undisturbed *Acacia tortilis* woodlands can still be found in different wadi beds.

Orchard-like *Ziziphus spina-christi* growth represents is a valuable method of cultivating fodder and provides high quality animal forage in the dry season, it also providing building materials, firewood, forage sites for bees; the fruits are eaten which are sold in local markets. The vegetation cover is very low in the region, and only few trees can be found in most parts. This could be a natural phenomenon.

A grassland-woodland association dominated by *Acacia tortilis*, *Panicum turgidum* and *Aerva javanica* occurs on wadis, drainage lines, along the edges of the wadi and sand dunes. A sparse shrub-woodland dominated by *Suaeda aegyptiaca* and *Salsola imbricata* occurs on undulating to almost flat, slightly saline soil areas (northern west Marib).

8) Socotra Island

Socotra Island lies at about 3625 km off the northeast corner of Africa (between latitude. 12° 19' to 12° 42', and longitude 53° 20' to 54° 30'), which is part of Hadhramot governorate. It can be divided into three main topographical zones: (1) coastal plains, (2) a limestone plateau, and (3) mountains; the elevation ranges from sea level to 1519m. The coastal plains and low inland mountains are covered by open shrubland dominated by the *Croton socotranus*, *Cissus subaphylla*, *Jatropha unicostata*, *Pulicaria stephanocarpa*, *Dendrosicypos socotrana*, and *Adenium obesum* subsp. *sokotranum*. Some 828 plant species have been recorded so far from the island, and of these about 270 are endemic. The following vegetation associations can be found in the island:

Limonium axillare - *Atriplex griffithii*
Croton socotranus - *Cissus subaphylla*
Aizon canatiensis - *Salsola sp.*
Salvadora persica - *Cissus subaphylla*
Indigofera nephrocarpoides - *Panicum rigidum*

At low and middle elevations (500-600m) we find a shrubland or woodland dominated by the following species: *Dracaena cinnabari*, *Buxus hildebrandtii*, *Croton socotranus*, *Heliotropium nigricans*, *Corchorus erodiodes*, *Trichocalyx obovatus*, *Rhus thyrsiflora*. At middle elevations on the plateau (about 650m) a dwarf shrubland dominated by *Aloe perry*, and *Corchorus erodiodes* can be found.

At higher elevations a woodland dominated by *Dracaena cinnabari*, *Buxus hildebrandtii*, *Croton sp.* and *Rhus sp.* can be found. In the valleys a thicket trees and shrubs are found, with the characteristic species being *Tamarix sp.*, *Ormocarpum caeruleum*, *Mussoenda capsulifera*, *Jasminum grandiflorum*, *Porana obtusa* and others. Many plants are used for the purposes of dyeing such as *Gaillonia tinctoria*, *Indigofera*, and *Rocella tinctoria*. Among important and valuable species are the Dragon's Blood Tree *Dracaena cinnabari*, which is found on the high altitude plateau and mountain grasslands (gum-resin exudes in

tears from the stem of the Dragon's Blood Tree). Other gum-resin producing trees are *Boswellia* spp. and *Aloe perry*.

4.4.2.2 Wetlands

Yemen's wetlands can be divided into natural and man-managed systems. The first category includes four subdivisions:

- Marshes and lagoons, around Aden, which form a suitable refuge for several species of birds.
- Mangrove sites in the Tihama "west coast of Yemen" and Bir Ali mangrove site on the southern coast.
- Valleys and permanent streams all over the country which support all kinds of freshwater biodiversity, including microorganisms, various invertebrates, fish, amphibians, birds, and many plant species.
- The swamps of Taiz, the only known site in Yemen for the globally threatened Bald Ibis *Geronticus eremicus*.

The man-managed systems, on the other hand include the lake of Marib Dam, which is the largest freshwater body within the Arabian Peninsula. This lake can play an important role in the conservation of large numbers of freshwater species.

4.4.2.3 Vegetation

The flora of Yemen is very rich and heterogeneous. Species diversity is a result of considerable climatic changes in former periods, which enabled different species to survive in the different ecological habitats. Over 3000 plant species are possibly found in the mainland, and about 10% of them are endemic. One checklist⁵ comprised 467 plant species belonging to 244 genera from 71 families. Socotra Island is unique in its flora and like many oceanic islands, has a high level of endemism. The latest study reported that Socotra contains approximately 850 plant species, 254 (about 30%) of which are endemic. Out of the eighteen plant genera endemic to the Arabian Peninsula, ten genera are restricted to the Socotra archipelago⁶.

The majority of endemic taxa in Yemen are associated with mountainous areas, which provide a rich variety of ecological niches and offer a degree of environmental stability during periods of climatic changes. Endemism is generally very high among the succulent plants. The largest numbers of endemic species are found within the Asclepiaceae taking into account the Stapeliad genera (*Carraluma*, *Duvalia*, *Huernia*, and *Rhytidocaulon*). Euphorbiaceae and Aloeaceae also have high percentage of endemism as they include the succulent *Euphorbia* and *Aloe* species respectively. Socotra Island contains about 30% of endemic species.

Precise data on the status and number of rare and endangered plants are not available. Some eight species (seven of these from Socotra) are included in the IUCN Red Data Book as being endangered or rare, and an additional 19 species are considered to be endangered or rare at the national level in Yemen.

The medicinal flora in Yemen is not yet well documented, as research on this subject is still limited. However, medicinal and aromatic plants are of great interest and use to Yemenis. There are accumulated experiences in using these plants as traditional remedies to cure an endless list of diseases in different areas of the country while others are used as cosmetics, condiments, coloring matters and flavoring agents. A list of 224 medicinal and aromatic plants species along with their scientific names, families, vernacular names, distribution,

⁵ Compiled by S. Gabali & A. Gifri, (1990).

⁶ A. Miller, (1999).

active substances, medicinal part and medicinal use has been compiled⁷. A similar study concentrated on the use of medicinal plants endemic to Yemen⁸.

Other uses include 19 species of common trees and shrubs used for fuel wood, seven species used as timber for construction, another 19 species for dune stabilization and a great number of plants (weeds, trees, shrubs, grasses and some succulents) are used by grazing ungulates.

4.4.2.4 Terrestrial Fauna

Yemen has a rich and diverse terrestrial fauna is primarily due to two factors:

- The wide range of habitats in the country that vary from the highest mountains, to the plains, dry sand-deserts, marshes, coastal habitats and volcanic ocean islands;
- The country's position at the juncture of three major biogeographic regions, the Palaearctic, Afrotropical and Oriental regions.

4.4.2.5 Mammals

Yemen has a population of 71 recorded land mammal species represented by eight orders including the bats (See Table 4.17). About one third of the mammals are relatively large-sized species some of which are rare in other parts of Arabia. Five species of gazelle have been recorded in Yemen⁹ the most common being the "Idmi" or Arabian Mountain Gazelle (*Gazella gazella*) which is typically found in Acacia and Savanna-like habitats, but close to barren rocky hills with wadis and depressions that support a scarce vegetation of mainly *Acacia tortoils*, *Leptadenia pyrotechnica* and *Panicum turgidum*. The remaining four species are rare, and are believed to be almost extinct in the country¹⁰. The Rhim or the Goitered Gazelle (*Gazella subguturosa*) is the typical desert gazelle being larger and stouter than the other four species. It is possible that Rhim may still occur in the most remote areas close to the hot desert area of Al-Rub Al-Kahli near the border with Oman. The Dorcas Gazelle (*Gazella saudiya*), the smaller and lighter species with relatively longer horns, formerly inhabited the plains of the interior but has not been reported in recent times, and is believed to be almost certainly extinct in the country. The Queen of Sheba's Gazelle (*Gazella arabica bilkisi*) is known only from Yemen. Four specimens collected in the past few years were represented to be held in a private collection in the State of Qatar¹¹. Two specimens from Ma'bar were currently held in the Field Museum of Natural History, Chicago¹².

Table 4.19. Preliminary record of orders, families, genera, and species of mammals

Order	Family	Genus	Species
Insectivora	2	3	6
Primates	1	1	1
Carnivora	6	11	16
Hyracoidea	1	1	1
Lagomorph a	1	1	1
Artiodactyl a	1	4	8
Rodentia	4	9	15
Chiroptera	8	18	23

⁷ Al-Dubaie and Al Khulaidi (1995).

⁸ Al-Dubaie (1993)

⁹ Al-Jumaily (1998).

¹⁰ Groves (1997).

¹¹ Stauart & Stauart (1997)

¹² Greth et al (1993).

Total	24	28	71
-------	----	----	----

The Ibex (*Capra ibex nubiana*) still occurs in the eastern part of Yemen, inhabiting the difficult rocky slopes in mountainous areas which have served to protect the animals from hunters in vehicles. The Arabian Oryx (*Oryx leucoryx*) is almost certainly extinct in the wild, and there is no evidence that it exists within the accessible terrain in the deserts of northeastern part of Yemen. The Baboon (*Papio hamadryas*) is still found in hilly terrain, preferring rocky slopes usually in the vicinity of permanent water. There has been a serious decline in the Baboon population with the occupation of nearly all water sources and fertile wadis by man.

The Arabian Red Fox (*Vulpes vulpes arabicus*) and the Striped Hyaena (*Hyaena hyaena*) are probably the most abundant mammals in Yemen and inhabit adequately vegetated areas throughout different parts of the country. Although the Striped Hyaena is primarily known as a scavenger feeding on carcasses of dead animals, people in many parts of the country have complained about Hyaenas attacking their domestic animals and raiding watermelon crops in the field. Two other species of foxes found in Yemen are Sand Fox (*Vulpus ruppelli*) a paler and smaller species with larger ears that inhabits the desert, and Blanford's Fox (*Vulpes cana*), similar to the Sand Fox in general appearance but inhabits rocky slopes. Its occurrence in Yemen is not certain. The Arabian Wolf (*Canis lupus arabus*) is found in many areas, especially in the eastern part of the country. The Jakal (*Canis aureus*) is a wolf-like animal and can be found near human settlements.

The Family Felidae has the largest number of members and is represented by 5 genera and 6 species, all of which are considered endangered or extinct. Among the most notable are the Arabian Leopard (*Panthera pardus nimr*), a very rare, if not an extinct mammal in Yemen, which was known to inhabit the rocky slopes of mountainous and hilly terrain. Recent reports indicate that a leopard was captured near the area of Wadeah, and was sent to the United Arab Emirates for a captive breeding program¹³. The Cheetah (*Acinonyx jubatus*) has not been observed in the wild in many years. Ducker saw the last individual in March 1963 in Wadi Mitán. However, there is some evidence that cheetah may still survive in remote areas of the southern part of the country. A stuffed skin of cheeta was seen hanging on a building in Ataq in 1985, and was said to have been killed in the area.

Table 4.20. Extinct and endangered mammals of Yemen (A preliminary estimation)

ENDANGERED		EXTINCT (in the wild)	
Scientific name	English name	Scientific name	English name
<i>Gazella gazelle</i>	Arabian Mountain Gazelle	<i>Gazella arabica bilkis</i>	Queen of Sheba's Gazelle
<i>Gazella subgutturosa</i>	Goitered Gazelle	<i>Oryx leucoryx</i>	Arabian Oryx
<i>Gazella saudiya</i>	Dorcas Gazelle	<i>Acinonyx jubatus</i>	Cheetah
<i>Capra ibex nubiana</i>	Ibex	-	-
<i>Canis lupus arabs</i>	Arabian Wolf	-	-
<i>Canis aureus</i>	Jakal	-	-
<i>Panthera pardus nimr</i>	Arabian Leopard	-	-

4.4.2.6 Birds

¹³ Nabil A. Obadi, personal communication March 1999

Yemen has a very rich bird fauna with more than 363 species thus far recorded representing 18 orders, 61 families and 177 genera. The main reasons for this richness are:

- Presence of a wide array of habitats (mountains, Tihama plains, wetlands and marshes, coastal areas, Gulf of Aden and Red Sea, and agricultural landscapes of many varieties) largely the result of the broad range of elevations and climate;
- Geographic isolation by the sea and deserts, resulting in 13 endemic or near-endemic species;
- Yemen's position at the transition zone of three bio-geographic regions: Afro-tropical, Oriental and Palearctic, resulting in a mixture of species from all three; and
- The country's strategic position at the foot of the Arabian Peninsula, thus acting as an important stop-over in the path of flyways for migrant birds, notably birds of prey and waders.

From the 363 bird species recorded in Yemen, seven groups are of particular importance:

a) Globally Threatened Species:

- Bald Ibis (*Geronticus eremita*): Yemen is probably a vital wintering area for a small population of this species and may possibly even be their breeding ground. The retention of grazing marshes, especially in the Taiz area is critically important.
- White-eyed Gull (*Larus leucophthalmus*): Occurs throughout the year on the coast and may well breed on Yemen's off-shore islands.

The main threats are oil pollution and destruction of nesting colonies through man's activities. Other important species are shown in Table 4.19 below.

Table 4.21. Globally threatened birds found in Yemen

Species	English Common Name	Endemic in Yemen	Restricted Distribution Including Yemen
<i>Aquila clanga</i>	Greater Spotted Eagle		
<i>Aquila heliaca</i>	Imperial Eagle		
<i>Aythya nyroca</i>	Ferruginous Duck		
<i>Crex crex</i>	Comerake		
<i>Emberiza socotra</i>	Socotra Bunting	*	
<i>Falco naumanni</i>	Lesser Kestrel		
<i>Geronticus eremic</i>	Northern Bald Ibis		
<i>Larus leucophthalmus</i>	White-eyed Gull		*
<i>Onychognathus futer</i>	Socotra Starling	*	
<i>Parisoma buryi</i>	Yemen Warbler	*	
<i>Turdus menachesis</i>	Yemen Thrush	*	

b) Species Endemic to Southwest Arabia

Yemen holds significant, and in most cases the major populations of 13 species unique to southwest Arabia. For a small country to be so richly endowed with endemic birds adds greatly to its international significance. With the exception of the Arabian Golden Sparrow (*Passer euchlorus*), all endemic species occur in the highlands.

The Arabian Accentor (*Prunella fagani*) is known only from the highlands of Yemen mainland. The demise of the terracing systems could adversely affect several of the endemics, as the resultant soil erosion will cause loss of trees.

Acacias in the highlands, even isolated trees or clumps, are important for the Arabian Woodpecker (*Dendrocopos dorae*), Yemen Thrush (*Turdus menachensis*), Yemen Warbler

(*Parisoma buryi*), Arabian Serin, (*Serinus rothschildi*), Golden-winged Grosbeak (*Rhynchostruthus socotranus*), and Yemen Linnet (*Carduelis yemenensis*). The distribution of endemic and semi endemic birds in mainland Yemen, Socotra, and two neighboring areas is shown in Table 4.20 Below

Table 4.22. Endemic and semi endemic bird species in Yemen

Species	Endemic to Yemen		Semi Endemic		
	Mainland	Socotra	Yemen	Asir	Dhofar
<i>Alectoris melanocephala</i> (Red-legged Partridge)			*	*	*
<i>Alectoris philbyi</i> (Philby's Rock Partridge)			*	*	
<i>Apus berliozi berliozi</i>		*			
<i>Carduelis yemenensis</i> (Yemen Linnet)			*	*	
<i>Cisticola haesitata</i>		*			
<i>Dendrocopos dora</i> (Arabian woodpecker)			*	*	
<i>Emberiza socotrane</i> (Soqotra Bunting)		*			
<i>Estrilda rufibarba</i> (Arabian Waxbill)			*	*	
<i>Incana incana</i>		*			
<i>Nectarinia balfouri</i> (Balfour Sunbird)		*			
<i>Oenanthe lugens boscaweni</i> (Mourning Wheatear)				*	*
<i>Oenanthe lugens lugentoides</i> (Mourning Wheatear)			*	*	
<i>Onychognathus frater</i>		*			
<i>Otus senegalensis pamela</i> (Senegal Scops Owl)			*	*	*
<i>Otus senegalensis socotranus</i>		*			
<i>Parisoma buryi</i> (Yemen Warbler)			*	*	
<i>Passer euchlorus</i> (Golden Sparrow)			*	*	
<i>Passer insularis</i> (Socotra Sparrow)		*			
<i>Prunella fagani</i> (Arabian Accentor)	*				
<i>Rhynchostruthus socotranus percivali</i>			*	*	*
<i>Rhynchostruthus s. socotranus</i> (Golden-winged Grosbeak)		*			
<i>Serinus menachensis</i> (Yemen Serin)			*	*	
<i>Serinus rothschildi</i> (Olive-rumped Serin)			*	*	
<i>Turdus menachensis</i> (Yemen Thrush)			*	*	
<i>Zosterops socotrana</i> (Soqotra White-eye)		*			

c) Seabirds

The biological richness of the Red Sea and offshore islands of Yemen combine to make an ideal feeding and breeding area for seabirds, notably Red-billed Tropicbird (*Phaethon aethereus*), Masked Booby (*Sula dactylatra*), Brown Booby (*Sula leucogaster*), Sooty Gull (*Larus hemprichii*) and possibly White-cheeked Tern (*Sterna repressa*). The globally threatened White-eyed Gull (*Larus leucophthalmus*) may also breed there. All these species plus many others feed in the relatively shallow inshore waters along the coast of Yemen. Oil

pollution, disturbance from military activities, port developments and planned tourist facilities may all have an adverse effect on the seabirds. The lack of recent information on the status of these birds in Yemen makes specific recommendations impossible. However, priority should be given to an ornithological survey of the offshore islands.

d) Waterbirds

Freshwater habitats are rare in Yemen. Concentrations of ducks and grebes occur in just two areas (both recently created sewage lagoons) but rarely exceed 1000 birds. These, together with the new dam at Ma'rib, may result in a notable increase in the numbers of waterbirds in winter; they have already led to some species breeding for the first time in Yemen.

For wading birds, coastal areas are important, particularly where wadis reach the sea. While comprehensive counts have not been undertaken it would appear that the biologically rich mudflats are particularly important for the following species: Carb Plover (*Dromas ardeola*), Greater Sand Plover (*Charadrius leschenaultii*), Lesser Sand Plover (*Charadrius mongolus*), Sanderling (*Calidris alba*), Little Stint (*Calidris minuta*), Curlew Sandpiper (*Calidris ferruginea*), Bar-tailed Godwit (*Limosa lapponica*), Grey Plover (*Pluvialis squatarola*), and Redshank (*Tringa totanus*). Storks, herons and egrets also occur on passage in small to moderate numbers but no important concentrations have been discovered. White Storks (*Ciconia ciconia*) winter in small numbers at freshwater sites and breeding species include Abdim's Stork (*Ciconia abdimii*) (on Tihama rooftops), Reef Heron (*Egretta gularis*) (coast), Cattle Egret (*Bubulcus ibis*) (trees on Tihama and foothills), Green-backed Heron (*Butorides striatus*) (mangroves), and Pink-backed Pelican (*Pelicanus rufescens*) (mangroves); though none have been censused. Despite the close proximity of many breeding colonies to villages and human activities, there is no evidence of interference or persecution. The highest conservation priority concerning waterbirds is of course the Bald Ibis, mentioned under 'Globally Threatened Species'.

e) Raptors

Raptors frequently suffer more than other species in terms of both indirect (e.g. pesticide pollution) and direct persecution. However neither is common in Yemen. As a consequence there appears to be a healthy raptor population with some 17 resident species and a further 15 occurring regularly on passage or in winter. The limited information suggests that the country is in the path of an important flyway, at least in autumn, for migrant Steppe Eagles (*Aquila rapax*), Buzzards (*Botus* spp.) and Black Kites (*Milvus migrans*) passing from their Palearctic breeding grounds to their main wintering area in East Africa. Clearly there is an international responsibility to ensure that these birds are unmolested.

f) Migrant and Wintering birds

Over 220 species have been recorded on migration in Yemen; mention has been made already of the waders, white storks and raptors. A number of passerines or near-passerines also occur on migration and/or in winter in what appear to be significant numbers. These are Golden Oriole (*Oriolus oriolus*), Bee-eaters (*Merops* spp.), Short-toed Lark (*Calandrella brachydactyla*), Swift (*Apus* spp.), Swallow (*Hirundo rustica*), Tawny Pipit (*Anthus campestris*), Yellow Wagtail (*Motacilla flava*), White Wagtail (*Motacilla alba*), White throated Robin (*Irania gutturalis*), Black Redstart (*Phoenicurus ochrurus*), Redstart (*Phoenicurus phoenicurus*), Stonechat (*Saxicola torquata*), Isabelline Wheater (*Oenanthe isabellina*), Pied Wheater (*Oenanthe pleschanka*), Olivaceous Warbler (*Hypolais pallida*), Menetries' Warbler (*Sylvia mystacea*), Desert Lesser Whitethroat (*Sylvia curruca minuta*), Chiffchaff (*Phylloscopus collybita*), Isabelline Shrike (*Lanius isabellinus*), and Great Gray Shrike (*Lanius excubitor*).

g) The Arabian Bustard (*Ardeotis arabus*)

Within the Arabian Peninsula, Yemen is probably now the only country with a self-sustaining population of Arabian Bustards. This may in fact be partly supplemented by

migrants crossing the Red Sea. The species may be threatened from hunting on the Tihama, the only place where this bird occurs in the country.

4.4.2.7 Reptiles and Amphibians

The herpetological fauna of Yemen is less studied than the mammals and birds, nevertheless new species continue to be discovered and described. Presently the recorded reptiles and amphibians of Yemen include 117 species. Eight are amphibians belonging to four genera, three families, and one order, while the remaining 109 species are reptiles belonging to 54 genera, 18 families and two orders.

The reptiles of Yemen include 71 species of lizards, 28 snakes and three amphibians, all belonging to the Order Squamata, which comprises the largest reptilian group. Turtles (Order Testudinata) are represented in Yemen by six species, one terrestrial species (*Geochelone sulcata*), one freshwater species (*Pelomadora subrufa*) and four species of marine turtles¹⁴.

Table 4.23. Preliminary records of orders, families, genera and species of the classes of reptiles and amphibians in Yemen

Class	Order	Suborder	Family	genus	species
<i>Amphibia</i>	<i>Anura</i>	_____	3	4	8
<i>Reptilia</i>	<i>Squamata</i>	<i>Lacertilia</i>	6	22	71
<i>Reptilia</i>	<i>Squamata</i>	<i>Amphisbaenia</i>	1	3	3
<i>Reptilia</i>	<i>Squamata</i>	<i>Ophidia</i>	7	22	28
<i>Reptilia</i>	<i>Testudinata</i>	_____	4	7	7

The 71 species of lizards recorded in Yemen belong to 22 genera and six families (Table 4.22), and the 28 snake species are shown in (Table 4.23).

Table 4.24. Number of lizard species and their families, recorded in Yemen.

Family	Number of genera	Number of species
<i>Agamidae</i>	3	11
<i>Chamaeleonidae</i>	1	5
<i>Geckonidae</i>	7	34
<i>Lacertidae</i>	5	9
<i>Scincidae</i>	5	10
<i>Varanidae</i>	1	2
TOTAL	22	71

Table 4.25. Number of snake species, and their families in Yemen.

Family	Number of genera	Number of species
<i>Boidae</i>	1	2
<i>Colubridae</i>	12	15
<i>Elapidae</i>	2	2
<i>Hydrophiidae</i>	1	1
<i>Leptotyphlopidae</i>	2	3
<i>Typhlopidae</i>	1	1
<i>Viperidae</i>	3	4
TOTAL	22	28

¹⁴ See Section XXX under Marine Biodiversity for a list of species.

4.4.2.8 Invertebrates

Five classes, 38 orders, 313 families, 1833 genera and 3372 species represent the terrestrial Arthropods in Yemen. Unfortunately all these species are listed in the literature only and by no means can serve for identification purposes. Almost all studies on Arthropods have been made by expatriates, and it seems that specimens were taken abroad for identification and never returned back, neither were duplicates left in any institute in the country. Presently Yemen has no recorded specimens in its collections.

Table 4.26. Preliminary records of classes, orders, families, genera and species of terrestrial arthropods in Yemen

Class	Order	Family	Genus	Species
1-Arachnida	8	52	134	252
2-Malacostraca	1	5	7	11
3-Diplopoda	2	2	2	5
4-Chilopoda	2	4	6	12
5-Hexapoda	25	250	1,684	3,092
TOTAL	38	313	1,833	3,372

The Class Arachnida (scorpions and spiders) is second after the insects in the number of species that have been recorded in Yemen. It is represented in Yemen by eight orders, 52 families, 134 genera and 252 species (see Table 4.25)

Table 4.27. Preliminary record of orders, families, genera and species of the Class Arachnida

Order	Family	Genus	Species
<i>Scorpiones</i>	3	8	19
<i>Amblypygi</i>	1	1	1
<i>Uropygi</i>	1	1	2
<i>Araneae</i>	31	85	160
<i>Opiliones</i>	2	2	3
<i>Acari</i>	8	25	49
<i>Pseudoscorpiones</i>	3	6	7
<i>Solifugae</i>	3	6	11
TOTAL	52	134	252

The remaining invertebrates recorded from Yemen are shown in the following table.

Table 4.28. Invertebrates other than Archnida recorded from Yemen

Class	Order	No. of families	No. of genera	No. of species
<i>Malacostraca</i>	Isopoda	5	7	11
<i>Diplopoda</i>	Polydesmida	1	1	3
"	Spirostreptida	1	1	2
<i>Chilopoda</i>	Scolopendromorpha	2	4	4
"	Geophilomorpha	2	2	3
<i>Hexapoda</i>	25 orders	250	1,684	3,092
TOTAL	30	261	1,699	3,115

4.4.2.9 Sustainable Use of Terrestrial Biodiversity

Several plant species are known to be used for different purposes in Yemen. These include:

- Grazing plants: There is a long list of plants including grasses and weeds, used for grazing by livestock.
- Aromatic and medicinal plants: There is a long list of plant species used in folk medicine as remedy for different disorders. Among the most commonly used plants are *Cassia senna*, (leaves used as laxative); *Ziziphus spina-christie*, (antiseptic); *Lowsonia inermis* (antiseptic and cosmetic); *Mentha longifolia* (for abdominal disorders); *Withania somnifera* and *Solanum incanum* (dental analgesic); and *Anisotes trisulcus* (for kidney stone).
- Wood for fuel, timber and sand stabilization: A number of plant species are used as fuel in rural areas in Yemen. The most common ones include *Accacia* spp., *Acalypha fruticosa*, *Cadia purpurea*, *Ficus* spp., *Rumex nervosus*, *Tamarix* spp., and other plant species. Plants used as timber for construction include *Acacia* spp., *Cordia africana*, *Ficus* spp., *Terminida brownii*, *Trichlia emetica*, and *Ziziphus spina-christi*. Moreover, a few trees and shrubs are used for sand stabilization in windy areas.
- Certain birds, such as *Alectoris* spp., Guinea fowl, pigeons, doves, and bustards are hunted for food, and some game animals are also killed for human consumption.

4.4.2.10 Threats and Constraints

Threats to the Vegetation : The country's vegetation is being drastically reduced by rapid degradation of the environment, a direct result of desertification and droughts, among the oldest global environmental phenomena. These phenomena have increased drastically in Yemen and threaten about 90% of the land and can be attributed to the following:

- a) Cultivation and poor agricultural practices;
- b) Wood cutting for firewood, timber and charcoal;
- c) Over grazing;
- d) Soil Salination;
- e) Wind erosion and Sand dune encroachment; and
- f) Construction expansion in cities and villages.

Threats to Terrestrial Fauna: Threats to terrestrial fauna in Yemen are common to many countries in the regions and are mainly:

- a) Destruction, degradation and loss of habitats;
- b) Over-hunting and proliferation of firearms; and
- c) Road construction opening up avenues into the hinterland.

Threats to Freshwater Biodiversity: Threats to freshwater biodiversity in ranking order of importance include:

- a) Overuse and depletion of water;
- b) Degradation of wetland ecosystems;
- c) Improper application of pesticides;
- d) Use of chemical fertilizers;
- e) Contamination of ecosystems with sewage; and
- f) Contamination by industrial waste.

4.4.3 Coastal Biodiversity

4.4.3.1 Coastal Habitats

Sandy coasts: Sandy shores are predominant along the Red Sea coast of Yemen. Also in some sites along the south coast, sandy coasts offer a very important nesting sites for turtles such as Green turtles (*Chelonia mydas*) and Hawksbill turtle (*Eretmochelys imbricata*) Perim Island, Zugar, the Hanish Archipelago in the Red Sea, Socotra, Sharma and Jethmun beaches in the south of Yemen are reported as important turtle nesting areas.

Rocky coasts: Rocky shores are mainly found along the southern coasts of Yemen (for example: Aden and little Aden, east of Mukkalla). Limestone cliffs are found near sharma bay, at Ras Sharwayn and at Ras Fartak. The ecology and composition of fauna and flora with the rocky shores habitats of Yemen are not well known.

Mangrove swamps: Along the Red Sea coast, mangrove swamps are found mainly north of Al-Urj. Obviously, mangroves have been observed associated with khawrs and sabkhahs. Mangroves swamps are considered as a highly productive natural system and act as nursery and feeding grounds for some important fishery resources, including marine shrimp (K. Hariri, 1998). Mangroves are characteristically found in the intertidal zone and growing along the brackish and seawater shores. They are distributed in the tropics and their latitudinal limits are dominated by low air temperature and sometimes-extreme salinities.

Palm groves: On the Red Sea coast, most of the wadi discharge directly into the sea at several places in Tihama plain, such as Al-Khawkhah. We can found fresh water by digging a few centimeters near the shore, hence we can found palm near the sea water like dom palm (*Hyphaena thebaica*) and date palm (*Phoenix dactylifera*).

4.4.3.2 Coastal Species

Mangroves: Mangroves are important biological features of Yemeni coast, providing the basis for many important marine food chains. The leaves after decomposition result in detritus and bacteria, which provide food for meiofauna, mollusks and crustaceans, including some commercial species of shrimps. They also provide nesting sites for shore and sea birds. They form one of the several recognized critical marine habitats in Yemen.

Two species of mangroves were recorded from the Yemen Red Sea coastal area; *Avicenna marina* (Black Mangrove), and *Rhizophora mucronata* (Red Mangrove). The total area of *A. marina* in Yemen Red Sea form 12% of the coastal strip with 100-200m wide and up to 5m high. The majority of mangrove stands occur to the north of Al-Urj; whereas the large stands occur around the Oreste point of the Yemen/Saudi border and Al-Luhayah/Bahr Ibn Abbas area. *R. mucronata* was recorded from a small island of one hectar area in Khor Kathib near Al-Hudydah.

The conditions along the Gulf of Aden coast are not suitable for mangroves growing. Because the upwelling phenomena which bring the deeper cold water to the surface, which is rich with nutrients cause more turbidity and because the competition with macroalgae, only one instance of a small (less than 1 ha) monospecific thicket was recorded. This is situated 4 km north of Khor Showran near Bir-Ali. There is a crater lake fringed with mangrove. The species is *A. marina*. This species is also recorded from Socotra Archipelago.

Fresh water vegetation: Fresh water vegetation includes those plants, which have a relatively low salinity tolerance and require an almost continuous supply of fresh water. Al-Khawkhah, Yakhtul, Al-Urj and Wadi Al-Mulk (North of Al-Mukha) are suitable areas for growing this type of vegetation in the Red Sea coast and Ahwar, Al-Hiswa in the Gulf of Aden, also in Socotra because the fresh water source is close to the surface (ex. 10cm deep in Al-Khawkhah).

There are four species recorded from the Yemen coastal area of the Red Sea and Gulf of Aden, These are:

- *Phoenix dactylifera* (Date Palm) covers most of the area between Al-Hudydah and Yakhtul in the Red Sea region and Ahwar in the Gulf of Aden.
- *Hypaene thebaica* (Dom Palm) recorded from Al-Urj and Al-Jabanah north of Al-Hudydah.
- Palm like trees *Pandanus odoratissimus* recorded only in Al-Mujaylis and al-Fassah in the Red Sea coast.
- *Salvadora persica* trees (A'arak) dominate between Al-Mukha and Dhubab, also between Ras Qawa'a and Khor Umirah. Many local people use the roots of this tree as toothbrushes.

Halophytes: Halophytic vegetation usually occurs where a fresh ground water supply is limited or absent and where saline intrusion is rare. Five species of halophytes were recorded from the Red Sea coastal area of Yemen, and 16 species were recorded from Socotra Archipelago coastal area. This type of flora has the ability of limiting beach erosion and allows other less tolerant species to germinate Halophytic vegetation supports a variety of fauna such as insects and birds. They also provide nesting places for several sea birds. Moreover, they form grazing ground for goats and camels.

Birds: The Arabian Peninsula is an important "land bridge" between Africa, Asia and Europe for approximately three billion birds, which annually migrates along north-south or east-west routes. A number of these birds can be observed along the coast of Yemen. About 82 species of sea and shore birds were recorded from the coastal area of Yemen along the Red Sea; in which 14 species were endemic to the region. Fifteen species were also recorded from the southern coastal region of Yemen. In Socotra Archipelago a total of 70 species were known to be found, however the following species were endemic to the region:

- 1- *Phalacrocorax nigrogularis*
- 2- *Onychognathus frater*
- 3- *Passer insularis*
- 4- *Fringillaria socotrana*
- 5- *Cyaromitra balfouri*
- 6- *Incana incana*
- 7- *Cisticola haesitata*

Marine Turtles: Marine turtles spend the whole of their life in the sea, except when they come briefly ashore to lay their eggs on the sandy beaches. In general, nesting sites for turtles usually located on restricted beaches of ideal conditions. The suitable supra-littoral zone for nesting must not be prone to the flooding during high tide. Thus, these sites are considered critical to the survival of marine turtles. Nearly, all species of marine turtles are regarded as endangered animals world wide by the IUCN. Four species of turtles were recorded from the Yemeni waters. These species are:

- 1- *Chelonia mydas* (Green turtle)
- 2- *Eretmochelys imbricata* (Hawksbill turtle)
- 3- *Caretta caretta* (Loggerhead turtle)
- 4- *Dermochelys coriacea* (Leatherbacks turtle)

Caretta caretta was recorded from Socotra Archipelago only. In particular, Ras Sharma beach is considered as the most important nesting area for the Green Turtle in the entire Arabian Region, including the Red Sea and Gulf of Aden. Approximately nesting 1,000 turtles were recorded in this area.

4.4.3.3 Threats

The following are considered the major threats to the coastal environment of Yemen:

- Uncontrolled use of coastal zone
- Destruction of coastal habitats and ecosystems
- Spatial conflicts among various users
- Unplanned coastal reclamation
- Liquid and solid waste pollution from sewage, industrial plants, ports facilities
- Agro-chemicals flushed by floods
- Cutting of mangroves for wood and use of mangroves for feeding camels

4.4.4 Protected Areas (Declared and Proposed)

In Yemen there are 36 important ecological sensitive areas 2 of which have been declared Protected Areas (Autma and Socotra), 4 were under declaration as at October 2003 and 30 proposed for declaration. The list of these areas is provided hereafter to together with their characteristics and location (Governorates and Physical Regions).

Table 4.29. List of Ecological sensitive Areas in Yemen
(Source: EPA)*

Status	No	Location	Characteristics	Governorate	Physical Region
Declared	1	Socotra	Protected Area	Hadhrumout	Yemeni Islands
	2	Automa	Protected Area	Dhamar	Mountain Massif
Under Declaration	3	Belhaf – Berum – Bir Ali	Marine Protected Area+Birds	Hadhrumout + Shabwa	Eastern Plateau
	4	Ras Sharma-Jathmun and nearby areas	Green Turtles Protected Area	Hadhrumout	Eastern Plateau
	5	Hawf	Forest – Wild Animal	Al Mahra	Coastal Plains
	6	Jabal Bura'a	Protected Area-Forest	Al-Hudaidah	Coastal Plains
Proposed for Declaration	7	Jabal – Eraf	Forests (Juniper)	Lahj	Coastal Plains
	8	Tarim	Wild Animal Protected Area	Hadhrumout	Eastern Plateau
	9	Qishen	Wetland	Al Mahra	Coastal Plains
	10	Myfa'a	Wild Gazelle	Shabwa	Coastal Plains
	11	Al-Luhaya	Marine Protected Area +Birds	Al Hodeidah	Coastal Plains
	12	Kamaran Island	Mangrove + Coral River	Al Hodeidah	Coastal Plains
	13	Al-Zubair, Zuqar Island, Hunaish Archipelago	Coral River + Biomarine	Al Hodeidah	Yemeni Islands
	14	Aljah – Gulaifigah	Wetland	Al Hodeidah	Coastal Plains
	15	Al-Fas'ah	Wetland	Al Hodeidah	Coastal Plains
	16	Al-Takrir		Al Hodeidah	Coastal Plains
	17	Qataba	Mangrove Protected Area	Al Hodeidah	Coastal Plains
	18	Al-Wahija	Mangrove + Wetland	Al Hodeidah	Coastal Plains
	19	Bahr Ibn Abas	Mangrove + Wetland	Al Hodeidah	Coastal Plains
	20	Yakhtul	Herbs Marine + Mangrove	Al Hodeidah	Coastal Plains
	21	Tihama	Bustard Bird	Al Hodeidah	Coastal Plains
	22	Bany Jabr, Bany Suham	Wild Animals + Plants	Sana'a	Mountain Massif
	23	Jabal Al-Lawz	Bidiversity (Ibex)	Sana'a	Mountain Massif
24	Kussma	Natural Park	Sana'a	Mountain Massif	
25	Raimah	Forests	Sana'a	Mountain Massif	
26	Al-Arem	Biodiversity	Sana'a	Mountain Massif	
27	Al-Ghourira	Wetland	Taiz	Mountain Massif	

28	Bab Al-Mandab	Wetland + Birds	Taiz	Coastal Plains
29	Birds Lake (Aden Coastal Wetlands)	Birds	Aden	Coastal Plains
30	Khour Umairah	Mangrove + Wetland	Aden	Coastal Plains
31	Meedy	Mangrove	Haja	Coastal Plains
32	Chain of Al-Kore Mountains	Wild Animal (Leopard)	Abian	Coastal plains
33	Al-Rivadi	Natural Park	Al-Mahwit	Mountain Massif
34	Al-Dhababia Valley	Wild Anima (Gazells)	Al-Baidha	Mountain Massif
35	Ketfah	Biodiversity	Sa'ada	Mountain Massif
36	Wadia'A	Arabic Leopard	Amran	Mountain Massif

*Note: This list reflects the scientific knowledge of 2003. Additional areas might be added due to new researches.

The Protected Areas already declared include:

- **Socotra**, Socotra Island lies at about 3625 km off the northeast corner of Africa (between latitude. 12° 19' to 12° 42', and longitude 53° 20' to 54° 30'), which is part of Hadramout governorate. Some 828 plant species have been recorded so far from the island, and of these about 270 are endemic. The following vegetation associations can be found in the island:
 - *Limonium axillare* - *Atriplex griffithii*
 - *Croton socotranus* - *Cissus subaphylla*
 - *Aizon canatiensis* - *Salsola* sp.
 - *Salvadora persica* - *Cissus subaphylla*
 - *Indigofera nephrocarpoides* - *Panicum rigidum*
- **Otma** is located in the highlands where variety of flora and fauna exist. The following endemic bird species live in Otma, just to name a few:
 - Arabian Red-legged Partridge *Electoris Melanocephala*
 - Yemen Warbler *Parisomaburui*
 - Arabian Woodpecker *Dendrocopos Dorae*

The 4 areas proposed include (see **Figure 4.5** overleaf for location)

- **Belhaf, Berum and Bir Ali**: it is a coastal shore line area which extends for 75 km in the borders of Shabwa and Hadramout. In particular Bir Ali includes several sites of conservation importance such as:
 - Karif Shoran, a unique habitat, consisting of a volcanic crater lagoon with mangrove vegetation, which is the only site on the southern coast.
 - The three islands of Baraqa, Sikha and Hallaniyah lying less than 10 km off Bir Ali on the Gulf of Aden coast, all important sites for breeding of the endemic Socotra Cormorant (*Phalacrocorax nigrogularis*) and Sooty Gull (*Larus hemprichii*).
- **Ras Sharma, Jathmum and nearby Areas**: A coastal line shore areas in Hadramout having a total length of 50km.
- **Hawf**: This site is located in the southeast part of Yemen in Al-Mahara Governorate at the border of Oman. The area faces the Arabian Sea, has a coastline of some 18km and a relief of 1,800m in its limestone mountains. With its 20,000 ha extension wawf is considered the largest forest in Yemen. The area has rich vegetation and of forests dominated by *Anogeissus dhofarica*, *Dodonaea angustifolia* and *Jatropha dhofarica*. The site is rich in species endemic to the Huf and Dhufar regions. Among the important endemic plant species are: *Maytenus dhofarensis*, *Euphorbia smithit*, *Jatropha dhofarica*, *Anogeissus dhofarica*, *Commiphora paliacea*. The major floristic communities of Huf include:
 - 1) *Anogeissus dhofarica*-*Jatropha dhofarica* community

- 2) *Dodonaea angustifolia* community
- 3) *Acacia etbaica* community
- 4) *Maytenus dhofarensis* - *Dodonaea angustifolia*
- 5) *Allophylus rubifolia* - *Dodonaea angustifolia*

The area is important for grazing; there are traditional rules by which the local people protect the vegetation, including controls on cutting of green wood.

- **Jabal Bura'a:** The site is located in the Tihama foothills about 20 km southeast of Bagel. The altitudinal range falls between 400-2000 m. Jabal Bura'a is 4,100 ha large and is considered to hold some of the richest habitats in the entire Arabian Peninsula. The main vegetation communities are:
 1. *Antsotes trisulcus* community
 2. *Maytenus sp.*
 3. *Acalypha fruticosa* community
 4. *Abrus bottae* community
 5. *Acacia asak* community
 6. *Commiphora kataf* community
 7. *Combretum molle* community

There are other 30 sensitive areas which vary in locations throughout all physical regions of Yemen. The variety in locations provides variety of species in term of wildlife, birds, plants, mangrove, forests and wetland with rich biodiversity in each site. Some sites are of particular importance for avifauna conservation and consideration needs to be given to afford better protection for the birds in these areas. These include:

Al-Luhayah: This is an area of some 30,000 ha located on the Red Sea coast that stretches for about 90 km from Midi near the Saudi border to Al-Luhayah. The site contains a well-developed mangrove fringe, extensive sand bars and mudflats, several seagrass beds and some coastal vegetation. The area is very important for migratory waterfowl and provides good habitat for at least three globally threatened animal species including the Green Turtle (*Chelonia mydas*), Dugong (*Dugon dugon*) and White eyed Gull (*Larus leucophthalmus*).

- **Bird lakes-Aden Coastal Wetlands (lagoon, marshes and beach):** The wetlands surrounding Aden city consist of:
 - a. marshland covering an area of 50 ha which receives the run-off of the swage treatment plant located nearby;
 - b. an artificial lagoon of the swage treatment plant;
 - c. four large lagoons on the west side of the Aden peninsula;
 - d. large intertidal flats; and
 - e. sandy beaches and rocky cliffs.

The Aden Coastal Wetlands are considered to be one of the most important sites for migratory birds and regularly host over 10,000 waterfowl including three globally threatened and 12 regionally important species populations (Table 4.28). The site meets the conditions of the International Ramsar site and Bonn Conventions. Among the most significant species found in the area are Lesser Flamingo (*Phoenicopterus minor*) with 9200 birds counted on the last census (in 1996), the largest concentration any where in the Middle East. Other important species include Great Spotted Eagle (*Aquila clanga*), Imperial Eagle (*Aquila heliaca*), and Crab Plover (*Dromas ardeola*).

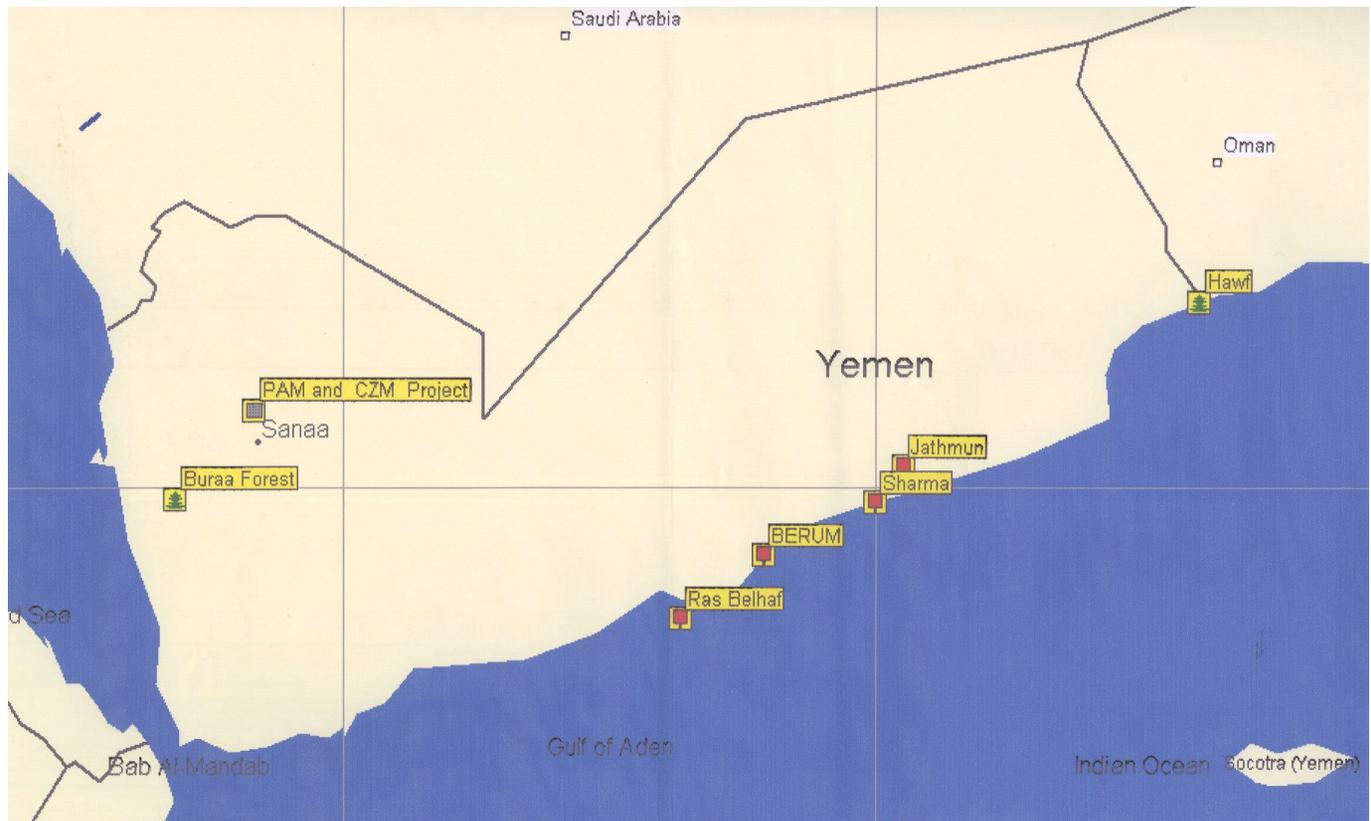
Table 4.30. Globally threatened and regionally important bird species populations found in Aden wetlands

Globally threatened	Regionally important species populations
---------------------	--

Scientific name	English name	Scientific name	English name
<i>Aquila clanga</i>	Great Spotted Eagle	<i>Phoenicopus minor</i>	Lesser Flamingo
<i>Aquila heliaca</i>	Imperial Eagle	<i>Phoenicopus ruber roses</i>	Larger Flamingo
<i>Larus leucophthalmus</i>	White-headed Gull	<i>Dromas ardeola</i>	Crab Plover
-	-	<i>Larus hemprichii</i>	Sooty Gull
-	-	<i>Platalea leucorodia</i>	Spoonbill
-	-	<i>Tringa tetanus</i>	Redshank
-	-	<i>Egretta gularis</i>	Reef heron
-	-	<i>Sterna caspia</i>	Caspian tern
-	-	<i>Sterna nilotica</i>	Gull-billed tern
-	-	<i>Sterna bergii</i>	Swift tern
-	-	<i>Limicola falcinellus</i>	Broad-billed sandpiper
-	-	<i>Himantopus himantopus</i>	Black-winged stilt

Jabal Iraf: A rocky plateau 1450-1680 m high with a good Acacia-Juniper woodland forms about 30% cover. This site is located on a plateau along the border of the Taiz and Lahj governorates (al Maqatera region). This is the largest remaining area of Juniper forest in Yemen. The vegetation is composed of forest dominated by *Juniperus procera* and *Pstadia arabica* and represents the Mediterranean region in Yemen.

FIGURE 4.5 LOCATION OF PROTECTED AREAS



Among the endemics in the area are: *Blepharispermum yemenense*, *Centaurea yemense*, *Crotalaria squamigera*, *Jatropha variegata*. There is a very rich herb and grass layer covering 50% of the area. Among the most significant endemic animal species recorded in the area are:

- The Arabian Wood Pecker (*Dendrocopus doraë*)
- The Arabian Waxbill (*Estrilda rufibarba*)
- The Golden-winged Grosbeak (*Rhynchostruthus sacotranus*)
- The Arabian Serin (*Serinus rothschildi*)
- The Baboon (*Papio hamadryas*)
- The Cat snake (*Telescopus dhara*)
- The Arabian toad (*Bufo arabicus*)
- The Dwarf day gecko (*Pristurus flavipunctatus*)

Khor Umairah: The site is characterized by a semi-enclosed lagoon isolated from the shore by a permanent sand spit running from the east consisting of fine mud and sand with rocks in the central part of the lagoon. There is also a coarse sand and gravel desert coastal plain in the surrounding area. The sheltered conditions in the lagoon reduce wave energy and limit the re-suspension of sediments. Additionally the sea grass beds downstream of Khor Umairah may be considerably important to the detritus food chain and sea turtle populations.

The construction of new roads creates new habitat edges, alters hydrological dynamics, and disrupts natural processes and habitats. Road maintenance and traffic contaminate the surrounding environment with a variety of pollutants and noise. In addition, infrastructure and traffic impose dispersal barriers to most terrestrial animals, and vehicle traffic causes the death of many animals.

4.4.5 Agricultural Biodiversity

Agriculture is an important sector of the Yemeni economy. It contributes to about 18% of the GDP, accounts for about 2% of exports and employs about 70% of the total labor force. Diverse vegetation types and crop species and varieties exist within and between environmental zones. This variation makes Yemen one of the most important sources of agricultural biodiversity in the Arabian Peninsula. Agriculture is the main source of food and income for the majority of the population of the country.

4.4.5.1 Crop Diversity

Differences in environmental conditions among the agro-ecological zones of Yemen make it possible to grow a wide range of tropical, subtropical and temperate crops. The main crops are cereals, vegetables, fruits, legumes and cash crops including sesame, cotton, tobacco, qat, and coffee.

The country's crop diversity is comprised of cultivated crop species and varieties grown for different uses of the community. These have evolved through natural selection and selective breeding by traditional agricultural practices over long periods of time in the different environmental conditions of the country. Crop relatives and wild species also have been used for different purposes. The resultant varieties and races of crops may form homogeneous varieties or heterogeneous populations. The number of land races of each crop species is dependent on the distribution of the crop across the environment. Crop diversity is the basis for successful agriculture and the sustainable use of the country's scarce water and soil resources.

Cereals: Cereals remain the principal crops in the country and occupy 55% of the cultivated land. The grains of these crops constitute the basic food source for the majority of the population and main source of forage for draft animals. Cereal crops include sorghum, millet, maize, wheat, and barley.

Vegetable crops: are grown in the most fertile soils of most agro-ecological zones of the country. The total area devoted to vegetable crops is about 67,000 ha out of which 50% is cultivated with potato and tomato crops. There are more than 20 species of vegetables, which are grown mainly under irrigation system. The areas under vegetable cultivation are gradually being increased due the expansion of irrigated lands. Ground water depletion is the main negative result of this expansion. Only few introduced varieties are currently in cultivation.

Fruits: The production of fruits covers an area of about 95,000 ha. The production of fruits was part of traditional agricultural practices from early historical times as evidenced by the development of water conservation technologies such as construction of dams and terrace systems. Wide variations of deciduous, tropical and subtropical fruit crops are grown in Yemen. Every agro-ecological zone has a specialized fruit crop production; deciduous fruits are grown in the highlands and tropical and subtropical fruits are grown in the lowlands of Tihama, and in the eastern and southern plains and plateaus.

Deciduous fruits such as peaches, apples, figs, pears, and almond are sometime grown around houses or wells and along the irrigation channels. In general, farmers own few trees, which receive little attention and keep the fruits for family and neighbors. There are only a few orchards that are planted with introduced varieties.

Yemen is particularly well known for its traditional production of grapes and pomegranates. Grapes are the most important fruit crop grown in the country and Yemen has been producing high quality grapes for centuries. Grapes are cultivated in areas ranging in altitude of 1350-2000 m and are concentrated in Sana'a and Sadah governorates.

Some 40 date palm varieties have been identified in Yemen, and most are grown mainly in the Tihama lowlands and Wadi Hadramout. Date palm plantations are concentrated on the banks of five major wadis dissecting the Tihama plain from the mountain foothills to the Red Sea, which include Russian, Zabid, Remaa, Surdod, and Mour wadis. Date palm plantations are under flood irrigation systems. Because of the shallow root systems of date palms, some plantations have even been established on the coastal areas of the Red Sea. Either naturally growing or planted, date palms depend on shallow ground water derived from rainfall in the mountains. In recent years, disturbance of the delicate balance between the fresh rainwater and salt water near the coast has been catastrophic for the palm trees in the coastal areas. The over pumping of ground water and construction of small dams have prevented the mountain rain water from reaching palm trees close to the sea coast, which has resulted in gradual death of these trees.

Pulses (Legume Crops): Legume crop species are grown at different agro-ecological zones and are considered to be important sources of protein. About 53,000 ha is devoted to legume crops annually which produces about 75% of the country's needs. The most important legumes cultivated under rainfed conditions include *vigna*, lentils, dry peas, and fenugreek. Beans and broad beans are grown under supplemental irrigation

Cash Crops: Coffee is cultivated in wide range of ecological zones and is best grown at altitudes between 1000-1800 m. Coffee is grown under irrigation from springs, wells, and wadi-based water. Different varieties of *Coffee arabica* are distinguished by differences to drought tolerance, shape of the plants, and color, size, shape, and taste of coffee fruits. The

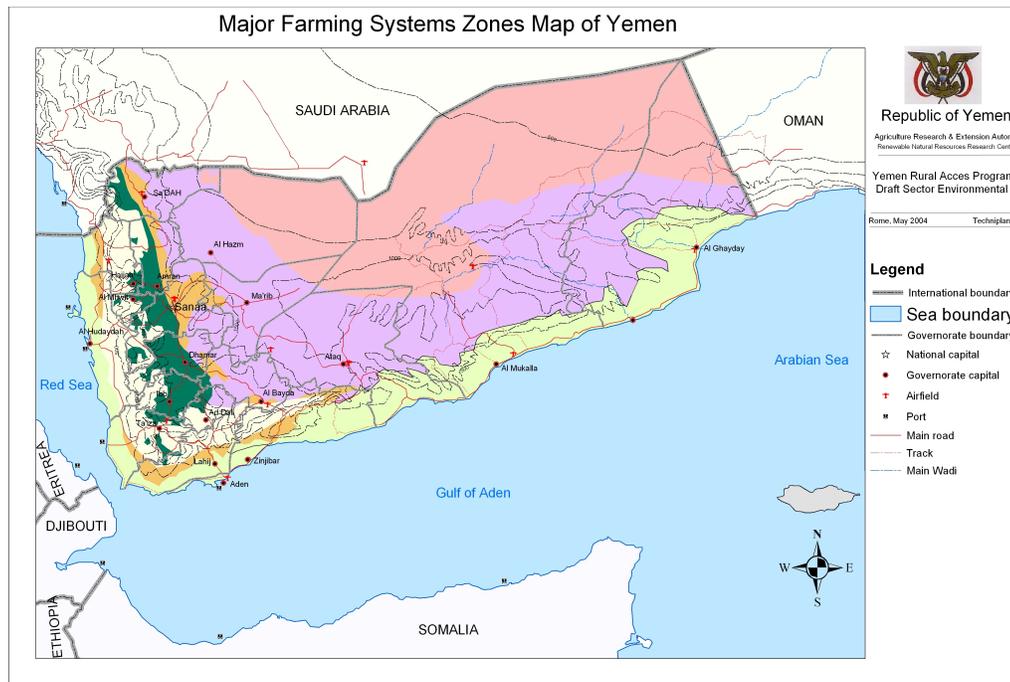
local names of coffee varieties in most cases refer to the cultivation areas or shapes of coffee trees and fruits. Qat, a high cash crop used as stimulant by most men and some women in the country, is one of Yemen's major crops and is cultivated on 91,418 ha or 5.5% of the total arable land in the country. In general qat is best grown under irrigation in areas above 1500 m. Qat cultivation seems to be increasing with the expansion of irrigated land at the expense of other crops. Since the most favorable environment for qat cultivation is similar to that of coffee and grapes, these crops are the most likely to suffer from qat expansion.

The distribution of the above data among the Governorates is shown in the table on next page.

Table 4.31. Area and production of crops in Yemen by Governorates - 2001
Source: Ministry of Agriculture-April 2002

N.	Governorate (Muhafazat)	1. Cereals		2. Vegetables		3. Fruits		4. Pulses		5. Cash Crops		6. Fodder		Total Area Cultivated (ha)	Total Production (M.T.)
		Area (ha)	Production (M.T.)	Area (ha)	Production (M.T.)	Area (ha)	Production (M.T.)	Area (ha)	Production (M.T.)	Area (ha)	Production (M.T.)	Area (ha)	Production (M.T.)		
1	Al-Beida	12,896	12,444	3,428	49,836	407	2,425	402	508	7,417	22,624	2,160	19,275	26,710	107,112
2	Al-Dhaleh														0
3	Al-Mahweet	14,074	11,266	328	2,675	427	1,849	1,965	1,323	6,337	3,569	5,768	64,634	28,899	85,316
4	Amran														0
5	Dhamar	69,755	94,268	5,820	76,262	1,006	7,764	5,953	4,360	9,132	4,139	5,742	47,649	97,408	234,442
6	Ibb	50,912	74,187	6,784	87,028	863	6,325	5,386	6,948	18,500	20,799	3,457	29,713	85,902	225,000
7	Sana'a	119,352	110,566	9,595	129,997	23,025	145,786	9,381	9,198	50,351	27,337	14,459	219,907	226,163	642,791
8	Sana'a City														0
9	Hajjah	27,554	23,554	1,061	9,955	4,472	50,584	794	528	21,058	22,523	6,541	67,061	61,480	174,205
10	Sa'adah	25,716	27,785	1,267	14,365	8,246	64,629	1,302	2,436	19,124	11,091	1,540	11,532	57,195	131,838
11	Taiz	54,170	54,969	4,204	50,446	1,483	22,253	3,462	3,369	4,649	2,661	1,956	23,810	69,924	157,508
12	Abyan	3,528	3,504	2,608	19,120	1,666	19,156	1,446	1,748	14,073	9,923	8,115	121,263	31,436	174,714
13	Aden	340	295	224	2,284	0	0	0	0	21	31	2,173	26,316	2,758	28,926
14	Al-Hodeidah	169,971	137,660	22,073	265,192	30,481	203,136	18,438	26,313	39,643	36,978	34,322	434,300	314,928	1,103,579
15	Laheg	5,155	3,782	2,152	15,798	815	3,655	159	115	6,545	5,995	7,025	114,856	21,851	144,201
16	Al-Jawf	29,075	51,447	2,805	28,273	2,550	19,414	1,777	4,368	2,217	2,118	10,406	113,376	48,830	218,996
17	Al-Mahrah	366	372	173	1,674	22	132	0	0	55	81	444	5,486	1,060	7,745
18	Hadramout	9,450	12,559	1,848	15,321	8,021	16,445	364	250	892	1,418	3,421	59,036	23,996	105,029
19	Mareb	62,946	78,117	1,402	16,159	11,353	137,052	1,625	2,368	6,856	5,522	6,725	64,385	90,907	303,603
20	Shabwah	2,611	3,366	1,604	18,348	410	2,815	225	201	1,425	1,082	3,382	45,107	9,657	70,919
	Total	657,871	700,141	67,376	802,733	95,247	703,420	52,679	64,033	208,295	177,891	117,636	1,467,706	1,199,104	3,915,924

FIGURE 4.6 MAJOR FARMING SYSTEMS ZONES MAP OF YEMEN



Main Farming System Zones

- Systeme 1 =Spares (arid) farming system below 50mm rainfall on North-eastern plateau
- Systeme 2=Pastoral farming system rainfall above 50 mm in years,but no growing period(considering wather harvesting)
- System 3=Costal artisanal fishing system 500 meters altitude parallele to the coast
- System 4=Urban based farming system No date avialable
- System 5=Irrigated farming system no date avialable
- System 6=Dryland mixed farming system growing period (including water harvesting) but below 250 mm annual rainfall
- System 7=Highland mixed farming system occasional or seasonal frost occurences at altitude above 2000 meters
- System 8=Rainfall mixed farming system frost free areas with rainfall above 250 mm

4.4.5.2 Livestock Diversity

The indigenous livestock of Yemen are cattle, sheep, goats, camels, donkeys and horses in addition to poultry and rabbits. The breed sizes, structure of herds or flocks, and the sustainability or reproductivity of the endemic livestock are unknown. The published Agricultural Statistics of Yemen is concerned only with cattle, sheep, goats and camels. An approximate estimate of their total population in the country is provided below.

Table 4.32. Livestock population and diversity in Yemen in 2001

Animal Production	Heads	%	Number of species
Camels	198,34	1.79	2
Cattle	1,400,593	12.64	2
Goats	4,452,540	40.18	6
Sheeps	5,028,968	45.39	9
Total Heads	11,080,535	100.00	

Based on previous livestock reviews, there were 0.587 million donkeys, 6.15 million indigenous Baladi chicken with an annual growth rate of 2.48% and 1000 horses in all governorates of Yemen in the 1980s. Figures for rabbits, Guinea fowl and Guinea pigs are unknown.

The distribution of the above data among Governorates is shown in the table here below:

Table 4.33. Livestock population and diversity in Yemen in 2001 by Governorate

Governorate (Muhafazat)		Camels (Heads)	Cattle (Heads)	Goats (Heads)	Sheeps (Heads)	Total Heads
N.	Name					
1	Al-Beida	3,915	33,194	172,759	366,746	576,614
2	Al-Dhaleh	n/a	n/a	n/a	n/a	n/a
3	Al-Mahweet	856	42,189	31,415	40,547	115,007
4	Amran	n/a	n/a	n/a	n/a	n/a
5	Dhamar	5,516	148,346	139,134	377,848	670,844
6	Ibb	4,444	230,471	207,390	355,611	797,916
7	Sana'a	5,900	223,276	517,540	1,046,972	1,793,688
8	Sana'a City	n/a	n/a	n/a	n/a	n/a
9	Hajjah	7,348	113,275	203,645	233,868	558,136
10	Sa'adah	1,149	63,276	88,346	190,328	343,099
11	Taiz	5,816	171,816	219,217	142,974	539,823
12	Abyan	13,760	16,087	450,741	405,508	886,096
13	Aden	1,904	3,879	108,199	48,423	162,405
14	Al-Hodeidah	17,733	205,103	320,898	366,116	909,850
15	Laheg	10,725	73,646	411,287	323,358	819,016
16	Al-Jawf	12,298	7,461	175,878	199,411	395,048
17	Al-Mahrah	37,119	1,208	258,336	99,556	396,219
18	Hadramout	47,256	47,988	606,908	273,337	975,489
19	Mareb	8,648	17,115	228,315	269,969	524,047
20	Shabwah	14,047	2,263	312,532	288,396	617,238
	Total	198,434	1,400,593	4,452,540	5,028,968	11,080,535

4.4.5.3 Forestry and Rangeland Diversity

Studies and research in forestry, rangelands and desertification are still very limited in Yemen. Local funds allocated for forestry resource development represents less than 1% of the budget of the Ministry of Agriculture & Irrigation. Rangelands, forests and other woodland areas comprise about 38% of the land area. The land is grazed by about 5 million sheep, 4.5 million goats and 1.4 million cattle (2001 data, see table 4.31 above). The remaining land, almost 57% of the total land area, is mostly desert with limited use potential.

Studies carried out in 1991-92 using aerial and satellite photography showed that the area of shrublands and forests was about 2.4 million ha of which 400,000 ha are located beside agricultural lands, illustrating the remaining traditional agroforestry that existed centuries ago. When the aerial photos of Jabal Bura'a woodland (Hodeidah Governorate) taken in 1973 were compared with those taken in 1987, it appeared that 60% of this woodland area was degraded. The natural woody vegetation had degenerated into low scattered shrubs or open woodland, the result of over-cutting for long periods of time, expansion of stock grazing and clearance for crop production or road construction purposes.

The available information reveals that almost 60% of the population still uses firewood. Assuming that individual consumption is about 0.5 cubic meter/person, an estimate of about 4.7 million cubic meters of firewood will be cut annually. This means that the rate at which forest trees are being cut exceeds forest regeneration, which indicates that it might be impossible to protect the remaining forest trees through issuing legislation and political procedures alone, unless alternative energy sources are available with convenient prices. The official statistics show that the country's import of wood in 1994 was estimated as 780 million Yemeni Rials. Some reports show that the area of rangeland may reach 16 million ha, characterized by weak biological balance, scarcity of species and poor forage value. The excessive grazing of livestock now estimated at about 11 million (2001 data) head continues to degrade plant cover.

4.4.5.4 Women and Agricultural Biodiversity Conservation

There are about 9.4 million women in the country (CSO -2001 Projections). Women play a crucial role in the rural economy of the country and contribute over 70% of the agricultural labour force in several different capacities. For example, women a) are the primary collectors of fodder and firewood which account for 50% of the energy consumption in rural areas; b) have their own livestock, and tend grazing animals; c) work in the honey production industry and have their own beehives; d) help in maintaining native cultivars of vegetables and field crops; e) are involved in breeding and pruning grapes in traditional ways; and f) select plants to be used as medicines or cosmetics for their families. They never differentiate between endemic or rare plants, as they are not aware of these issues. Women in rural areas should be a major focal group in any biodiversity awareness program as they live and work closely agriculture and nature in the day to day work in providing for their families. The actual situation of poverty problems in rural areas compels women to care for and provide food for their families using cheap sources of naturally available energy. In many respects, providing food for rural communities goes side by side with biodiversity conservation.

4.4.5.5 Threats to Agricultural Biodiversity

The impact of various agricultural projects and their activities on the sustainable use of natural resources is clearly reflected in several problems now faced by the country. For example, the most important problems in agriculture are:

- Limited and generally overexploited and inefficiently used physical resources base, largely due to the policies favoring ground-water-irrigated agriculture;
- Neglect of the traditional methods in farming in research and extension activities; and
- Introduction and promotion of technologies unsuited to the farmers' needs and resources.

As a result, the production, productivity and incomes are low in agriculture. Provision of highly subsidized crop seeds leads to the negligence of the traditional systems of seed security and seed treatments, which result in the spread of plant disease (smut and rust) and decreased yields. Major threats include:

- Introduction of homogenous, high yielding crop varieties which replace the heterogeneous low-yielding local crop varieties has resulted in genetic erosion and narrowing the genetic variability of the crops;
- Changes in human consumption habits and diet preference in recent years due to the availability of heavily subsidized commodities such as wheat and wheat products, have resulted in the deterioration of local varieties of sorghum and millet which are under constant threat caused by the introduction of improved varieties;
- Over grazing and over exploitation of the vegetative cover have resulted in degradation of terraced land and a loss of crop biodiversity,
- The rapid expansion of irrigated lands have caused deterioration of rainfed farming systems including the loss of drought resistant crop varieties;
- Periodic drought in the absence of genetic reservation systems has resulted in the loss of valuable genetic resources;
- The rapidly increasing urbanization process at the expense of agricultural land may also further threaten agricultural biodiversity;
- The use pesticides and the negligence of traditional methods of pest control are threatening the beneficial insects which are part of the biodiversity of this country;
- Immigration has led to a deterioration of indigenous knowledge and the loss of biodiversity.
- The lack of clear agriculture policies regulating the usage of natural resources and promoting the sustainable use of these resources.

4.5 AIR QUALITY AND NOISE

Air pollution is usually due to the solid or gaseous substances suspended in the air. Such substances come from different sources and they are namely:

- Carbon dioxide (CO₂)
- Carbon monoxide (CO)
- Hydrocarbon
- Dust etc.

In spite of great improvements in most countries due to the reduction in leaded fuels, traffic emission of lead remains a persistent air quality problem in Yemen. The range of tetraethyl in the gasoline is 0.6 – 0.75 g/l which is above WHO standards. Recent studies indicate that as the number of vehicles continues to grow, motor vehicle emissions and the product of their transformation in the air are becoming increasingly important contributors to air pollution.

Data on air quality in Yemen is scarce and is unlikely to be used in any RAP project analysis and not enough studies are available to present the effects of rural roads on air quality. However, it is well known that the emission of CO₂ and CO from heavy traffics causes damage to the environment. The increase in the rural roads around the country with the use of old petrol engines and diesel fuel would have negative effects on the environment. As a major threat is that CO constitutes 66% of the major components of traffic emissions and that it is very poisonous to the human health since it has no smell, no color and no taste. The newly constructed roads are a source for dust emission, which may cause problems to people and the environment. It would have a negative impact on the environment.

Noise nuisance is seen as a minor concern in Yemen. It is the qualitative/judgmental assessment of EPA staff that noise is not a significant concern within Yemeni culture. The concept of noise pollution is not readily recognised and the potential adverse impacts on health are not generally understood.

4.6 SOCIO-ECONOMIC AND CULTURAL

4.6.1 Administrative Structure

The Rural Access Program will be implemented nation-wide and occur in all 20 Governorates. As at 2001, the administrative structure of Yemen included 20 Governorates, 333 districts, 2,210 Sub-districts and 39,284 Villages (Official CSO Figures taken from the PAD). Official figures regarding the area of each Governorate do not exist; in order to make a preliminary assessment of the average area of the administrative units, the Consultant measured the area of each governorate on the GIS provided by the Social Fund for Development, which, in turn has been elaborated on the CSO GIS. The measured areas give a total of 455,000 Sq. km. The average areas of the administrative units are: District 1370 Sq. km; Sub-district 206 Sq. km; Village area is 12 Sq. km. Summary and details of this assessment are tabulated below (Note: the data are those shown in the 2001 CSO Statistical Yearbook).

Table 4.34. Summary of Yemen's Administrative Structure (CSO-2001)

Level	Name in Arabic	Number	Average surface, km ²	Average number of inhabitants
Governorate	Muhafadhah	20	22,750	943,150
District	Mudiriyah	333	1,370	56,650
Sub-district	'Uzlah	2,210	206	8,535
Village	Qariya	39,284	12	493
Locality	Mahalla	90,000	5	210

Table 4.35. Details of Administrative Structure of Yemen (CSO-2001)

Administrative structure									
Governorate (Muhafazat)		Area (*)		Districts		Sub-Districts		Villages	
N	Name	km ²	%	N. (**)	Average Area (km ²)	N. (**)	Average Area (km ²)	N. (**)	Average Area (km ²)
1	Al-Beida	9,270	2.0%	21	441.4	119	77.9	1,426	6.5
2	Al-Dhaleh	4,000	0.9%	9	444.4	42	95.2	1,631	2.5
3	Al-Mahweet	2,330	0.5%	9	258.9	123	18.9	1,224	1.9
4	Amran	7,900	1.7%	20	395.0	127	62.2	1,626	4.9
5	Dhamar	7,590	1.7%	12	632.5	313	24.2	3,288	2.3
6	Ibb	5,350	1.2%	20	267.5	253	21.1	2,739	2.0
7	Sana'a	13,850	3.0%	22	629.5	240	57.7	2,968	4.7
8	Sana'a City	380	0.1%	10	38.0	44	8.6		
9	Hajjah	8,300	1.8%	31	267.7	161	51.6	3,776	2.2
10	Sa'adah	12,370	2.7%	15	824.7	124	99.8	1,109	11.2
11	Taiz	10,010	2.2%	23	435.2	236	42.4	1,904	5.3
12	Abyan	16,450	3.6%	11	1,495.5	11	1,495.5	2,582	6.4
13	Aden	760	0.2%	8	95.0	8	95.0	10	
14	Al-Hodeidah	13,250	2.9%	26	509.6	138	96.0	2,288	5.8
15	Laheg	12,650	2.8%	15	843.3	44	287.5	3,841	3.3
16	Al-Jawf	39,500	8.7%	12	3,291.7	97	407.2	422	93.6
17	Al-Mahrah	67,310	14.8%	9	7,478.9	12	5,609.2	306	220.0
18	Hadramout	167,280	36.8%	30	5,576.0	34	4,920.0	3,625	46.1
19	Mareb	17,450	3.8%	13	1,342.3	60	290.8	537	32.5
20	Shabwah	39,000	8.6%	17	2,294.1	24	1,625.0	2,982	13.1
	Total	455,000	100.0%	333	1,366.4	2,210	205.9	38,284	11.9

Sources: * Unofficial figures: Measured from topographic maps

*** CSO official taken from the RAP Project Appraisal Document, May 2001*

NGOs are engaged in development and the most important organizational feature at the community level is the existence of local cooperatives, designated as Local Development Councils (LDC's), which form the basis of rural infrastructure development. Their activities, up to 1994 were coordinated at the central level by an agency known then as the Confederation of Yemeni Development Association (CYDA). This was changed to the General Confederation of Local Councils, then to the Directorate General of Local Councils under the Ministry of Local Administration.

The move towards decentralization is intended to improve the provision of basic social services through increased community participation in the allocation of public spending. When local officials, who are directly responsible for providing public services, are praised for success and blamed for failure, they will have more motivation to succeed. Moreover, when the cost of providing services is borne by the local authorities, the provision of services is more likely to be cost-effective.

Each of the 20 Governorates differs significantly in terms of development, institutional capacities and population density. In 1996, the Government began to consider the decentralization of some services to local jurisdiction. The growing central bureaucracy, as well as the expansion of the country's territories after unification, necessitates urgent policies to delegate responsibilities from the center to the governorates in order to reduce bottlenecks within the Government structure.

4.6.2 Population

According to the December 1994 census, the total population of the country was:

- Urban: 3,423,518 (23.5%)
- Rural: 11,164,289 (76.5%)
- Total: 14,587,807 (100.00%)
- Growth rate: 3.71

Based on the 3.7% growth rate, the estimated population at 2001 (Source:CSO 2001 Statistical Yearbook) was:

- Urban: 5,003,254 (26.5%) or 24.6 %
- Rural: 13,859,746 (73.5%) SEE TABLE 4.35
- Total: 18,863,000 (100.00%)

The major cities in Yemen have been growing at alarming rates since 1976. For example, the population of the capital Sana'a jumped from 427,502 in 1986 to 972,011 in 1994 and to 1,590,624 in 2001. This tremendous growth is putting severe pressure on services including water quality and a fast dwindling water supply.

There is a tendency for internal migration from rural depressed areas to the main cities for economic reasons. This movement is a world wide phenomenon, and is reducing the percentage of rural population to the total population from about 88.6% in 1975 to 76.5 % in 1994 and to 73.5 % in 2001 (Increasing urbanization was also partly due to the settlement of a large portion of the political returnees to the large cities). It is estimated that the growth rate for rural areas will gradually decline. The urban growth rate is, however, expected to remain high.

Details on population forecast at 2001 by Governorate are given in table 4.38 hereafter.

Table 4.36. Detail on population forecast at 2001 by Governorate
(Source: Consultant's Elaboration based on the CSO Statistical Yearbook-2001)

Governorate (Muhafazat)		Urban		Rural		Total	Density (Inhab/km ²)	Average population per administrative unit		
N	Name	Population	%	Population	%			Inhabit. per District	Inhabit. per Sub-district	Inhabit. per Village
1	Al-Beida	98,761	17.0%	481,194	83.0%	579,955	62.6	27,617	4,874	407
2	Al-Dhaleh	44,847	10.8%	370,219	89.2%	415,066	103.8	46,118	9,883	254
3	Al-Mahweet	34,726	7.5%	429,433	92.5%	464,159	199.2	51,573	3,774	379
4	Amran	133,484	13.4%	860,238	86.6%	993,722	125.8	49,686	7,825	611
5	Dhamar	146,283	11.9%	1,088,141	88.1%	1,234,424	162.6	102,869	3,944	375
6	Ibb	300,364	14.5%	1,773,775	85.5%	2,074,139	387.7	103,707	8,198	757
7	Sana'a	26,956	1.9%	1,367,991	98.1%	1,394,947	100.7	63,407	5,812	470
8	Sana'a City	1,590,624	100.0%			1,590,624	4,185.9	159,062	36,151	
9	Hajjah	139,555	9.9%	1,264,999	90.1%	1,404,554	169.2	45,308	8,724	372
10	Sa'adah	77,104	12.5%	537,578	87.5%	614,682	49.7	40,979	4,957	554
11	Taiz	528,593	22.4%	1,834,893	77.6%	2,363,486	236.1	102,760	10,015	1,241
12	Abyan	89,953	20.8%	342,576	79.2%	432,529	26.3	39,321	39,321	168
13	Aden	509,886	98.1%	9,936	1.9%	519,822	684.0	64,978	64,978	
14	Al-Hodeidah	767,922	38.3%	1,236,127	61.7%	2,004,049	151.2	77,079	14,522	876
15	Laheg	29,116	4.4%	634,954	95.6%	664,070	52.5	44,271	15,093	173
16	Al-Jawf	56,426	12.6%	390,594	87.4%	447,020	11.3	37,252	4,608	1,059
17	Al-Mahrah	24,924	34.4%	47,631	65.6%	72,555	1.1	8,062	6,046	237
18	Hadramout	321,288	36.1%	568,958	63.9%	890,246	5.3	29,675	26,184	246
19	Mareb	28,263	12.1%	205,432	87.9%	233,695	13.4	17,977	3,895	435
20	Shabwah	54,179	11.5%	415,077	88.5%	469,256	12.0	27,603	19,552	157
	Total	5,003,254	26.5%	13,859,746	73.5%	18,863,000	41.5	56,646	8,535	493
			24.5		75.5					

Population density varies markedly across the country and is closely linked to rainfall distribution. In desert areas (like Al-Mahrah Governorate) densities are no more than 1.1 people per sq. km and high as 387.7 in the wet areas in Ibb. Sana'a city and Aden densities are exceptional being cities.

At current rates of growth, Total population is expected to reach 25.6 million in 2011. The population growth rate is attributed to natural increases from the high fertility and decreasing mortality rates with improvement in health services. The total fertility rate (TFR) in Yemen is estimated at 6.48 in 1997 (Source 2001 Statistical Yearbook). Fertility in Yemen is not only one of the highest in the world but also shows that until recently it was increasing. A number of factors contribute to this high TFR; they include:

- ③ Marriage is universal among women, and most marry at a young age, so that by the age of 40 nearly 98% have been married; the average marrying age is about 18 years;
- ③ Births usually follow in rapid succession of each other;
- ③ Women continue to bear children until the end of their reproductive life;
- ③ Contraceptive methods are not widely known or available and because of unfamiliarity with devices, they are often not properly used;
- ③ Children especially boys are by tradition socially and economically important in Yemen.

Although mortality rates are declining the overall level is relatively high as compared with world average (Yemen's IMR is 121 per 1000 live births); the associated life expectancy at birth is 50 years (NEAP, Policies and Guidelines, 1995).

Yemen was the first country in the region to formulate and launch a comprehensive population strategy based on the long-term recognition that unless the country's development is along sound economic planning, a growing population beyond resources supply capacity will constitute a threat of social unrest, political instability and pressure on the environment.

4.6.3 Education

The education in Yemen consists of six years of primary education followed by six years of secondary education. Secondary education is divided into three years of preparatory education and three years of secondary education. Data regarding students enrolled in primary and secondary schools for the school year 2000/2001 are provided in the following table:

Table 4.37. Students in Primary and Secondary Schools in Yemen for the Year 2000/2001
(Source: Consultant's elaboration on CSO- Statistical Yearbook 2001)

Governorate (Muhafazat)		Basic Schools (Primary Education)					Secondary Schools				
N	Name	Female Students	%	Male Students	%	Total Students	Female Students	%	Male Students	%	Total Students
1	Al-Beida	33,207	34.5%	63,073	65.50%	96,280	1,262	13.4%	8,167	86.6%	9,429
2	Al-Dhaleh	28,828	32.6%	59,597	67.40%	88,425	1,684	13.6%	10,710	86.4%	12,394
3	Al-Mahweet	28,233	34.6%	53,266	65.36%	81,499	1,722	15.0%	9,734	85.0%	11,456
4	Amran	47,456	28.6%	118,629	71.43%	166,085	4,297	14.6%	25,105	85.4%	29,402
5	Dhamar	60,345	27.4%	159,506	72.55%	219,851	3,139	13.2%	20,730	86.8%	23,869
6	Ibb	147,064	34.3%	281,430	65.68%	428,494	12,331	21.9%	43,957	78.1%	56,288
7	Sana'a	64,769	27.9%	167,167	72.07%	231,936	3,101	10.9%	25,380	89.1%	28,481
8	Sana'a City	147,364	46.7%	168,193	53.30%	315,557	27,347	45.0%	33,411	55.0%	60,758
9	Hajjah	58,062	30.7%	131,028	69.29%	189,090	4,296	18.0%	19,582	82.0%	23,878
10	Sa'adah	19,431	22.1%	68,470	77.89%	87,901	970	9.5%	9,226	90.5%	10,196
11	Taiz	230,420	41.0%	331,309	58.98%	561,729	32,661	34.6%	61,766	65.4%	94,427
12	Abyan	30,829	37.2%	52,117	62.83%	82,946	2,993	25.4%	8,800	74.6%	11,793
13	Aden	44,375	46.5%	51,010	53.48%	95,385	8,765	44.7%	10,837	55.3%	19,602
14	Al-Hodeidah	104,855	37.4%	175,728	62.63%	280,583	13,526	37.7%	22,397	62.3%	35,923
15	Laheg	52,841	36.6%	91,566	63.41%	144,407	4,733	23.7%	15,224	76.3%	19,957
16	Al-Jawf	12,625	34.7%	23,739	65.28%	36,364	1,393	21.5%	5,101	78.5%	6,494
17	Al-Mahrah	5,283	43.4%	6,884	56.58%	12,167	255	37.1%	433	62.9%	688
18	Hadramout	64,703	38.1%	105,168	61.91%	169,871	4,047	24.6%	12,377	75.4%	16,424
19	Mareb	14,336	35.8%	25,729	64.22%	40,065	1,155	17.6%	5,397	82.4%	6,552
20	Shabwah	21,214	29.1%	51,669	70.89%	72,883	153	2.3%	6,409	97.7%	6,562
	Total	1,216,240	35.8%	2,185,278	64.24%	3,401,518	129,830	26.8%	354,743	73.2%	484,573

The Government of Yemen has emphasized the need to educate the population and to increase the proportion of students enrolled in schools. However, given the increase in the number of children who will need to be educated, simply maintaining current levels will pose a large challenge to Yemen. In 1999 only 58.5% children between 6 and 14 years of age were enrolled in primary schools, a figure far below the world standards. In the same year Adult illiteracy was 36% of men and 75% of women as shown in the following table:

Table 4.38. Primary School Enrolment rate and Adult Illiteracy in Yemen in 1999
(Source: SFD elaboration)

Governorate (Muhafazat)		Primary School Enrolment Rate % (6-14 yrs)			Adult Illiteracy 1999 (>15 years)		
N	Name	Female	Male	Total	Female	Male	Total
1	Al-Beida	43.6	70.4	57.0	79.4	40.1	59.8
2	Al-Dhaleh	39.5	74.2	56.9	77.4	29.1	53.3
3	Al-Mahweet	36.9	71.4	54.2	86.7	42.8	64.8
4	Amran	32.2	77.6	54.9	84.6	34.0	59.3
5	Dhamar	28.8	68.8	48.8	86.1	41.9	64.0
6	Ibb	48.9	78.2	63.6	79.2	36.9	58.1
7	Sana'a	31.4	71.6	51.5	87.1	40.2	63.7
8	Sana'a City	82.9	86.3	84.6	42.1	13.3	27.7
9	Hajjah	26.7	58.1	42.4	87.8	56.3	72.1
10	Sa'adah	20.8	67.0	43.9	91.1	47.6	69.4
11	Taiz	59.3	80.7	70.0	68.3	28.3	48.3
12	Abyan	47.8	73.4	60.6	65.9	25.8	45.9
13	Aden	85.6	89.0	87.3	34.3	13.7	24.0
14	Al-Hodeidah	37.0	59.5	48.3	77.4	48.1	62.8
15	Laheg	53.8	79.5	66.7	72.9	27.2	50.1
16	Al-Jawf	27.2	59.5	43.4	89.2	61.9	75.6
17	Al-Mahrah	57.5	62.1	59.8	65.9	45.2	55.6
18	Hadramout	57.2	70.7	64.0	59.5	23.2	41.4
19	Mareb	42.1	67.6	54.9	81.5	36.1	58.8
20	Shabwah	41.5	74.2	57.9	83.2	29.1	56.2
	Total	45.0	72.0	58.5	75.0	36.0	55.1

From 1990-1995, education expenditures significantly declined in real terms while student enrolments increased 28% during that period. A lack of qualified teachers exacerbates an already difficult situation. In 1999, the education expenditures were 23.5% of total Government spending, accounting for 5.0% of GDP (Source: World Bank-Poverty Update December 2002 –Volume II-Annex 7 –Table 7.19). The total expenditure in the educational sectors in 1999 was 67.4 billion. The recurrent expenditures make up 91% of total spending. About 75% of this went towards salaries, while 13% was allocated for goods and services. Only 9% was targeted for investment expenditures at the pre-university level. Only 2% was allocated for maintenance, which explains the deteriorated state of many schools in the country especially in rural areas.

With increased enrolment, but declining funds and few teachers, classes have become larger. In 2001 the average number of students per class of primary schools was 29.2 students 34.7 for secondary schools as illustrated in the following table:

Table 4.39. Number of Schools and Classes in the Primary and Secondary Education sector in Yemen in 2001
(Source: CSO- Statistical yearbook 2001)

Governorate (Muhafazat)		Basic Schools (Primary Education)			Secondary Schools		
N	Name	No. of Schools	No. of Classes	No of Students per class	No. of Schools	No. of Classes	No. of Students per class
1	Al-Beida	355	3,635	26.5	8	316	29.8
2	Al-Dhaleh	238	2,959	29.9	13	353	
3	Al-Mahweet	352	3,681	22.1	1	442	25.9
4	Amran	696	7,134	23.3	6	792	37.1
5	Dhamar	863	9,331	23.6	5	1,005	23.8
6	Ibb	922	12,191	35.1	13	1,522	37.0
7	Sana'a	1,064	11,002	21.1	4	1,108	25.7
8	Sana'a City	159	5,995	52.6	4	1,133	53.6
9	Hajjah	1,015	9,021	21.0	30	813	29.4
10	Sa'adah	467	4,503	19.5	3	427	23.9
11	Taiz	698	14,721	38.2	10	2,553	37.0
12	Abyan	293	3,012	27.5	32	348	33.9
13	Aden	75	2,016	47.3	23	427	45.9
14	Al-Hodeidah	967	9,847	28.5	8	975	36.8
15	Laheg	398	5,073	28.5	25	594	33.6
16	Al-Jawf	231	2,165	16.8	1	267	24.3
17	Al-Mahrah	71	405	30.0	3	26	26.5
18	Hadramout	464	4,791	35.5	43	440	37.3
19	Mareb	293	2,404	16.7	1	241	27.2
20	Shabwah	309	2,722	26.8	16	200	32.8
	Total	9,930	116,608	29.2	249	13,982	34.7

One of the greatest challenges facing the Government is education of women. Especially in rural areas, girls' enrolment and drop out rates are high. In 1999 some 72% of male children are enrolled in primary schools, compared to only 45% of girls (Source SFD). The disparity is even greater at higher education levels. Only 11% of girls are enrolled in secondary schools, compared to 32% of boys, and in universities only 3% of women are enrolled. The low levels of education and high illiteracy rates make it difficult for women to enter the workforce, especially in urban areas where skilled labour is in greater demand.

At the university level, several difficulties face the Government. First, the rapid increase in the number of students seeking higher education has exceeded the capacity of the universities. The university student population increased from 114 students in 1970 to more than 167,730 students in 2001. Demand for private higher education is increasing as parents and families become aware of the opportunities higher education offer. Second, enrolment in applied sciences accounts for only 9% of the total university student population, which has led to a lack of scientifically qualified professionals to fill both teaching and research positions and has led to a need to "import" qualified personnel from other countries. Third, there is a growing concern about the quality of education of public university graduates. Labour market surveys reveal a gap between the knowledge of university graduates and the real needs of the labour market. The double challenge of globalization and expansion of information technologies puts great demand on Yemen to build its human resources capacity in skilled professions in order to achieve an economic advantage.

4.6.4 Health

Despite the reasonable improvement in health conditions in Yemen over the last two decades, the health sector is still facing three large challenges: i) a persistent high fertility rate (7.7 child per women), ii) high population growth rate (3.7%), and iii) a chronic shortage of health services. These challenges are reflected in the alarming health indicators. Recent data indicate that infant mortality rate (IMR) is 75.3 (CSO- Statistical yearbook 2001) per live birth, which are among the highest in the world. The leading causes for IMR are diarrhoeal diseases, malnutrition and parasitic diseases. These diseases can be directly attributed to poverty, low personal hygiene, and lack of sanitation and safe water supplies.

The health sector is facing many pressing issues. Difficulties in rural populations, lack of financing, organizational and management problems and inadequate training of healthcare personnel are among the most serious challenges. Only 55% of the population has access to medical facilities, while public health services in many of the rural areas are almost non-existent. According to official statistics for 2001, there were only 121 hospitals (with an average, 79 health centers with beds and 432 without beds and 1540 primary health care unit .The total patient-beds were estimated at 10,690 nationwide with significant disparity between urban and rural areas.The situation of health services in 2001 is illustrated in the following table:

Table 4.40. Number of health services and beds in 2001
(Source: CSO- Statistical Yearbook-2001)

Governorate (Muhafazat)		Health Facilities in 2001 (Source: CSO-Statistical Yearbook-2001)							
		Pharmacies & Drugstores	Maternity Centres	Primary Health Care Units	Health Centres without beds	Health Centres with beds		Hospitals	
N.	Name					N.	Beds	N.	Beds
1	Al-Beida	28	1	56	17	1	20	7	285
2	Al-Dhaleh	91	6	75	7	7		4	220
3	Al-Mahweet	28	4	75	5			4	370
4	Amran	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	Dhamar	180	123	114	35			2	186
6	Ibb	211	48	123	62	1	6	10	498
7	Sana'a	73	20	128	20			10	100
8	Sana'a City	415	48		85			6	1.582
9	Hajjah	147	6	137	5	10	100	4	200
10	Sa'adah	72	22	16	13			7	105
11	Taiz	462	7	110	75	8	130	6	1,250
12	Abyan	8	30	101	10	10	65	7	553
13	Aden	179		5	7	1	7	4	1,330
14	Al-Hodeidah	124	43	118	43			2	720
15	Laheg	61	2	118	17	2	12	15	846
16	Al-Jawf	14		47	4	10	132	2	105
17	Al-Mahrah	49	4	43	4			5	264
18	Hadramout	41	23	119	4	8	142	18	703
19	Mareb	22	4	69	19	11		2	125
20	Shabwah		4	86		10	174	6	360
	Total	2,205	395	1,540	432	79	788	121	9,802

The Government has made it a priority to make health services more effective and accessible to the most needed segments of the population. In order to do this, preference will be given to preventive health care concentrating on immunization programs, family planning, nutrition and health and health education and access to safe water drinking water.

The incidence of disease registered in 2001 at Governorate level is shown in the table overleaf.

4.6.5 Labor Force and Employment

The labour market in Yemen is characterized by a surplus of unskilled and semi-skilled workers and a shortage of qualified personnel with professional and technical skills. During the 1990 Gulf Crisis the labour market experienced a major shock. With the return of more than 800,000 labourers from Gulf States, the labour supply increased dramatically with limited opportunities for employment. As result, real wages and the standard of living declined.

According to the 1994 census, only 3.3 million people (22% of the total population) were involved in economic activity. Of these, 53% were involved in agriculture and fishing, 16% in the public sector including defense and education, 15% in trade and other services, 6% in construction, and 4% in industry. Such a distribution demonstrates the limited capacity of workers resulting in low income levels and welfare.

In Yemen, labor force data demonstrates the lack of training and education for the population over 10 years old. Illiteracy is prevalent in all the age groups. Data from the 1994 census indicates that 37% of males are illiterate, 18% obtain basic education and only 37% can read and write. Only 6% finish their secondary education and less than 2% receive university degrees. For females, the situation is worse. Illiteracy among females is 74%. These statistics have a direct negative impact on the productivity of workers in the economy.

Labor in Civil Services: Official data show that there were around 400,000 civil servants (excluding military personnel) in 1995 of which 75% received educational training ranging from primary school to post graduate programs. Data desegregated by gender is not properly documented, however, it is estimated that females account for approximately 15% of the total civil labor force.

Currently, the Government cannot employ more staff due to the low absorptive capacity of Government institutions. There is a clear recognition of the need for major reform of public administration and the civil services. The reform may include freezing overall recruitment for Government employment, removing ghost employees from the payroll and enforcing retirement laws. Moreover, official projections show that the Government labor requirement for graduates of university and vocational and technical institutes will be short of the expected supply. In 1997, only about 10% of graduates from agriculture, humanities, and law will be needed. For graduates of commerce faculties, there will be a need for around 50% of the available supply. At the same time, projections show that the supply of teachers will fall short of the demand in basic and secondary schools by about 10%.

Table 4.41. Infectious diseases reported during 1999-2001 and their distribution by Governorate
(Source : CSO- Statistical yearbook-2001)

Governorate	Diphtheria	Enteritis	Dysentery	Malaria	Bilharzia	Pneumonia	Measles	Whooping	Poliomyelities	T.B.C.	Rabies	G.S. Meritis	Infection A Hepatis	Typhoid
AL-Beida	n.d.	12938	2326	11186	4494	n.d.	301	477	36	n.d.	n.d.	1744	2164	n.d.
Al-Dhaleh	n.d.	11904	n.d.	9367	1201	n.d.	897	261	n.d.	n.d.	n.d.	n.d.	4	n.d.
AL-Mahweet	108	2145	n.d.	1738	1264	n.d.	n.d.	n.d.	n.d.	2010	n.d.	n.d.	2013	n.d.
Amran	n.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.
Dhamar	399	1593	6308	10419	1573	12518	1106	397	61	697	n.d.	670	165	2850
Ibb	n.d.	26854	25869	21337	2138	32647	325	235	n.d.	n.d.	5	n.d.	731	n.d.
Sana'a	8	13161	2673	19252	6530	n.d.	244	157	n.d.	n.d.	n.d.	37	291	n.d.
Sana'a City*	n.d.	27943	9529	3375	2471	n.d.	586	606	n.d.	734	n.d.	n.d.	1417	1121
Hajjah	6	41584	3045	84249	6688	4938	996	498	n.d.	1778	74	16	582	10803
Sa'adah	n.d.	26519	10849	19989	2509	27814	1732	338	n.d.	2057	n.d.	n.d.	4729	n.d.
Taiz	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.	u.d.
Abyan	n.d.	27584	n.d.	29841	153	n.d.	622	91	n.d.	124	n.d.	n.d.	n	36
Aden	n.d.	14526	n.d.	5324	2	n.d.	655	3	n.d.	1938	n.d.	n.d.	1967	3310
AL-Hodeidah	n.d.	68186	55362	152576	n	110682	n.d.	n.d.	38	1166	485	n.d.	n.d.	n.d.
Laheg	n.d.	n.d.	2580	10128	369	5768	630	n.d.	n.d.	n.d.	n.d.	n.d.	841	1052
AL-Jawf	177	15478	609	14988	62	1109	n.d.	882	n.d.	351	395	n.d.	363	n.d.
AL-Mahrah	n.d.	5819	n.d.	394	n	n.d.	153	n.d.	2	62	n.d.	n.d.	35	140
Hadramout*	n.d.	17382	4410	4637	n	n.d.	492	n.d.	n.d.	174	n.d.	68	552	5452
Mareb*	21	10239	3386	10949	79	n.d.	169	83	1	135	n.d.	n.d.	428	n.d.
Shabwh	n.d.	8864	n.d.	4797	135	9357	167	126	n.d.	n.d.	n.d.	n.d.	n.d.	927

Legend:

n.d. : never data

u.d. : unavailable data

4.6.6 History and Culture

The earliest records prove a highly developed culture existed back to the tenth century BC in Yemen where Saba was the center and heart during this period. In the seventh century BC, when life in Europe was primitive, the prehistoric Yemen was prosperous. At that time, ancient civilizations were established including the kingdoms of Ausan, Karban Ma'ain, Hadramout and Sheba. The prosperity of these ancient civilizations depended on trade and agricultural activities. Yemen is thought to have been the home of the legendary Queen of Sheba, and the Romans called it "Arabia Felix". Yemenis have carried out the sophisticated engineering projects like the Marib Dam and irrigation systems which helped in creating surplus in agriculture products. Ancient civilizations also, controlled the early spice and Frankincense trade and developed cities and seaports. The region has long been a meeting place for ancient cultures.

The archaeological history of Yemen begins with Homo erectus crossing from Africa to Arabia, perhaps across the Bab al-Mandab straits some 2 million years ago, and thus the oldest artefacts yet found in Yemen belong to the developed Oldawan industry. It would appear that South Arabia has known virtually all of the subsequent cultures, with the possible exception of the late Palaeolithic and Epipalaeolithic industries familiar in the Levant. Thus the archaeological history of Yemen virtually parallels that of humanity, for the Oldawan industries are the oldest known.

The Lower and Middle Palaeolithic industries are known from Yemen, and it is possible that the Middle Palaeolithic technical traditions survived into the chronological Palaeolithic. In any case, the Middle Palaeolithic is virtually immediately followed by the Neolithic, of whom the representative varieties in Yemen parallel those of the Rub Al-Khali Neolithic.

A Bronze Age of indeterminate length at an unclear point followed the Neolithic in time. During the Bronze Age, many of the subsequently prevalent funerary customs developed, particularly the construction of burial tumuli commonly called cairns. Such cairns are known from throughout the Arabian peninsula, although Yemeni cairns would appear to have been primarily tombs with single burials, while multiple burials are more frequent elsewhere on the peninsula. The dolmens and ritual platforms familiar from the eastern part of the peninsula are also present in Yemen.

The traditional cultures of South Arabia emerged during the second millennium B.C. creating irrigation systems and introducing monumental rectangular architecture. With the invention of writing and control of the caravan routes using the camel to transport incense and spices up to the Mediterranean world, their kingdoms grew wealthy and established outposts on the western part of the peninsula.

For several centuries they were able to control the aromatics trade, until Greek and Roman traders discovered a method of exploiting the monsoon winds, and were thus able to reach India themselves. This undermined the trading capability of the South Arabian Kingdoms and shifted control from the cities ringing the desert to the mountain kingdom of Himay, which controlled the port of Muza.

Prosperity was short-lived as the Christian world abandoned traditional religious practices and the demand for incense was reduced (although not altogether eliminated). The advent of Islam found Yemen at the forefront, one of the first countries to accept Islam, and the pagan temples were used as templated for the Yemeni mosuques. For several centuries of the Renaissance and the Enlightenment, the international traders found Yemen to be strategically placed and later discovered the virtues of coffee. Competition between ports has been a constant feature of Yemeni development but the general openness of the southern ports and

adjacent territories has been matched by a contrasting reticence of the northern rulers ever since the introduction of Zaydi Islam at the end of the first millennium AD. Thus, late Ming shards will be found on the southern coast, but not in the northern capital at Sana'a. The Islamic states were the first real system of states in the Middle East as a whole, replacing the South Arabian Kingdoms and transforming the trade routes.

Islam was largely accepted as the principal religion of the country in the mid 7th century. During the Islamic Empire, Yemen had very intensive agricultural practices, the products of which were traded with other Islamic states. Once these civilizations fell, the economy declined and was subsequently intensified by a number of invaders including the Christian, Abyssinian and Ottoman Turks.

During the period from 1917 to 1962 Yemen was isolated from modern influences and under the rule of Imams. During this Imamate regime, people worked on the land, and were crippled with heavy taxes. Yemen remains a Moslem country and the common language is Arabic. The major ethnic divide falls between the majority of high-landers and the Negroid who live mostly in Tihama and originated from Ethiopia. All laws and legislation are revived from the holy Quraan and Sharia. First loyalties are to God, then to tribe, then to the state.

4.6.7 Cultural Heritage

The Republic of Yemen's has a very rich and diverse cultural heritage. It has been estimated that 20-30,000 sites of environmental, archaeological, cultural and historical interest are present in its territory.

Many of its major cultural assets are of local, national, and universal significance. In particular, the Walled Historic Cities of Yemen (Old cities of Sana'a, Zabid, and Shibam) together with the Wadi Hadramout have been long inscribed by UNESCO on the World's Heritage list. The old city of Sana'a preserves a wealth of mud brick buildings of great architectural beauty and irreplaceable cultural value. The city of Shibam is a magnificent example of Yemen's vernacular architecture and is surrounded throughout the entire Wadi Hadramout Valley by a large number of monuments, fortresses, palaces, watch towers, mosques, tombs, old settlements. In turn, the city of Zabid and its old citadel, its mosques, madrassas and pre-Islamic and Islamic heritage, perhaps less known but enormously valuable, conquered a unique place in history as the city where the human genius created the foundations of algebra.

Many other cultural assets of Yemen's heritage are literally strewn across the country, in both urban and rural environments. In addition, the rural landscape itself comprises a unique cultural heritage with ancient terraced farming systems and a spectacular village architecture.

The Architecture. Yemen is world renowned for its architectural heritage. The unique vernacular architecture of the original "skyscrapers" in the cities of Sana'a and Shibam, the dam at Marib from the fifth century BC, numerous mosques dating back to the days of the Prophet, and the fortified mountain villages all present the fascinating and diverse heritage of Yemen.

The unique quality of Yemen's historic environment is found in urban and rural areas that have extraordinary homogeneous and practical forms of planning, construction and detailing of buildings. The urban environment often consists of tall buildings which are close together to provide shade from the heat of the sun. The urban organization has grown out of practical consideration for the convenient relationship between the markets and residential areas, and for access and defense. The towns and villages were often built in defensible locations with the urban structures closely reflecting the topology of the land. This has led to settlements

with great individuality and reflecting the historic pressures and unique social relationships and conflicts, which have been such an enduring characteristic of Yemen's long history.

Furthermore, until now, Yemen has been late in developing a modern economy and in absorbing the industrial and socio-economic practices of other developed countries. This has preserved the unique cultural and historic qualities of the towns and cities. Nevertheless, the historic environment does not comply with the requirements of the modern world. The inhabitants cannot find solutions for a healthy and safe environment in the old buildings, with modern levels of standards. The type of construction currently used requires repair and maintenance with traditional material and techniques, renewed on a regular basis. This conflicts with seemingly modern solutions which use concrete and other new techniques, seems to be more sustainable, and less labor-intensive. Therefore, the new modern way of living, and methods of construction can seriously erode the physical and social historic environment, and weed out traditional building skills.

The terracing system. The terrace systems have developed in response to rainfall patterns and rainfall uncertainties and provide optimal soil and water management in dry, mountainous terrain. Such terracing constitute a national heritage and a monument to environmental sustainability in land resource management and food security. The farming systems schemes so designed were sustained until recently.

The system is known to be an efficient method of water conservation. It also helps preventing soil erosion and enable farmers to grow crops on rigid steep mountain region. Step terracing is used on the steep slopes of the catchments while water spreading is used in the downstream parts of it. Terracing depends solely on rainfall; cultivation evolved under various topographic and climatic conditions.

The slope, depth of fertile soil, availability of technique and labour, influence the design features of the terraces. The general rule is the steeper the slope, the narrower the terrace. Widths of terracing are very small and can range from 2 to 15 m and sometimes 20 m. In areas with higher flow velocities, the terrace tends to be longer than in areas with lower velocities. The surface of the step (terrace) may be level, but usually sloped in the range of 5-10% so that runoff will be carried laterally with the purpose to promote runoff to drain to successively lower terraces. Whilst level terraces will allow infiltration of large portion of rainfall, the walls of the terrace with sloped surface is twice the depth of soil excavation.

Traditional terracing is practiced in the Arabian Peninsula countries; Yemen, Oman and Saudi Arabia and other countries. However, over the last ten years, terracing has been declining due to the lack of maintenance, migration of labour and emphasis on large scale irrigation development.

Status of Data Collection and Research. Although some important inventories have been carried out (such as Hadramout inventory done by an Italian company in one year and maintained by the GOPHC), a comprehensive inventory of all existing environmental, archaeological, cultural and historical sites in Yemen still does not exist. Those ones that have been carried out are not integrated in a comprehensive Data Base and utilized as would be necessary. An estimated period of 5 years would be necessary to carry out an overall comprehensive inventory as a fundamental management tool for the cultural heritage in Yemen;

Donors, such as UNESCO, Dutch, German, Swiss, and French organizations have pursued research in specific areas, leading to important data collection and operational work. Donors were very active in the 1970s and 1980s in providing preservation and rehabilitation assistance, targeting, in particular, the three cities listed in the World Heritage: Old Sana'a, Shibam and Zabid. In the 1990s, financial aid decreased to diminishing enthusiasm after the

euphoric start, and also due to economical and political problems with which Yemen had to cope after the Gulf War and the civil war in 1994.

The American Center for Yemeni Studies and the French Center for Yemeni Studies (*Centre français d'études yéménites*), have an important bibliographical collection in their own libraries, mainly in response to university research. Recently, the German and Dutch cooperation has strengthened their presence through an active development program.

Nevertheless, thus far, investments have mainly been done opportunistically, based on available funds and on the individual initiative of the donors. Even in a city like Old Sana'a, the restorations completed over the last decade have not changed the overall picture, as they are an island in an ocean of needs.

Threats to Cultural Heritage. Notwithstanding the existing legal framework and despite various conservation efforts, adverse factors are severely threatening the integrity and sustainability of Yemen's cultural monuments. Among these factors are: uncontrolled urbanization inside and around the Historic Cities, modernization in living patterns, new house amenities and services, behavioural carelessness, economic downturns, destruction caused by uncontrolled road construction and lack of conservation resource and investments.

Moreover there are threats to Yemen's old architecture related to the increase in the poverty level of the old cities: (i) economic decline, caused by shifting patterns of trading and broader global forces; this is the case in Zabid, where the textile industry declined dramatically, leaving a legacy of unused, dilapidated historic buildings; (ii) pressures of development, lack of adapted urban regulation and inadequate enforcement procedures, which lead to the replacement of the traditional population by immigrants from cities, such as Sana'a, gentrification could bring about an irreversible change in the city landscape, with the use of non-traditional construction methods, and a definitive evolution in architectural design; (iii) lack of maintenance, as with some of the mud built architecture in Shibam where the impact can be irreversible to one building and can extent to the neighboring buildings. Lack of maintenance can have even a more drastic impact when combined with a strong rainy season (Sana'a in 1999). If these issues are not addressed during the next a decade or two, the Yemenis and foreigners alike will witness the destruction of Yemen's urban qualities. That destruction will mean that one of the world's most uniquely-built environments and the skills that go along with maintaining it will irreversibly disappear, even though this may happen in progressive and subtle ways.

The negative impacts of such factors are amplified by the weakness of the legislative and institutional frameworks commensurate with the magnitude and complexity of Yemen's cultural heritage. The following problems have been identified by the present study:

- Until recently most of the roads projects in Yemen have been implemented without any study on the impact on cultural heritage; One of the example is the inter-Arabian peninsula coastal highway which has been designed without carrying out any study on environmental, social and cultural heritage impact;
- There are no provision for executive regulations in the Law on Antiquities;
- There are no regulations to halt works being implemented in important landscapes; as matter of fact article 14 of the Law on Antiquities establish to the possibility of stopping works damaging **only for archaeological objects and archaeological areas**;
- There is lack of integrated Data Base fro cultural heritage management,
- A public awareness campaign would be necessary to make Yemen population aware about the richness and importance of their cultural heritage. Without the public concern, the Yemen's cultural heritage may be damaged, if not destroyed, within the next 10 years;

- The awareness campaign should be especially direct to public officers of the various governmental agencies directly or indirectly concerned with cultural heritage. Presently there are very few people aware of the magnitude and importance of the Yemen's cultural heritage,
- As conclusion the protection of the Yemen cultural heritage would require:
 - An awareness campaign to spread the knowledge of the cultural heritage of Yemen and its social and economic importance;
 - The preparation of and integrated Data-base;
 - The strengthening of the legal and regulatory framework and its extension to a wider concept of "cultural heritage" which should include landscape, archaeological, cultural and historical sites;
 - The strict application of established rules and regulations.

* * *

**Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)**

Draft Final Report

Chapter 5

ENVIRONMENTAL IMPACTS

Chapter 5. ENVIRONMENTAL IMPACTS

Potential environmental impacts of rural road projects are assessed in relation to the major baseline resource categories, and as they may occur during the design/construction and the operational (post-construction and maintenance) phases of the projects. The potential for sector-wide issues and cumulative effects are also addressed. Mitigation measures for these impacts are discussed in Chapter 7, Environmental Management Plan.

5.1 DESIGN/CONSTRUCTION PHASE

5.1.1 Land Resources

5.1.1.1 Site survey investigations

Site surveys and investigations are required for proper design of the roads. While the impacts of some of these activities, such as topographic surveys, are negligible, involving only access to lands, others, such as geotechnical investigations, may have more direct negative impacts, since they involve excavation of soils and rocks, drilling of boreholes etc.

5.1.1.2 Permanent land acquisition

Permanent land acquisition can arise from unavoidable needs to: (i) widen the existing alignment; (ii) adjust existing alignment or create a new alignment to improve maneuverability or visibility; or (iii) establish disposal sites for cut material or surplus fill. In many cases, minor alignment adjustments are inevitable for safety or technical reasons, and must be carried out with prior approval of land owners under the auspices of the Beneficiary Committee. For major alignment adjustments requiring land taking, the RAP approach is to first seek avoidance, through narrower design widths and the introduction of “pinch points”, as well as alignment modifications that minimize land taking needs. However, where avoidance is not possible, a Resettlement Plan will be prepared, in accordance with the *RAP Resettlement Policy Framework*.

5.1.1.3 Temporary land acquisition

Temporary land acquisition during construction is required for: (i) establishing the contractor’s site compound; (ii) temporary roads for traffic diversion; and (iii) haul roads to shuttle to/from borrow pits and quarries. Despite the very local nature of these activities, they affect local lands; in particular, the establishment of the site compound involves a temporary change in land use, and diversions and haul roads may adversely affect terraces or other agricultural lands. Such locations and conditions must therefore be determined by the contractor in conjunction with the Supervisor Engineer and Beneficiary Committee.

5.1.1.4 Slope stabilization

Perhaps the most important issue in vertical alignment design is the avoidance of landslides where slopes are unstable and particularly to ensure that lands down slope are not adversely affected. Lack of slope stabilization measures can cause damage to agricultural land or endanger people and property. Slope stabilization is a particularly important issue in mountainous areas.

5.1.1.5 Contractor site compound management, materials and equipment storage

Site compounds are required to establish administrative and residential accommodation, plant and installations, workshops, garages, storage space and other facilities required for road construction. They generally include workers' living and eating areas, and the grounds where equipment is stored and serviced and where materials are stockpiled. Negative effects on land resources can include pollution from inadequate sanitation, disposal of solid and liquid waste and leakage of spills from petroleum products, paving or other construction materials. Site compounds also tend to generate small shops and services, which could give rise to shanty type settlements and concomitant sanitation and waste disposal issues.

5.1.1.6 Disposal of cut materials and surplus fill – destruction of agricultural land

When spoil material from road excavation or surplus fill is dumped along the side of the road, it can kill or damage vegetation, contribute to erosion and slope stability problems and destroy terraces or other agricultural land. Large amounts of spoil or cut materials are usually generated in mountainous terrain. In view of the pervasiveness of terraced agriculture in Yemen, potential damage to terraces is a particularly important impact.

5.1.1.7 Borrow pits and quarry areas

Borrow pits and quarry areas involve land excavation and/or blasting, and the opening of new sites involves a change in land use. Potential negative impacts include chronic erosion and siltation, dangerous areas, as well as permanent visual and aesthetic intrusion.

5.1.2 Hydrology and Water Resources

5.1.2.1 Sources of construction water

During construction, water is required for consumption at site compounds and for physical works. The water has to be taken from surface flows or extracted from deep aquifers. Surface water may not be available for all rural projects in the country (or part of it) depending on project location. Where surface or piped water is particularly scarce, gaining agreement to access to available resources may be problematic. Any attempt by a contractor to access waters without prior approval of local communities, can cause social tensions because it may interfere with the pattern of locally established use of water. Extracting indiscriminately from the deep aquifer beyond safe levels of annual recharge may lead to the aggravation of the present water crisis, which is particularly acute in the Western Highland part of the country.

5.1.2.2 Pollution from wastewater, diesel or asphalt spills from site compounds and machinery

During the construction period, surface and groundwater resources may be polluted by uncontrolled disposal of camp sites liquid and solid wastes, uncontrolled disposal of construction waste water; and spillage of diesel, oil, grease or asphalt machines.

5.1.2.3 Flood protection in wadis

The construction of road embankments could alter seasonal water flow patterns especially in mountain areas and within the wadis. This could bring about: (i) additional erosion within the wadis; and/or (ii) a disruption of the traditional water harvesting practices to the farms on mountain areas. This risk is to be addressed through proper hydrological assessment and

avoided as much as possible through appropriate engineering design measures and through local consultations to avoid potential disruption of water harvesting practices and potential social tensions.

Adverse impacts may be experienced where road works will physically modify channel characteristics by narrowing available flow channels and/or modifying or diverting main flow patterns. However, new channels would be expected to be designed in such a way to quickly re-establish new equilibrium and as such effects are unlikely to be significant over the long term. Short-term damage may however be considerable.

In many mountainous areas, road and track access has been a traditionally via wadi floors. The EA and design studies must pay particular attention in assessing whether to maintain the existing alignment in wadi floors or follow an alternative upstream alignment avoiding the wadis. Possible adverse impacts can be mitigated in many cases by upstream water harvesting systems and downstream water management systems which in the former case serve to reduce flow volumes and velocities and in the latter to provide effective management of downstream flow. Elsewhere the characteristics of wadis in mountainous and rolling terrain suggests that significant difficulties would be experienced and considerable care must be taken to establish the preferred design option for each site on a case by case basis.

On flatter lands with more gentle relief, wadi channels are wider and it is less likely that significant modification to channels and hence flow patterns will be generated; however, care must be also taken when the road would intercept or divert existing flows.

5.1.2.4 Alteration of water harvesting patterns

Local farmers often construct simple water harvesting structures on the road surface, similar to speed-bumps, to channel runoff water to their terraced fields below the roads. This action also tends to protect the road by slowing down runoffs and draining water off the road, thereby reducing road surface degradations and maintenance requirements. Such traditional practices need to be taken account in the design of the project roads. Even where only minor changes in road level and flow patterns are proposed, such changes may reduce rates of water harvesting, modify the allocation of harvested water and affect system operational efficiencies.

5.1.2.5 Cross drainage and scour effects on new fills

If new fill is not adequately compacted, a large number of scour points can be created on the road edge and also on the fill slope edge. Uncorrected, these scour points will eventually erode the roadbed. Remedial treatment will therefore be required. This situation may be found in areas where newly cut roads will create new catchments and associated water collection and discharge features. These are potentially very high-energy channels.

5.1.2.6 Discharge to adjacent lands

Uncontrolled discharge to loose materials will lead to rapid creation of a deeply incised scour channels, widespread erosion, increased slope instability and large-scale movement of materials down slope. These materials will cover and destroy any downslope features in their path. Of particular concern are effects on: (i) new fills; (ii) unstable slopes; (iii) channels in a stack; (iv) graveyards; (v); agriculture terraces and (vi) other sensitive areas or structures.

- i. Discharge to new fills: if the new fill is not adequately compacted and as a result a large number of scour points are evident on the road edge and on fill slope

edge. Uncorrected to these scour points will eventually threaten the road bed.

- ii. Discharge to unstable slopes: uncontrolled discharge to loose materials will lead to rapid creation of a deeply incised scour channels, widespread erosion, increased slope instability and large-scale movement of materials down slope. These materials will cover and destroy any down slope features in their path.
- iii. Discharge to channel in a stack: in this case any discharge from a high point will be crossed again by the road on a lower section. In cases where discharge is to colluvial material and on concave slopes serious problems may be created by erosion and wash down of materials even if only a limited volume of water is involved. Where substantial volumes of water are discharged, very significant engineering works must be implemented to stabilise the existing situation and control future discharges.
- iv. Discharge to graveyards: excessive drainage from the road onto graveyards can causing flooding may have scouring effects on graveyards stones. This can lead to social problems.
- v. Discharge to agriculture terraces: uncontrolled discharged may have scouring effects on terrace stone walls and destabilize agricultural land. This can lead to social problems.
- vi. Discharge to other sensitive areas or structure: : other areas sensitive to uncontrolled discharge include buildings, walls water channels or other structures.

5.1.3 Air Quality and Noise

5.1.3.1 Dust & potential pollutants from construction machinery, stored material and spoil heaps

During rural road construction, dust and particulate concentrations may be dispersed in the air especially during dry months and on windy days. This will be generated mainly by excavation of soils, blasting and crushing of rocks and transport of soils to/from sites. Dust pollution may also disturb local wildlife especially in the vicinity of protected areas. However, these adverse impacts will be felt only in the vicinity, of a work areas, unsurfaced access corridors and materials stockpiles.

5.1.3.2 Smoke from burning of waste materials

Air pollution during the construction period may take place as consequence of the burning of waste materials.

5.1.3.3 Noise from construction machinery

Heavy machines, plants and construction traffic will make vibration and noise. The nuisance will be transient and good work practice should curb it. Noise nuisance may disturb local wildlife especially in the vicinity of protected areas.

5.1.4 Biological Resources

5.1.4.1 Conversion or degradation of natural habitats or critical natural habitats

The improvement of roads located adjacent to, or within, any of the 36 important ecological sensitive areas in Yemen or other identified sensitive areas can result in significant conversion or degradation of natural habitats or critical natural habitats. The location of any

potential project road adjacent to or within *natural habitats* or *critical natural habitats* as described below will trigger the RAP's *Natural Habitat Policy Framework*.

Natural habitats are defined as land and water areas where: (i) the ecosystem's biological communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the area's primary ecological functions.

Critical natural habitats are defined as: (i) existing protected areas and areas officially proposed by Governments as protected areas (e.g. reserves that meet the criteria of the World Conservation Union-IUCN- classification), areas initially recognised as protected by traditional local communities (e.g. sacred groves or forests), and sites that maintain conditions vital for the viability of these protected areas (as determined by the EA process); or (ii) sites identified on supplementary lists prepared by the Bank or an authoritative source determined by the Regional Environmental Sector of the World Bank.

Significant conversion is defined as the elimination or severe diminution (reduction) of the integrity of a critical or other natural habitat caused by a major, long-term change in land or water use. Significant conversion may include, for example, land clearing; replacement of natural vegetation; drainage; dredging, filling or channelization of wetlands, etc. Conversion can result directly from the action of a project or through indirect mechanism (e.g. though induced settlement along a road).

Degradation is defined as the modification of a critical or other natural habitat that substantially reduces the habitat's ability to maintain viable populations of its native species.

5.1.4.2 Damage to biological resources during construction

Loss of small brush and trees along the roads may occur during construction. This impact is generally considered minor, except when it involves productive, ancient or other trees or vegetation considered important by the local community. Construction activities may also interfere with bird nests or small animal dens located in verges, quarries or borrow areas.

5.1.4.3 Damage to biological resources by construction workers

During the construction and maintenance periods death of wild animals can be caused by poaching or wanton cutting of trees and mangroves for fuel wood by construction workers.

5.1.5 Socio-Economic and Cultural Resources

5.1.5.1 Tribal tensions

Although tribal social organisation in Yemen has been undergoing some changes in recent years, the social order in most parts of rural Yemen is still organized according to the tribal system. This includes a social hierarchy, which gives a commanding position to local tribal leaders who, in some cases, do not hesitate to stop by force the implementation of a larger Government project if they feel that it does not seem to benefit them directly. Overall, competition for scarce Government resources involves competition between tribes to obtain basic services from the Government or from donors. This often results in tensions and occasional armed clashes about the location of infrastructure improvements, such as the alignment of a rural road going through the territories of various tribes. Changing relations between leading individuals and tribal groups may result in a sudden deterioration of social relations in a particular region and affect implementation of projects.

Even assuming that any pre-existing sources of tribal tension and or issues relating to the preferred road alignment and length are resolved, there still remain a number of potential

issues that could give rise to social tensions. These include the distribution of project benefits, in particular employment opportunities, and the allocation of benefits and costs associated with the acquisition and purchase of raw materials. Clearly, if during this process, communities feel that they have been specifically denied from potential benefits or have borne a disproportionate share of the costs burden and that others have been favoured, there is potential for tribal rivalries to intensify.

5.1.5.2 Land acquisition and resettlement

Road improvements during the first phase of the RAP occurred on existing right-of-way only. In addition, the road designs feature a reduction of the typical width of rural roads as part of the upgrading. During Phase I of the program, the risk of land acquisition has therefore been low. Nevertheless, during phases II and III of RAP, project roads may at times require permanent acquisition of lands and/or structures, particularly when unavoidable for technical and/or safety reasons. In these cases, the RAP *Resettlement Policy Framework* will be triggered, which defines the extent of impacts (“minor impacts” defined as fewer than 200 affected persons; and “major impacts” defined as more than 200 affected persons), and distinguishes impacts related to “land assets” (either productive or unproductive) and “houses and other structural assets”, involving infrastructure for shelter or productive/income generating activities, such as shops.

5.1.5.3 Destruction or relocation of utility services

Project works may interfere with utility services, such as telephone lines, electric lines, water or sewage pipes, canals and wells, when these services lie in or adjacent to the right of way.

5.1.5.4 Public health and safety at construction site

The health and safety of the workers and of communities surrounding rural roads may be affected during the construction period due to:

- The risk of accidents for workers and the public arising from the use of construction vehicles and machinery, blasting, the creation of excavated areas and detour roads, the working on steep slopes and the risk of falling rock or excavated material in mountainous areas; and
- The health risks to workers and the community arising from potentially unsanitary conditions at site compounds and the increased risk of communicable and sexually transmitted diseases.

5.1.5.5 Road closures and detours

In some mountainous (and possibly other areas) the terrain, diversions around construction works may not be practicable. In these circumstances it will be necessary to close the road to public access for certain periods with consequent adverse social and economic impacts on communities on both sides of the closure.

5.1.5.6 Graveyards and burial plots

Graveyards and burial plots occur commonly along roadsides in Yemen and they could be adversely affected by rural roads works either through: (i) physical intrusion into the graveyard; or (ii) excessive drainage from the road onto the graveyard, causing flooding.

5.1.5.7 Damage to known archaeological and historic sites and resources

Proposed road projects that affect directly, or are adjacent to, known physical cultural resources can have an adverse affect through: (i) physical damage or intrusion from construction; or (ii) secondary affects from increased traffic or induced development.

5.1.5.8 Chance finds of cultural resources

Even when known physical cultural resources have not been identified, there is still a chance that during the course of construction physical cultural heritage can be discovered.

5.1.5.9 Gender considerations

Separate consultations with women generally reveal a number of gender-related concerns, such as the potential adverse impact a road improvement can have on travel patterns for collecting water, going to market and safety concerns for children.

5.1.5.10 Employment

Proportionate to the investment of each sub-project, employment opportunities will be generated as a result of the rural roads implementation. Normally the labour component of rural access roads is quite high, 30-40% depending on the need of drainage protection works and type of road surfacing used. The employment opportunities will be created for skilled, semiskilled and unskilled labourers by:

- The construction of site compounds;
- The road works themselves; and
- Security arrangements.

While most of the skilled labourers may come from other parts of the country, the opportunities for semi-skilled and unskilled sections of the workforce will be mainly available by local communities. Consultations held during Phase I or RAP revealed that local communities do not insist on employment on road works rather than participating in certain activities, such as security arrangements for equipment and stonework. The Social Framework Agreements of each rural road sub-project will define the mechanisms to maximize the benefits and ensure that local populations are the beneficiaries. The arrangements must be, as much as possible, realistic and must take into account the social and tribal context of each road. The job opportunities created for workers along each particular road section will also have the advantage of social harmony between the workers and local communities.

5.2 OPERATIONS PHASE

5.2.1 Land Resources

5.2.1.1 Slope stabilization

During operations, there is a continuing danger of instability of upslope areas, which could lead to landslides or rockslides, posing a hazard to traffic on the roads and downslope people and agricultural lands, and leading to erosion.

5.2.1.2 Agricultural land or terrace damage during maintenance

Terrace or agricultural land destruction can occur during maintenance operations, either from uncontrolled disposal of cut and fill or interference from maintenance machinery or other operations. On paved roads, however the cut and fill operations during maintenance will be limited.

5.2.1.3 Maintenance contractor site compounds, materials and equipment storage

Maintenance compounds will be less extensive than those during construction. Nevertheless, the maintenance contractors may, from time to time, establish administrative and residential accommodation, plant and installations, workshops, garages, storage space and other facilities. They generally include workers' living and eating areas, and the grounds where equipment is stored and serviced and where materials are stockpiled. Negative effects on land resources can include pollution from inadequate sanitation, disposal of solid and liquid waste and leakage of spills from petroleum products, paving or other construction materials. Site compounds also tend to generate small shops and services, which could give rise to shanty type settlements and concomitant sanitation and waste disposal issues.

5.2.1.4 Management of induced development

Construction of rural roads may bring induced development, such as shops, petrol stations and new houses. This may occur at intersections or involve an extension of the villages along the road. Development of these fringe areas is facilitated by movement of people from rural areas in search of work. This induced development can bring about a change in land use and result in stress on basic resources, such as water supply, wastewater disposal, solid waste disposal etc.

5.2.2 Hydrology and Water Resources

5.2.2.1 Water harvesting

During the operational period, water harvesting structures may deteriorate, or undergo unforeseen damage by heavy storms.

5.2.2.2 Blockage of cross drains/culverts - Uncontrolled discharge

Cuts and fills may contribute to the sedimentation of surface water reservoirs (such as dams and weirs) and wadi beds due to the transportation of sediments after storms or floods.

5.2.2.3 Erosion of road platform from drainage discharge

Where new horizontal road sections have been constructed, nick points may be created where the ground level of small channels crossing the road has been raised. This typically occurs on sections running across wadi side slopes. Each nick point is subject to scour and will rapidly erode the road bed, particularly if the new fill is unconsolidated or poorly consolidated.

5.2.2.4 Pollution from vehicle leakage or accidents with hazardous cargo.

Surface or groundwater pollution may occur from routine spillage or leakage from vehicles using the road, or from overturned trucks bearing petroleum or other hazardous materials. This is not considered a major threat, since the quantity of routine leakage is not expected to have a major impact.

5.2.3 Air Quality and Noise

5.2.3.1 Air Pollution from Vehicles

Increased traffic could result in higher concentrations of carbon dioxide, carbon monoxide, hydrocarbons and dust particles. However, given the expected level of traffic and dispersed rural locations of the roads, air pollution is not expected to significantly increase as a result of the project. Moreover, upgrading of earth roads to paved standard will reduce the amount of dust generated by traffic, would be a positive environmental impact.

5.2.3.2 Noise Nuisance from Vehicles

Increased traffic could bring about increased noise levels, which could disturb local residences, hospitals, schools or wildlife. Given anticipated traffic levels, this impact is considered to be relatively low, except where roads impact on hospitals or identified sensitive habitats.

5.2.4 Biological

5.2.4.1 Increased Pressure on Biological Resources from Induced Development

Induced development as a result of improved access may contribute to increased and unsustainable pressure on the area's biological resources, such as increased wood cutting for firewood, timber and charcoal, increased grazing.

During the operational period, road accidents may kill wild animals utilizing verge habitats or crossing the roads. Movement of vehicles may also impact the domesticated animals, as they may become liable to accidents. Collisions between traffic vehicles and animals are also an important traffic safety issue.

5.2.5 Socio-Economic and Cultural

5.2.5.1 Increased accidents

During operations, higher speeds induced by better driving conditions may raise accident rates, particularly among children.

5.2.5.2 Public health and safety during maintenance

Although not occurring at the same intensity as the construction period, maintenance activities will still entail similar basic health and safety concerns for the workers and their interaction with the community.

5.2.5.3 Socio-Economic Benefits

Numerous socio-economic benefits are expected to occur following the road improvements. These include:

Reduced Transport Costs. The implementation of rural roads may reduce sub regional and regional transport costs, between towns and villages and between rural villages along road alignments; the possible reduction is to be ascertained through Vehicle Operating Costs analysis to be carried out for each rural road sub-project. The enhancement of such potential positive impact requires, upon road completion, proper maintenance of roads (including routine and periodic maintenance) which is to be performed by the Road Maintenance Fund (RMF) and local administrations depending on relevant maintenance responsibilities.

Reduced Travel Times. The implementation of rural roads may considerably reduce the journey times for people and especially for goods with consequent less damage to perishable foodstuff.

Improved comfort and safety. The implementation of rural road may improve the ride quality of roads with consequent better comfort for passengers travelling with public or private vehicles. In order to enhance such positive impact proper road maintenance (including routine and periodic maintenance) is to be performed by the Road Maintenance Fund (RMF) and local administrations.

Increased mobility. Better connectivity provided by the rural roads will increase the mobility of rural population and therefore access to job opportunities outside the area. Improved transport and higher mobility will help the distribution of medicines. Patients will receive faster medical attention. Health workers will enjoy easier access to work places. More doctors and nurses may reach the rural areas. More teachers (especially women teachers for girl schools) may reach the rural areas.

Stimulus to Diversified Economic Development. Development of roads usually accompanies growth and mushrooming of services from local entrepreneurs along the highway. Services such as small shops, petrol pumps, vehicle-repair shops, small hotels, transportation and other travel related services are expected to generate significant earnings and employment opportunities for local communities.

Improved community cohesion and promote intercommunity cooperation. It has been already mentioned that the cohesiveness of the tribal social organisation in Yemen is undergoing some changes. Nevertheless, the concept of tribal territorial domain still persists and enjoys collective recognition. The rural roads may connect many of such domains and help in integrating the local identities with the national one. The rural roads could, therefore, be seen as an opportunity of promoting inter-community relations. Studies on social dynamism in Yemen are very few. Without such studies the object of realising national identity by the society may continue to suffer from hindrances or obstructions. A possible tool to enhance this possible positive impact is to carry out anthropological studies for the rural road sub-project in order to:

- Demarcate the diverse territorial domains of the social groups along the road corridors;
- Identify the structure of authority granted within each tribal domain to person or persons to negotiate the terms for maximising opportunities of rural road improvements for the communities as a whole;
- Identify the general nature of supplementary investments required to advance the interest of the largest numbers amongst these communities;
- Help the RAP CMO and other governmental authorities to negotiate in this regard.

Improved accessibility to social services and markets. Isolation aggravates rural poverty, illiteracy and poor health care. In 1994, the combined basic and secondary enrollment rate was just 55%, with the overall rate of female enrollment at 24% (Source CSO). Due to isolation, only 50% of the population had direct access to health services. A potential positive impact of the rural road implementation is the improved access to education and health facilities with consequent increase in enrolment rates and health care among rural communities. In order to enhance such positive impact, Government and regional investment budgets should target the implementation of rural health services and educational facilities, taking advantage of lower transport costs and better accessibility to the road influence zone.

5.2.5.4 Chance finds of cultural resources

As many of the country's antiquities are unrecorded, it is possible that during construction such cultural resources may be discovered during excavation of other works. In such cases, standard procedures for minimizing damage to these resources need to be put in place.

5.3 CUMULATIVE IMPACTS AND SECTOR-WIDE ISSUES

It is anticipated that under RAP, approximately 2,000 – 3,000 km of intermediate and village access roads will be improved, which represents less than 1% of the entire road network. Given that these improvements will be dispersed among 20 Governorates, impacts are expected to be localized and it is reasonable to assume that there is a negligible risk of cumulative negative impacts.

From a sector wide perspective, the RAP is introducing an operational approach to systematically address environmental and social issues on rural roads. As RAP expands its operations and becomes “mainstreamed” with the Ministry of Public Works and Highways, these processes will serve as a model for addressing such issues in the road sector in general.

* * *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

Chapter 6

ANALYSIS OF ALTERNATIVES

Chapter 6. ANALYSIS OF ALTERNATIVES

6.1 PROGRAM OBJECTIVES AND ALTERNATIVE APPROACHES

The overall purpose and long-term development objective of RAP is an improved livelihood and reduced isolation for the rural population. This is to be achieved by investing in rural road improvements on the intermediate and village access road networks, complemented by institutional strengthening to ensure capacity to manage the nation's rural road networks at the central and decentralized level. With these objectives in mind, several alternative project concepts were assessed:

1. Village-level multipurpose project
2. Large-scale Phase I alternative
3. Large-scale single phase project
4. Combined intermediate and village access approach
5. "No-Project" alternative

6.1.1 Village-Level Multipurpose Alternative

The initial Program concept focused on various types of village infrastructure improvements, including small local feeder roads and access tracks to small settlements. Under this concept, the Program would pursue a "multi-purpose" approach, with rural road improvements being only one element within an array of several types of non-transport accessibility-enhancing interventions, such as the relocation of facilities and services.

The advantage of such an approach is that it is participatory, demand-driven and responds directly to expressed needs of the rural poor. On the other hand, this approach would not address the needs to: (i) fill a vital "gap" in the intermediate level road network; and (ii) establish a coherent approach to tie rural roads into the national road network. Often, such programs improve small stretches of road which do not necessarily link the beneficiaries to the wider network.

Moreover, there are already several ongoing large-scale projects in Yemen, which follow that same concept, including as the IDA-supported Social Fund for Development Project and the Public Works Project. Discussions between the Government, the IDA identification mission and other donors revealed that due to funding ceilings for individual investments, none of those projects is able to intervene on longer and more strategic rural roads, which connect several Districts with each other and with the main highway network.

6.1.2 Large-Scale Phase I

A second considered option was to *immediately embark on a large-scale rural roads improvement program* in Phase I. However, considering the absence, at the program onset stage, of:

- (i) the required institutional arrangements and capacities;
- (ii) full-fledged technical and environmental standards;
- (iii) sustainable mechanisms for maintenance funding and execution; and:

(iv) adequate planning tools and selection criteria for investments,

it became clear that that option would carry a very high risk of resource wastage and serious implementation difficulties. It was therefore decided to address these concerns in an initial phase, which would lay the foundation for the subsequent large-scale rural access road improvements.

6.1.3 Large-Scale Stand Alone Project

The option of using *a large stand-alone 5-6 year project* supported by an IDA credit was also considered and rejected, on the grounds that: (i) the sheer size of the needs and the limited implementation capacity requires a much longer implementation period; (ii) there are high up-front costs in preparing such a project and the time required is long; and: (iii) flexibility needs to be maintained so as to adjust the Program to the gradual decentralization process, the speed of which is difficult to forecast at this time. Given these conditions, a programmatic approach seems to provide the most appropriate instrument to achieve the overall rural transport development objectives.

6.1.4 Combined Intermediate & Village Access Alternative

A further option screened at the beginning of the program focused exclusively on the intermediary road network. However, there is growing evidence that isolated investments do not achieve their full impact unless incorporated into a "sub-network" approach. Accordingly, it was decided to introduce a sub-network approach, or "Cluster Development Model", by including village access roads within the areas of influence of the pilot intermediary roads. This approach has been further tested and developed during Phase I, as a framework for assisting local governments to prioritize investments, so as to assure the minimum required access levels within their jurisdictions, as well as to enhance the rural transport economy at large.

6.1.5 "No-Project" Option

Under the no-project option, poor rural access to markets and services would continue to pose serious constraints on efforts to reduce poverty and promote economic development.

6.2 CONCLUSION

From an environmental viewpoint, the first alternative (village access roads only) may entail somewhat less environmental concerns because of the smaller scale of the interventions. However, the potential impacts of intermediate roads as described in the previous chapter are manageable (see Environmental Management Plan – Chapter 7) and not so severe as to warrant a change in project concept or preference for the no-project alternative. Table 6.1 summarizes the comparison of the five options.

Table 6.1. Comparative assessment of Rural Access Program alternatives

Alternative		COMPARISON WITH THE PROPOSED PROGRAM		
		<i>advantages & disadvantages</i>	<i>cost implications</i>	<i>environmental implications</i>
I	Village-level multipurpose	Participatory approach, but objectives not reached	Insignificant cost differences	Insignificant environmental differences
II	Large-Scale Phase I	High risk of resource wastage		
III	Large-Scale Stand Alone	Long time required		
IV	Combined Intermediate & Village Access	Isolated investments not enough Road cluster approach increases socio-economic benefit		
V	"No Project"	The rural population will go on suffering from severe isolation	No survey cost Lack of investments	Environmental advantage from doing nothing does not outweigh positive impacts would be missed.

* * *

**Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)**

Draft Final Report

Chapter 7

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Chapter 7. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The EMP consists of standard mitigation measures to be adapted to each individual road and institutional arrangements for ensuring consistent implementation of the environmental and social management processes. The EMP Table at the end of this chapter provides an overall summary of mitigation measures and responsibilities.

Standard mitigation measures have been developed to address potential environmental impacts as they may occur on individual road projects during the design/construction and the operational (post-construction/maintenance) phases.

7.1 IMPACT MITIGATION DURING DESIGN/CONSTRUCTION PHASE

Mitigation during this period includes:

- Improved and environmentally-sound technical designs, which were tested during Phase I and will be applied as appropriate to RAP-financed roads in Phases II and III; and
- Mitigation measures related to the conduct of design and construction activities.

7.1.1 Land Resources

7.1.1.1 Site survey investigations

Outside the right of way, the Contractor shall locate and select sites needed for the site compound, quarries and borrow sites, geotechnical investigations, road diversions, haulage roads, etc. These shall be identified so as to minimize environmental damage or disruption to current agricultural or other activities, and will be subject to approval by the Resident Engineer (RE) and the Beneficiary Committee.

7.1.1.2 Minimize permanent land taking – narrower road design width and pinch points

Traditionally, rural roads designs in Yemen have featured a roadbed of 8 meter width, with a road surface 6 meters wide and shoulders of 1.0 meter on each side. In the case of mountain roads, this design requires rather deep cuts into the mountainside to achieve the design width of the roadbed, leading to the erosion of exposed slope surfaces and often to slides of slopes onto the road. In addition, such road widths can lead to land taking through populated or agricultural areas, which is difficult to justify, given the volume of traffic on these roads. Narrower road widths provide more economically justified investments and reduce the need for land taking or excessive excavations.

Based on pilot operations in Phase I, the RAP roads shall include narrower road platforms, which reduce the need for land taking and cut if required to reach width. In addition, “pinch points” (limited narrowing of the road at selected locations) shall be introduced, so as to avoid or minimize land taking, resettlement or interference with utilities.

In cases where land taking is unavoidable by the above measures, the *Resettlement Policy Framework* will apply (see item 7.1.5.2, under Socio-Economic and Cultural Resources).

7.1.1.3 Planning of site compound, road diversions and haul roads

The Contractor shall plan and place the site compound and all road diversions and haulage routes in collaboration with the RE and Beneficiary Committee, with an aim to minimize affects on agricultural, residential or other lands or commercial or community purpose.

7.1.1.4 Slope stablization

Slope stabilization or protection measures, such as retaining walls, protection barriers, terracing or mesh gabion works, shall be introduced as appropriate, particularly in mountainous areas characterized by steep, unstable slopes above and below the roads.

7.1.1.5 Management of contractors' site compound

The Contractors' site compound shall include adequate living and sanitation facilities for the workers, including an approved plan for solid and liquid waste disposal. The Contractor shall also have an approved management and safety plan for storage of equipment, petroleum products, paving materials, etc., so as to minimize risk of spillage or leakage, as well as safety and emergency response procedures. At the end or the contract period, the Contractor shall leave the site compound in a clean and rehabilitated condition to the satisfaction of the RE and the Beneficiary Committee.

7.1.1.6 Controlled disposal of materials and surplus fill – minimize impact on agricultural land and terraces

Disposal of excavated materials, removed debris and demolished structural materials shall be transported to dumping locations approved by the RE, and authorization for dumping shall be secured by from the landowners, the Beneficiary Committee and/or relevant government authority. The Contractor shall avoid dumping excavated materials onto adjacent farmlands or terraces. Where such impacts are unavoidable or occur inadvertently, agreement for compensatory measures will be reached with the land owners under the auspices of the SFA and Beneficiary Committee.

7.1.1.7 Recovery of borrow pits and quarry areas.

All borrow pits and quarry areas shall be rehabilitated to the satisfaction of the RE and in conjunction with the Beneficiary Committee. Measures include: (i) full reinstatement of the area to its original use; (ii) development of revised use, such as livestock watering areas; or (iii) protection for future borrow operations during maintenance or other road construction.

7.1.2 Hydrology and Water Resources

7.1.2.1 Sourcing of construction water

The Contractor shall obtain access authorization for use of water resources and address any local concerns for excessive draw-down on the water table or surface water supplies.

7.1.2.2 Avoidance of surface or groundwater pollution

The Contractor shall take appropriate measures to avoid pollution to ground or surface water supplies through measures such as:

- (i) Provision of sedimentation/septic tanks, water-incepting ditches and drains to prevent contamination of water resources from contractor's compounds facilities and run off
- (ii) Garbage separation at the source and use of organic material as compost
- (iii) Storage of non-biodegradable materials
- (iv) Temporary drains to dispose of eroded sediments, preventing intrusion in surface water bodies
- (v) Limitation of works near wells, or covering them to prevent pollution
- (vi) Waste water management, including use of wastewater to irrigate camp-site plantation
- (vii) Not dumping of chemicals, coal tar, asphalt or anything which may pollute the aquifers
- (viii) Refueling of plants or transfer of materials far water courses
- (ix) Good practice to avoid spillage and pursue collection and recycling
- (x) In case of accidental spill of fuel or chemicals, efforts to offset pollution
- (xi) Anti-spillage devices installed in storehouses, workshops and vehicle parks
- (xii) Fuel, oil and grease interceptors with impervious bed, to be located underneath the parking areas to drain the runoff into the oil interceptors and prevent contaminated discharges from entering into any water body without adequate treatment
- (xiii) Collection of used lubricants for safe disposal or recycling
- (xiv) Riparian buffers along the edges of ponds to prevent water contamination
- (xv) Construct bridges and culverts in the dry season, when river flow is minimum or nil.

7.1.2.3 Flood protection in the wadis

Design of roads located in, or adjacent to wadis shall include appropriate hydrological analyses as an input to defining the alignment and design of the platform and drainage structures. Alignments shall be placed so as to minimize interference with flows and reduce impact on the road platform.

7.1.2.4 Incorporate water harvesting practice into design

All designs shall take into account current water harvesting practices as they relate to the road. During road construction, the contractor shall adopt measures to avoid damage to the drainage networks and protect existing water harvesting channels to ensure the normal feeding of irrigation systems. Temporary channels and pipes shall be used if the works are conducted during the rainy season, minimizing interference with both channeled and unchanneled or diffused runoff.

7.1.2.5 Reduce cross drainage and scour effects

The design shall provide: appropriate drainage design; use of culverts, Irish crossings, protection walls, riprap, side drainage ditches and outlets; tree planting.

Hydrological analyses shall be carried out to predict and design appropriate measures to mitigate such effects, such as, culverts, irish crossings, protection walls, riprap, side drainage ditches and outlets, tree or vegetation plantings, terracing and soil conservation measures.

7.1.2.6 Reduce discharge to adjacent unstable slopes, graveyards and other structures

The design shall take account of needs to prevent or minimize discharge to adjacent areas, especially those prone to erosion, as well as graveyards and other structures.

7.1.3 Air Quality and Noise

7.1.3.1 Limit dust and potential pollutants from construction machinery, stored material and spoil heaps

The Contractor shall take all necessary measures to limit pollution from dust and any wind blown materials during the works. Measures include:

- (i) Utilize water spraying during operation on sections within 500 m of settlements or crops.
- (ii) Trucks leaving the site are properly covered to prevent discharge of dust, rocks, sand, etc.
- (iii) Crushers and other equipment conform to relevant dust emission control.

Stored materials and heaps should preferably be located away from communities and farmlands; or materials should be covered and fugitive dust should be effectively controlled during delivery.

7.1.3.2 Limit smoke from burning of waste materials

As part of the rubbish removal system, the Contractor shall be prohibited from burning of waste material.

7.1.3.3 Noise control

The Contractor shall adopt the the best practicable means of minimizing noise during construction. For any particular job, the quietest available plant/and or machinery shall be used. Equipment such as compressors, percussion tools and vehicles shall be fitted with silencers. Pneumatic drills and other noisy equipment shall not be used during days of rest or after normal working hours without the consent of the RE and Beneficiary Committee.

7.1.4 Biological Resources

7.1.4.1 Environmental management plans for critical or non-critical habitats

If any proposed road passes through, or is adjacent to: (i) any “declared” or “proposed declared” protected area; or (ii) any natural habitat not “declared” or “proposed declared”, but is locally known as a sensitive natural habitat, it will trigger the *RAP Natural Habitat Policy Framework*. In such case, scoping and screening will include an initial assessment to determine whether project impacts can be avoided or minimized through design measures or post-development restoration. These may include such measures as: (a) realignment to avoid the natural habitat; (b) mitigation measures to minimize ecological damage; (c) post development restoration works; or (d) avoidance through the no-project alternative. If the only feasible alternative would involve establishing and maintaining an ecologically similar protected area, the no-project alternative will be chosen, as this would fall outside the Program’s scope. Should options (a) or (b) be selected, the *Natural Habitat Policy Framework* outlines the procedures to be followed, which will be carried out in conjunction with the Ministry of Water and Environment (MWE).

7.1.4.2 Limit damage to biological resources by construction equipment

The Contractor shall take all necessary measures to identify and minimize potential impacts of construction equipment on flora or fauna resources, such as:

- (i) Realignment, or establishment of “pinch points” to avoid destruction of productive, ancient or other trees or vegetation identified during screening; and
- (ii) Avoidance or restoration of known or chance finds of small animal habitats, such as nests or dens destroyed by construction activities.

7.1.4.3 Prevent damage to biological resources by construction workers

As part of his employee management policy, the Contractor shall forbid animal poaching or wanton cutting of trees by construction workers. Measures in this regard include strict employment rules and sanctions regarding such practices. Utilization of gas for cooking is recommended as a disincentive for cutting of trees.

7.1.5 Socio-Economic and Cultural Resources

7.1.5.1 Consultations to reduce tribal tensions

Project screening will identify any potential tribal tensions along a proposed road. During initial consultations, it shall be made clear to tribal leaders that resolution of such issues, under the auspices of the Governor, is a prerequisite for project implementation. The Social Framework Agreement (SFA) will lay out these agreements for each rural road sub-project to ensure consensus among the tribes living along the roads on the organization and achievement of the road improvement, road alignments and distribution of project benefits.

7.1.5.2 Land acquisition and resettlement plans

The scoping and screening process will identify potential requirements for land acquisition or resettlement and the extent of “affected persons”. The screening will also determine whether such impacts can be avoided or minimized through design measures. These may include such measures as reducing the design standard at the contentious location (“pinch points”) or leaving the contentious section as is, in agreement with affected people. If these impacts cannot be avoided through such measures, the *Resettlement Policy Framework* will be triggered, and the project will follow the procedures outlined in that *Resettlement Policy Framework*. If the project is included in the Program, a stand-alone *Resettlement Plan (Full, in the case of major impacts – more than 200 affected persons; or Abbreviated, in the case of minor impacts – less than 200 affected persons)* will be prepared prior to commencement of project implementation. This Plan will be established in coordination with the Beneficiary Committee and referred to in the Social Framework Agreement (SFA).

7.1.5.3 Precautionary measures for utility services

Precautionary measures shall be taken to avoid interference with utilities such as telephone and power lines, and water and sewage pipelines. Services falling within the right of way shall be relocated in collaboration with the relevant agencies, the RE and the Beneficiary Committee.

7.1.5.4 Compliance with public health and safety requirements at construction sites

The Contractor shall take all necessary action to comply with the *General Safety, Health and Environment Regulations*. Mitigation measures shall be taken in respect of:

Reducing construction site risks to the workers and the public – safety rules for work operations shall be instituted by the Contractor, including, but not limited to; location of plant (crushers, asphalt plants, generators) away from sensitive locations (hospitals, schools,

etc.), equipment operation procedures, safety barriers, warning signs, protective hard hats, shoes and clothing for the workers, first aid and medical kits and procedures, and safety training for the workers.

Reducing health risks from compound living conditions and interaction with the community – employee rules and information campaigns shall be instituted by the Contractor on health practices and communicable diseases; awareness raising meetings with the community; all regulations shall be clearly displayed in Arabic and English.

7.1.5.5 Road safety and traffic management measures

The Contractor will install and maintain warnings to guide detour users and avoid collision with construction vehicles between work sites and gravel pits. Detours will be carefully planned and drivers using unfamiliar detours assisted with manual regulation of traffic. Speed restrictions shall be introduced along detour roads. Road closures, where unavoidable, shall be planned in close collaboration with the RE and the Beneficiary Committee.

7.1.5.6 Graveyards and burials

Where graveyards or burial plots are located adjacent to the roads, the project will avoid disturbance through: (i) pinch points or adjustments to alignments; and/or (ii) drainage and other design measures to avoid excessive runoff or erosion onto the graveyard or burial. If unrecorded graveyards or burials are found during the course of construction, the following procedures will apply:

- (i) As soon as graveyards or burials are discovered, the Contractor must report to the RE, who will inform RAP CMO and the Beneficiary Committee. Consultations with local religious authorities and communities will be carried out for possible identification of remains and agreed solutions (i.e., road deviations or re-alignments)
- (ii) If deviations or realignments are impossible, the RAP CMO will agree with the Beneficiary Committee and local religious authorities a proper relocation and procedures for reburial of the remains.

7.1.5.7 Cultural resource assessments and management plans

The scoping and screening process will identify potential impacts on known cultural resources. If such impacts are identified, scoping and screening will include an initial assessment to determine whether these impacts can be avoided or minimized through design measures. These may include such measures as: (a) realignment or road narrowing to avoid the physical cultural resource identified; or (b) avoidance through the no-project alternative. If, following consultations, the project remains a candidate to be included in the Program, the *Cultural Resources Policy Framework* will be triggered, and the project will follow the procedures outlined in the *Cultural Resources Policy Framework*. The assessment of the impacted physical cultural property and mitigation measures will form an integral part of the project EA (including EMP) and will be carried out in coordination with the General Organization for Antiquities, Museums and Manuscripts (GOAMM).

7.1.5.8 Use of archeological “chance find” procedures

The Contract Data will contain procedures for archaeological “chance finds” during the course of construction activities. The Government (Ministry of Culture) will make available (on demand) a qualified archaeologist to conduct field investigations when important search work and new materials sites are opened. The archaeologist would be paid by RAP CMO and be attached temporarily to the construction manager's team and provided with logistical

support when necessary. The following procedures should be executed whenever archaeological relic, antiquity or any other object of archaeological importance is discovered during road construction:

- (i) Halt construction activities.
- (ii) Delineate the discovered site area.
- (iii) Secure the site to prevent any damage or loss of removable objects. In case of removable antiquities or sensitive remains, a night guard should be present until the responsible authority takes over.
- (iv) Notify the responsible foreman/archaeologist, who in turn will notify the GOAMM, the Environmental and Social Management Unit (ESMU) of RAP CMO and the local authorities (within less than 24 hours).
- (v) GOAMM would be in charge of protecting and preserving the site before deciding on the proper procedures to be carried out.
- (vi) GOAMM will evaluate the importance of the finding according to criteria relevant to cultural heritage, as aesthetic, historic, scientific or research, social and economic values.
- (vii) Decision on how to handle the finding will be reached based on the above assessment and could include changes in the project layout (in case of finding an irremovable relic of archaeological importance), conservation, preservation, restoration or salvage.
- (viii) Implementation of the GOAMM decision concerning the management of the finding.
- (ix) Construction works should resume only when permission is given from GOAMM after the decision concerning the safeguard of the heritage is fully executed.

7.1.5.9 Gender Considerations

Gender-related concerns identified during the womens' consultations will, as appropriate, be incorporated into road designs. Such design measures may include pathways and steps to facilitate daily activities, as well as safety measures, such as speed bumps or signs, near schools or populated areas. In addition, safety issues and responsibilities will be mentioned in the SFA, and safety information campaigns will be introduced.

7.1.5.10 Consultations regarding local employment

Mechanisms for maximizing local employment benefits will be discussed during initial consultations and specified in the SFA.

7.2 MANAGEMENT OF IMPACTS DURING OPERATIONS PHASE

7.2.1 Land Resources

7.2.1.1 Maintain and monitor slope stabilization measures

Protection and stabilization measures carried out on steep upslope and downslope areas shall be regularly maintained and monitored as part of maintenance operations. Additional measures may be instituted where necessary, in collaboration with the Beneficiary Committee.

7.2.1.2 Avoid damage to terraces and agricultural lands during maintenance

The Maintenance Contractor shall take care to avoid damage to terraces and agricultural lands during any cut and fill, haulage or other machine operations.

7.2.1.3 Management of maintenance site compounds, materials and equipment storage

To the extent that the Maintenance Contractor establishes such facilities, the site compound shall include adequate living and sanitation facilities for the workers, including an approved plan for solid and liquid waste disposal. The Maintenance Contractor shall also have an approved management and safety plan for storage of equipment, petroleum products, paving materials, etc., so as to minimize risk of spillage or leakage, as well as safety and emergency response procedures. At the end of the contract period, the Maintenance Contractor shall leave the site compound in a clean and rehabilitated condition to the satisfaction of the RE and the Beneficiary Committee.

7.2.1.4 Management of induced development

The effects of induced development, such as uncontrolled settlements at intersections, increased litter or increased cutting of trees, shall be addressed by the Beneficiary Committee and District authorities, who are responsible for controlling land use in the project area. Such issues shall be raised and agreed during the preparation of the SFA.

7.2.2 Hydrology and Water Resources

7.2.2.1 Maintain and monitor water harvesting measures

Water harvesting measures instituted during construction shall be maintained and monitored during maintenance operations. Additional measures may be instituted where necessary, in collaboration with the local farmers and Beneficiary Committee.

7.2.2.2 Maintain cross drains/culverts

Regular cleaning of cross drains, culverts and other drainage structures shall be carried out as part of maintenance operations, in collaboration with the Beneficiary Committee.

7.2.2.3 Maintain road protection and other structures

Regular maintenance of retaining structures, such as walls, gabions, riprap, etc. will be carried out as part of maintenance operations, in collaboration with the Beneficiary Committee.

7.2.2.4 Clearing of hazardous waste from accidents

The community shall be made aware of the need for timely clean up of spillage of hazardous waste resulting from accidents.

7.2.3 Air Quality and Noise

7.2.3.1 Air quality measures

Expected increases in traffic levels are not anticipated to be so high as to bring about significant air pollution on individual roads. Smoother and less dusty roads and the use of smaller lighter vehicles will promote less dust and will likely result in lower emissions. Outside the purview of this project, measures to lower overall emissions in the country are

strict enforcement of vehicle quality standards and the conversion to unleaded petrol.

7.2.3.2 Noise reduction measures

Noise impacts are not expected to be a serious issue, given the levels of traffic and dispersed nature of the rural road investments. In particularly sensitive areas, design measures to address noise may be introduced in collaboration with the Beneficiary Committee, involving for example signs near hospitals or schools, or concrete or vegetation barriers if practical.

7.2.4 Biological Resources

7.2.4.1 Reduce induced impacts on flora and fauna

Potential induced impacts, such as increased wood cutting or grazing, shall be addressed through community awareness and relevant programs implemented by government agencies, such as the Ministry of Agriculture, and NGOs. The risk of increased road kills of wildlife or domestic livestock shall be addressed through the maintenance of speed reduction measures at appropriate locations. Such measures shall be maintained, monitored and, if necessary adapted to actual experience.

7.2.5 Socio-Economic and Cultural

7.2.5.1 Accident reduction measures

To reduce road accidents and fatalities resulting from increased traffic and speed, speed humps and vertical and horizontal signs shall be maintained during the operational period. Pedestrian safety, in particular the threat posed to women and children by higher standard roads, shall be addressed through mitigation measures such as for pedestrian crossings and walkways to schools, water sources, etc., where practical. In collaboration with the Beneficiary Committee, safety awareness campaigns shall be carried out, and such campaigns will be specified in the SFA. Target groups include: drivers and students of primary and secondary schools. Implementation and monitoring responsibilities will belong to traffic police, schoolteachers, NGOs, assisted by the RAP CMO and Ministry of Transport and Highways.

7.2.5.2 Conformance with public health and safety regulations during maintenance

To the extent relevant, the Maintenance Contractor shall take all necessary action to comply with the *General Safety, Health and Environment Regulations*. Mitigation measures shall be taken in respect of:

- **Reducing construction site risks to the workers and the public** – safety rules for work operations shall be instituted by the Contractor, including, but not limited to; location of plant (crushers, asphalt plants, generators) away from sensitive locations (hospitals, schools, etc.), equipment operation procedures, safety barriers, warning signs, protective hard hats, shoes and clothing for the workers, first aid and medical kits and procedures, and safety training for the workers.
- **Reducing health risks from compound living conditions and interaction with the community** – employee rules and information campaigns shall be instituted by the Contractor on health practices and communicable diseases; awareness raising meetings with the community; all regulations shall be clearly displayed in Arabic and English.

7.2.5.3 Monitoring of socio-economic benefits

The RAP CMO, through the E&SU, will monitor selected socio-economic impacts of the rural road investments. This will be done through baseline and follow up surveys for each RAP road, which will focus on travel time and cost to markets and social and administrative services, as well as the price of various transport-sensitive basic commodities.

7.2.5.4 Cultural Resources Chance Find Procedures

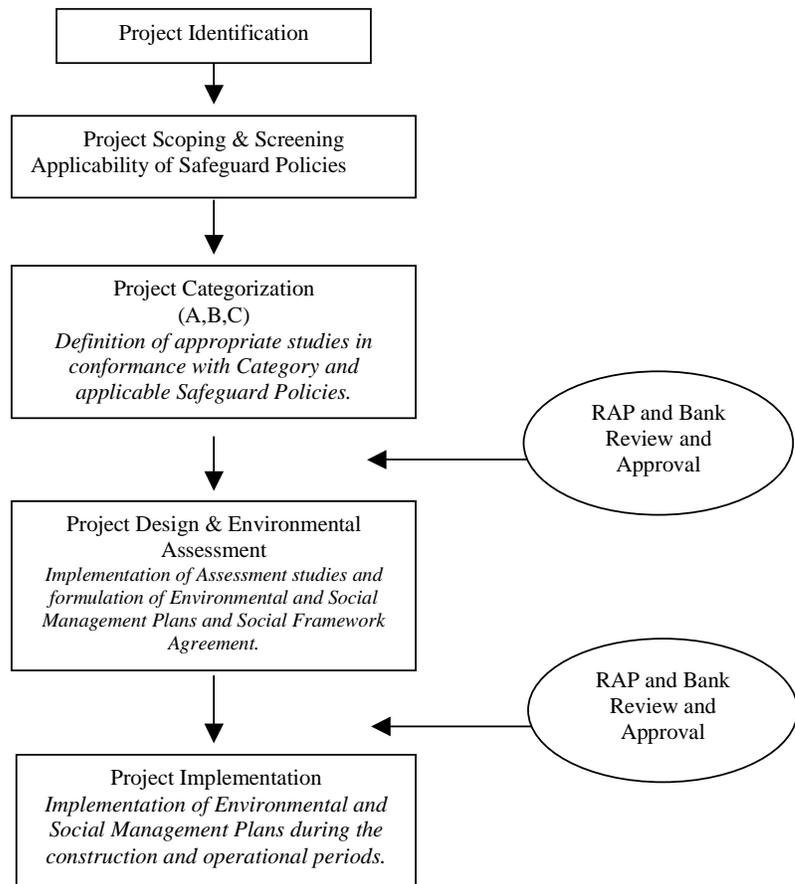
The Contract Data for maintenance contracts will contain the same procedures for archaeological “chance finds” as those defined in the construction contracts. These are described in section 7.1.5.8 above, as well as the *Cultural Resources Policy Framework*.

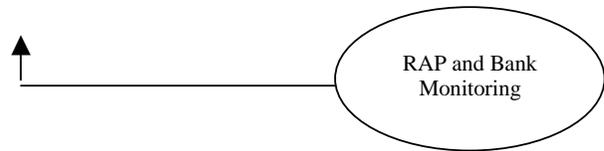
7.3 IMPLEMENTATION ARRANGEMENTS

7.3.1 Environmental and Social Management Process

All roads financed under the RAP will undergo an Environmental and Social Management Process, in which candidate rural road projects are screened to identify potential environmental and social issues and determine whether Safeguard Policies should be triggered. This process is summarized below.

Overview of RAP Environmental and Social Management Process (For Individual Projects Financed under the Program)





7.3.2 Responsibilities and Procedures

Overall responsibility for the implementation of the above process will be with the RAP CMO, through its Environmental and Social Unit (E&SU). The procedures of the E&SU are designed to incorporate, or “mainstream” environmental and social considerations into the overall process for rural road planning and implementation. These procedures are summarized below.

Road Project Cycle	Phase	Activities	Responsibilities
PLANNING	Scoping and Screening	<ul style="list-style-type: none"> ☞ Initial site visit & consultations. ☞ Identification of issues and applicable safeguards policies ☞ Categorization ☞ Action plan 	CMO-E&S Unit
	Preparation of EA, SFA and consultations	<ul style="list-style-type: none"> ☞ Draft EA ☞ Draft SFA ☞ Women consultations 	Consultant /CMO-E&S Unit
DESIGN	Disclosure and agreement signing	<ul style="list-style-type: none"> ☞ Disclosure of draft EA & SFA to communities ☞ Signing of final SFA 	CMO-E&S Unit/ Consultant Districts & communities
	Finalization and Incorporation	<ul style="list-style-type: none"> ☞ Final version of EA ☞ Incorporation of EMP into contract documents 	Consultant /CMO-E&S Unit
EXECUTION	Implementation and monitoring	<ul style="list-style-type: none"> ☞ Implementation ☞ Monitoring & reporting on environmental and social mitigation measures 	Contractors CMO-E&S Unit RE & local community
OPERATIONS	Operations and maintenance	<ul style="list-style-type: none"> ☞ Implementation ☞ Monitoring & reporting on environmental and social mitigation measures 	Contractors CMO-E&S Unit RE & local community

EA = Environmental Assessment, including Environmental Management Plan (EMP)

SFA = Social Framework Agreement

7.3.2.1 Contract provisions

General contract clauses related to construction and maintenance operations are specified in the RAP Standard Bidding Documents and Works Contracts, *Volume II General Specifications and Regulations*. Under *General Regulations* is included (I) *General Safety, Health & Environment Regulations* and (II) *Other Regulations and Requirements*. Section (I) includes the following relevant subsections:

(I) Safety, Health & Environment General Regulations

1. Introduction
 2. Compliance with Regulations
 3. Failure to Comply with Regulations
 4. General Requirements
 5. Safety Requirements
 6. Environmental and Health Requirements
 7. Additional Requirements in Public Areas
 8. Contractor's Site Checklist
- Annex 1 Sample Contractor's Site Checklist
Annex 2 Environment and Social Management Plan for Construction Period (EMP)

7.3.2.2 Pre-tender conference

To ensure full understanding of the above clauses by the contractors, all pre-qualified contractors will attend a Pre-Tender Conference, where they will be briefed on their responsibilities to address environmental, social, health and safety issues. These briefings will outline the general requirements in the *General Conditions of Contract* and the *General Health and Environmental Regulations*, as well as road specific provisions in the tender documents and contracts, as laid out in the Contract Data.

7.3.3 Environmental Assessment Instruments

7.3.3.1 Scoping and screening

Scoping and screening will consist of identifying, for each potential project, the major issues, the appropriate environmental category, and establishing a plan for appropriate environmental assessment (EA) studies. It will also serve to heighten awareness of these issues among stakeholders and initiates the participatory planning process. Scoping will rely on baseline data drawn from documents, interviews, air photographs, satellite images and maps, supplemented by on-site inspection and initial stakeholder consultations. All Screening Reports will follow a standard layout, presented in Chapter 9.

7.3.3.2 Environmental categorization

Each potential project will be categorized to determine the appropriate extent and type of EA, based on the particular characteristics of the road. Because of the nature of road projects, roads will be categorized into one of two categories:

Category A:	A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.
-------------	---

Category B:	A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas-including wetlands, forests, grasslands, and other natural habitats-are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.
-------------	--

7.3.3.3 Policy Frameworks for Resettlement, Natural Habitats and Cultural Resources

If, during initial screening or implementation, it is determined that a sub-project has issues related to (i) permanent land acquisition or resettlement; (ii) impact on natural habitats; or (iii) cultural resources, this will trigger the appropriate Policy Framework developed for this purpose are incorporated into Volume 2 of the SEA. These are:

- Resettlement Policy Framework
- Natural Habitats Policy Framework; and
- Cultural Resources Framework.

Automatic Triggers for Categorization:

- **Resettlement.** Projects involving “major” resettlement impacts (i.e. more than 200 affected persons) shall automatically be placed under environmental screening Category A and will require a *Full Resettlement Plan* as defined in the *Resettlement Policy Framework*. Projects with less than 200 affected persons shall be placed under Category B and will require an *Abbreviated Resettlement Plan*, also as defined in the *Resettlement Policy Framework*.
- **Natural Habitats.** Projects whose proposed road alignment passes through, or is adjacent to, any of the “declared”, “proposed declared” protected areas in Yemen, as shown in Table 4.30, shall automatically be placed in Environmental Category A and will require the recruitment of a qualified consultant to carry out a detailed impact assessment and Environmental Management Plan (EMP), as defined in the *Natural Habitats Policy Framework*, as part of the overall EA. Projects whose proposed alignment pass through or are adjacent to any “non-critical habitat” may be Category A or B, depending on its relative location and extent of anticipated impacts, but in either case, a qualified consultant will be recruited to carry out the detailed impact assessment and EMP.
- **Cultural Resources.** Projects whose proposed alignment runs through or is adjacent to any physical cultural resources shall trigger the application of the *Cultural Resources Policy Framework*, but may be placed in Environmental Category A or B, depending on the relative location and extent of anticipated impacts. In either case, a qualified specialist will be recruited to carry out the impact assessment and EMP, in collaboration with GOAMM.

7.3.3.3 Environmental Assessments (EA)

- **Category A projects EA.** For roads classified as Category A, the project will carry out a full Environmental Assessment and any additional Safeguard Plans triggered. The Environmental Assessment and any Safeguard Plans will be carried out by

independent experts, in conjunction with the preparation of the design. This will enable the incorporation of adequate mitigation measures into the final design, as well as affording a review and approval of these measures and other Safeguards Policy Plans (such as Resettlement Plan, Cultural Resources Plan or Natural Habitats Plan) by the World Bank. Each Report will follow the standard format shown in Chapter 9.5. If triggered, the Resettlement Plan, Cultural Resources Plan, or Natural Habitats Action Plan will follow the standard procedures defined in their respective Policy Frameworks.

- **Category B projects EA.** For roads classified as Category B, the project will carry out an abbreviated Environmental Assessment, in conjunction with the design consultant. The general format of the Category B Environmental Assessment Report will follow the same as that of Category A projects, with appropriate levels of detail.

7.3.3.4 Social Framework Agreements (SFA)

During the preparation of the Environmental Assessment and Environmental Management Plan, the Government will assist the beneficiary communities to address jointly the environmental and social issues of the project and achieve optimal, or minimum-impact, design alternatives. The instrument of this policy approach is the SFA. The SFA will bear evidence of the approval, by the Beneficiary Committee, of all planned environmental and social mitigation and enhancement measures. It also provides a framework for addressing unforeseen environmental and social issues that may arise during final design and implementation. If applicable, the affected individual holders, as well as the legal representatives of the collective holders, of affected land rights and business activities will be signatories of the compensation transactions annexed to the SFA. The signing of the SFA is a pre-condition for the final approval and funding of each road project, and will be attached to each EMP. The SFA will follow a standard format provided in Chapter 9.4.1.

7.3.3.5 Environmental Management Plans (EMP)

Each road specific EA will also include an Environmental Management Plan, which summarizes the impacts, mitigation measures and responsibilities for environmental and social impacts associated with the road. It will be summarized in a table, which will be an adaptation of the EMP table presented in Section 7.4.

7.3.3.6 Consultations and Disclosure of Information

As part of the EA process, on-site consultations shall be undertaken with a range of agencies and stakeholders for each rural access road to be financed under the Program. The draft SFA for each road shall be made available in Arabic and English for public review before being finalized.

7.3.3.7 Women's Consultations

Separate consultations shall be held to solicit women's view on the proposed projects and incorporate their concerns into the Environmental Management Plan (EMP) and the Social Framework Agreement (SFA).

7.3.4 Environmental Monitoring

The RAP CMO through its Environmental and Social Unit (E&SU) shall be responsible for monitoring of the overall environmental and social management process. This will include:

Planning and Preparation:

- Review and approval of EA, ESMP and SFA for all projects.
- Review and approval of special Safeguard reports related to Resettlement Plans, Natural Habitat Plans or Cultural Resources Plans, in collaboration with MWE or GOAMM.

Execution:

- Review and evaluation of Resident Engineer's Monthly Reports on Contractors' compliance with general and specific environmental contract clauses.
- Review and evaluation of special monitoring reports related to Resettlement Plans, Natural Habitat Plans or Cultural Resources Plans, in collaboration with the Ministry of Water and Environment or GOAMM.

Operations:

- Review and evaluation of Resident Engineer's Reports on Maintenance Contractor's compliance with general and specific environmental clauses.
- Liaison with community on safety campaigns and other mitigation during operations.
- Monitoring of socio-economic impact indicators.

The E&SU shall maintain a dossier for each project road. This dossier will include:

- Initial requests for support and all ensuing correspondence
- Screening Report and all attachments
- Draft and Final EA, EMP and SFA
- Records of all consultations at Governorate and local levels
- Copies of Special Reports, such as *Resettlement Plans*, *Natural Habitats Plans* or *Cultural Resources Plans*, when applicable
- Monthly RE reports of compliance with EMP. The EMP for each road will include a checklist of impacts and mitigation measures for that road. This will be based on the generic Environmental and Social Management Plan Table at the end of this Chapter and will be attached to the Resident Engineer's Reports. A sample of such a report is presented in Chapter 9.

During construction, the Resident Engineer (RE) will be responsible for monitoring the Contractor's compliance with all contract clauses addressing environmental and social impact mitigation, to be carried out under the purview of the General Safety, Health and Environmental Regulations. For this purpose, the RE will refer to the project-specific EMP and report on such compliance in his monthly reports.

RAP/CMO will produce Quarterly Reports describing the progress of the environmental and social screening, planning and implementation of all individual road EMPs.

7.3.5 Costs of Mitigation

The quantities, specifications and estimated costs of design measures to avoid or mitigate negative impacts will be assessed by the design consultant and incorporated into the works bidding documents. The contractor will execute all required works and will be reimbursed through pay items in the bill of quantities, which will be financed by the project.

Temporary acquisition for diversions, camps, borrow areas and other work sites will constitute a community contribution, under the auspices of the Beneficiary Committee and confirmed through Social Framework Agreement. Additional costs of rehabilitating all such areas to their original state will be incurred by the contractor and borne by the project, as a pay item in the bill of quantities.

As stated in the Resettlement Policy Framework, owners of affected houses and other structures will be compensated in-kind, which is defined as the cost of the works required to replace the asset in its existing condition. As with design measures noted above, The quantities, specifications and estimated costs will be assessed by the design consultant and incorporated into the works bidding documents. The contractor will execute all required works and will be reimbursed through pay items in the bill of quantities, which will be financed by the project.

In conformance with Yemeni traditional rural practice, owners of affected lands will not be compensated by the Project in cash for loss of land, but the affected owners will donate such land for public purposes and community benefit. However, this donation will occur within the context of a mutually signed community-based Agreement, which is appended to the SFA, and which specifies the terms under which the donation is made. These terms will be based on local traditional practice concerning the donation of private land for public purposes and specifies any special terms or conditions related to the particular case, which are to be settled internally by the community. Generally, these include one of two options: (i) the affected person freely donates the land to the community; or (ii) the community may allocate part of its lands to the affected person.

During operations, the costs of mitigation in the course of maintenance contracts will be incurred by the contractor and borne by the employer, who may be the Road Fund, Government or local government, and reimbursed as a pay item in the bill of quantities. The maintenance of water harvesting, footpaths and other social measures will be the responsibility of the community. In addition, the community will be expected to carry out basic cleaning of drains and culverts as part of their contribution to maintenance. The cost of safety and driver information campaigns will initially be borne by the project, however the communities will be responsible for continuous community education and safety campaigns. Selected safety audits will be carried out by the project, in conjunction with communities.

7.3.6 Compliance Monitoring

Following its exercise of prior review, the World Bank will monitor the implementation of road specific EAs, SFAs, Resettlement Plans and specific mitigation plans for Natural Habitats or Cultural Resources. The Bank will also carry out targeted and spot review of specific social cases and resettlement plans involving land donation and asset replacement, as part of regular supervision, or separate missions.

7.3.7 Institutional Strengthening

During Phases II and III, the role of the E&SU will shift from one of *implementor* of the Environmental and Social Management Process, including the preparation of EA, ESMP and SFA, to one of *manager* of the Process. In this revised role, ES&U will still be responsible for Screening of all projects, but then will focus on the planning and oversight of EA preparation, which will be carried out by a pool of competent consultants trained in the RAP E&SU. The E&SU will prepare terms of reference (TOR) for EA studies, review and approve EA studies, liaise with other agencies, maintain records, exercise quality control, carry out reporting and monitor implementation.

The present E&SU is fully operational. Its staff consists of two engineers, who have undergone on-the-job training during Phase I and are fully competent in all aspects of the ESM Process. In addition, RAP CMO is establishing 5 Regional Branches, who will also provide additional potential manpower for carrying out Screening and overseeing the preparation of the EAs, ESMPs and SFAs. However, in view of the increased workload, the RAP E&SU staff will need to be expanded to at least 4 members.

Institutional strengthening will be carried out through:

- (i) Recruitment of additional staff and required equipment at RAP CMO;
- (ii) Training of additional RAP CMO staff through in-house seminars and workshops
- (iii) In-service training for existing staff through seminars and workshops
- (iv) In-service training for existing staff at national, regional or international levels, to be identified and financed through the IDA Project.

7.4 SUMMARY TABLES OF ENVIRONMENTAL MANAGEMENT PLAN

The following tables summarize the potential impacts, standard mitigation measures to be adapted road-specific conditions, and responsibilities for implementation and monitoring. These tables will be adapted to each road circumstances and will provide the basis for a checklist to be utilized by the following Design Engineer (DE), Resident Engineer (RE), Contractor, Beneficiary Committee and the RAP CMO Environmental and Social Unit (E&SU). General contract provisions are expressed in the *General Conditions of Contract (GCC)*, further elaborated in the *General Safety, Health and Environmental Regulations (GSHER)*, while road-specific provisions are expressed in the Conditions of *Particular Application* (Contract Data) of each road's bidding documents and contract.

ENVIRONMENTAL MANAGEMENT PLAN SUMMARY

A. DESIGN/CONSTRUCTION PHASE

Impact	Mitigation		Responsibility	
	Mitigation Measures	Contract and Social Framework Agreement (SFA) Clauses	Implementation (Cost/Finance)	Monitoring
A.1 Land Resources				
A.1.1 Site survey investigations	Prudent selection and limitation of construction sites; reinstatement of intrusive investigation sites.	General Regulations: II. Other Regulations and Requirements Clause 17.1.3.	DE, RE, Contractor (Design Consultant/ Project)	E&SU
A.1.2 Permanent land acquisition	Pinch points and appropriate design to reduce platform and minimize land taking; Application of Resettlement Policy Framework when unavoidable.	Issues identified during screening; design measures in Contract Data, contract drawings and SFA.	DE, RE (Contractor/ Project; community land donation & collaboration)	E&SU
A.1.3 Temporary land acquisition	Siting of site compounds, diversions and haul roads; traffic management.	General Regulations: I. Safety, Health & Environmental Regulations Clause 7.3; II. Other Regulations and Requirements Clause 17.2.2.	DE, RE, Contractor (Contractor/Project)	E&SU
A.1.4 Slope stabilization	Stabilize upslopes in mountainous areas; design measures to minimize adverse downstream impacts.	Issues identified during screening; design measures in Contract Data, contract drawings.	DE, RE (Contractor/ Project)	E&SU
A.1.5 Contractor site compounds, materials and equipment storage	Provision of adequate living and sanitation facilities; adequate materials management and safety plan; handover of rehabilitated compound site.	General Regulations: I. Safety, Health & Environmental Regulations Clauses 6.1, 6.4; II. Other Regulations and Requirements Clauses 17.3, 17.4, 17.5.	RE, Contractor (Contractor/Project; community land donation & collaboration)	E&SU
A.1.6 Disposal of cut materials and surplus fill – agricultural land destruction	Controlled disposal of cut material and surplus fill.	General Regulations: I. Safety, Health & Environmental Regulations Clause 6.6.	DE, RE, Contractor (Contractor/ Project)	E&SU
A.1.7 Borrow pits and quarry areas	Prudent selection of site; management during use and reinstatement.	General Regulations: I. Safety, Health & Environmental Regulations Clause 5.15.	DE, RE, Contractor (Contractor/Project; community land donation & collaboration)	E&SU
A.2 Hydrology and Water Resources				
A.2.1 Sources of construction water	Appropriate sourcing of water and prior arrangements with communities.	Contractor's obligation defined in contract document and community obligations defined in SFA.	DE, RE, Contractor (Contractor/Project)	E&SU
A.2.2 Pollution from wastewater, diesel or asphalt spills from site compounds and machinery	Measures to prevent groundwater or surface water contamination.	General Regulations: I. Safety, Health & Environmental Regulations Clause 6.3.	DE, RE, Contractor (Contractor/Project)	E&SU

A.2.3 Flood Protection in Wadis	Appropriate road alignment within wadis; design for protection and drainage discharge works that minimize adverse downstream impacts.	Issues identified during screening; design measures in Contract Data, contract drawings.	DE, RE, Contractor (Contractor/Project)	E&SU
A.2.4 Alteration of water harvesting patterns	Incorporate current water harvesting practices into design; use of irrigation pipes; improvement of channel performance by riprap work.	Issues identified during screening; design measures in Contract Data, contract drawings and in SFA.	DE, RE, Contractor (Contractor/Project)	E&SU
A.2.5 Wadi cross drainage and scour effects on new fill.	Appropriate drainage design; use of culverts, Irish crossings, protection walls, riprap, side drainage ditches and outlets; tree planting.	Issues identified during screening; design measures in Contract Data, contract drawings and SFA.	DE, RE, Contractor (Contractor/Project)	E&SU
A.2.6 Discharge to: - new fill - unstable slopes - channel in a stack - Graveyards - agriculture terraces and - other sensitive and roadside structures	Appropriate positioning and design of drainage structures; protection walls or riprap.	Issues identified during screening; measures in Contract Data , contract drawings and SFA.	DE, RE, Contractor (Contractor/Project)	E&SU
A.3 Air Quality and Noise				
A.3.1 Dust & potential pollutants from construction machinery, stored material and spoil heaps	Water spraying during operations; dust emission controls on crushers and other equipment; Preferably, locate heaps away from communities and farmlands; cover material-laden trucks; control of fugitive dust during material delivery.	General Regulations: I. Safety, Health & Environmental Regulations Clause 6.2.	RE, Contractor (No additional cost; Community collaboration)	E&SU
A.3.2 Smoke from burning of waste materials	Prohibition of burning waste material.	General Regulations: Safety, Health & Environmental Regulations Clause 6.2.	RE, Contractor (No additional cost)	E&SU
A.3.3 Noise Nuisance	Noise control devices (such as silencers) on compressors, percussion tools; avoid equipment use after working hours.	General Regulations: I. Safety, Health & Environmental Regulations Clause 6.5.	RE, Contractor (No additional cost)	E&SU
A.4 Biological Resources				
A.4.1 Conversion or degradation of a critical or non-critical natural habitats	Assessment and mitigation plan under <i>Natural Habitats Policy Framework</i> .	Issues identified during screening; design measures in Contract Data, contract drawings and SFA.	E&SU, DE, RE, Contractor (Design Engineer/Contractor/Project)	E&SU, MinWater & Env.
A.4.2 Damage to biological resources by construction equipment	Avoidance through realignment or pinch points; restoration of nests, dens or other small animal habitats.	General Regulations: I. Safety, Health & Environmental Regulations Clause 16.2.2. Issues identified during screening; design measures in Contract Data, contract drawings and SFA.	DE, RE, Contractor (Contractor/Project)	E&SU
A.4.3 Damage to biological resources by construction workers	Contractor employment rules; information campaigns to RE and contractor personnel.	General Regulations: I. Safety, Health & Environmental Regulations Clause 4.11.	RE, Contractor (No additional cost)	E&SU

A.5 Socio-Economic and Cultural Resources				
A.5.1 Tribal Tensions	Consultation and negotiation during during project preparation.	Issues identified during screening; agreements and commitments expressed in SFA.	DE, RE, Contractor, Beneficiary Committee (No additional cost)	E&SU
A.5.2 Land acquisition and resettlement	Abbreviated or Full Resettlement Plan, as specified during screening.	General Regulations: I. Safety, Health & Environmental Regulations Clause 5.13. Issues identified during screening; design measures in Contract Data, contract drawings and SFA. Procedures specified in <i>Resettlement Policy Framework</i> .	DE, RE, Contractor, Beneficiary Committee (Contractor/Project; Community land donation & collaboration)	E&SU
A.5.3 Destruction or relocation of utility services (electricity and phone lines, water pipes and wells, etc.).	Design avoidance measures through pinch points or alignment adjustment, OR relocation of utility; precautionary measures with construction machinery during operations.	General Regulations: Safety, Health & Environmental Regulations Clause 16.2.4. Issues identified during screening; measures in Contract Data, contract drawings and SFA.	DE, RE, Contractor, Beneficiary Committee (Contractor/Project)	E&SU
A.5.4 Public health and safety at construction site -Safety and health for the construction workers. -Public safety at the site and interaction between the workers and the public.	Safety rules for work operations, such as equipment operation procedures, protective hard hats, shoes and clothing for workers; first aid and medical kits and procedures; health and safety regulations clearly displayed in English and Arabic. Public health and safety measures, such as barriers and warning signs to borrow areas or other dangerous zones; information campaigns on health practices and communicable diseases.	General Regulations: I. Safety, Health & Environmental Regulations Clauses 4, 5 & 6. Community precautions defined in SFA.	RE, Contractor, Beneficiary Committee (Contractor/Project)	E&SU
A.5.5 Road closure and detours	Traffic management; define closures and detours with Beneficiary Committee; install and maintain warnings guides to drivers.	General Regulations: I. Safety, Health & Environmental Regulations Clause 7.3; II. Other Regulations and Requirements Clause 17.2.2.	DE, RE, Contractor, Beneficiary Committee (Contractor/Project)	E&SU
A.5.6 Graveyards and burials	Avoid disturbance through pinch points or alignment adjustments; drainage and design measures to avoid flooding; barriers during construction.	General Regulations: I. Safety, Health & Environmental Regulations Clause 7.5. Issues identified during screening, design measures in Contract Data and SFA.	DE, RE, Contractor, Beneficiary Committee (Contractor/Project)	E&SU
A.5.7 Known archaeological and historic sites and resources	Assessment and mitigation plan under the <i>Cultural Resources Policy Framework</i> .	Issues identified during screening; procedures specified in <i>Cultural Resources Policy Framework</i> ; agreements and commitments expressed in SFA.	E&SU, DE, RE, Contractor, Beneficiary Committee, GOAMM (Design Engineer/Contractor/Project)	E&SU, GOAMM

A.5.8 Chance finds of Cultural Resources or other socio-economics resources	Application of <i>Chance Find Procedures</i> to assess requirements and implement mitigation.	Chance Find Procedures specified in Annex 2 of <i>Cultural Resources Policy Framework</i> ; agreements and commitments carried out within the SFA framework.	RE, Contractor, Beneficiary Committee, GOAMM (<i>Contractor/Project</i>)	E&SU
A.5.9 Gender considerations	Women's consultations and incorporate concerns into EMP.	Issues identified during screening, design measures in Contract Data and SFA.	Women Consultant, DE, Contractor, Beneficiary Committee (<i>RAP CMU/Project</i>)	E&SU
A.5.10 Employment	Mechanisms to maximize local employment benefits explored during consultations.	General Regulations: I. Safety, Health & Environmental Regulations Clause 4.11.	DE, RE, Contractor, Beneficiary Committee (<i>No additional cost</i>)	E&SU

B. OPERATIONS PHASE

Impact	Mitigation		Responsibility	
	Mitigation Measures	Contract and Social Framework Agreement (SFA) Clauses	Implementation (Cost/Finance)	Monitoring
B.1 Land Resources				
B.1.1 Slope stabilization	Regular maintenance of stabilization measures; protection works	Maintenance measures defined in contract data.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt)	E&SU
B.1.2 Agricultural land or terrace damage during maintenance	Controlled disposal of cut and fill during maintenance; controlled equipment operations.	General Regulations: I. Safety, Health & Environmental Regulations Clause 6.6.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt)	E&SU
B.1.3 Maintenance contractor site compounds, materials and equipment storage	Provision of adequate living and sanitation facilities; adequate materials management and safety plan; limitation of construction site.	General Regulations: I. Safety, Health & Environmental Regulations Clauses 6.1, 6.4; II. Other Regulations and Requirements Clauses 17.3, 17.4, 17.5.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt)	E&SU
B.1.4 Management of induced development	Land use planning and zoning for intersections and village extensions.	Not applicable.	Beneficiary Committee, Local Government (Local govt)	E&SU, MoPW^H
B.2 Hydrology and Water Resources				
B.2.1 Water harvesting	Regular maintenance of water harvesting structures.	Maintenance measures defined in contract data and SFA.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt/Community)	E&SU
B.2.2 Blockage of cross Drains/culverts Uncontrolled discharge	Regular maintenance of drainage structures; avoid uncontrolled community discharges.	Maintenance measures carried by the beneficiaries defined in SFA.	RE, Contractor, Beneficiary Committee (Community)	E&SU
B.2.3 Erosion of road platform from drainage discharge	Maintenance of retaining structures, such as walls, gabions, riprap; planting of shrubs and grasses.	Maintenance measures defined in Contract Data and SFA.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt/Community)	E&SU
B.2.4 Pollution from vehicle diesel and oil spills or accidents with hazardous cargo.	Timely clean up following accidents.	Not applicable.	Beneficiary Committee (Community)	N.A.
B.3 Air Quality and Noise				
B.3.1 Air pollution from increased traffic	Vehicle maintenance; enforcement of emission controls; lead free fuels.	Not applicable.	Ministry of Transport (National Govt)	N.A.

B.3.2 Noise Nuisance	Speed controls in populated areas; signs and warnings in sensitive areas; driver information/education campaigns.	General Regulations: I. Safety, Health & Environmental Reg. Clause 6.5.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt/Community)	E&SU
B. 4 Biological Resources				
B.4.1 Increased pressure on biological resources from induced development - Animal road kill - Destruction of vegetation	Maintenance of speed reduction measures, signs and warnings; planned development of growth areas; educational campaigns.	Local maintenance and actions defined in SFA.	RE, Contractor, Beneficiary Committee (Community)	E&SU
B.5 Socio-Economic and Cultural Resources				
B.5.1 Increased road accidents	Maintenance of speed reduction measures, signs and warnings; Information campaigns to drivers and at villages.	Local maintenance and actions defined in SFA.	RE, Contractor, Beneficiary Committee (Community)	E&SU
B. 5.2 Public health and safety during maintenance -Maintenance works site risks to workers and the public -Health risks from compound sanitation and communicable diseases	Safety rules for work operations, such as equipment operation procedures, safety barriers, warning signs, protective hard hats, shoes and clothing for workers; first aid and medical kits and procedures; appointment of Safety Officer. Information campaigns on health practices and communicable diseases; health and safety regulations clearly displayed in English and Arabic.	General Regulations: I. Safety, Health & Environmental Regulations Clauses 4, 5 & 6. Community precautions defined in SFA.	RE, Contractor, Beneficiary Committee (Contractor/local govt; Community collaboration)	E&SU
B.3 Socio Economic Benefits	Monitoring of benefits.	Consultants' contracts to carry out data collection, analysis and reporting.	Consultants, E&SU (RAP CMU/Project)	E&SU
B.4 Chance finds of Cultural Resources or other socio-economics resources	Application of Chance Find Procedures to assess requirements and implement mitigation.	Chance Find Procedures specified in Annex 2 of <i>Cultural Resources Policy Framework</i> ; agreements and commitments carried out within the SFA framework.	RE, Contractor, Beneficiary Committee (Contractor/Road Fund/local govt; Community)	E&SU

* * *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

Chapter 8

PUBLIC DISCLOSURE AND RECORD OF CONSULTATIONS

Chapter 8. PUBLIC DISCLOSURE AND RECORD OF CONSULTATION

8.1 PUBLIC DISCLOSURE

8.1.1 Disclosure of Sectoral Environmental Assessment

Consistent with procedures of the World Bank, the Government of Yemen will make the Sectoral Environmental Assessment available to the public through:

- (a) The World Bank InfoShop
- (b) The RAP CMO, Sana'a and on the RAP CMO Website
- (c) The Environmental Protection Authority, Sana'a
- (d) The RAP CMO Regional Offices
- (e) Each of the MPWH Governorate Offices

The Sectoral Environmental Assessment will be made available in English and Arabic.

8.1.2 Disclosure of Individual Category B Subprojects

As part of the Environmental & Social Review Management Process of each rural road sub-project, disclosure will be implemented as follows:

- Initial consultations will include a discussion of the environmental and social review process and preliminary observations on environmental and social issues with the concerned communities, local authorities and the Governor. At that time, the Governor will be requested to oversee the creation of a Beneficiary Committee.
- The preparation of the Environmental Assessment (EA), including the Environmental Management Plan (EMP) will also include the drafting of the Social Framework Agreement (SFA), under the auspices of the Beneficiary Committee.
- The Draft SFA will be sent to the Beneficiary Committee and the Governor for their review and comment.
- Following this review and comment, the EMP will be finalized and the SFA will be signed by the Beneficiary Committee, the Governor and the RAP CMO.

8.1.3 Disclosure of Individual Category A Subprojects

All Category A subprojects will undergo the above local disclosure process, but in addition will be disclosed internationally, to the World Bank InfoShop.

8.2 RECORD OF CONSULTATIONS

The RAP Program is a vast endeavor, with large-scale potential repercussions on the physical and socio-economic environment of Yemen. To achieve its development goals while keeping

under full control any possible adverse impact, the Program needs the understanding and active participation of a broad range of institutions, professional groups and territorial communities, which can only be mobilized via an effective disclosure, dissemination and feedback process.

The present study has already conducted the required consultations of the sector stakeholders in Sana'a, as described in the Inception Report and reproduced in *Annex 3* of the present document. The consultations have included visits to the professional categories of engineers and contractors at national level. Moreover, the Team Leader and the Gender Specialist have visited institutions, women groups and NGO's promoting equal gender opportunities in rural areas, among which the following agencies:

- Social Protection Unit of the Social Fund for Development (SFD)
- Women Affairs Unit of the Environmental Protection Authority (EPA)
- Women Affairs and Women Administration Units of the Ministry of Social Affairs
- National Women Committee
- The international NGO Oxfam, a frontrunner in cooperation schemes targeting the legal status and the living conditions of women, especially among poverty-stricken social layers.

The output of central-level consultations has been incorporated in the SEA.

8.2.1 Summary of the field consultations carried out at local level

The SEA team carried out consultations at local level in four rural road areas (3 of which falling within the RAP).

- Thulah - Amran (23rd July 2003)-RAP
- Khawlan Affar - Al Maghrabah (23rd July 2003)-RAP
- Akamat – Mudaykhirah (10th, 11th and 16th October 2003)-RAP
- Badan - Ibb (21st, 22nd and 23rd August 2003)-MOPW&H

The consultations have targeted the categories of local stakeholders that will be involved in the disclosure process, including both the decentralized agencies and the beneficiary communities that are present in the rural road influence areas.

8.2.2 Approach

The method utilized to carry out the field consultations across the selected road project areas in view of the EMP disclosure process can be summarized as follows:

- Visual inspection of the impact of road works on the physical and social environment, both inside the right of way, where already defined, and the broader road influence area, during road construction and after the opening of the road to service
- Discussion, with the local communities and the concerned individuals, of the impact of the road projects, reviewing the way negative environmental effects can be minimized and positive ones enhanced during road construction and operation / maintenance
- Interviews with the women of the rural communities of the sub-project areas, to incorporate their concerns and views about the road impacts and the related mitigation or enhancement measures

- Meetings with the design and resident engineers and with representatives of the constructors, to jointly evaluate the preparatory, implementation and maintenance process of the environmental mitigation / enhancement measures
- Visits to the concerned authorities at Governorate, District and Village Area level, to discuss the impacts of road projects, jointly evaluating local administrative attitudes and capacities to take over decentralized responsibilities and executive tasks in the conception, design, construction and maintenance of the environmental safeguards
- Encounters with the local NGOs to examine their present and potential contributions to the environmental and social management process of rural road sub-projects in their areas of activity

8.2.3 Issues Arising from Consultations

8.2.3.1 Discussions with the local communities and concerned individuals

The interviews have revealed a low level of concern of the rural people about the generic environmental impacts of the road projects. Their main interest is the construction of the road, no matter what are the detrimental impacts on the local ecology, wildlife, landscapes, water resources and land use systems. For this purpose, many land or building owners are ready to sacrifice their estates without compensation to speed up the project and reap the expected benefits, including higher prices for their residual estate. However, the following specific concerns have emerged from the interviews:

- Hydraulic works are sometimes believed to reduce the discharge of the water harvesting systems that feed the irrigated farms downstream of the road embankment
- There is a felt risk that transport development may reduce the number of trees used as a source of fuel wood
- Village crossing are sometimes seen as a factor of hazard, especially for children
- For the crossing of market areas, it is expected that parking areas and bus bays be created
- The relocations of charities (*waqf*) are sometimes a matter of discussion, because they involve local communities complex socio-economic and religious interests.
- Even though they generally have a low perception of environmental issues, they appear ready to collaborate with public authorities and NGOs in mitigating the negative and enhance the positive impacts they do not perceive, if only they are sensitized about such issues.

8.2.3.2 Discussions with local women

The interviews with concerned rural women and female associations have revealed the following priorities:

- Participation to road alignment design across settlements, markets and water harvesting areas
- Pollution and invasion of farmlands by road works and spoil materials (the concern exists also when the contractor pays the damages, because the compensation is cashed by the husband, but the women mainly carry the burden of harder farm works

- Decrease of irrigation water supply in damaged runoff harvesting networks
- Availability of fuel wood after the opening of the road to service
- Increased job opportunities for the male relatives during the road construction and maintenance periods
- Displacement of graveyards (this concern is particularly intensive in the littoral lowlands and coastal areas) (Tihama)

As traditional local culture does not provide formal channels for the women to express their concerns about road projects, the prevailing female attitude is a high level of confidence in the administrative process at local level, especially through District offices close to the villages, which enable the women to participate to local project management through the elective bodies and other representation facilities. The women have also manifested their interest for a more direct participation to the formulation and execution of the Social Framework Agreements (SFA). The gender specialists of the SEA study team have recorded the meetings with the female stakeholders.

8.2.3.3 Encounters with the local government authorities

The interviews with the concerned administrations in the road sub-project areas have shown that the de-centralization process in the Governorates, Districts and Administrative Villages is still at an early stage. Local authorities are willing to step up the decentralization process and take over more general responsibilities or specific executive tasks.

The SEA study team believes that the five Regional Branches of RAP CMO can play a major role in the decentralization process, enabling the local administrations to strengthen their project preparation and execution process in rural access matters, as outlined by the proposed EMP.

8.2.3.4 Review of current and potential contributions of local NGOs

The field interviews have shown the availability of several NGOs to contribute to the environmental management process of the RAP Program. They are generally based in the urban areas and collaborate with ongoing environmental projects outside the road sector. Some of them are associated with charities and can provide support in the relocation of trust properties (*waqf*) affected by road works. They can also effectively assist the local disclosure and post-disclosure stages of the Road Sub-projects.

8.2.3.5 Sessions with design engineers and contractors

The main topics have been how to distribute the design process of environmental safeguards between the first (design) and second (implementation) stages of the road sub-project cycle. The prevailing conclusion is that the following activities should be anticipated to Stage I (design) of the cycle:

- Mapping and materialization of the road centerline and the right of way, with continuous updating as the project progresses, to demonstrate to local stakeholders the land use limits and impacts in the road influence areas, with the related environmental safeguard measures.
- Improvement of the hydrology studies and hydraulic works before road construction.

- Completion of both the voluntary and involuntary resettlement process before road construction.
- Revision and update of the formats for construction and maintenance contracts, in line with the recommendation of the present study.

8.2.3.6 Substantive issues explored during the local consultations

Outcome of the visual inspections: they have allowed identifying the following major issues:

1. *borrow pits, quarries and disposal areas of waste materials* : their impact can be further mitigated if the road engineering design process produces a better and more detailed identification of the borrow and dumping areas, defining the related avoidance and mitigation measures before the commencement of works, and incorporating the related safeguards in the contract documents for road construction and maintenance
2. *building of houses within the right of way* : it can be prevented if the road reserve area is mapped and materialized on the ground before the start of the works, and the local communities are informed about the land use rules within the right of way
3. *hydraulic works* that minimize the interference of the road with water harvesting and spate irrigation patterns can be improved if the culverts and drainage systems are designed prior to the construction of the road and the geometric road design takes into account the design of the hydraulic works
4. *a vegetation management and forestry component* should be incorporated in the road design and implementation process to mitigate the impact on air (village crossings, steep slopes), land (farms, mobile dunes, erosion-prone slopes, scenic landscapes in tourist areas and so forth), biological complexes (natural forests, especially in the escarpment) and socio-economy (collection of fire-wood and timber)
5. *voluntary resettlement schemes* can greatly expedite the sub-project implementation process, avoiding lengthy expropriation and compensation issues, especially in market and commercial areas that currently occupy the potential right of way of the rural roads to be upgraded
6. *sprawling of ribbon settlements along the upgraded roads:* they cause negative environmental and social impacts, including difficulty to serve the buildings with linear infrastructure (water supply, sewer, power, telecommunication, traffic management systems and so forth), which can be prevented by enhancing the town planning capacities of the local administrations in collaboration with the beneficiary communities and the professional categories, especially the traders
7. *levels of poverty:* the impact of the roads already upgraded on the local economy is self-evident, in terms of commercial traffic, building development, agricultural intensification and business activities along the road influence areas. However, the divide between income levels and social categories seems to be increased by road development, as shown by the number of poor dwellings and marginal or makeshift settlements with insufficient amenities, that contrast with the luxury houses recently built along the new roads. Such contrasts do not exist in the rural villages prior to road construction. Therefore social-impact mitigations are advised, to continue the struggle against rural poverty also after the opening of the access roads to service.

* *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)

Draft Final Report

Chapter 9

ENVIRONMENT ASSESSMENT INSTRUMENT FORMATS

Chapter 9. ENVIRONMENT ASSESSMENT INSTRUMENT FORMATS

9.1 SCREENING REPORT – TABLE OF CONTENTS

1. LOCATION
 - 1.1. Governorate
 - 1.2. Districts
2. LENGTH
3. PROJECT DESCRIPTION
 - 3.1. Existing alignment
 - 3.2. Proposed Works
 - 3.3. Estimated Cost
4. SUMMARY OF ENVIRONMENTAL AND SOCIAL ISSUES:
 - 4.1. Land Resources
 - 4.2. Hydrology and Water Resources
 - 4.3. Air and Noise
 - 4.4. Biological Resources
 - 4.5. Socio-Economic and Culture
 - 4.5.1. Population and Settlements
 - 4.5.2. Poverty Status
 - 4.5.3. Benefits
 - 4.5.4. Land Acquisition/Resettlement
 - 4.5.5. Other Site-Specific Issues
5. APPLICABLE SAFEGUARD POLICIES
6. ENVIRONMENTAL SCREENING CATEGORY
7. ACTION PLAN
8. PREPARATION AND AUTHORIZATION
 - 8.1. Date and signature of the preparer
 - 8.2. Date and signature of RAPCMO reviewing and approving the Screening Report
9. ATTACHMENTS
 - 9.1. Road Alignment
 - 9.2. Photos
 - 9.3. Location and Administrative Maps
 - 9.4. Population and Poverty Maps
 - 9.5. Environmental Checklist

9.2 ENVIRONMENTAL CHECKLIST (SCREENING AND EMP)

Road Name :												Date: / / 200_										
Road Length:												Governorate:										
ASPECT	PHASE	Item No.	POTENTIAL IMPACTS	POTENTIAL IMPACT CHARACTERISTICS										Comments								
				Type		Effect		Change		Extent		Degree										
				Negligible	Uncertain (to be determined)	Positive	Negative	Direct	Indirect	Temporary	Permanent	Localized	Extensive		Minor & reversible	Major & reversible	Major & Irreversible					
LAND RESOURCES	A1- Design / Construction	A-1.1	Site survey investigation																			
		A-1.2	Permament Land Acquisition																			
		A-1.2.1	Widening																			
		A-1.2.2	Pinch Point																			
		A-1.2.3	Local Re-Alignment / New Alignment																			
		A-1.2.4	Dumping Sites																			
		A-1.3	Temporary Land Acquisition																			
		A-1.3.1	Site Compound																			
		A-1.3.2	Diversion and Haul Road																			
		A-1.4	Slope Stabilization																			
		A-1.5	Management of Costruction Site Compound																			
		A-1.5.1	Solid and Liquid Waste Disposal																			
		A-1.5.2	Management and Safety Plan for Petroleum Products and Paving Material																			
		A-1.5.3	Safety And Emergency Responce Procedures																			
		A-1.5.4	Living and Sanitation Facilities																			
		A-1.5.5	Rehabilitation of Site																			
		A-1.6	Disposal of Cut Material and Surplus Fill																			
	A-1.7	Borrow Pits and Quarry Areas																				
	B1 - Operation	B- 1.1	Slope Stabilization																			
		B- 1.2	Agricultural Land or Terrace Damage During Maintenance																			
B- 1.3		Maintenance Contractor Site Compound, Material and Equipment Storage																				
B- 1.4		Management of Induced Development																				
HYDROLOGY AND WATER RESOURCES	A2 - Design / Construction	A-2.1	Sources of Construction water																			
		A-2.2	Pollution from Wastewater,Diesel or Asphalt Spills from Site Compound and Machinery																			
		A-2.3	Flood Protection in Wadi																			
		A-2.4	Alteration of Water Harvesting Patterns																			
		A-2.5	Cross Drainage and Scour Effects																			
		A-2.6	Discharge to Adjacent Lands:																			
		A-2.6.1	Discharge to Unstable Slopes																			
		A-2.6.2	Discharge to Rock Surface																			
		A-2.6.3	Discharge to Channel in a Stack																			
		A-2.6.4	Discharge to Graveyards																			
	A-2.6.5	Discharge to Terraces																				
	A-2.6.6	Discharge to Other Sensitive Areas or Structures																				
	B2 - Operation	B-2.1	Water Harvesting																			
		B-2.2	Blockage of Cross Drairage / Culverts from Uncontrlled Discharged																			
B-2.3		Erosion of Road Platform from Drainage Discharge																				
B-2.4		Pollution from Vehicles Diesel and Oil Spills or Accidents with Hazardous Cargo																				

Road Name :										Date: / / 200_										
Road Length:										Governorate:										
ASPECT	PHASE	Item No.	POTENTIAL IMPACTS	POTENTIAL IMPACT CHARACTERISTICS										Comments						
				Type	Effect	Change	Extent	Degree												
				Negligible	Uncertain (to be determined)	Positive	Negative	Direct	Indirect	Temporary	Permanent	Localized	Extensive		Minor & reversible	Major & reversible	Major & Irreversible			
AIR QUALITY AND NOISE NUISANCE	A3 - Design/ Construction	A-3.1	Dust & Potential Pollution from Construction Machinery, Stored Materials and Spoil Heaps																	
		A-3.2	Smoke from Burning of Waste Materials																	
		A-3.3	Noise Nuisance																	
	B3 - Operation	B-3.1	Air Pollution from Increased Traffic																	
		B-3.2	Noise Nuisance																	
	BIOLOGIC RESOURCES	A4 - Design/ Construction	A-4.1	Conversion or Degradation of a Critical or non-Critical Natural Habitats																
A-4.2			Damage to Biological Resources by Construction Equipment																	
A-4.3			Damage to Biological Resources by Construction Workers																	
B4 - Operation		B-4.1	Increased Pressure on Biological Resources from Induced Development																	
		B-4.1.1	Animal Road Kill																	
		B-4.1.2	Destruction of Vegetation																	
SOCIO-ECONOMIC AND CULTURAL	A5 - Design/ Construction	A-5.1	Tribal Tensions																	
		A-5.2	Land Acquisition and Resettlement																	
		A-5.3	Destruction or Re-Location of Utility Services (Electricity and Phone Pole Lines, Water Pipes)																	
		A-5.4	Public Health and Safety at Construction Site																	
		A-5.4.1	Safety and Health for the Construction Workers																	
		A-5.4.2	Public Safety at the Site and Interaction between the Workers and the Public																	
		A-5.5	Road Closure and Detours																	
		A-5.6	Graveyards and Burials																	
		A-5.7	Known Archaeological and Historic Sites																	
		A-5.8	Chance Finds of Cultural Resources or Other Socio-Economics Resources																	
	A-5.9	Gender Considerations																		
	A-5.10	Employment																		
	B5 - Operation	B-5.1	Increased Road Accidents																	
		B-5.2	Public Health and Safety During Maintenance																	
		B-5.2.1	Maintenance Works Site Risks to Workers and the Public																	
		B-5.2.2	Health Risks from Compound Sanitation and Communicable Diseases																	
B-5.3		Socio-Economic Benefits																		
B-5.4		Chance Finds of Cultural Resources or Other Socio-Economics Resources																		

9.3 PUBLIC CONSULTATIONS FORMAT AND CHECKLIST

The minutes of Consultations will have the following contents:

- Road Name
- Date
- Location
- List of attendees
- Summary of issues discussed which may include:

Adopted approach

Substantive issues explored during the local consultations

Discussions with the local communities and concerned individuals

Discussions with local women

Sessions with design engineers and contractors.

Encounters with the Local Government Authorities

Review of current and potential contributions of local NGOs

Sample Questions:

Are you concerned about:

- ♣ potential loss of private property?
- ♣ increased traffic and/or speed?
- ♣ increased noise and/or air pollution?
- ♣ effect on pedestrian safety?
- ♣ inconveniences during execution?
- ♣ effect on agricultural areas? (if any)
- ♣ effect on natural reserves? (if any)
- ♣ effect on water resources? (if any)
- ♣ effect on cultural heritage sites? (if any)

Other concerns or objections

.....

.....

As part of this public consultation, how do you expect to participate in the project?

.....

.....

Interviewer:

Reviewed and endorsed by:

9.4 SOCIAL FRAMEWORK AGREEMENT

The Social Framework Agreement is a participative instrument to incorporate social issues in the standard procedures of road project screening, planning, construction and operation, including the assessment of impacts and the introduction of mitigation or enhancement measures in the final design. The SFA is the agreement that formalizes these procedures through consultations with the beneficiaries during the project design stage. A Committee of Road Beneficiaries is appointed to negotiate the agreement with all concerned parties. The SFA lays out all areas of potential social concern, with agreed and specific mitigation or enhancement measures to address them. The SFA also serves as a framework through which unforeseen problems will be solved during the course of construction. Separate consultations are held for men and women. The SFA is appended to the Environmental Management Plan of each road.

**Ministry of Public Works and Highways
Rural Access Project
Central Management Office**

SOCIAL FRAMEWORK AGREEMENT (SFA) (ENGLISH VERSION) FOR

Project Name:

This SFA is carried out in accordance with Law No. 14 (2001) concerning the Agreement between the Government of Yemen and the International Development Association (IDA) signed August 2, 2001 for the Rural Access Project (RAP). The project, under the Ministry of Public Works and Highways (MPWH), will carry out rural road improvements to improve access of communities inDistrict(s) and Governorate to markets and public services.

The SFA is signed following consultation with the Governor and Chairman of the Local Council to form a Beneficiary Committee, including members of Parliament, sheikhs, local councils and women representatives, that will be appointed by Governorate Decree No. (copy attached).

The SFA is based on the environmental and social studies of the project area and reached on between: Mr. Hakim Aghbari, General Director for RAP Central Management Office (CMO), Ministry of Public Works and Highways, and the Chairman of the Beneficiary Committee,.....

On the Following:

1. PROJECT DESCRIPTION

1.1 Objectives

The project aims to improve the road for the public to markets and public services through:

- Improvement of the existing alignment; and
- Maintenance of the improved alignment

1.2 Existing Alignment

This project starts from(starting point) and will pass through (major villages) and will end at(ending point) for a total length ofkm, which includes(description of preliminary excavation of other works).

1.3 Proposed Works

Proposed works will be mainly on the existing alignment, and will include (describe basic works, such as earthworks, , structural and drainage works, basecourse layer and type of pavement, such as asphaltic concrete, surface treatment or other).

2. PROJECT ISSUES

2.1 Land Acquisition and/or Building Destruction

The project has a Resettlement Policy Framework, which defines the mechanism for addressing issues arising out of land acquisition and/or building destruction impacts. If such impacts are identified, an initial assessment shall determine whether such impacts can be avoided or minimized through design measures. These may include such measures as narrow sections or “pinch points”, in agreement with affected people. If these impacts cannot be avoided, the Policy provides for the following:

- (a) *Land assets:* In conformance with Yemeni traditional rural practice, owners of affected lands will not be compensated by the Project in cash for loss of land, but the affected owners will donate such land for public purposes and community benefit. However, this donation will occur within the context of a mutually signed community-based Agreement, which is appended to the SFA, and which specifies the terms under which the donation is made.
- (b) *Houses and other structures:* Owners of affected houses or other structures will be compensated in-kind at replacement cost, which is defined as the cost of the works required to replace the asset in its existing condition. This, in addition to arrangements for providing the land on which the replacement structure will be built, shall be stated in a mutually signed community-based Agreement, signed by the asset owner(s) and appended to the SFA.

Particular application of this Policy to this road is described below.

2.1.1 Narrow sections to avoid land acquisition

The major narrow sections identified along the alignment are at the following locations: (list narrow sections and pinch points)

2.1.2 Unavoidable land acquisition or building destruction

In the case of unavoidable land acquisition or building destruction, details of locations and affected persons are presented in the attached Community – Based Agreement.

2.2 Other Issues

The following other issues have been identified and will be addressed under this SFA:

For each issue, such as water harvesting systems, existing water pipes, telephone or electricity poles, obstructing trees, etc., indicate the following:

- Issue:
- Location:
- Solution:

3. RURAL ACCESS PROJECT RESPONSIBILITIES

The RAP, under the MPWH, will finance and improve the existing road according to the proposed works mentioned above. The RAP, under MPWH reserves the right to change the project funding source and/or the project description.

4. BENEFICIARY COMMITTEE RESPONSIBILITIES

According to the Decree creating the Beneficiary Committee, the Committee will:

Approve and sign this SFA and, if necessary a Community Based Agreement related to land acquisition and building destruction.

Cooperate with the RAP CMO in carrying out the Project improvements.

Assist RAP CMO in avoiding and/or minimize any negative environmental and social impacts related to project implementation.

Work on solving any problems that may arise during works implementation, either with local communities, government agencies and local councils.

Give priority for collecting appropriate funds for maintenance through the local council(s). Continue to collect funds to ensure maintenance works according, to the laws, if other maintenance funding is not available.

Assist the RAP and the Resident Engineer (RE) in implementing the design and other necessary project improvements.

Assist the RAP to provide either lands owned by government, local community or trust lands, for the following:

- Temporary camp site and storage of equipment
- Temporary diversions during construction period
- Haulage roads for borrow areas
- Locations for waste disposal to avoid agricultural land destruction
- Resources of water for road construction
- Any other sites required

Assist the RE and Contractor to obtain approval for relocation of utility services (water pipes, electricity, telephone, etc.) adjacent to, or on the right of way to avoid damage during construction, in collaboration with the relevant agencies.

Assist the RE and Contractor to obtain approval for the locations, timing and duration of road closures.

Assist the RE and Contractor to avoid disturbance of graveyards and, in rare cases, arrange for graveyard relocation, with approval of, and collaboration with appropriate religious authorities.

Assist the RE and Contractor to avoid or minimize disturbance of cultural resources and facilitate chance find procedures.

Assist in discussions among the RAP, RE and Contractor in reaching appropriate solutions related to agricultural and domestic use water harvesting systems, such as irrigation pipes and road bumps, related to the road works.

Assist the Contractor in protecting equipment against theft or vandalism and take appropriate safety precautions to protect children and the public in and around the work sites.

Carry out any other responsibilities required to ensure successful project implementation.

5. SIGNATURES AND AUTHORIZATION

Position: General Director of RAP	Position: Chairman of Beneficiary Committee
Name:	Name:
Signature:	Signature:
Date:	Date:

Position: Minister of Public Works and Highways	Position: Governor Governorate:
Name:	Name:
Signature:	Signature:
Date:	Date:

ATTACHMENTS

A. BENEFICIARY COMMITTEE APPROVAL

B. PROJECT ALIGNMENT

C. COMMUNITY – BASED AGREEMENT FOR RESETTLEMENT (IF NECESSARY)

C.1 Agreement Forms (Land Donation, Building Replacement)

C.2 List of Affected Persons and Resettlement Plan Procedures

9.5 ENVIRONMENTAL ASSESSMENT REPORT – TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION
 - 1.1. Location
 - 1.2. Length
 - 1.3. Context and Environmental Category
 - 1.4. Environmental & Social Review Process and Consultations
 - 1.4.1. Environmental and Social Review Processes
 - 1.4.2. Consultation Program
 - 1.4.3. Women’s Consultations
 - 1.5. Policy, Legal and Administrative Framework
2. PROJECT OBJECTIVES AND DESCRIPTION
 - 2.1. Objectives
 - 2.2. Description
 - 2.2.1. Existing Alignment
 - 2.2.2. Proposed Works
 - 2.2.3. Construction Program
 - 2.2.4. Land Acquisition and Compensation
3. BASELINE DATA
 - 3.1. Land Resources
 - 3.1.1. Physical Region
 - 3.1.2. Land Use
 - 3.1.3. Geology and Soils
 - 3.2. Hydrology and Water Resources
 - 3.2.1. Climate
 - 3.2.2. Rainfall
 - 3.2.3. Hydrology
 - 3.2.4. Water Harvesting Systems
 - 3.3. Air Quality and Noise
 - 3.4. Biological Resources
 - 3.4.1. Vegetation
 - 3.4.2. Animals
 - 3.4.3. Protected Areas or Critical Natural Habitats
 - 3.5. Socio-Economic and Cultural
 - 3.5.1. Population and Community Structure
 - 3.5.2. Economic Activities and Poverty Status
 - 3.5.3. Services and Facilities
 - 3.5.3.1. Water Resources
 - 3.5.3.2. Electricity Supply
 - 3.5.3.3. Health Facilities
 - 3.5.3.4. Education Facilities
 - 3.5.3.5. Transportation and Accessibility
 - 3.5.4. Cultural Resources
4. POTENTIAL IMPACTS
 - 4.1. Land Resources
 - 4.1.1. Design/construction Phase
 - 4.1.2. Operation Phase
 - 4.2. Hydrology and Water Resources
 - 4.2.1. Design/Construction Phase

- 4.2.2. Operations Phase
- 4.3. Air quality and Noise Nuisance
 - 4.3.1. Design/Construction Phase
 - 4.3.2. Operation Phase
- 4.4. Biological Resources
 - 4.4.1. Design/Construction Phase
 - 4.4.2. Operations Phase
- 4.5. Socio-economic and Cultural
 - 4.5.1. Design/Construction Phase
 - 4.5.2. Operation Phase
- 5. ANALYSIS OF ALTERNATIVES
- 6. ENVIRONMENTAL MANAGEMENT PLAN
 - 6.1. General
 - 6.2. Mitigation Measures
 - 6.2.1. Design Phase
 - 6.2.2. Tender and Construction Phase
 - 6.2.3. Operational Phase
 - 6.2.4. Management of Social Impacts
 - 6.3. Monitoring Plan
 - 6.3.1. Environmental Impacts
 - 6.3.2. Socio-economic Impacts
 - 6.4. Institutional Arrangements
 - 6.5. Institutional Strengthening
 - 6.6. Reporting and Supervision

* * *

Rural Access Program (RAP)
Sectoral Environmental Assessment (SEA)
Draft Final Report

ANNEXES

ANNEX 1. LIST OF SEA PREPARERS

The following persons participated in the preparation of the Sectoral Environmental Assessment:

Mr. Angelo D'Urso: Senior Environmentalist Specialist-Team Leader (Italian)
Mr Ezio Moriondo: Senior Social Scientist (Italian)
Mr Carlo Moriondo: Engineer (Italian)
Mr. Angelo Boccolini: Institutional Expert (Italian)
Mr. Taha M. Tahir: Environmentalist/Ecologist (Yemeni)
Mr. Hussein Hayder: Road Engineer –Geologist (Yemeni)
Mr. Ibrahim Keksi : Road Engineer (Yemeni)
Mr. Abdallah Sahari: Road Engineer (Yemeni)
Mrs. Hana Hamoud Al-Shami: Social Scientist/Gender Specialist (Yemeni)
Mr. Fouad Dhumran : Legal/Resettlement Expert (Yemeni)
Mr. Mahamud Emad: GIS and Mapping Expert (Yemeni)
Mr. Marco Liviadotti: Cultural Resources Specialist (Italian)

ANNEX 2. BIBLIOGRAPHY

Agency	Documentation Collected
RAP CMO	Rural Accessibility Improvement Program-Yemen- Formulation of a Methodology and Work Plan-April 2001-Rob Dingen and John Howe
	Yemen Rural Access Program-Pilot Application of Appropriate Rural Road Standards-Feasibility Report- Dar al-Handasah, October 2001
	Yemen Rural Access Program-Pilot Application of Appropriate Rural Road Standards-Environmental Report- Dar al-Handasah, July 2001
	Yemen Rural Access Program-Pilot Application of Appropriate Rural Road Standards-Environmental Report- Dar al-Handasah, October 2001
	Yemen Rural Access Program-Pilot Application of Appropriate Rural Road Standards-Environmental Report-Annexes- Dar al-Handasah, October 2001
	EMP & Draft SFA for five pilot roads (group one)-Dar al-Handasah, July 2001
	Social Survey/Consultation for five pilot roads(group one)-Dar al-Handasah, July 2001
	Design Standard Manual for Rural Intermediate and Village Access Roads
Ministry of Public Works and Highways (MPW&H)	Development of national Highway Master Plan- Design Standards, February 1986
Road Maintenance Fund (RMF)	Data on primary and secondary roads
	National map showing the road network
Social Fund for Development (SFD)	Data and interventions on Feeder Roads program
	SFD-1997 Annual Report
	SFD-1998 Annual Report
	SFD-1999 Annual Report
	SFD-2001 Annual Report
	SFD-Project Outline : Third Phase 2004-2008
	Environmental Auditing Report for Year 2002 (SFD projects)
	Flow diagram for EIA for SFD projects
	Data Base (based on 1994 Census) containing : Population, schools, health etc. subdivided by Governorate, District, sub-district and village level
	Data Base (based on 1999 National Poverty Survey) combined social and poverty indicators at Governorate and District level
GIS developed by SFD with ranked zones (at Governorate, district, sub-district and village level) according to the indicators developed by SFD	

Ministry of Planning and Development (MP&D)	List of International NGOs operating in the road and environment sector
Central Statistical Organization (CSO)	CSO -Statistical Yearbook 1998
	CSO -Statistical Yearbook 2001
	CSO -Statistical Yearbook 1991
	CSO -Statistical Yearbook 1992
	Final Result of Population, Housing and Establishment Census-1994
	Final Report on Labour Force Survey -1999
	Demographic and maternal and child health survey-1997
	Report on the State of the Environment for the Year 2001 (EPA)
Environmental Protection Authority (EPA)	Executive Regulations
	List of international conventions signed by Yemen
	EPC Tasks
	Environment Protection Law N. 26-1995
	Environmental Impact Assessment Policy for the Republic of Yemen- Euroconsult
	Evaluation of Future Development of the EIA System in Yemen- University of Manchester Mediterranean Environmental Technical Assistance Programme, February 2001
	National Environmental Action Plan (2002-2007)
	Land degradation Project in the Republic of Yemen
	List of identified protected areas in Yemen
	Women's role in the environment (draft)
	Ministry of Water and Environment
Maps on pilot PAM & CMZ areas	
Ecological assessment and community awareness in Protected Areas Management Pilot Sites (report)	
Ecological assessment and community awareness in Coastal Management Pilot Sites (report)	
Data sets and GIS for the protection of marine Ecosystem of the Red Sea Coast of Yemen (CD)	
Yemen map sources	
Ministry of Legal Affairs	
	State Land Law-n. 21/1995
	Civil Law -n. 40/2002
	Endowment Law (awqaf)
Ministry of Culture General Organization of Antiquities & Museums GOAMM	Maps with cultural heritages sites in Yemen (CD)
	Reports on foreign archaeological missions in Yemen (CD)
	Information about legislation and regulations related to the recording of cultural heritage
	Law on Antiquities n. 21/1994
	Decree of the Republic 128/1997 for the institution of GOAMM
	Decree of the Republic 128/1997 for the institution of GOPHCY
	Decree on Urban Plan Regulation n,260/1997
OXFAM	Gender Development in Yemen-Marta Colburn-Oxfam-2002

ANNEX 3. LIST OF PEOPLE AND ORGANIZATIONS CONTACTED

Table A3.1 People and Organizations contacted

Organization	Unit	Person contacted or interviewed
Rural Access Project Central Management Office RAP CMO	General Management	Hakim Aghbari Project Director
		Eng. Mahmoud Y. Al-Husayni Sr Procurement Officer
	Environmental and Social Management Unit (ESM)	Ibrahim Basalamah Environment and Social Science Specialist
	Environmental and Social Management Unit (ESM)	Osama H. Almadani - Environmental and Social Science Assistant
	Road Engineering Unit	Nabil A. Al-Haifi Sr. Highway Engineer
	MIS Unit	Hesham A. Othman Sr. MIS Specialist
Ministry of Public Works and Highways (MPW&H)	General Management	Eng. Hussein Hayder
Road Maintenance Fund (RMF)	Planning Unit	Eng. Nabil Al-Wazir Head of Planning
Social Fund for Development (SFD)	Infrastructure Unit-Road Sector	Eng. Ali Al-Shami
	Social Protection Unit	Afrah Alahmadi
	Community Development Unit	Eng. Abdulwahab Almojahed Environmental Specialist
	Infrastructure Unit	Abdullah A. Dailami Head of Infrastructure Unit
	Programming and Evaluation Unit	Abdo M. N. Al-Qubati
	Programming and Evaluation Unit	Ahmed Saleh Bashrahil
Ministry of Social Affairs (MSA)	Minister's Director Office	Ali A. Nadeesh Minister's Director Office
	Women Affairs Unit	Rasifa Ali Alnasiri General Director for Women Affairs

	Women Administration Unit	Asia Mackawee-Director of Woman Administration
Ministry of Planning and Development (MP&D)	Deputy Minister's Office	Hisham Sharaf Abdalla-Deputy Minister for International Cooperation
	Direction General for International Cooperation	Ahmed Hussein A. Jawi D.G. for Cooperation with NGOs
		Mrs. Anisa Mohammad Ali
	Advisory Services to the Ministry	Dr. Eva Weidnitzer- Team Leader-GTZ
European Commission (EC)	Food Security Management Unit (FSMU)	Reinhart Bartsch Team Leader
		Dirk Hein Westerveld Irrigation Engineer
	Agricultural Survey Project	Guido Ferrari-Team Leader
Central Statistical Organization (CSO)	General Management	D.Amin M. Mohie Al Din Chairman
		Hamdi Abdulakeen
	Documentation Department	D.P. Olofi
Environmental Protection Authority (EPA)	Monitoring and Evaluation Unit (MEU)	Salem Abdullah Baquhaizel Director General MEU
		Elal Al Riashi Deputy General Director MEU
	Climate Change Unit	Anwar Abdulaziz
	Women's Affairs Unit	Hayal Ghalib
		Ellen Von Zitzewitz (Environment Consultant)
Ministry of Water and Environment	Direction General for Environment Affairs (DGEA)	Mohammed A. Shamsan Director General EA
	Protected Areas and Coastal Zone Management Project	Eng. Ali A. Al-Fadeel PAM & CZM - Project-General Director
	Department of Natural Resources & Biological Environment	Abdullah Hamoud Abo Al-Fotoh Marine Reserve Expert
Ministry of Legal Affairs	Official Gazette	Ahmed Awad Deputy Director of the Official Gazette
		Tarek Rashed-Translator
	Library	Abdu Rahman Maresh
Ministry of Culture	General Organization Antiquities, Museums & Manuscripts	Mr. Ahmed M. Shamsan Deputy Director -GOAMM
	General Organization for Protection of Historical Cities	Dr (Mrs) Madiha Rachad Prehistoric Archaeologist-GOPHCY

		Salah Alhosaini
World Bank	World Bank Mission in Yemen	J.B. Collier Environmentalism
		Tarek Genena (EcoConSev)

ANNEX 4. MINUTES OF CONSULTATIONS

The Consultant has carried out consultations at central and field level as part of the sector environmental scoping work and to prepare the disclosure process of both the Programmatic Sector EMP and the specific EMPs of each rural access sub-project.

A.4.1 CONSULTATIONS AT CENTRAL LEVEL

The study team has interviewed a number of project stakeholders - public agencies, representatives of the affected parties and NGOs - to discuss the rural road environment and receive their suggestions for the sector EMP preparation and disclosure work.

Table A.2 Sector stakeholders met during the scoping & consultation sessions at central level

Entities and Internal Articulation	
i	ENVIRONMENTAL PROTECTION AUTHORITY (EPA)
	General Management Monitoring and Evaluation Unit Climate Change Unit Women Affairs Unit
ii	MINISTRY OF LEGAL AFFAIRS (MLA)
iii	MINISTRY OF CULTURE (MC)
	General Organization of Antiquities, Museums and Manuscripts (GOAMM) General Organization for the Protection of Historical Cities (GOPHCY)
iv	RURAL ACCESS PROGRAM-CENTRAL MANAGEMENT OFFICE (RAP CMO)
	General Management Environmental and Social Management (EMS) Unit Road Engineering Unit MIS Unit
v	MINISTRY OF PUBLIC WORKS AND HIGHWAYS (MPW&H)
vi	ROAD MAINTENANCE FUND (RMF)
Vii	SOCIAL FUND FOR DEVELOPMENT (SFD)
	General Management Community Development Unit Social Protection Unit Infrastructure Unit and Road Infrastructure Sub-Unit Programming and Evaluation Unit
viii	MINISTRY OF WATER AND ENVIRONMENT (MW&E)
	General Management Environmental Affairs Unit Protected Areas and Coastal Zone Management Project Unit (PAM & CZM) Natural Resources & Biological Environment Unit

ix	MINISTRY OF SOCIAL AFFAIRS
	General Management Women Affairs Unit Women Administration Unit
x	MINISTRY OF PLANNING AND DEVELOPMENT (MP&D)
	General Management Unit International Cooperation Sector
xi	NATIONAL WOMEN COMMITTEE
xii	WORLD BANK MISSION IN YEMEN
xiii	LOCAL LEADERS DURING THE VISITS TO TWO R.A.P. PILOT PROJECTS

The scoping-consultation process has focused upon the following thematic areas:

Development and maintenance policies of rural roads networks
 Administrative set-up and regulatory framework of rural road design, construction, maintenance, impact assessment and implementation of mitigation / enhancement measures
 Baseline physical and social conditions of the road environment, including gender issues
 Ownership rights and legal framework of cultural heritage protection

Several stakeholders have been interviewed repeatedly to share with them the results of the desk review work and the feedback from other stakeholders.

The Consultant has jointly examined with the stakeholders the best way to carry out the study tasks. As a first step, he has compiled a list of ecologic and social issues raised during the scoping sessions.

Major issues raised by the stakeholders:

Inter-agency communication and collaboration on environmental issues, including database sharing

Production of *Yemen's Environment Map*, featuring biotopes, protection areas, cultural heritage, etc.

EIA, SIA, RIA & EMPs in road projects (in the past, roads were built without such studies)

Social awareness campaigns on environmental issues

Adoption of a single rural road design manual, unifying the four currently used in the country

Accurate classification and comprehensive inventory of tertiary roads

Road design standards geared to safeguard the natural and artificial water drainage patterns

Need of cultural heritage surveys and enforcement of heritage protection rules

Enhanced safety measures for both road construction and use

Contrast between customary (tribal) and statutory law in land registration and compensation

Joint analysis of the issues raised by the stakeholders

The study team members have evaluated the criticism expressed by the stakeholders, comparing each raised issue with the guidelines of the Government and the World Bank and questioning the stakeholders about how the guidelines should be applied or adapted to cope with the issues. Some of the issues raised concern areas not covered either by the Yemeni or the World Bank guidelines, as the protection of historical landscapes and villages suddenly exposed to road development. Also largely uncovered is the contrast of tribal customary law and statute law in land expropriation and compensation processes. Other criticism concerns the divergence in road design manuals that may impact negatively in environmental assessment and management. A large number of open issues concern the non-application of existing norms, especially in matters related to the safeguard of natural and cultural heritage

sites. Thanks to the joint scoping work, the Consultant can rank the priorities and single out the areas where the contribution of the stakeholders can be mobilized.

A.4.2 CONSULTATIONS AT LOCAL LEVEL

During the course of the present study, the consulting team has carried out consultations at local level in four rural road project areas.

Thulah - Amran (23rd July 2003)-RAP
 Khawlan Affar - Al Maghrabah (23rd July 2003)-RAP
 Akamat – Mudaykhirah (10 and October 2003)-RAP
 Badan - Ibb (August 2003)-MOP&H

The visit of a road already constructed (Badan – Ibb) has been included to explore the impacts during the operation and maintenance period. In fact, the road sub-projects upgraded during Phase I of the RAP Program have not yet reached the operation and maintenance stage. The visit to the rural road opened to service five years ago has also permitted to explore the perception of the local population about the impacts of traffic and road maintenance on the physical and social environment. For instance, local women are divided while answering the question if they preferred village-crossings or village-bypasses to avoid air pollution, noise, loss of privacy and traffic hazards within major rural settlements.

As part of the fieldwork, the study team has consulted with the project stakeholders, including:

- resident and design engineers (the latter especially for waterworks and erosion control)
- managers of the contractor enterprise
- representatives of the beneficiary communities, including traditional leaders
- local authorities at Administrative Village level
- professional categories (especially traders who are likely to trigger a voluntary resettlement process to facilitate project implementation)
- owners of farmlands and buildings possibly affected by road construction and operation
- groups of rural women concerned with the project
- local charities related to urban NGOs, particularly interested in real estate trusts potentially affected by the sub-project.

Details of the visit to each of the above roads are given hereafter:

A.4.2.1 Thula-Amran Road

Date: 23rd July 2003

Location: Yemeni Highlands, some 52 km northwest of Sana'a.

List of attendees:

- Mr. Ibrahim I. Basalamah, Environmental and Social Science Specialist of RAP CMO
- Shaik Mohamed Al Dhaiani, local leader (only for Thula-Amran road)
- Mr. Angelo D'Urso, Team Leader, for the Consultant
- Dr. Taha Tahir, Ecologist for the Consultant
- Mr. Hesham Abdel Wahab Ali, Resident Engineer
- Various assistants of the Resident Engineer

Summary of issues:

This road is located in the northern Yemeni Highlands, some 52 km northwest of Sana'a. The visit started from Amran for logistic reasons but the description starts from Thula (about 3,000 m of altitude) from where the road descends along Wadi Dhaian to Amran (2,100 m of altitude). The road is composed by six sections, crossing various landscapes, as follows:

Plateau (for about 6 km), with no major problems in the alignment

Descent to Wadi Dhaian (4 km). Various villages are located along this part of the road presenting some narrow sections due to the presence of houses along the road alignment in some cases the road embankment is too close to houses protection measures are required)

Wadi Gorge: the design alignment along the wadi bed has been abandoned for hydrological reasons and the new alignment is being built upstream outside the farms and along contour levels

Wadi floor: at this point the wadi channel is 200-300 m wide with farmland irrigated both by spate and tube-wells. Boulders have dropped from road embankments into the farms. Some cultivated land has been occupied by road construction

Climb out from wadi: for half km the road runs parallel to the wadi, confined by terrace walls on either side. Slight dumping problems exist. A historical bridge is shown in picture

Amran Urban area. At around km 21 the road begins to climb out of the main wadi crossing a ridge line into a side wadi until 1.5 km from Amran where the project road ends.

A.4.2.2 Kholan Affar- Al Maghrabah Road

Date: 23rd July 2003

Location: Yemeni Highlands, some 115 km northwest of Sana'a.

List of attendees:

Mr. Ibrahim I. Basalamah, Environmental and Social Science Specialist of RAP CMO

Shaik Mohamed Al Dhaiani, local leader (only for Thula-Amran road)

Mr. Angelo D'Urso, Team Leader, for the Consultant

Dr. Taha Tahir, Ecologist for the Consultant

Mr. Hesham Abdel Wahab Ali, Resident Engineer

Various assistants of the Resident Engineer

Summary of issues:

The second road is also located in the northern Yemeni Highlands, 115 km northwest of Sana'a and about 12 km east of Hajjah on the main Sana'a-Hajjah road. The visit started from Kholan. The road is composed by four sections as follows

Initial Climb: The road begins at a 3-way junction with Sana'a-Hajjah road and climbs for about half a kilometer with steep vertical alignment which required some safety measures

Cliff Section: After the initial climb, the road runs along a cut ridge with downstream slopes created by road construction, which may create some problems but there is little or no activity below the slopes. Safety parapets are being constructed on the downstream side

Ridgeline Sections: they include long sections of smooth grades and short sections of sharp grades down to wadi floors. Some terraces on lower slopes are damaged.

Descent to Road End: the section descends steep steeply with hairpin bends exposed to high erosion risks. Retaining walls are required in this area.

A.4.2.3 Akamat Al-Ajoud-Mudhaikhira road

The road has been visited twice as follows:

Date of first visit: Friday 10th and Saturday 11th October 2003

Date of second visit: Saturday 18th October 2003

Location: Hodeidah Governorate in the Mountain area

List of attendees of the first visit:

Mr. Ibrahim I. Basalamah, Environmental and Social Science Specialist of RAP CMO

Mr. Ezio Moriondo, Senior Social Scientist, for the Consultant

Mr. Angelo Boccolini, Institutional Specialist, for the Consultant

Dr. Taha Tahir, Ecologist for the Consultant

Mr. Ibrahim Kebsi : Road Engineer for the Consultant

Resident Engineer of the road

Various local leaders

Summary of issues:

The fieldwork has involved visual inspections of the ongoing design and implementation of environmental mitigation measures, especially in erosion control, tree protection, avoidance of damage to scenic landscapes and hydraulic works to preserve water harvesting systems and irrigation supply to the farms intersected by the road alignment.

The themes analyzed and developed by the SEA study team with the local stakeholders can greatly enhance the efficiency and effectiveness of the sub-project EMP disclosure process in the area and similar areas of future sub-projects during Phases II & III of RAP Program.

A Survey and Consultation Card has been filled during the project's environmental evaluation. The following paragraphs summarize the outcome of the visual inspections and local consultation meetings.

Physical Impacts

Borrow pits and quarries

Current impacts. At km 1+850, a big borrow pit exerts a strong visual impact on the landscape (see *picture 2* of the album). Many small quarries and borrow pits are strewn along the first 12 km of the road, where construction works are fairly advanced. Two quarries (at km 5+930 and 10+050), are worth mentioning for their heavy impact on the landscape (*pictures 5 and 6*). The conditions of contract oblige the contractor to restore the borrow areas, after use, to their previous conditions. The size and cost of remediation would be reduced if the borrow pits and quarries were managed by manpower trained or briefed in environmental mitigation work.

Critical aspects. The contractor negotiates with the landowners the use of their soil in the Road Construction Stage. Therefore, borrow pits and quarries are not mentioned in the EIA, EMP and SFA reports, which are prepared in the earlier Feasibility Stage. The three environmental instruments of the project should thus be updated by the contractor and the resident engineer during the works, so as to ensure a sound environmental management of road materials.

Slope stabilization

A retaining structure is needed to consolidate the steep cut between km 4+750 and 5+000 (*picture 3*), where rocks have fallen in the adjacent farm (*picture 4*). Similar situations are found elsewhere along the road and are yet to be dealt with by environmental design.

Water stream

There is a semi-permanent stream at km 12. A water supply pipe runs along the wadi bed conveying drinkable groundwater from the mountains to local villages (*picture 7*). Shallow wells in the wadi bed are used for animal watering (*picture 8*). Stream water is pumped into tanks and transported by lorry to nearby villages for domestic water use (*picture 9*). Stream water flows and hydraulic infrastructures are vital for the villages all around and must be safeguarded. The contractor has not yet a clear idea on how the upgraded road will cross the stream, which in the flood season swells up more than two meters. Streamlining and protection works against scouring and bank erosion are required, with provisions for maintenance.

Narrowing of the road section along a steep watershed line

At km 25+525, on top of a mountain ridge, the existing track runs along a sharp crest straddling the watershed between two steep valleys (*picture 10*). Any carriageway and shoulder complying with minimum rural road standards would entail the through-cut of the whole crest. Even a narrow section would exert adverse visual impacts on the landscape, as the crest is at the center of a vast panoramic view, visible to scores of villages within a range of ten km. Attentive, landscaped road design is needed to trace the alignment in this critical section.

Impact on natural vegetation and wood resources

Cutting of natural trees. Current road works are slightly impacting on the natural vegetation interspersed with the farmlands. It is estimated that not more than 150 spontaneous trees have been felled for road building purposes. At least an equal number of similar trees should be planted in the same or nearby sites at the end of the works.

Residual forest grove. At km 27, the present route traverses, for about 500 meters, a residual natural forest. Here, the upgraded carriageway should be as narrow as possible to avoid damaging the dense wood formation.

Road interference with natural and artificial drainage patterns

Akamat-Mudaykhirah road crosses some 40 seasonal streams, most of them tapped by local farmers for water harvesting and spate irrigation purposes. The project mitigation consists in installing one or more pipe culverts (Ø12", length 12 m) in minor streams and box culverts in major ones. The largest stream, at km 12, will be crossed by a bridge or a battery of four box culverts. These measures are estimated to preserve at least 80% of the water inflow to the farms located downstream of the road embankment. However, the higher plots of the farms - that used to be fed by diffuse runoff - will be exposed to a water deficit after the project. It would be too costly to replace the lost runoff by pumping water from the streams. The final water balance of water harvesting systems downstream of the road is likely to suffer an average loss of 25 to 30%. In fact, the runoff from the carriageway will have a lower volume than the previous diffuse inflow. In general, the net loss will not exceed 25%, equal to the damage quota that the current administrative practice bars from compensation (cf. § 21 of the Agreement). Therefore, the issue will be solved by the Local Framework Agreements (SFA) signed between the farmers and the Government. A clause of the SFA should envisage the levelling of the terrain and the adaptation of the irrigation networks of

those farms that are worse affected by the disruption of water harvesting systems. The levelling is required to redistribute, via adapted networks, the culvert-channelled stream-water to the higher parts of the farms that were previously fed by diffused runoff from the mountain slopes, now intercepted by the higher embankment.

Dumping of road materials in farming areas

Big stones and construction debris fallen in several farms along the road are compensated by the contractor to the landowners. More than 20 hectares of private farmland have been occupied by quarries, temporary deposits of materials, detours and other land-taking project activities. The related compensation issues are being negotiated and solved by the Contractor, as part of the Social Framework Agreement sponsored and overseen by RAP CMO.

Visual impact on landscape

Akamat-Mudaykhirah road traverses beautiful mountain landscapes and crosses characteristic villages that offer good attractions to visitors from the nearby cities of Ta'iz and Ibb. Tourism development authorities classify the zone as having potential for agri- and eco-tourism. For this reason, road works in the second part of the alignment, yet to be designed by the Contractor, should be assisted by a landscape architect, especially along three sections:

the approaches to the large wadi at km 12, amidst lush agricultural and natural vegetation
the serpentine route climbing the steep slopes between km 18 and 21
the crest across the watershed at km 25, for a length of about 600 meters

Decorative plants should be selected from the native flora with the advice of the Forest Department and planted in rows to mitigate the visual impact of fresh road cuts and fills along the sections that enjoy tourism potential.

Social Impacts

Voluntary resettlement at market places

There are five markets along the road, all of them with dozens of shops located on the verge of the current road alignment and presumably in the right of way of the future route, where the final road design is not yet ready. Local traders do not resent the relocation of their shops and do not even intend to claim damages, because they expect their revenues to increase, thanks to the road, beyond the value of lost shops. This is a typical case of applicability of the “voluntary resettlement” principle. The Resettlement Framework Policy worked out as part of the Sector Environmental Evaluation (SEA) of Phase I of the Rural Access Program prescribes that the free contribution of land and other assets to the project be formalized by the Social Framework Agreement (SFA). Therefore, the format of the SFA should be updated to accommodate the voluntary resettlement decisions of local traders (cf. Annex 7, page 11 above).

Environmental awareness of the local population

The communities along Akamat-Mudaykhirah road do not seem to care much about the ecologic impact of road works. The road is their utmost economic priority, with expected benefits – as easier access to the city and better job opportunities - that overwhelm the damage caused to their farms by debris, quarrying, detours and loss of soil or vegetation cover. However, the project beneficiaries should be sensitised on the importance of preserving natural resources and on the fact that they should be the environmental guardians

during road construction. A way to achieve this goal is to make them aware of tourism potentials, as agro-tourism from the nearby urban areas.

Environmental awareness of contractor personnel

The unskilled manpower of the Contractor does not appear to be fully aware of the environmental and social implications of the road works. Even the laborers recruited in the villages along the road display little concern for the safeguard of the resource basis of their communities, with the only possible exception of the loss of spate irrigation water (see § 1.6). Local laborers have not undergone training or briefing sessions on prevention and mitigation measures after their recruitment by the contractor. This undermines or greatly reduces the environmental performance of road-work crews and may even affect negatively the net revenue of the contractor, in case Rap Cmo holds him liable for the poor execution of mitigation works. It is advised that RAP CMO introduce, as part of the Conditions of Contract of the Contractors, the duty to brief the workers on the environmental management of road works. RAP CMO would assist with manpower training, in collaboration with the local authorities and communities.

Gender Issues

The field survey of Akamat-Mudaykhirah road has identified the following gendered concerns:

Water harvesting systems. In the project area, women grow the crops but do not manage irrigation water supply. This is a men's task, mainly fulfilled with water harvesting systems. Road works interfere with such systems in some 60 farms downstream of the new embankment (cf. § 1.6). Even where the consequent water deficit does exceed the 25% threshold that the Government excludes from compensation, safeguards should be introduced, as the building of cisterns, the amelioration of irrigation networks and the levelling of farm soils to ensure a better spread of the reduced water volume. This will directly benefit the female farmers, who can be further assisted by some training in the use of runoff water after its harnessing through the culverts, focusing on the adaptation of old water harvesting methods to the new situation.

Firewood. In local homesteads, women cater for fuel-wood supply. Based on the experience of previous rural access projects, bottled gas is expected to largely replace fuel-wood after road upgrading. However, poor families will continue to rely on wood as the main source of energy. Even affluent families will prefer charcoal to gas for cooking special meals. After the opening of the new road to traffic, therefore, the natural wood cover of the project area will be exposed to higher pressure. More trees are inevitably going to be felled to supply charcoal to the towns. On mid-term, the residual forests will dwindle, unless preventive measures are taken, including reforestation. The Environmental Management Plan should target the creation of nurseries and the transplanting of seedlings on soils unsuitable for farming, with initial watering and protection against grazing animals. Village people, assisted by the Forest Department, may carry out this environmental scheme, benefiting not only rural women, but also the overall ecological balance of the road project.

Road safety. A major women's concern is the protection of children against traffic hazards, especially in built-up areas. The present project envisages mitigation measures, with speed-reducing devices for vehicles and pedestrian crossings in the villages served by the road.

Job opportunities. The women interviewed locally have expressed satisfaction for the employment of their male relatives in the road project. At the same time, they have vented their concern for the temporary nature of such jobs. Some ladies have suggested that the Local Government - through the regional representation of the Ministry of Social Affairs - should assist the temporary workers to seek new job opportunities in the towns after project completion, putting to account the skills acquired when they worked for the Contractor.

Impact on Cultural heritage

Relics from ancient cultures

There is no visible physical cultural resource of archaeological or historical value directly affected by the Akamat-Mudaykhirah road works inside or near the design right of way. So far, no chance finding of relics has been reported in this domain.

Local physical cultural resources

The new rural road may exert adverse impacts, mostly indirect, on the typical local architecture that utilizes crafted rose and yellow stones for structural and decoration purposes, perpetuating old and beautiful building techniques. A few houses built in old style are located within the future right of way of the upgraded road. They deserve protection by narrowing or shifting the alignment in correspondence with them. After the opening of the upgraded road to service, cement will be much cheaper. Shabby concrete constructions will tend to replace old building styles, changing the century-old outlook of the villages and the landscape, now interspersed with fine traditional houses. The Government can help preserving the local architecture by constructing public buildings that respect the customary standards and aesthetic values. This has not been the case with some schools and health centers recently built along the project road. The Ministry of Culture and Tourism can assist the safeguard of local traditions by advising the other public authorities to incorporate the old building lore in the new constructions. The same Ministry can also stimulate, through the media, the awareness about the value of the ancient architecture not only for the owners but also for tourism development and as way to preserve the cultural identity of the local populations.

Graveyards and burial sites

Several cemeteries are located within or close to the design right of way. Special care should be taken to relocate the burials in nearby places complying with the rules of religious law and local traditions, including the record of the names of the buried persons if still remembered.

A.4.2.4 Baadan-Ibb Road

Date: 21st, 22nd and 23rd August 2003

Location: Yemeni Highlands, Ibb Governorate. The road is a gravel road recently upgraded to asphalt road. The pavement was under completion at the moment of the visit.

List of attendees:

Mrs. Hana Hamoud Al-Shami: Social Scientist/Gender Specialist (Yemeni) and a colleague of her;
16 women interviewed

Summary of issues:

In order to generate information about rural women's concern, the Gender Specialist has prepared field questionnaires. 16 women (out of which 5 were widows) have been interviewed. The interviews have revealed the following priorities:

e 1. Participation to road alignment design across settlements, markets and water harvesting areas

- e 2. Pollution and invasion of farmlands by road works and spoil materials (the concern exists also when the contractor pays the damages, because the compensation is cashed by the husband, but the women mainly carry the burden of harder farm works)
- e 3. Decrease of irrigation water supply in damaged runoff harvesting networks
- e 4. Availability of fuel wood after the opening of the road to service
- e 5. Increased job opportunities for the male relatives during the road construction and maintenance periods
- e 6. Displacement of graveyards (this concern is particularly intensive in the littoral lowlands and coastal areas (Tihama))

As traditional local culture does not provide formal channels for the women to express their concerns about road projects, the prevailing female attitude is a high level of confidence in the administrative process at local level, especially through District offices close to the villages, which enable the women to participate to local project management through the elective bodies and other representation facilities. The women have also manifested their interest for a more direct participation to the formulation and execution of the Local Framework Agreements (LFA). The meetings with the female stakeholders have been recorded by the gender specialists of the SEA study team. The results of such meetings have been incorporated in the EMP presented in Chapter 8 of this Report.

* * *

